

9. Kongres farmaceuta Srbije

sa međunarodnim učešćem

9th Serbian Congress of Pharmacy

with international participation

Farmaceuti u vremenu izazova: Snaga znanja, moć promene

Pharmacists in Challenging Times: Empowered by Knowledge, Leading the Change

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Beograd, Srbija, 14-17. 10. 2026.

Zbornik sažetaka

Book of Abstracts

SFUS
Savez farmaceutskih udruženja Srbije

UNIVERZITET U BEOGRADU
Farmaceutski fakultet

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sa međunarodnim učešćem
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Uvodna reč

Intenzivan razvoj nauke i tehnologije, sve složeniji zdravstveni sistemi, nove profesionalne uloge i očekivanja koja se pred nas postavljaju, ubrzano menjaju svet u kome živimo i radimo.

Cilj 9. Kongresa farmaceuta Srbije sa međunarodnim učešćem, koji organizuje Savez farmaceutskih udruženja Srbije u saradnji sa Farmaceutskim fakultetom Univerziteta u Beogradu, je da strateški osnaži farmaceute da na ove izazove odgovore primenom najnovijih naučnih saznanja i zdravstvenih tehnologija, i da budu aktivni nosioci promena u unapređenju zdravstvenog sistema, održivom razvoju profesije i kontinuiranom profesionalnom i ličnom razvoju.

Pod sloganom „*Farmaceuti u vremenu izazova – snaga znanja, moć promene*", u skladu sa prepoznatim izazovima u farmaceutskoj nauci i praksi, Naučni program Kongresa koncipiran je kroz pet tematskih oblasti: *Personalizovano*, *Inovativno*, *Digitalizovano*, *Održivo* i *Profesionalno*. U okviru 24 tematske sesije predstavljena su najnovija naučna dostignuća, kao i njihove praktične implikacije, u cilju unapređenja profesionalne prakse, poboljšanja zdravstvenih ishoda pacijenata, očuvanja javnog zdravlja i ukupne dobrobiti stanovništva.

Zbornik obuhvata 300 sažetaka prihvaćenih za prezentaciju u okviru 9. Kongresa farmaceuta Srbije, uključujući jedno uvodno predavanje, tri plenarna predavanja (PL), 74 predavanja po pozivu (PP), 29 usmenih saopštenja (US), pet prezentacija projekata (PRO) i 188 poster prezentacija (P).

Veliku zahvalnost dugujemo svim članovima Naučnog odbora 9. Kongresa farmaceuta Srbije na izuzetnom angažovanju i timskom radu u osmišljavanju i izboru tema i predavača, recenziranju pristiglih sažetaka i moderiranju pojedinačnih sesija.

Ispred Naučnog odbora 9. Kongresa farmaceuta Srbije i Saveza farmaceutskih udruženja Srbije, zahvaljujemo se svim predavačima i autorima poster prezentacija na njihovom učešću i doprinosu uspehu Kongresa.

Srdačno,

prof. dr Jelena Parojčić
predsednica Naučnog odbora

prof. dr Branislava Miljković
predsednica Saveza farmaceutskih udruženja Srbije

Editorial

Intensive development of science and technology, increasingly complex health systems, and the new professional roles and expectations placed before us are rapidly changing the world in which we live and work.

The aim of the 9th Congress of Pharmacists of Serbia with International Participation, organized by the Pharmaceutical Association of Serbia in cooperation with the Faculty of Pharmacy, University of Belgrade, is to strategically empower pharmacists to respond to these challenges by applying the latest scientific knowledge and health technologies, and to become active agents of change in improving the health system, ensuring sustainable development of the profession, and pursuing continuous professional and personal growth.

*Under the slogan "*Pharmacists in Challenging Times: Empowered by Knowledge, Leading the Change*", in line with the recognized challenges in pharmaceutical science and practice, the Scientific Programme is organized around five thematic areas:* Personalized, Innovative, *Digitalized,* Sustainable, *and* Professional. *Across 24 thematic sessions, the latest scientific achievements are presented together with their practical implications, with the goal of improving professional practice, enhancing patient health outcomes, protecting public health, and promoting the overall well-being of the population.*

The Book of Abstracts comprises 300 abstracts accepted for presentation at the 9th Congress of Pharmacists of Serbia, including one introductory lecture, three plenary lectures (PL), 74 invited lectures (PP), 29 oral presentations (US), five project presentations (PRO), and 188 poster presentations (P).

We are grateful to all members of the Scientific Committee for their commitment and teamwork in designing the Scientific Programme, reviewing submitted abstracts, and moderating scientific sessions.

On behalf of the Scientific Committee of the 9th Congress of Pharmacists of Serbia and the Pharmaceutical Association of Serbia, we thank all speakers and poster authors for their participation and their contribution to the success of the Congress.

Sincerely,

Prof. Jelena Parojčić
President of the Scientific Committee

Prof. Branislava Miljković
President of the Pharmaceutical Association of Serbia

Organizator / *Organizer*

Savez farmaceutskih udruženja Srbije / *Pharmaceutical Association of Serbia*

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Uvodno predavanje
Keynote lecture

PHARMACY IN CHALLENGING TIMES

M. Henman
Trinity College Dublin, Dublin, Ireland

Pharmacists use their knowledge, skills and expertise to support patients and society in meeting their medicine needs. However, a detailed knowledge of medicines together with skills such as medication reconciliation and review are not sufficient to justify the privilege of professional recognition. It is the expert judgement and the independent analysis of the options with which the patient and society are faced that makes a valued professional. And it is the collective contribution of all pharmacists, whatever their role, that makes them an essential member of the healthcare team.

Healthcare faces both unprecedented challenges and extraordinary opportunities. Among the challenges are familiarity with medicines and with professionals - this has led to ignoring the risks of medicines and a demand for convenience rather than the assessment and advice of a medicines expert. Closely associated with this is the prioritisation of wants over needs which focuses on availability today instead of considering good health in the longer term.

Responses to the challenges must derive from professional values, evidence, advocacy and patience. Pharmacy should aim to establish that the provision of every medicine is treated as a process of patient care not of customer supply; that pharmacists are collaborative and are entrusted with the care of medicines for health services and for public health; that through competency-based education followed by advanced practice and specialisation, pharmacists will contribute to strengthening health services and that consistent advocacy for sustainable pharmacy services to meet patient's needs will result in improved health outcomes.

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Plenarna predavanja
Plenary lecures

PL1 HYBRID CARE READINESS: THE CHALLENGE OF THE COMMUNITY PHARMACY

C. Rijcken[1,2,3]
[1]Founder & CEO Pharmovate, [2]Founder Pharmi, [3]Associate Professor Digital Pharmaceutical Care University of Utrecht, Utrecht, the Netherlands

Community pharmacies across Europe face converging pressures: workforce shortages, growing numbers of patients with chronic conditions, and constrained budgets. Digitalisation offers a way to keep pharmaceutical care accessible by combining digital and physical touchpoints into one continuous care pathway: hybrid care — digital where possible, human where needed.

This lecture explores how digitalisation is reshaping the patient experience and expanding pharmacy-led care into the home. Specific technologies are illustrated, including app-based digital care pathways for first-dispensing counselling, anticoagulant (DOAC) guidance and opioid tapering; conversational AI and digital human avatars answering medication questions 24/7; tele-pharmacy consultations; electronic product information (ePI); AI-supported medication reviews; and agentic AI that autonomously handles drug shortages and telephone triage.

European reimbursement pathways that accelerate adoption are discussed, such as Germany's DiGA scheme and France's PECAN pathway for prescribed digital health applications, alongside the European Health Data Space, which will give patients and pharmacists cross-border access to electronic prescriptions and dispensation data.

Drawing on more than seven years of hybrid pharmaceutical care practice in the Netherlands, the lecture provides a practical overview of what is available today and a grounded three-to-five-year outlook on how the community pharmacy may transform into a hybrid care organisation. Some focused ethical aspects — human oversight, digital inclusion and accountability under the EU AI Act — and an interactive discussion anchor the session.

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PL2 NOVEL APPROACHES FOR PHARMACISTS TO ENSURE RESPONSIVENESS TOWARDS PATIENTS AND PROFESSIONALS WHEN COMMUNICATING

S. Kaae
Department of Pharmacy, University of Copenhagen, Denmark

Due to the increase in the role of pharmacists in society contributing to optimal medicines use, communication between pharmacists and patients – likewise between pharmacists and other health professionals, is of increasing importance. To optimally support pharmacists in this process, the lecture will cover 20 years of pharmacy communication research in Denmark.

This research has firstly illustrated the necessity of person-centered approaches to communication in pharmacy practice. Secondly, the research has demonstrated how collaborative research-practice efforts can lead to new daily, satisfying communication practices. As a result of such efforts, the person-centered communication initiative of 'Mentalizing' is covered, which has been applied in Denmark and the Netherlands is presented. The technique is based on psychological theory, including theory of emotions, and is relevant across various pharmacy settings with either patients or professionals. Other research-based techniques to enhance person-centered counseling, such as Question Prompt Lists, will also be presented.

PL3 KAKO TERANOSTIČKE NANOČESTICE POSTAJU NOVI LEKOVI: DIZAJN VOĐEN BUDUĆOM KLINIČKOM PRIMENOM

J. Janjić
School of Pharmacy, Duquesne University, Sjedinjene Američke Države

Razvoj klinički značajnih teranostičkih lekova ne počinje od nanočestice, već od kliničke potrebe, željenog biološkog odgovora i osobina koje lek mora da ima da bi zaista koristio pacijentu. U ovom predavanju predstaviću filozofiju dizajna koja objedinjuje terapijsku i dijagnostičku funkciju kako bi se razvili lekovi koji precizno modulišu imunski odgovor, a istovremeno pružaju objektivne biološke informacije koje usmeravaju personalizovano lečenje i produbljuju naše razumevanje mehanizama bolesti. Koristeći primere iz našeg rada u oblasti terapije bola i regenerativne medicine, pokazaću kako je ovaj pristup vodio razvoju teranostičkih lekova, uz naglasak da uspešan prenos u kliničku praksu zahteva da se bezbednost, mogućnost proizvodnje, reproduktivnost, skalabilnost, pristupačnost i dostupnost planiraju od samog početka razvoja. Integracijom imunomodulacije, kvantitativnog molekularnog snimanja i proizvodnje zasnovane na principima *Quality by Design*, teranostička nanomedicina može prerasti iz inovativne tehnologije u praktične lekove koji unapređuju lečenje pacijenata i otvaraju nove mogućnosti za razvoj budućih terapija.

Zahvalnica
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PL3 HOW THERANOSTIC NANOPARTICLES BECOME NEW MEDICINES: DESIGN GUIDED BY FUTURE CLINICAL APPLICATION

J. Janjić
School of Pharmacy, Duquesne University, United States of America

Designing clinically meaningful theranostic medicines begins not with the nanoparticle itself, but with the unmet clinical need, the desired biological response, and the medicine patients ultimately require. In this lecture, I will present a design philosophy that integrates therapeutic and imaging functions to create medicines that not only precisely modulate immune responses but also provide objective biological feedback to guide personalized treatment and deepen our understanding of disease mechanisms. Using examples from our work in pain medicine and regenerative medicine, I will illustrate how this philosophy has guided the development of theranostic medicines while demonstrating that successful translation requires safety, manufacturability, reproducibility, scalability, affordability, and accessibility to be considered from the earliest stages of development. By integrating immune modulation, quantitative imaging, and quality-by-design manufacturing into a single development strategy, theranostic nanomedicines can evolve beyond innovative technologies into practical medicines that improve patient care while advancing our understanding of human disease.

Acknowledgement
NIH, CDMRP, USAF, NAMRU, and ARPA-H have funded the collaborative multidisciplinary work of Dr. Janjic and her team since 2014. Laboratory link: https://www.duq.edu/research/faculty-research/nanomedicine-lab/index.php

Sesija 1
Session 1

Biološki lekovi u eri precizne medicine: razvoj, primena i optimizacija

Biologics in the era of precision medicine: Development, application and optimisation

Biološki lekovi u eri precizne medicine: razvoj, primena i optimizacija

Biološki lekovi su tokom poslednjih decenija redefinisali terapiju inflamatornih, autoimunskih i malignih bolesti. Ova sesija prati njihov put — od razvoja, preko formulacije u stabilne farmaceutske proizvode, do njihove kliničke primene i optimizacije doziranja. Posebna pažnja biće posvećena iskustvima sa biološkom terapijom reumatoidnog artritisa i inflamatornih bolesti creva, kao primerima kontinuiteta između istraživanja i svakodnevne kliničke prakse. Sesija povezuje farmaceutsku nauku i kliničku praksu u zajedničkom cilju: preciznija, efikasnija i bezbednija terapija za svakog pacijenta.

Biologics in the era of precision medicine: Development, application and optimisation

Over the past decades, biologics have redefined the treatment of inflammatory, autoimmune, and malignant diseases. This session follows their journey — from the development of monoclonal antibodies, through the formulation of protein drugs into stable pharmaceutical products, to their clinical application and dosing optimization. Special attention will be given to experience with biologic therapy in rheumatoid arthritis and inflammatory bowel disease, as examples of the continuum between research and everyday clinical practice. Bringing together pharmaceutical science and clinical practice, the session shares a common goal: more precise, effective, and safer therapy for every patient.

PP1.1. RAZVOJ TERAPIJSKIH MONOKLONSKIH ANTITELA: OD INHIBICIJE CITOKINA DO INOVATIVNIH IMUNOMODULATORNIH STRATEGIJA

Z. Stojić-Vukanić
Univerzitet u Beogradu – Farmaceutski fakultet, Beograd, Srbija

Monoklonska antitela (mAt) u okviru grupe bioloških lekova predstavljaju jednu od oblasti koja se najbrže razvija, zahvaljujući značajnom napretku u molekularnoj imunologiji i proteinskom inženjerstvu. Tokom 2025. godine, regulatorne agencije širom sveta odobrile su 19 novih mAt. Primena mAt je suštinski unapredila terapiju imunski posredovanih bolesti preciznim ciljanjem citokina i njihovih receptora značajnih u održavanju hronične inflamacije, uključujući TNF, IL-6, IL-1, IL-17, IL-12/IL-23p40 i IL-23p19, kao i putem deplecije B-ćelija, modulacije T-ćelija i inhibicije migracije leukocita. Uprkos značajnom kliničkom uspehu, njihova primena i dalje je ograničena pojavom primarnog izostanka odgovora i stečene rezistencije. Podstaknuta dostignućima imunoterapije malignih bolesti, ova oblast se dalje usmerava ka razvoju nove generacije terapija zasnovanih na antitelima, koje preciznije reprogramiraju imunski sistem u cilju eliminacije patogenih imunskih ćelija i obnavljanja imunološke tolerancije. Među ključnim strategijama izdvajaju se Fc inženjering u cilju pojačane interakcije sa inhibitornim receptorima B-ćelija, uklanjanje autoantitela blokiranjem neonatalnog Fc receptora, kao i agonističko ciljanje PD-1 i CTLA-4 radi ponovnog uspostavljanja imunološke tolerancije. Bispecifična/multispecifična antitela i konjugati antitela i lekova blokiranjem sinergističkih citokinskih puteva ili selektivnom deplecijom patogenih limfocita dodatno obezbeđuju veću preciznosti. Ovaj koncept dalje je proširen adoptivnim ćelijskim terapijama, pri čemu CAR T-ćelije ciljaju autoreaktivne B ćelije, dok CAR Treg ćelije doprinose ponovnom uspostavljanju imunske regulacije. Rani rezultati kliničkih ispitivanja kod sistemskog eritemskog lupusa, reumatoidnog artritisa i mijastenije gravis, ukazuju na značajan terapijski potencijal ovih strategija koje bi u budućnosti mogle da budu prekretnica u lečenju imunski posredovanih bolesti, otvarajući put ka preciznoj, personalizovanoj i dugotrajnoj terapijskoj kontroli bolesti.

PP1.1. THE DEVELOPMENT OF THERAPEUTIC MONOCLONAL ANTIBODIES HAS PROGRESSED FROM SIMPLE INHIBITION OF CYTOKINES TO INNOVATIVE IMMUNOMODULATORY STRATEGIES

Z. Stojić-Vukanić
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The monoclonal antibody (mAb) sector is among the fastest-growing areas in biopharmaceuticals, driven by advances in molecular immunology and protein engineering. In 2025, regulators worldwide granted first marketing approval to 19 mAbs while 209 candidates in late-stage development may enter regulatory review by the end of 2026. mAbs have transformed the treatment of immune-mediated diseases by precisely targeting cytokines and their receptors that drive chronic inflammation, including TNF, IL-6, IL-1, IL-17, IL-12/IL-23p40, and IL-23p19, as well as by depleting B cells, modulating T cells, and blocking leukocyte trafficking. Despite their great clinical success, limitations remain, including primary non-response, and acquired resistance. Inspired by advances in cancer immunotherapy, the field is shifting toward next-generation antibody-based strategies that more precisely reprogram the immune system to eliminate pathogenic immune cells, and restore tolerance. Key strategies include Fc engineering to enhance engagement with inhibitory B-cell receptors, neonatal Fc receptor blockade to promote autoantibody clearance, and agonistic targeting of PD-1 and CTLA-4 to restore immune tolerance. Bispecific/multispecific antibodies and antibody-drug conjugates add precision by blocking synergistic cytokine pathways or selectively depleting pathogenic lymphocytes. Cellular therapies extend this approach, with CAR T cells targeting autoreactive B cells and CAR Tregs re-establishing immune regulation. Early clinical trial results in systemic lupus erythematosus, rheumatoid arthritis, and myasthenia gravis highlight the substantial therapeutic potential of these strategies, which may represent a future turning point in the treatment of immune-mediated diseases by paving the way for precise, personalized, and durable disease control.

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PP1.2. BIOLOŠKI LEKOVI I TERAPIJA REUMATOIDNOG ARTRITISA: ČETVRT VEKA (NE)ISPUNJENIH OČEKIVANJA

U. Pecikoza
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Reumatoidni artritis (RA) je česta hronična inflamatorna bolest sinovijalnih zglobova, koja dovodi do njihovog trajnog strukturnog i funkcionalnog oštećenja. Posledično, RA je povezan sa značajnim narušavanjem funkcionalnosti i kvaliteta života pacijenata, ali i povećanom stopom mortaliteta. Značajan napredak u lečenju RA učinjen je sa uvođenjem antireumatika koji modifikuju tok bolesti (ARMB), lekova koji sprečavaju nastanak oštećenja zglobova, i poboljšavaju kvalitet života i dugotrajnu prognozu pacijenata. Iako je prema većini stručnih preporuka metotreksat (konvencionalni ARMB) lek prvog izbora za započinjanje lečenja RA, biološki lekovi su postali nezaobilazan deo terapije RA, naročito kod pacijenata koji ne uspeju da postignu kontrolu bolesti primenom konvencionalnih ARMB. Prvi biološki ARMB odobreni za lečenje RA su bili usmereni ka neutralizaciji efekata TNF-α (anti-TNF-α lekovi), i oni danas predstavljaju najkorišćeniju grupu bioloških ARMB. Dostupne su i druge klase bioloških ARMB usmerene prema smanjenju patoloških efekata drugih citokina (IL-6 i IL-1), kao i funkcije B- ili T-limfocita. Zahvaljujući upotrebi bioloških ARMB postizanje dugotrajne remisije RA (i smanjenje rizika od trajnog oštećenja zglobova i komplikacija) je postalo realnost za mnoge pacijente. Uprkos ovim naprecima, kod značajnog broja pacijenata RA ostaje nekontrolisan i pored primene bioloških ARMB, što stvara potrebu za razvojem novih ili optimizacijom upotrebe postojećih lekova. Takođe, sa uvođenjem bioloških ARMB pojavili su se novi izazovi u lečenju RA, poput imunogenosti ovih lekova (stvaranje neutrališućih anti-lek antitela) i specifičnih rizika povezanih sa njihovom upotrebom (povećan rizik od ozbiljnih infekcija i reaktivacije latentnih infekcija). Na kraju, dostupnost bioloških ARMB je i dalje ograničena, kao posledica njihove relativno visoke cene.

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PP1.2. BIOLOGIC DRUGS AND THE TREATMENT OF RHEUMATOID ARTHRITIS: A QUARTER CENTURY OF (UN)MET EXPECTATIONS

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Rheumatoid arthritis (RA) is a common chronic inflammatory disease of synovial joints, which leads to their permanent structural and functional damage. Consequently, RA is associated with significant impairment of patient functionality and quality of life, and increased mortality. Significant progress in the treatment of RA was made with the introduction of disease-modifying antirheumatic drugs (DMARD), which prevent joint damage, improve the quality of life and the long-term prognosis of patients. Although according to most expert recommendations, methotrexate (conventional DMARD) is the drug-of-choice for starting RA treatment, biological drugs have become an indispensable part of RA therapy, especially in patients who fail to achieve disease control using conventional DMARDs. The first biologic DMARDs approved for the treatment of RA targeted TNF-α (anti-TNF-α drugs), and they represent the most widely used group of biologic DMARDs today. Other classes of biologic DMARDs are also available, and they target other cytokines (IL-6 and IL-1), and B- or T-lymphocyte function. The use of biologic DMARDs has made achieving long-term RA remission (which reduces the risk of permanent joint damage and complications) a reality for many patients. Regardless of these advances, RA remains uncontrolled in a significant number of patients despite the use of biologic DMARDs, creating a need to develop new or optimize the use of existing biologics. Also, with the advent of biologic DMARDSs, new challenges have appeared in the treatment of RA, such as the immunogenicity of these drugs (appearance of neutralizing anti-drug antibodies) and specific risks associated with their use (increased risk of serious infections and reactivation of latent infections). Finally, the availability of biologic DMARDs is still limited due to their relatively high cost.

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PP1.3. FORMULACIJA PROTEINSKIH LEKOVA: 3PREVOĐENJE BIOLOŠKI AKTIVNIH SUPSTANCI U STABILNE FARMACEUTSKE PROIZVODE

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Klinički uspeh proteinske terapije zavisi od transformacije inherentno nestabilnih, biološki aktivnih makromolekula u robusne farmaceutske proizvode sa prihvatljivim rokom trajanja i profilima bezbednosti. Za razliku od lekova malih molekula, proteini su podložni višestrukim fizičkim i hemijskim putevima razgradnje – uključujući agregaciju, deamidaciju, oksidaciju i denaturaciju – što može ugroziti efikasnost i izazvati imunogenost. Ovaj apstrakt opisuje osnovne izazove i strateške pristupe u razvoju formulacije proteina.

Uspešna formulacija zahteva duboko razumevanje konformacione stabilnosti i kinetike razgradnje proteina pod različitim uslovima stresa (termički, mehanički i međupovršinski). Ključni parametri formulacije uključuju izbor puferskih sistema za održavanje optimalnog pH (obično 5–7), dodavanje stabilizatora kao što su šećeri (trehaloza, saharoza) i polioli za preferencijalnu hidrataciju površine proteina i uključivanje surfaktanata (polisorbat 20 ili 80) za sprečavanje adsorpcije i agregacije na međupovršinama. Za tečne formulacije, optimizacija jonske jačine i korišćenje antioksidanata (npr. metionina) ublažavaju hemijsku degradaciju. Kada je stabilnost tečnih formulacija kompromitovana, primenjuju se liofilizacija ili sušenje raspršivanjem koji omogućuju stabilizaciju i formulisanje amorfnih čvrstih oblika, iako oni zahtevaju pažljiv izbor pomoćnih supstanci (sredstva za dopunjavanje, lio- i krioprotektanti) i optimizaciju ciklusa kako bi se sačuvala nativna struktura tokom zamrzavanja i sušenja.

Formulacije visoke koncentracije (>100 mg/ml) potrebne za supkutanu primenu nameću dodatne izazove u pogledu regulisanja viskoznosti i reverzibilne samoasocijacije. Integracijom analitičkih alata (*size-exclusion* hromatografija, dinamičko rasejanje svetlosti, FTIR i nano-DSF) sa racionalnim dizajnom pomoćnih supstanci, mogu se pouzdano postići stabilni, bezbedni i efikasni proteinski lekovi.

PP1.3. PROTEIN DRUG FORMULATION: CONVERTING BIOLOGICALLY ACTIVE SUBSTANCES INTO STABLE PHARMACEUTICAL PRODUCTS

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The clinical success of protein therapy depends on transforming inherently unstable, biologically active macromolecules into robust pharmaceutical products with acceptable shelf life and safety profiles. Unlike small-molecule drugs, proteins are susceptible to multiple physical and chemical degradation pathways – including aggregation, deamidation, oxidation, and denaturation – which can compromise efficacy and trigger immunogenicity. This abstract describes the core challenges and strategic approaches in protein formulation development.

Successful formulation requires a deep understanding of conformational stability and protein degradation kinetics under various stress conditions (thermal, mechanical, and interfacial). Key formulation parameters include the choice of buffer systems to maintain optimal pH (typically 5–7), the addition of stabilizers such as sugars (trehalose, sucrose) and polyols for preferential hydration of the protein surface, and the inclusion of surfactants (polysorbate 20 or 80) to prevent adsorption and aggregation at interfaces. For liquid formulations, optimization of ionic strength and the use of antioxidants (e.g., methionine) mitigate chemical degradation. When the stability of liquid formulations is compromised, lyophilization or spray drying is applied, enabling stabilization and formulation into amorphous solid forms, although these require careful selection of excipients (bulking agents, lyo- and cryoprotectants) and cycle optimization to preserve the native structure during freezing and drying.

High-concentration formulations (>100 mg/ml) required for subcutaneous administration impose additional challenges in terms of viscosity control and reversible self-association. By integrating analytical tools (size-exclusion chromatography, dynamic light scattering, FTIR, and nano-DSF) with rational excipient design, stable, safe, and effective protein drugs can be reliably achieved.

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PP1.4. OD PODATAKA DO KLINIČKE ODLUKE: OPTIMIZACIJA DOZIRANJA MONOKLONSKIH ANTITELA U TERAPIJI INFLAMATORNIH BOLESTI CREVA

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Monoklonska antitela (mAb) predstavljaju ključne terapijske opcije u lečenju umerenih do teških formi inflamatornih bolesti creva (IBD). Međutim, izražena inter- i intra-individualna farmakokinetička varijabilnost često dovodi do suboptimalnog terapijskog odgovora. Reaktivni terapijski monitoring lekova (TDM) se trenutno preporučuje, posebno kod anti-TNF terapije, i predstavlja važan korak ka optimizaciji lečenja. Ipak, tradicionalni pristup u donošenju odluka o doziranju ne omogućava pouzdano predviđanje izloženosti leku pred narednu dozu i terapijski odgovor. Cilj istraživanja u okviru optYmAb projekta bio je korišćenje kliničkih i TDM podataka za razvoj farmakometrijskih modela mAb kod pacijenata sa IBD. U istraživanju su korišćeni podaci pacijenata lečenih u Univerzitetskom kliničko-bolničkom centru „Zvezdara". Analiza podataka sprovedena je korišćenjem NONMEM softvera (ver. 7.6). Analize su obuhvatile razvoj novih populacionih farmakokinetičkih modela bioloških lekova korišćenjem prethodnih saznanja, uz kvantitativno ispitivanje izvora farmakokinetičke varijabilnosti. Dodatno, uspostavljene su povezanosti parametari izloženosti leka i povoljnih terapijskih ishoda, uključujući endoskopsku remisiju. Implementacija farmakometrijskih modela u TDM omogućava prelazak sa reaktivnog na prediktivni pristup doziranju bioloških lekova kod IBD paciejnata. Integracijom individualnih karakteristika pacijenta, parametara bolesti i farmakokinetičkih podataka, ovi modeli imaju potencijal da unapred predvide izloženost leku i verovatnoću terapijskog odgovora, čime se omogućava preciznije, proaktivno i individualizovano donošenje terapijskih odluka u rutinskoj kliničkoj praksi.

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PP1.4. FROM DATA TO CLINICAL DECISION: OPTIMIZATION OF MONOCLONAL ANTIBODY DOSING IN INFLAMMATORY BOWEL DISEASES

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Monoclonal antibodies (mAbs) are key therapies for moderate-to-severe inflammatory bowel disease (IBD). However, substantial inter- and intraindividual pharmacokinetic variability often leads to suboptimal treatment outcomes. Reactive therapeutic drug monitoring (TDM) is currently recommended, particularly for anti-TNF therapies, and represents an important step toward treatment optimization. Nevertheless, the traditional approach to dosing decisions does not enable reliable prediction of drug exposure before the next dose or future therapeutic response. The aim of the research conducted within the optYmAb project was to utilize clinical and TDM data for the development of pharmacometric models of mAbs in patients with IBD. Real-world data from patients treated at the University Clinical Hospital Center "Zvezdara" were used. Data analysis was performed using NONMEM (ver.7.6). The analyses included development of new population pharmacokinetic models of biologic drugs using prior knowledge, together with quantitative investigation of sources of pharmacokinetic variability. In addition, exposure-response analyses demonstrated associations between drug exposure and favorable therapeutic outcomes, including endoscopic remission, were established. Implementation of pharmacometric models into TDM enables a transition from a reactive to a predictive approach in biologic dosing for IBD patients. By integrating individual patient characteristics, disease-related parameters, and pharmacokinetic data, these models have the potential to predict future drug exposure and probability of therapeutic response, thereby enabling more precise, proactive, and individualized therapeutic decision-making in routine clinical practice.

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Sesija 2
Session 2

Digitalizacija u farmaceutskoj praksi

Pharmacy practice digitalisation

Digitalizacija u farmaceutskoj praksi

U okviru sesije prikazane su aktuelne teme vezane za digitalizaciju zdravstvenog sistema Srbije, unapređenja i dostignuća u poslednjih nekoliko godina, kao i glavni izazovi. Istaknuta je uloga farmaceuta u digitalnoj transformaciji zdravstva, uključujući rezultate istraživanja u okviru kojeg je procenjivana njihova pismenost u oblasti korišćenja digitalnih zdravstvenih tehnologija, uključujući mobilne aplikacije za podršku pacijentima u kontroli bolesti, kao i digitalne platforme za komunikaciju sa drugim zdravstvenim profesionalcima i pacijentima.

Pharmacy practice digitalisation

In this session, current topics related to the Serbian healthcare system digitalisation, improvements and achievements in the recent years are presented, as well as the main challenges. The role of pharmacists in healthcare digital transformation is highlighted, including the research data obtained through a study assessing their literacy in the field of the digital health technologies usage, including mobile applications to support patients in disease control, and digital platforms for communication with other health professionals and patients.

PP2.1. OD FRAGMENTISANIH PODATAKA KA DIGITALIZACIJI U ZDRAVSTVENOM SISTEMU: KOLIKO JE SRBIJA NAPREDOVALA?

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Digitalna transformacija zdravstva više nije samo tehnološko pitanje, već važan sistemski preduslov za kvalitetniju, bezbedniju i efikasniju zdravstvenu zaštitu, bolje upravljanje resursima i donošenje odluka zasnovanih na podacima. Ovaj rad prikazuje promene u zrelosti zdravstvenog informacionog sistema (ZIS) u Srbiji na osnovu dve nacionalne procene sprovedene 2021. i 2024. godine, primenom standardizovanog alata *Health Information Systems Stages of Continuous Improvement* (SOCI). Procena obuhvata pet ključnih domena: rukovođenje i upravljanje, upravljanje resursima i radnom snagom, informaciono-komunikacione tehnologije, standarde i interoperabilnost, kao i kvalitet i korišćenje podataka. Rezultati pokazuju značajan napredak u relativno kratkom periodu. Ukupna ocena zrelosti HIS-a porasla je sa 1,6 u 2021. na 2,5 u 2024. godini, uz poboljšanja registrovana u svim posmatranim domenima. Ovakav pomak ukazuje na ubrzavanje digitalne transformacije zdravstvenog sistema Srbije, ali istovremeno pokazuje da sistem još nije dostigao nivo pune funkcionalnosti, integrisanosti i interoperabilnosti. Posebni izazovi ostaju u daljem povezivanju informacionih sistema, unapređenju infrastrukture, standardizaciji podataka, razvoju digitalnih kompetencija zdravstvenih profesionalaca i sistematskom korišćenju podataka u kliničkom radu, upravljanju i planiranju. Za farmaceutsku praksu, razvoj interoperabilnog digitalnog ekosistema otvara prostor za bezbednije propisivanje i primenu lekova, bolji uvid u terapiju pacijenata, praćenje ishoda i racionalniju farmakoterapiju. Kontinuirano praćenje zrelosti HIS-a zato predstavlja važan instrument za usmeravanje budućih politika digitalnog zdravlja u Srbiji.

PP2.1. FROM FRAGMENTED DATA TO DIGITAL HEALTHCARE: HOW FAR HAS SERBIA PROGRESSED?

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Digital transformation in healthcare is no longer merely a technological issue, but an important prerequisite for improving the quality, safety, and efficiency of healthcare delivery, strengthening resource management, and supporting data-driven decision-making. This paper presents changes in the maturity of Serbia's health information system (HIS) based on two national assessments conducted in 2021 and 2024 using the standardized *Health Information Systems Stages of Continuous Improvement* (SOCI) tool. The assessment covers five key domains: leadership and governance, management and workforce, information and communication technology, standards and interoperability, and data quality and use. The findings demonstrate substantial progress over a relatively short period. The overall HIS maturity score increased from 1.6 in 2021 to 2.5 in 2024, with improvements observed across all assessed domains. This progress indicates accelerating digital transformation within Serbia's health system, while also showing that the system has not yet reached full functionality, integration, and interoperability. Key challenges remain, including further integration of information systems, strengthening of infrastructure, data standardization, development of digital competencies among healthcare professionals, and systematic use of data in clinical practice, management, and planning. For pharmaceutical practice, the development of an interoperable digital health ecosystem creates opportunities for safer prescribing and medication use, improved insight into patients' pharmacotherapy, better monitoring of outcomes, and more rational use of medicines. Continuous monitoring of HIS maturity therefore represents an important instrument for guiding future digital health policies in Serbia.

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PP2.2. ULOGA FARMACEUTA U OBLASTI UPOTREBE DIGITALNIH ZDRAVSTVENIH TEHNOLOGIJA I PODRŠKA PACIJENTIMA

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Digitalne zdravstvene tehnologije (DZT) postaju sastavni deo farmaceutske prakse, a farmaceuti u javnim apotekama, zahvaljujući neposrednom kontaktu sa pacijentima, imaju značajnu ulogu u njenoj primeni, posebno kod pacijenata sa hroničnim bolestima kao što je dijabetes. Cilj rada bio je da se proceni opšta digitalna pismenost i pismenost u oblasti upotrebe DZT (DHTL) kod farmaceuta u javnim apotekama u Srbiji, kao i stavovi i iskustva u vezi sa primenom digitalnih tehnologija i mobilnih aplikacija za pacijente sa dijabetesom. Istraživanje je sprovedeno na uzorku od 368 farmaceuta (89,1% ženskog pola; prosečno radno iskustvo 13,9 ± 9,8 godina). Srednji ili visok nivo opšte digitalne pismenosti imalo je oko 85% ispitanika, dok je isti nivo DHTL zabeležen kod 64% (35,9% nizak DHTL), što ukazuje da opšte digitalne veštine ne garantuju spremnost za primenu DZT u praksi. Preferencije u edukaciji zavisile su od nivoa DHTL – niži nivo je pratila sklonost ka edukaciji uživo, a viši ka samostalnom online učenju. Iako je 89,4% farmaceuta procenilo da su pacijenti sa dijabetesom zainteresovani za mobilne aplikacije, svega 15,8% bilo je upoznato sa aplikacijama za samoupravljanje ovom bolešću, a samo 4,9–5,2% pružalo je aktivnu podršku pacijentima u njihovoj upotrebi, pri čemu je viši DHTL povezan sa značajno većom informisanošću (p = 0,02). Čak 92,1% ispitanika podržalo je uvođenje zvaničnih smernica za primenu ovih aplikacija u praksi. Rezultati ukazuju na jaz između digitalne osposobljenosti farmaceuta i njene primene u radu sa pacijentima sa dijabetesom, što nameće potrebu za ciljanim edukativnim programima i smernicama za primenu digitalnih tehnologija u praksi.

Zahvalnica
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PP2.2. THE ROLE OF PHARMACIST IN THE FIELD OF USE OF DIGITAL HEALTH TECHNOLOGIES AND PATIENT SUPPORT

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Digital health technologies (DHT) are becoming an integral part of pharmacy practice, and community pharmacists, owing to their direct contact with patients, play a significant role in its implementation, particularly among patients with chronic conditions such as diabetes. The aim of this study was to assess general digital literacy and Digital Health Technology Literacy (DHTL) among community pharmacists in Serbia, and to examine their attitudes and experiences regarding digital technologies and mobile applications for patients with diabetes. The study included 368 pharmacists (89.1% female; mean work experience 13.9 ± 9.8 years). A medium or high level of general digital literacy was found in about 85% of participants, whereas the same level of DHTL was recorded in only 64% (35.9% low DHTL), indicating that general digital skills do not guarantee readiness for DHT use in practice. Educational preferences differed by DHTL level: lower DHTL favoured in-person training, higher DHTL favoured self-paced online learning. Although 89.4% of pharmacists estimated that patients with diabetes were interested in mobile applications, only 15.8% were familiar with applications for diabetes self-management, and only 4.9–5.2% actively supported patients in their use, with higher DHTL associated with greater awareness (p = 0.02). As many as 92.1% of respondents supported the introduction of official guidelines for the use of these applications in practice. The results indicate a gap between pharmacists' digital competence and its application in caring for patients with diabetes, highlighting the need for targeted education and guidelines to support the implementation of digital technologies in practice.

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Sesija 3
Session 3

Farmaceuti u prevenciji i kontroli antimikrobne rezistencije

Pharmacists in the prevention and control of antimicrobial resistance

Farmaceuti u prevenciji i kontroli antimikrobne rezistencije

Rastuća antimikrobna rezistencija predstavlja jedan od najvećih globalnih zdravstvenih izazova. Neracionalna i neadekvatna primena antibiotika doprinosi nastanku i širenju rezistentnih mikroorganizama, što ima značajne posledice po efikasnost terapije, bezbednost pacijenata i održivost zdravstvenih sistema.

U okviru ove sesije predstavljene su preporuke ekspertske grupe Evropske asocijacije bolničkih farmaceuta (*EAHP*) za kontrolu antimikrobne rezistencije, principi upravljanja antibiotskom terapijom u kliničkoj praksi, inovativni pristupi u razvoju antimikrobne terapije zasnovani na inhibiciji faktora virulencije, kao i potencijal za primenu prirodnih proizvoda u razvoju novih antimikrobnih strategija.

Pharmacists in the prevention and control of antimicrobial resistance

Increasing antimicrobial resistance is one of the most significant global public health challenges. Irrational and inappropriate use of antibiotics contributes to the emergence and spread of resistant microorganisms, resulting in significant consequences for therapy efficacy, patient safety, and the sustainability of healthcare systems.

In this session, the recommendations of the expert group of the European Association of Hospital Pharmacists (EAHP) for the control of antimicrobial resistance are presented, as well as the principles of antibiotic stewardship in clinical practice, innovative approaches to antimicrobial therapy development based on the inhibition of virulence factors and the potential of natural products in the development of novel antimicrobial strategies.

PP3.1. EAHP EXPERT GROUP RECOMMENDATIONS ON ANTIMICROBIAL RESISTANCE CONTROL

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Antimicrobial resistance (AMR) is one of the most serious global health threats. Hospital pharmacists help address resistance through antimicrobial stewardship, consumption monitoring, education, and medication management. However, their policy recognition remains uneven across Europe. Therefore, in March 2025, EAHP established a Working Group on AMR to inform policy development. The first task was to map whether and how hospital pharmacists' role is recognized in national action plans (NAPs) on AMR across EAHP member countries and to recommend ways to strengthen it. Members reviewed the 2023 European Commission study on barriers to national AMR policies, together with current NAPs and other national documents. For each country, they recorded whether a NAP existed and whether hospital pharmacists (or pharmacists generally) were mentioned. To date, nineteen member countries have a current NAP. Six explicitly recognized hospital pharmacists, while eight referred to pharmacists generally. Despite limited formal recognition, hospital pharmacists' involvement is most often recognized within multidisciplinary stewardship teams. This is established practice in at least nineteen countries (including some without a NAP), although information remains missing for twelve countries. Overall, hospital pharmacists are widely engaged in AMR control across Europe, but their contribution is rarely formalized in national policy. EAHP recommends adopting NAPs in all countries and formally recognizing hospital pharmacists as key contributors and core members of stewardship teams. Future phases will develop accredited AMR/AMS education and practical strategies to reduce resistance and support hospital pharmacists across Europe.

Acknowledgement
I would like to thank all members of the EAHP AMR Working Group for their enthusiasm, motivation, and valuable contribution.

PP3.2. UPRAVLJANJE ANTIBIOTSKOM TERAPIJOM – PUT KA ODRŽIVOM LEČENJU

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Rezistencija bakterija na antibiotike predstavlja gorući problem na globalnom nivou. Različite organizacije poput Svetske zdravstvene organizacije (WHO), Američkog (CDC) i Evropskog centra za prevenciju i kontrolu bolesti (ECDC), redovno prate situaciju na terenu i upozoravaju na ovaj problem. Infekcije multirezistetnim sojevima bakterija (MDR) povezane su sa većom stopom mortaliteta i morbititeta, produženim bolničkim lečenjem, naročito u jedinicama intenzivnog lečenja, kao i upotrebom različitih antibiotika, što povećava cenu lečenja i opterećuje zdravstveni sistem.

Prema WHO Listi prioritetnih bakterijskih patogena iz 2024. godine, u grupi kritičnih sojeva nalaze se, između ostalog, sojevi *Enterobacterales* koji su rezistentni na treću generaciju cefalosporina i/ili na karbapeneme (CRE) i karbapenem rezistentni *Acinetobacter baumannii* (CRAB), dok su MDR *Pseudomonas aeruginosa*, vankomicin rezistentni *Enterococcus faecium* i meticilin rezistentni *Staphilococcus aureus* u grupi visokog rizika. Ove bakterije su, takođe, najčešći izazivači teških infekcija u Univerzitetskom kliničkom centru Srbije (UKCS). U cilju unapređenja ishoda lečenja pacijenata sa infekcijama izazvanim MDR sojevima bakterija i sprečavanja daljeg razvoja rezistencije sprovođenjem racionalne primene antibiotika, u bolnicama se osnivaju multidisciplinarni timovi. U Urgentnom centru UKCS 2018. godine zvanično je formiran tim (infektolog, mikrobiolog, anesteziolog, epidemiolog i farmaceut) koji konsultativno određuje antimikrobnu terapiju pacijenatima sa najtežim infekcijama, analizira mikrobiološku zastupljenost, potrošnju antibiotika, načine uzorkovanja i prevenciju infekcija. Poslednjih godina povećava se broj zahteva za konsultacije i sa drugih Klinika UKCS.

PP3.2. ANTIBIOTIC STEWARDSHIP – A PATH TOWARD SUSTAINABLE THERAPY

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Bacterial resistance to antibiotics is a pressing problem at the global level. Various organizations such as the World Health Organization (WHO), the American (CDC) and the European Center for Disease Prevention and Control (ECDC) regularly monitor the situation on the ground and warn about this problem. Infections with multidrug-resistant strains of bacteria (MDR) are associated with a higher rate of mortality and morbidity, prolonged hospital treatment in intensive care units, as well as the use of different antibiotics, which increases the cost of treatment and burdens the healthcare system.

According to the WHO List of Priority Bacterial Pathogens from 2024, the group of critical strains include strains of Enterobacterales that are resistant to third-generation cephalosporins and/or carbapenems (CRE) and carbapenem-resistant *Acinetobacter baumannii* (CRAB), while MDR *Pseudomonas aeruginosa*, vancomycin-resistant *Enterococcus faecium* and methicillin-resistant *Staphylococcus aureus* are in the high-risk group. These bacteria are also the most common causes of severe infections at the University Clinical Center of Serbia (UCCS). In order to improve the outcome of the treatment of patients with infections caused by MDR strains of bacteria and to prevent the further development of resistance by implementing the rational use of antibiotics, multidisciplinary teams are established in hospitals. In 2018, a team (infectologist, microbiologist, epidemiologist, anesthesiologist and pharmacist) was officially formed in the UCCS Emergency Center, which consultatively determines antimicrobial therapy for patients with the most severe infections, analyzes microbiological prevalence, consumption of antibiotics, ways of sampling and prevention of infections. In recent years, the number of requests for consultations from other UKCS Clinics has been increasing.

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PP3.3. INHIBICIJA FAKTORA VIRULENCIJE KAO ALTERNATIVA KLASIČNOJ ANTIMIKROBNOJ TERAPIJI

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Razvoj i širenje rezistencije na antibiotike predstavljaju jedan od najznačajnijih izazova savremene medicine. Primena antibiotika, čije se delovanje zasniva na inhibiciji rasta ili ubijanju bakterija, stvara selektivni pritisak koji pogoduje opstanku i širenju rezistentnih sojeva. Zbog toga se, pored razvoja novih antimikrobnih lekova, sve više ispituju pristupi usmereni na smanjenje virulencije patogenih bakterija, bez direktnog uticaja na njihov rast i vijabilnost.

Poznato je da faktori virulencije omogućavaju bakterijama kolonizaciju domaćina, izbegavanje imunskog odgovora i oštećenje ćelija i tkiva. Potencijalna ciljna mesta u inovativnom, anti-virulentnom pristupu, uključuju adhezine i druge površinske strukture uključene u kolonizaciju, formiranje biofilma, komunikaciju između bakterija (*quorum sensing)*, produkciju toksina i sekrecione sisteme. Posebno kod Gram-negativnih bakterija, pili i drugi adhezini imaju važnu ulogu u vezivanju za ćelije domaćina i kolonizaciju, dok sekrecioni sistemi omogućavaju transport proteina uključenih u patogenezu infektivnog oboljenja. Ometanje formiranja i funkcije ovih struktura predstavlja jednu od mogućnosti za ciljano smanjenje virulencije patogenih bakterija. Inhibicija faktora virulencije može smanjiti sposobnost bakterija da izazovu infekciju i olakšati njihovu eliminaciju od strane imunskog sistema domaćina. U odnosu na konvencionalne antibiotike, ovakav pristup može imati i značajno manji negativan uticaj na mikrobiotu domaćina.

Kao potencijalni inhibitori faktora virulencije ispituju se različita jedinjenja prirodnog i sintetskog porekla, uključujući biljne sekundarne metabolite, kao i produkte probiotskih mikroorganizama.

Iako inhibicija faktora virulencije patogenih bakterija predstavlja obećavajuću strategiju, njena šira primena zahteva precizno definisanje ciljnih molekula na koje je usmerena, dodatnu procenu mogućnosti razvoja rezistencije i potvrdu efikasnosti u odgovarajućim *in vivo* modelima i kliničkim ispitivanjima.

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PP3.3. INHIBITION OF VIRULENCE FACTORS AS AN ALTERNATIVE TO CLASSICAL ANTIMICROBIAL THERAPY

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Antibiotic resistance and its global spread represent a major challenge in modern medicine. The use of antibiotics, which inhibit bacterial growth or kill bacterial cells, creates selective pressure favouring the survival and spread of resistant strains. Therefore, alongside the development of new antimicrobial drugs, increasing attention is being given to approaches that reduce virulence of pathogenic bacteria without directly affecting their growth or viability.

Virulence factors enable bacteria to colonize the host, evade the immune response, and damage cells and tissues. Potential targets of this anti-virulence approach include adhesins and other surface structures involved in colonization, biofilm formation, bacterial communication (*quorum sensing*), toxin production, and secretion systems. In Gram-negative bacteria in particular, pili and other adhesins are important for attachment to host cells and colonization, while secretion systems mediate the transport of proteins involved in pathogenesis of infectious diseases. Interfering of virulence factors may reduce the ability of bacteria to cause infection and facilitate their elimination by the host immune system. Compared with conventional antibiotics, this approach may also have a considerably lower impact on the host microbiota.

Various compounds of natural and synthetic origin are being investigated as potential inhibitors of virulence factors, including plant secondary metabolites and products derived from probiotic microorganisms.

Although inhibition of virulence factors in pathogenic bacteria is a promising strategy, its broader application requires clearly defined molecular targets, further assessment of the potential for resistance development, and confirmation of efficacy in appropriate *in vivo* models and clinical studies.

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PP3.4. POTENCIJAL PRIRODNIH PROIZVODA U BORBI PROTIV ANTIMIKROBNE REZISTENCIJE

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Antimikrobna rezistencija predstavlja jednu od najvećih pretnji globalnom javnom zdravlju, dok prirodni proizvodi i dalje ostaju značajan i istorijski potvrđen izvor antimikrobnih agenasa i potencijalnih novih lekova. Brojni antibiotici koji se danas koriste potiču direktno ili indirektno iz prirodnih izvora, uključujući bakterije i plesni. Lekovite biljke predstavljaju važan izvor jedinjenja sa antimikrobnim potencijalom, pri čemu se posebno izdvajaju sekundarni metaboliti sa fenolnim, hinonskim i organosumpornim grupama. Na primer, monoterpenski fenoli timol i karvakrol, prisutni u brojnim aromatičnim vrstama, kao što su biljke rodova *Thymus* i *Origanum*, ubrajaju se među najpoznatije antimikrobne agense biljnog porekla zahvaljujući izraženoj aktivnosti protiv širokog spektra bakterija i gljiva.

Savremeni pristupi istraživanju antimikrobnih prirodnih proizvoda sve više obuhvataju različite biološke izvore, uključujući morske mikroorganizme, endofitne gljive i bakterije, humanu mikrobiotu, mikroorganizme iz ekstremnih staništa, kao i mikroorganizme iz zemljišta koje ranije nije bilo moguće kultivisati. Ovakva istraživanja su dovela do otkrića novih jedinjenja, kao što su teiksobaktin, klovibaktin i lugdunin, koja pokazuju potencijal u borbi protiv rezistentnih patogena. Istovremeno, napredak analitičkih metoda, kao što je masena spektrometrija visoke rezolucije i integracija hemijske karakterizacije sa biološkim ispitivanjima omogućavaju bolje razumevanje veze između hemijskih karakteristika i antimikrobne aktivnosti prirodnih proizvoda. Zbog svega navedenog, prirodni proizvodi ostaju jedno od najvažnijih područja istraživanja u potrazi za novim antimikrobnim agensima i strategijama za prevazilaženje antimikrobne rezistencije.

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PP3.4. THE POTENTIAL OF NATURAL PRODUCTS IN COMBATING ANTIMICROBIAL RESISTANCE

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Antimicrobial resistance represents one of the greatest threats to global public health, while natural products continue to be a significant and historically proven source of antimicrobial agents and potential new drugs. Many antibiotics currently in clinical use are derived directly or indirectly from natural sources, including bacteria and molds. Medicinal plants represent an important source of compounds with antimicrobial potential, with secondary metabolites containing phenolic, quinone and organosulfur groups being particularly prominent. For example, the monoterpene phenols thymol and carvacrol, found in numerous aromatic plant species, such as those belonging to the genera *Thymus* and *Origanum*, are among the best-known plant-derived antimicrobial agents due to their pronounced activity against a broad spectrum of bacteria and fungi.

Contemporary approaches to the discovery of antimicrobial natural products increasingly encompass diverse biological sources, including marine microorganisms, endophytic fungi and bacteria, the human microbiota, microorganisms inhabiting extreme environments, as well as previously uncultivable soil microorganisms. Such research has led to the discovery of new compounds, including teixobactin, clovibactin and lugdunin, which exhibit considerable potential in combating resistant pathogens. At the same time, advances in analytical techniques, particularly high-resolution mass spectrometry, and the integration of chemical characterization with biological testing have enabled a better understanding of the relationship between the chemical features and antimicrobial activity of natural products. Consequently, natural products remain one of the most important areas of research in the search for novel antimicrobial agents and strategies to overcome antimicrobial resistance.

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Sesija 4
Session 4

Novi pristupi u proceni bezbednosti hemikalija i zaštiti zdravlja

Emerging approaches to chemical safety and health protection

Novi pristupi u proceni bezbednosti hemikalija i zaštiti zdravlja

Zdravstveni značaj izloženosti hemikalijama sve češće se sagledava kroz integrisane pristupe koji povezuju računarsko modelovanje, napredne analitičke tehnike, mehanističko tumačenje i translacione strategije usmerene ka prevenciji i zaštiti zdravlja. Sesija pruža uvid u ulogu *in silico* studija u savremenoj proceni rizika, kao i nova saznanja o per- i polifluoroalkil supstancama (PFAS) kao perzistentnim kontaminantima životne sredine sa potencijalnim prenatalnim, niskodoznim i intergeneracijskim efektima. Sesija obuhvata i značaj potvrdne LC-MS/MS analize u forenzičkoj toksikologiji, detekciju neonikotinoida kod uginulih pčela kao pokazatelja kontaminacije životne sredine, značaj detekcije neregistrovanih supstanci u biljnim proizvodima, kao i primenu *in silico* toksikologije u ispitivanju uticaja smeša ftalata na endokrini i reproduktivni sistem. U okviru sesije su predstavljeni i inovativni pristupi za podršku terapiji steatoze jetre povezane sa metaboličkom disfunkcijom (MASLD) na bazi probiotika kao primer prevođenja naučnih saznanja u rešenja usmerena ka zaštiti zdravlja. Povezujući analitičke, računarske, ekološke, mehanističke i translacione perspektive, ova sesija ukazuje na savremene strategije za razumevanje bioloških odgovora na izloženost hemikalijama i razvoj pristupa koji doprinose zaštiti zdravlja.

Emerging approaches to chemical safety and health protection

Chemical exposures and their health implications are increasingly assessed through integrated approaches that combine computational modelling, advanced analytical techniques, mechanistic interpretation, and translational strategies for prevention and health protection. This session provides insight into the role of in silico studies in modern risk assessment, as well as emerging evidence on PFAS as persistent environmental contaminants with potential prenatal, low-dose, and intergenerational effects. The session also addresses the importance of confirmatory LC-MS/MS analysis in forensic toxicology, the detection of neonicotinoids in dead bees as an indicator of environmental contamination, the importance of detection of unregistered substance in plant products, and the use of network toxicology to explore the role of phthalate mixtures in endocrine and reproductive disorders. In addition, innovative probiotic approaches for metabolic dysfunction-associated steatotic liver disease are presented, illustrating how scientific evidence can be translated into health-oriented solutions. By bringing together analytical, computational, environmental, mechanistic, and translational perspectives, this session highlights contemporary strategies for understanding biological responses to chemical exposures and developing approaches that support health protection.

PP4.1. *IN SILICO* ISPITIVANJA U TOKSIKOLOGIJI: ISKUSTVA, IZAZOVI I PERSPEKTIVE

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Ispitivanja na životinjama i dalje predstavljaju standard u proceni bezbednosti lekova i hemikalija; međutim, računarski potpomognute (*in silico*) metode se sve više razvijaju kao efikasne alternative ili dopuna *in vivo* ispitivanjima, uz podršku regulatornih okvira kao što je REACH. Njihove prednosti uključuju niske troškove, mogućnost analize hipotetičkih jedinjenja i oslanjanje na podatke relevantne za čoveka, čime se smanjuje ekstrapolacija rezultata između različitih bioloških vrsta. Od sredine 1990-ih, ove tehnologije postaju ključne u razvoju lekova, naročito u proceni ADMET svojstava i predviđanju toksičnih efekata, koji čine značajan deo neuspeha u kasnim fazama razvoja farmaceutika. Bioinformatika i in silico pristupi u toksikologiji omogućavaju bržu, etički prihvatljiviju i ekonomičniju procenu bezbednosti hemikalija, u skladu sa 3R principima. Dosadašnja iskustva obuhvataju QSAR modelovanje, identifikaciju toksofora, toksikogenomske analize i rudarenje podataka iz javnih baza. Posebno se izdvajaju rezultati srpsko-kineske saradnje u istraživanju bioaktivnih jedinjenja, gde je in silico toksikogenomska analiza sulforafana kod kolorektalnog karcinoma identifikovala genske potpise i molekularne obrasce povezane sa terapijskim efektima, kao i potencijalne neželjene ishode u zavisnosti od genetskog profila pacijenata. Primena koncepta puteva neželjenih ishoda (AOP) i prediktivnih alata dodatno je unapredila razumevanje mehanizama toksičnosti. Uprkos ovim prednostima, izazovi uključuju ograničenu interpretabilnost kompleksnih modela, zavisnost od kvaliteta podataka, nedovoljno precizno modelovanje odnosa doza–odgovor i potrebu za eksperimentalnom validacijom rezultata. Budući pravci razvoja toksikologije zasnivaju se na integrisanim pristupima testiranju i proceni (IATA), koji kombinuju *in silico*, *in vitro* i *in vivo* metode u cilju razvoja pouzdanijih i personalizovanih strategija procene rizika.

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PP4.1. *IN SILICO* STUDIES IN TOXICOLOGY: EXPERIENCES, CHALLENGES, AND PERSPECTIVES

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Animal testing remains the standard for assessing the safety of drugs and chemicals; however, computer-aided (*in silico*) methods are increasingly being developed as efficient alternatives or complements to *in vivo* testing, supported by regulatory frameworks such as REACH. Their advantages include low cost, the ability to analyze hypothetical compounds, and reliance on human-relevant data, thereby reducing extrapolation of results between different biological species. Since the mid-1990s, these technologies have become essential in drug development, particularly for assessing ADMET properties and predicting toxic effects, which account for a significant proportion of late-stage failures in pharmaceutical development. Bioinformatics and in silico approaches in toxicology enable faster, more ethical, and more cost-effective chemical safety assessment, in line with the 3R principles. Previous experience includes QSAR modeling, identification of toxicophores, toxicogenomic analyses, and data mining of public databases. Notably, Serbian–Chinese collaborative research on bioactive compounds demonstrated that in silico toxicogenomic analysis of sulforaphane in colorectal cancer identified gene signatures and molecular patterns associated with therapeutic effects, as well as potential adverse outcomes depending on the patient's genetic profile. The application of the Adverse Outcome Pathways (AOP) framework and predictive tools has further improved understanding of toxicity mechanisms. Despite these advantages, challenges remain, including limited interpretability of complex models, dependence on data quality, insufficiently precise dose–response modeling, and the need for experimental validation. Future directions in toxicology rely on integrated approaches to testing and assessment (IATA), combining *in silico*, *in vitro*, and *in vivo* methods to develop more reliable and personalized risk assessment strategies.

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PP4.2. PFAS KAO TIHI PROGRAMERI LJUDSKOG ZDRAVLJA: PRENATALNA IZLOŽENOST, EFEKTI NISKIH DOZA I RIZIK ZA BUDUĆE GENERACIJE

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Per- i polifluorisane alkilne supstance (PFAS) predstavljaju postojane i široko rasprostranjene kontaminante životne sredine od značaja za javno zdravlje. Zbog hemijske stabilnosti, bioakumulacije i primene u industrijskim i potrošačkim proizvodima, izloženost PFAS jedinjenjima postala je gotovo neizbežna, uključujući trudnoću i rani život. Prenatalni period je posebno osetljiv razvojni prozor, tokom kojeg i niske doze endokrinih disruptora mogu uticati na fetalno programiranje i dugoročne zdravstvene ishode.

Posebnu zabrinutost izaziva sposobnost PFAS jedinjenja da prolaze placentarnu barijeru i dospevaju do fetusa. Prenatalna izloženost povezuje se sa mogućim poremećajima endokrinih, metaboličkih, imunoloških i razvojnih puteva, pri čemu se posledice mogu ispoljiti tek kasnije tokom života. Koncept PFAS jedinjenja kao „tihih programera" ljudskog zdravlja odražava njihovu sposobnost da menjaju biološke procese u ključnim fazama razvoja, često bez neposredno vidljivih kliničkih manifestacija. Efekti niskih doza, nemonotoni odnosi doza–odgovor i kombinovana izloženost hemijskim smešama dodatno otežavaju klasičnu toksikološku procenu rizika.

Humani biomonitoring, zasnovan na uparenim uzorcima krvi majke i pupčanika, placentarnom tkivu i ranim biomarkerima, ključan je za razumevanje maternalno-fetalnog prenosa i ranih bioloških odgovora. Regionalne kohortne studije majka–dete, uključujući TOXMOM i PrenTox, doprinose boljem razumevanju prenatalne izloženosti PFAS jedinjenjima i drugim endokrinim disruptorima u populacijama sa ograničenim biomonitoring podacima. Prenatalna izloženost PFAS jedinjenjima zato predstavlja važno pitanje toksikologije životne sredine, reproduktivnog zdravlja, razvoja dece i javnozdravstvene prevencije.

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PP4.2. PFAS AS SILENT PROGRAMMERS OF HUMAN HEALTH: PRENATAL EXPOSURE, LOW-DOSE EFFECTS, AND INTERGENERATIONAL RISK

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Per- and polyfluoroalkyl substances (PFAS) are persistent environmental contaminants. Due to their chemical stability, bioaccumulative potential, and use in industrial and consumer products, human exposure to PFAS has become unavoidable. The prenatal period represents a sensitive developmental window, during which even low-level exposure to endocrine-disrupting chemicals may interfere with fetal programming and contribute to long-term health outcomes.

PFAS are of particular concern because they can cross the placental barrier. Prenatal exposure has been associated with disturbances in endocrine, metabolic, immune, and developmental pathways, with consequences that may become evident later in life. The concept of PFAS as "silent programmers" of human health reflects their capacity to alter biological processes during critical stages of development, often without immediate clinical manifestations. Low-dose effects, non-monotonic dose–response relationships, and combined exposure to chemical mixtures further complicate toxicological risk assessment.

Human biomonitoring studies based on paired maternal and umbilical cord blood samples, placental tissue, and early-life biomarkers are essential for understanding maternal–fetal transfer and early biological responses. Regional mother–child cohort studies, including TOXMOM and PrenTox, contribute to evidence on prenatal exposure to PFAS and other endocrine-disrupting chemicals, particularly in populations with limited biomonitoring data.

Prenatal PFAS exposure represents an important issue at the intersection of environmental toxicology, reproductive health, child development, and public health prevention. Improved exposure assessment, early preventive strategies, and communication among researchers, healthcare professionals, pharmacists, policymakers, and the public are needed to reduce risks for future generations.

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US4.1. FORENZIČKO-TOKSIKOLOŠKI ZNAČAJ LC-MS/MS POTVRDE U INTERPRETACIJI REZULTATA SKRININGA NA AMFETAMINE U URINU

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Imunohromatografski testovi urina predstavljaju standardnu metodu preliminarnog skrininga psihoaktivnih supstanci u kliničkoj i forenzičkoj toksikologiji zbog jednostavne primene i brzog dobijanja rezultata. Njihova dijagnostička vrednost ograničena je unapred definisanim cut-off vrednostima i mogućom unakrsnom reaktivnošću sa drugim jedinjenjima, što može dovesti do lažno pozitivnih i lažno negativnih nalaza. U sudsko-toksikološkoj praksi takvi nalazi mogu imati značajne posledice po donošenje stručnog mišljenja i interpretaciju činjenica od značaja za postupak.

Cilj rada bio je da se kroz prikaz slučajeva iz rutinske forenzičko-toksikološke prakse ukaže na ograničenja imunohromatografskog skrininga na amfetamin i značaj potvrdne analize metodom tečne hromatografije sa tandemskom masenom spektrometrijom (LC-MS/MS). Prema laboratorijskom protokolu, potvrdna analiza se ne sprovodi kod negativnih skrining nalaza, osim u slučajevima postojanja posebnog zahteva ili forenzičke indikacije. U prikazanom slučaju, skrining test na amfetamin sa cut-off vrednošću od 1000 ng/mL dao je negativan rezultat. Naknadnom LC-MS/MS analizom potvrđeno je prisustvo amfetamina u koncentraciji od 540 ng/mL. Utvrđena koncentracija bila je niža od granične vrednosti skrining testa, što je dovelo do lažno negativnog nalaza uprkos prisustvu amfetamina u uzorku.

U forenzičkoj praksi češći su lažno pozitivni nalazi, koji nisu potvrdili prisustvo amfetamina LC-MS/MS analizom. Upotreba preparata sa dekongestivnim komponentama, može dovesti do interferencije i pogrešne preliminarne interpretacije rezultata.

Prikazani slučajevi potvrđuju da se skrining nalazi ne mogu smatrati konačnim dokazom prisustva ili odsustva amfetamina. Pouzdana forenzičko-toksikološka interpretacija zahteva primenu visoko specifičnih potvrdnih metoda. LC-MS/MS predstavlja zlatni standard za identifikaciju i kvantifikaciju amfetamina u biološkim uzorcima.

US4.1. FORENSIC TOXICOLOGICAL SIGNIFICANCE OF LC-MS/MS CONFIRMATION IN THE INTERPRETATION OF AMPHETAMINE SCREENING RESULTS IN URINE

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Urine immunochromatographic tests are widely used for the preliminary screening of psychoactive substances in clinical and forensic toxicology due to their simplicity and rapid turnaround time. However, their diagnostic value is limited by predefined cut-off values and potential cross-reactivity, which may result in false-positive or false-negative findings. In forensic toxicology, such results may significantly affect expert opinions and the interpretation of case-relevant facts.

The aim of this study was to highlight, through case presentations from routine forensic toxicology practice, the limitations of immunochromatographic amphetamine screening and the importance of confirmatory analysis using liquid chromatography-tandem mass spectrometry (LC-MS/MS). According to the laboratory protocol, confirmatory analysis is not routinely performed following negative screening results, except when specifically requested or indicated by forensic circumstances.

In the presented case, an amphetamine screening test with a cut-off value of 1000 ng/mL yielded a negative result, whereas subsequent LC-MS/MS analysis confirmed amphetamine at 540 ng/mL. The concentration was below the screening cut-off, resulting in a false-negative finding despite the presence of amphetamine.

False-positive screening results, not confirmed by LC-MS/MS, are also encountered in forensic practice, potentially due to cross-reactivity with decongestant-containing preparations.

These cases demonstrate that immunochromatographic screening results should not be considered definitive evidence of the presence or absence of amphetamine. Reliable forensic-toxicological interpretation requires highly specific confirmatory methods, with LC-MS/MS serving as the gold standard for amphetamine identification and quantification.

US4.2. ANALIZA UGINULIH PČELA NA PRISUSTVO SISTEMSKIH INSEKTICIDA - NEONIKOTINOIDA

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Neonikotinoidi su grupa sistemskih insekticida koji deluju kao agonisti postsinaptičkih nikotinskih acetilholinskih receptora centralnog nervnog sistema insekata i odlikuju se niskom postojanošću u tlu, niskom toksičnošću za životinje i ljude i visokom delotvornošću na insekte. Zbog izrazite toksičnosti za pčele, 2013. godine je nastupilo ograničenje upotrebe sredstava za zaštitu bilja koja sadrže pojedine insekticide iz ove grupe. Cilj rada je bio da se validovanom LC-MS/MS metodom (SANTE) uz korišćenje brzog i jednostavnog postupka pripreme uzorka primenom Quechers extraction kits (SPE), ispitaju uzorci uginulih pčela na prisustvo 5 neonikotinoida: imidakloprida, tiakloprida, tiametoksama, klotianidina i acetamiprida. Analizirano je 47 uzoraka uginulih pčela i kod 19 uzoraka (40%) je dokazano prisustvo neonikotinoida: imidakloprid kod 8 uzoraka (18%), a tiametoksam kod 7 uzoraka (15%). Klotianidin je detektovan u najvećem broju uzoraka - 14 uzoraka (30%), dok je acetamiprid detektovan samo u 2 uzorka (4%). Kod 5 uzoraka je detektovano prisustvo tri neonikotinoida, a kod 2 uzorka dva neonikotinoida. U slučaju 2 uzorka nađene vrednosti ostataka neonikotinoida su bile veće od procenjenih LD50, što bi moglo da ukaže da je razlog uginuća pčela bila ekspozicija neonikotinioidima. Za utvrđivanje razloga uginuća pčela i gubitka kolonija neophodno je uzeti u obzir i druge faktore, među kojima su i količine ostataka drugih pesticida pronađene u pojedinim uzorcima, kao i eventualne bolesti pčela.

US4.2. ANALYSIS OF DEAD BEES FOR THE PRESENCE OF SYSTEMIC INSECTICIDES – NEONICOTINOIDS

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Neonicotinoids are systemic insecticides that act as agonists of postsynaptic nicotinic acetylcholine receptors of the central nervous system of insects and are characterized by low persistence in the soil, low danger to animals and humans and high effectiveness on insects and consequently high toxicity to bees, which is why in 2013 the restriction on the use of plant protection products containing certain insecticides from this group has been occurred. The aim of the work was to use a validated LC-MS/MS method (SANTE) with the fast and simple sample preparation procedure using Quechers extraction kits (SPE), to examine samples of dead bees for the presence of 5 neonicotinoids: imidacloprid, thiacloprid, thiamethoxam, clothianidin and acetamiprid. 47 samples of dead bees were analyzed and in 19 samples (40%) the presence of neonicotinoids was proven: imidacloprid in 8 samples (18%) and thiamethoxam in 7 samples (15%). Clothianidin was detected in the largest number of samples- 14 samples (30%), while acetamiprid was detected in 2 samples (4%). The presence of three neonicotinoids was detected in 5 samples, and two neonicotinoids in 2 samples. In 2 cases values of neonicotinoid residues were higher than the estimated LD50, which could indicate that the reason for the death of the bees was exposure to neonicotinoids. In order to determine the reason for the death of bees and the loss of colonies, it is necessary to take into account other factors, such as the amounts of residues of other pesticides found in certain samples and possible bee diseases.

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US4.3. DETEKCIJA NEREGISTROVANOG BETAMETAZONA U BILJNIM PREPARATIMA KAO IZVOR NEKONTROLISANE EKSPOZICIJE U PEDIJATRIJSKOJ POPULACIJI: ANALITIČKO-TOKSIKOLOŠKA ANALIZA

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Topikalni kortikosteroidi predstavljaju zlatni standard u terapiji inflamatornih oboljenja kože, međutim, njihova primena u pedijatrijskoj populaciji je strogo ograničena zbog rizika od sistemske apsorpcije i supresije hipotalamusno-hipofizno-nadbubrežne osovine. Na domaćem tržištu je evidentna ekspanzija preparata deklarisanih kao prirodni biljni proizvodi, čiji regulatorni status kozmetičkih sredstava zakonski izuzima ove artikle iz obavezne analitičke verifikacije i nadzora od strane Agencije za lekove i medicinska sredstva Srbije (ALIMS). Cilj ovog rada bio je analitička detekcija i identifikacija farmakološki aktivnih supstanci u dva legalno distribuirana preparata biljnog porekla za tretman dečjih ekcema, gde je nesrazmerno brz klinički odgovor ukazivao na prisustvo sintetičkih dodataka. Analitički protokol se zasnivao na primeni tečne hromatografije sa UV skenirajućim detektorom na C8 koloni, uz gradijentnu eluciju mobilne faze koju su činili acetonitril i fosfatni pufer (inicijalno 15:85) pH 3,6, pri protoku od 1,5 ml/min. Uzorci su pripremani rastvaranjem 1 g preparata u 10 mL 10% sirćetne kiseline u metanolu. Identifikacija analita izvršena je primenom Empower softvera na osnovu poređenja retencionih vremena i apsorpcionih spektara betametazona iz kompjuterske biblioteke i spektra pika analita u uzorku. Potvrda identiteta izvršena je nakon analize metanolnog rastvora referentnog standarda betametazona pod istim uslovima kao i za uzorak. U oba ispitivana uzorka nedvosmisleno je potvrđeno prisustvo betametazona koji nije označen na pakovanju. Terapijska primena proizvoda van kontrole ALIMS-a predstavlja direktnu opasnost po zdravlje pedijatrijske populacije. S obzirom na limitiran broj analiziranih proizvoda, dobijeni nalaz preliminarno ukazuje na potencijalno ozbiljan javnozdravstveni rizik od nekontrolisane ekspozicije pedijatrijske populacije glukokortikoidima, što nameće potrebu za rigoroznijim regulatornim nadzorom.

US4.3. DETECTION OF UNREGISTERED BETAMETHASONE IN HERBAL PRODUCTS AS A SOURCE OF UNCONTROLLED EXPOSURE IN THE PEDIATRIC POPULATION: AN ANALYTICAL-TOXICOLOGICAL STUDY

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Topical corticosteroids represent the gold standard in treating inflammatory skin disorders; however, their use in the pediatric population is strictly limited due to risks of systemic absorption and hypothalamic-pituitary-adrenal axis suppression. An expansion of products marketed as natural herbal preparations is evident on the domestic market. Their regulatory classification as cosmetics legally exempts them from mandatory analytical verification and surveillance by the Medicines and Medical Devices Agency of Serbia (ALIMS). This study aimed to analytically detect and identify pharmacologically active substances in two legally distributed herbal preparations for pediatric eczema treatment, where a disproportionately rapid clinical response suggested the presence of synthetic additives. The analytical protocol utilized liquid chromatography with a UV-scanning detector on a C8 column, employing gradient elution with a mobile phase of acetonitrile and phosphate buffer (initial ratio 15:85, pH 3.6) at a flow rate of 1.5 mL/min. Samples were prepared by dissolving 1 g of preparation in 10 mL of 10% acetic acid in methanol. Analyte identification was conducted via Empower software by comparing retention times and absorption spectra against a computerized library of betamethasone. Identity confirmation was achieved by analyzing a methanolic betamethasone reference standard under identical conditions. In both examined samples, undeclared betamethasone was unequivocally confirmed. Therapeutic use of products outside ALIMS control poses a direct hazard to pediatric health. Given the limited sample size, these findings preliminarily indicate a severe public health risk from uncontrolled pediatric glucocorticoid exposure, necessitating more rigorous regulatory oversight.

US4.4. UTICAJ SMEŠE FTALATA NA RAZVOJ SINDROMA POLICISTIČNIH JAJNIKA I PROCENA PROTEKTIVNOG POTENCIJALA KURKUMINA, SULFORAFANA I RESVERATROLA: *NETWORK TOXICOLOGY* PRISTUP

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Ftalati su hemikalije koje ometaju rad endokrinog sistema i povezani su sa nepovoljnim ishodima po reproduktivno zdravlje žena, uključujući disfunkciju jajnika i sindrom policističnih jajnika (PCOS). Budući da su ljudi pretežno izloženi smešama ftalata, a ne pojedinačnim jedinjenjima, razumevanje njihovih zajedničkih molekularnih efekata predstavlja veliki izazov. U ovom radu primenjen je pristup mrežne toksikologije (engl. *Network toxicology*) da bi se ispitali efekati smeše di(2-etilheksil) ftalata (DEHP), dibutil ftalata (DBP) i benzil butil ftalata (BBP) na mehanizme povezane sa PCOS-om, kao i da bi se uporedili potencijalni protektivni efekati kurkumina, sulforafana i resveratrola.

Interakcije između hemikalija i gena preuzete su iz Komparativne toksikogenomičke baze podataka (CTD), a analiza bioloških puteva zajedničkih gena sprovedena je korišćenjem alata *ToppGene Suite*.

CTD analiza identifikovala je 80, 53 i 60 gena povezanih sa DEHP, DBP i BBP, pri čemu je 26 gena bilo zajedničko za sva tri ftalata. Kurkumin, sulforafan i resveratrol bili su povezani sa 14, 29 i 73 gena, pri čemu su sa smešom ftalata delili 6, 9 i 17 gena, redom. Analiza bioloških puteva ukazala je da toksičnost smeše ftalata prvenstveno uključuje poremećaje steroidogeneze, metabolizma hormona, mitohondrijske funkcije i apoptoze. Geni povezani sa kurkuminom bili su povezani sa putevima intrinzične apoptoze, geni povezani sa sulforafanom putevima sinteze prostaglandina, feroptoze i apoptoze, dok su geni povezani sa resveratrolom bili povezani sa putevima steroidogeneze, metabolizma steroidnih hormona i funkcije jajnika.

Ovi nalazi ukazuju na protektivni potencijal kurkumina, sulforafana i resveratrola, pri čemu je, na osnovu broja zajedničkih gena, najveći potencijal pokazao resveratrol.

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US4.4. THE INFLUENCE OF A PHTHALATE MIXTURE ON THE DEVELOPMENT OF POLYCYSTIC OVARY SYNDROME AND THE PROTECTIVE POTENTIAL OF CURCUMIN, SULFORAPHANE, AND RESVERATROL: A NETWORK TOXICOLOGY APPROACH

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Phthalates are endocrine-disrupting chemicals associated with adverse female reproductive outcomes, including ovarian dysfunction and polycystic ovary syndrome (PCOS). Because human exposure occurs predominantly to phthalate mixtures rather than individual compounds, understanding their combined molecular effects remains a major challenge. This study applied a network toxicology approach to investigate the effects of a mixture of di(2-ethylhexyl) phthalate (DEHP), dibutyl phthalate (DBP), and benzyl butyl phthalate (BBP) on PCOS-related mechanisms and to compare the potential protective roles of curcumin, sulforaphane, and resveratrol.

Gene–chemical interaction data were retrieved from the Comparative Toxicogenomics Database (CTD). Genes shared by the three investigated phthalates were identified, together with overlapping genes between the phthalate mixture and each investigated protective compound. Pathway enrichment analysis of the overlapping genes was performed using the ToppGene Suite.

CTD analysis identified 80, 53, and 60 genes associated with DEHP, DBP, and BBP, respectively, with 26 genes shared by all three phthalates. Curcumin, sulforaphane, and resveratrol were associated with 14, 29, and 73 genes, respectively, sharing 6, 9, and 17 genes with the phthalate mixture. Enrichment analysis indicated that phthalate mixture toxicity primarily involves steroidogenesis, hormone metabolism, mitochondrial function, and apoptosis. Curcumin-associated genes were enriched in intrinsic apoptotic pathways, sulforaphane in prostaglandin synthesis, ferroptosis, and apoptosis, and resveratrol in steroidogenesis, steroid hormone metabolism, and ovarian function.

These findings highlight the protective potential of natural compounds, with resveratrol demonstrating the strongest predicted effect based on the highest number of overlapping genes and enriched pathways, followed by sulforaphane and curcumin.

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US4.5. RAZVOJ I KLINIČKA VALIDACIJA PROBIOTIKA *LACTOBACILLUS HELVETICUS* BGRA43: INOVATIVNI PRISTUP ZA PODRŠKU TERAPIJI STEATOZE JETRE POVEZANE SA METABOLIČKOM DISFUNKCIJOM

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Steatoza jetre povezana sa metaboličkom disfunkcijom (MASLD) najčešća je hronična bolest jetre u svetu i usko je povezana sa metaboličkim poremećajima kao što su gojaznost, insulinska rezistencija i dislipidemija. Kako se njena učestalost stalno povećava, a trenutne strategije lečenja prvenstveno se zasnivaju na modifikaciji načina života, neophodno je razvijati nove pristupačne i naučno utemeljene intervencije.

Sve više dokaza ukazuje na disbiozu mikrobiote creva i oštećenu funkciju crevne barijere u patogenezi MASLD-a, pozicionirajući probiotike kao obećavajuće terapijske kandidate. Stoga smo istraživali efekte probiotskog soja *Lactobacillus helveticus* BGRA43 (LHBGRA43) u prekliničkom modelu gojaznosti izazvane ishranom. Oralna primena LHBGRA43 značajno je smanjila masu subkutanog masnog tkiva i potpuno sprečila steatozu jetre kod gojaznih miševa, što je potvrđeno histološkom analizom. Ovi efekti praćeni su smanjenom ekspresijom proteina SREBP-1c, transportera masnih kiselina CD36, enzima uključenih u sintezu ceramida i proinflamatornih markera. LHBGRA43 je takođe poboljšao integritet crevne barijere, što je potvrđeno povećanim nivoima proteina ZO-1, i povoljno uticao na sastav mikrobiote creva, uključujući smanjen odnos filuma *Firmicutes/Bacteroidota* i povećano prisustvo rodova *Alistipes*, *Acetatifactor* i *Odoribacter*, kao i smanjene koncentracije metabolita masnih kiselina razgranatog lanca.

Na osnovu ovih nalaza, razvili smo i komercijalizovali probiotičku formulaciju zasnovanu na LHBGRA43 namenjenu podršci lečenju MASLD-a. Translacioni put je napredovao od prekliničke validacije do postmarketinške randomizovane kontrolisane kliničke studije, koja je potvrdila korisne efekte kod pacijenata sa MASLD-om. Ovi nalazi podržavaju LHBGRA43 kao naučno validiran probiotički pristup za poboljšanje zdravlja jetre i nude rešenje za značajnu potrebu u lečenju metaboličkih bolesti.

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US4.5. DEVELOPMENT AND CLINICAL VALIDATION OF LACTOBACILLUS HELVETICUS BGRA43: AN INNOVATIVE PROBIOTIC APPROACH FOR MASLD

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Metabolic dysfunction-associated steatotic liver disease (MASLD) is the most common chronic liver disease worldwide and is closely associated with metabolic disorders such as obesity, insulin resistance, and dyslipidemia. Its prevalence continues to increase, and current management strategies rely primarily on lifestyle modification, it is necessary to develop new affordable and scientifically based interventions.

Increasing evidence implicates gut microbiota dysbiosis and impaired intestinal barrier function in MASLD pathogenesis, positioning probiotics as promising therapeutic candidates. We investigated the effects of the probiotic strain *Lactobacillus helveticus* BGRA43 (LHBGRA43) in a preclinical diet-induced obesity model. Oral administration of LHBGRA43 significantly reduced subcutaneous adipose tissue mass and completely prevented hepatic steatosis in obese mice, as shown by histological analysis. These effects were accompanied by reduced expression of sterol regulatory element-binding protein-1c (SREBP-1c), the fatty acid transporter CD36, enzymes involved in ceramide synthesis, and pro-inflammatory markers. LHBGRA43 improved intestinal barrier integrity, as indicated by increased ZO-1 protein levels, and favorably modulated gut microbiota composition, including a reduced *Firmicutes/Bacteroidota* ratio, enrichment of the genera *Alistipes*, *Acetatifactor*, and *Odoribacter*, and decreased concentrations of branched-chain fatty acid metabolites.

Based on these findings, we developed and commercialized a probiotic formulation based on LHBGRA43 intended to support MASLD management. The translational pathway progressed from preclinical validation to a post-marketing randomized controlled clinical study, which confirmed beneficial effects in patients with MASLD. Collectively, these findings support LHBGRA43 as a scientifically validated probiotic approach for improving liver health and providing a novel strategy to address a recognized gap in current metabolic disease management.

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Sesija 5
Session 5

Lekovi po meri starijih pacijenata: terapijski izazovi i rešenja

Tailoring medicines for the ageing population: Therapeutic challenges and solutions

Lekovi po meri starijih pacijenata: terapijski izazovi i rešenja

Globalno starenje stanovništva donosi rastuće izazove u vezi sa polifarmacijom, terapijom hroničnog bola i drugim specifičnim zdravstvenim potrebama zbog kojih je u okviru zdravstvenih sistema potrebno uspostaviti nove pristupe farmakoterapiji i zdravstvenoj zaštiti starijih osoba. Tema ove sesije je na koji način strategije usmerene ka pacijentu oblikuju lekove sa unapređenom bezbednošću, poboljšanom adherencom i kvalitetom života starijih osoba. Sesija se bavi aktuelnim izazovima i inovativnim rešenjima za optimizaciju terapije kod starijih pacijenata, uključujući depreskripciju, unapređenje terapije bola, pristupe u formulaciji kojima se olakšava primena lekova i razvoj savremenih oftalmoloških proizvoda.

Tailoring medicines for the ageing population: Therapeutic challenges and solutions

With the globally aging population, healthcare systems need to adopt new approaches to pharmacotherapy and pharmaceutical care that address the growing challenges of polypharmacy, chronic pain, and age-specific therapeutic needs. This session addresses how patient-centered strategies are tailoring medicines with improved safety, adherence, and quality of life in elderly patients. The session provides an overview of current challenges and innovative solutions for optimizing therapy in elderly, including deprescribing, advances in pain management, formulation approaches that facilitate medication use, and development of modern ophthalmic products.

PP5.1. FORMULATION SOLUTIONS TO EASE THE PILL BURDEN FOR OLDER ADULTS

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Pill burden refers to the total number of oral solid dosage forms (e.g., tablets or capsules) that a patient takes within a given period and has become increasingly relevant in clinical research and practice. Pill burden is not determined by pill count alone; dosage frequency, formulation type, and specific administration instructions are also considered. Elevated pill burden has been associated with reduced medication adherence, a greater risk of adverse drug events, and diminished quality of life, particularly among older adults with multiple chronic conditions. It also contributes to increased hospitalisation rates, higher treatment costs, and more complex prescribing. Pill burden in older adults is widely acknowledged in practice to adversely affect patient outcomes. Formulation design, combined with medication review and deprescribing, can be employed to reduce pill burden.

The studies presented will address the challenges of pill burden for older persons living in community and residential care settings. A framework to identify and define the parameters required for pill burden assessment will be presented. The shortcomings of approved drug products widely prescribed for older persons will be discussed, as well as the prevalence of unauthorised manipulations, such as tablet crushing. The advantages and limitations of a range of formulation approaches purported to ease pill burden—such as oral polypills, sustained-release tablets, transdermal patches, and subcutaneous infusions—will also be presented. Patient-factor considerations informing formulation design will be highlighted, including the increased prevalence of dysphagia (swallowing difficulties) with age and the patient's overall medication regimen.

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PP5.2. DEPRESKRIPCIJA – NOVA PARADIGMA U LEČENJU STARIJIH PACIJENATA

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Starenje populacije i rastuća prevalencija hroničnih bolesti uzrokuju sve češću primenu polifarmacije kod starijih pacijenata. Iako istovremena primena više lekova često predstavlja racionalnu farmakoterapiju, ona je povezana sa povećanim rizikom od neželjenih reakcija na lekove, lek-lek interakcija, smanjenim stepenom adherence i hospitalizacijama. Uzimajući navedeno u obzir, depreskripcija se poslednjih godina razvila kao važna strategija optimizacije farmakoterapije.

Depreskripcija predstavlja sistematski proces identifikacije i isključivanja primene lekova kod kojih potencijalni rizici prevazilaze očekivane koristi, uzimajući u obzir ciljeve lečenja, životni vek, funkcionalni status i preferencije pacijenta. Kroz prezentaciju će biti prikazani savremeni principi depreskripcije i uloge farmaceuta u tom procesu.

Proces depreskripcije obuhvata redovni pregled terapije, procenu indikacija za svaki lek, identifikaciju potencijalno neodgovarajućih lekova, procenu rizika od obustavljanja primene terapije i kontinuirano praćenje pacijenta. Za identifikaciju kandidata za depreskripciju koriste se validirani alati, uključujući Beers kriterijume, STOPP/START kriterijume i različite skale antimuskarinskog (antiholinergičkog) opterećenja. Studije su pokazale da process depreskripcije može biti veoma uspešan za lekove poput benzodiazepina, nesteroidnih antiinflamatornih lekova, inhibitora protonske pumpe i dr.

Iako logističke barijere, poput nedostatka vremena i adekvatne nadoknade, otežavaju praksu, dokazano je da uključivanje farmaceuta u process depreskripcije vodi ka boljim zdravstvenim i ekonomskim ishodima

Depreskripcija predstavlja novu paradigmu u lečenju starijih pacijenata, usmerenu ka individualizovanoj, bezbednoj i racionalnoj farmakoterapiji. Njena uspešna implementacija zahteva multidisciplinarni pristup, pri čemu farmaceuti imaju značajnu ulogu u unapređenju kvaliteta zdravstvene zaštite starije populacije.

PP5.2. DEPRESCRIBING – A NEW PARADIGM IN THE TREATMENT OF OLDER PATIENTS

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Population aging and the increasing prevalence of chronic diseases have led to an increase in polypharmacy among older patients. Although polypharmacy often represents rational pharmacotherapy, it is associated with an increased risk of adverse drug reactions, drug–drug interactions, reduced medication adherence, and hospitalizations. Considering these challenges, deprescribing has emerged in recent years as an important strategy for optimizing pharmacotherapy.

Deprescribing is a systematic process of identifying and discontinuing medications for which the potential risks outweigh the expected benefits, while taking into account treatment goals, life expectancy, functional status, and patient preferences. This presentation will outline contemporary principles of deprescribing and highlight the role of pharmacists in this process.

The deprescribing process includes regular medication reviews, assessment of indications for each medication, identification of potentially inappropriate medications, evaluation of the risks associated with treatment discontinuation, and ongoing patient monitoring. Validated tools used to identify candidates for deprescribing include the Beers Criteria, STOPP/START criteria, and various anticholinergic burden scales. Studies have demonstrated that deprescribing interventions can be successful for medications such as benzodiazepines, nonsteroidal anti-inflammatory drugs, proton pump inhibitors, and others.

Although practical barriers, including limited time and inadequate reimbursement, may hinder implementation, evidence suggests that pharmacist involvement in deprescribing initiatives leads to improved clinical and economic outcomes.

Deprescribing represents a new paradigm in the care of older adults, focused on individualized, safe, and rational pharmacotherapy. Its successful implementation requires a multidisciplinary approach, with pharmacists playing a key role in improving the quality of healthcare for older adults.

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PP5.3. ZLATNE GODINE, BORBA S BOLOM: IZAZOVI TERAPIJE HRONIČNOG BOLA KOD STARIJIH OSOBA

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Hroničan bol je visoko prevalentan u starijih od 65 godina. Najčešći je bol u lokomotornom sistemu (osteoartritis, bol u donjem delu leđa različite etiologije, koštane metastaze), slede bolne neuropatije (dijabetička ili izazvana hemoterapijom) i bol povezan s drugim hroničnim bolestima. Hroničan bol često dovodi do smanjene pokretljivosti, anksioznosti, depresije i socijalne izolacije i značajno narušava kvalitet života.

Ključni izazovi u farmakoterapiji bola u starih su multimorbidnost, polifarmacija i opadanje fizičkih i mentalnih funkcija organizma. Komorbiditeti menjaju odnos koristi i rizika analgetika, paralelna primena s drugim lekovima povećava rizik od interakcija, a smanjeni hepatični i bubrežni klirens, zajedno sa izmenjenim telesnim sastavom menjaju farmakokinetičke procese. Svi ovi faktori sužavaju terapijske mogućnosti i povećavaju rizik od neželjenih efekata lekova.

Paracetamol se preporučuje kao terapija prve linije za blag do umeren bol zbog povoljnog bezbednosnog profila. Sistemska primena nesteroidnih antiiflamatornih lekova (NSAIL) zahteva poseban oprez zbog gastrointestinalnih, kardiovaskularnih i bubrežnih rizika i davanje u najmanjoj efikasnoj dozi tokom najkraćeg vremena. Topikalni NSAIL su znatno bezbedniji i preporučuju se za mnoga bolna stanja mišićno-koštanog sistema. Opioidi se mogu razmotriti za umeren do jak bol, dok su određeni predstavnici tricikličnih antidepresiva ili antiepileptika opcije za neuropatski bol. Za sve lekove, savetuje se princip otpočinjanja terapije malom dozom leka i postepenog povećavanja doze („*start low and go slow*“).

Preporučuje se individualizovan pristup, kombinovanje farmakoloških i nefarmakoloških modaliteta lečenja (fizikalna terapija, vežbanje, kognitivno-bihejvioralne tehnike, uključivanje negovatelja), uz periodično praćenje potrebe za nastavkom/modifikacijom terapije.

PP5.3. GOLDEN YEARS, FIGHTING PAIN: CHALLENGES OF CHRONIC PAIN TREATMENT IN THE ELDERLY

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Chronic pain is highly prevalent in people over 65. The locomotor system is most frequently affected (osteoarthritis, low back pain of various aetiologies, bone metastases), followed by painful neuropathies (diabetic or chemotherapy-induced) and pain associated with other chronic diseases. Chronic pain often leads to reduced mobility, anxiety, depression, and social isolation, and markedly impairs quality of life.

Key challenges in the pharmacological management of pain in older adults are multimorbidity, polypharmacy, and age-related decline in physical and cognitive function. Comorbidities shift the benefit–risk ratio of analgesics; concomitant drugs increase the risk of interactions; and reduced hepatic and renal clearance, together with altered body composition, change pharmacokinetics. Together these factors narrow therapeutic options and increase the likelihood of adverse effects.

Paracetamol is recommended as first-line treatment for mild to moderate pain because of its favourable safety profile. Systemic non-steroidal anti-inflammatory drugs (NSAIDs) require particular caution due to gastrointestinal, cardiovascular, and renal risks and should be used at the lowest effective dose for the shortest possible time. Topical NSAIDs are considerably safer and are preferred for many musculoskeletal conditions. Opioids may be considered for moderate to severe pain, while certain tricyclic antidepressants or antiepileptic drugs are options for neuropathic pain. For all agents, a “start low and go slow” approach, with gradual titration is advised.

Management should be individualised and should combine pharmacological and non-pharmacological modalities (physical therapy, exercise, cognitive–behavioural techniques, and involvement of caregivers) with periodic reassessment of the need to continue, adjust, or discontinue therapy.

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PP5.4. SAVREMENI FARMACEUTSKI PRISTUPI RAZVOJU OFTALMOLOŠKIH PROIZVODA NAMENJENIH TRETMANU OKA KOD STARIJIH PACIJENATA

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Savremeni farmaceutski pristupi razvoju oftalmoloških proizvoda za starije pacijente usmereni su na prevazilaženje anatomskih i fizioloških promena u zrelom životnom dobu, povećanje okularne raspoloživosti lekovitih supstanci i olakšanu samostalnu primenu terapije kod populacije koja se često suočava sa fizičkim i kognitivnim ograničenjima. Značajan porast prevalencije bolesti kao što su sindrom suvog oka, katarakta i senilna degeneracija makule (AMD) nakon 50. godine života dodatno naglašava potrebu za efikasnim i neinvazivnim terapijskim rešenjima.

Za primenu oftalmoloških proizvoda u prednji segment oka, među najvažnijim formulacionim strategijama izdvajaju se primena mukoadhezivnih i in situ gelirajućih sistema. Upotreba biopolimera, poput hitozana i hijaluronske kiseline omogućava interakciju sa mucinom na površini oka i produžava vreme zadržavanja na mestu primene što doprinosi smanjenju učestalosti aplikacije i poboljšanju adherence. Primena nanonosača u sastavu oftalmoloških preparata, uključujući liposome, nanočestice i nanoemulzije olakšava prolazak lekovitih supstanci kroz kornealnu i konjunktivalnu barijeru, a istovremeno omogućava ciljanu isporuku u zadnji segment oka, što predstavlja značajnu prednost u terapiji AMD-a. Uprkos velikom istraživačkom interesovanju za oftalmološke inserte, njihova klinička primjena i komercijalna dostupnost veoma su ograničene.

Dugotrajna primena oftalmoloških proizvoda povećava rizik od neželjenih efekata konzervanasa, zbog čega se savremene formulacije sve više razvijaju bez njihovog prisustva, uz primenu inovativnih višedoznih kontejnera koji omogućavaju očuvanje sterilnosti i jednostavno, kontrolisano doziranje kapi odgovarajuće zapremine. Smanjena manuelna spretnost, slabija vidna oštrina i motoričke poteškoće otežavaju pravilnu primenu terapije kod starijih osoba. Savremeni oftalmološki proizvodi i unapređeni sistemi za njihovu primenu imaju značajan potencijal da poboljšaju uspešnost terapije, ishode lečenja i kvalitet života starijih pacijenata.

PP5.4. MODERN PHARMACEUTICAL APPROACHES TO DEVELOPMENT OF OPHTHALMIC PRODUCTS FOR EYE TREATMENT IN ELDERLY PATIENTS

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Modern pharmaceutical approaches to developing ophthalmic products for elderly patients are focused on overcoming age-related anatomical and physiological changes, enhancing ocular bioavailability, and facilitating independent therapy administration in a population frequently affected by physical and cognitive limitations. The increasing prevalence of disorders such as dry eye syndrome, cataract, and age-related macular degeneration (AMD) after the age of 50 further highlights the need for effective and noninvasive therapeutic strategies.

For drug delivery to the anterior segment of the eye, major formulation approaches include mucoadhesive and in situ gelling systems. The application of biopolymers, such as chitosan and hyaluronic acid, enables interactions with mucin on the ocular surface and prolongs residence time at the site of administration, thereby reducing dosing frequency and improving adherence. The incorporation of nanocarriers, including liposomes, nanoparticles, and nanoemulsions, facilitates drug penetration through corneal and conjunctival barriers and enables targeted delivery to the posterior segment of the eye, providing advantages in AMD therapy. Despite considerable research interest, ophthalmic inserts still have limited clinical application and commercial availability.

Long-term administration of ophthalmic products increases the risk of preservative-related adverse effects; therefore, preservative-free formulations combined with innovative multidose containers are increasingly being developed. These systems ensure sterility and enable simple, controlled delivery of drops with appropriate volume. Reduced manual dexterity, impaired visual acuity, and motor difficulties often hinder proper therapy administration in older adults. Advanced ophthalmic formulations and delivery systems have significant potential to improve therapeutic outcomes and quality of life in elderly patients.

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Sesija 6
Session 6

Zdravlje planete: ekspozom, klimatske promene i održiva farmaceutska praksa

Planetary health: exposome, climate change and sustainable pharmacy practice

Planetary health: exposome, climate change and sustainable pharmacy practice

Zdravlje planete zasniva se na neraskidivoj povezanosti zdravlja ljudi i stanja životne sredine. Izloženost različitim faktorima iz životne sredine, klimatske promene, zagađenje i zahtevne zdravstvene prakse koje troše resurse, sve snažnije utiču na trendove obolevanja i zahtevaju da zdravstveni radnici preispitaju svoju ulogu izvan okvira pojedinačne terapije. U okviru ove sesije upoznaćete se sa značajem ekspozoma u razumevanju uticaja životne sredine na dobrobit ljudi, zdravstvenim posledicama klimatskih promena, kao i konkretnim mogućnostima farmaceutske prakse da doprinese zdravlju planete smanjenjem upotrebe plastike i nastanka otpada u apotekama i biohemijskim laboratorijama. Sesija će povezati naučne, profesionalne i regulatorne aspekte održivog zdravstva i pokazati kako se globalni koncept zdravlja planete može prevesti u svakodnevne, merljive i odgovorne farmaceutske odluke.

Zdravlje planete: ekspozom, klimatske promene i održiva farmaceutska praksa

Planetary health emphasizes the inseparable connection between human health and the natural systems that sustain life. Environmental exposures, climate change, pollution, and resource-intensive healthcare practices increasingly shape disease patterns and challenge health professionals to rethink their role beyond individual patient care. In this session, you will learn how exposome research helps map the complex environmental determinants of human well-being, how climate change affects health risks and healthcare priorities, and how pharmacy practice can contribute to planetary health by reducing plastic use and waste generation in pharmacies and biochemical laboratories. The session will connect scientific, professional, and regulatory perspectives on sustainable healthcare, showing how the global concept of planetary health can be translated into concrete, measurable, and responsible decisions in everyday pharmaceutical practice.

PP6.1. USING HUMAN EXPOSOMICS TO COMPLEMENT AND ENRICH GENOMIC RESEARCH

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Because genetics and the environment interact to drive gene expression, we propose that exposomics must now be incorporated into the multi-omics paradigm to complete the overall biological pathway. Exposomics' groundbreaking tools and life-course framework holistically characterize non-genetic (environment) components of chronic diseases and integrate with multi-omics. This work brings forward the importance of the human exposome as a major driver of gene/protein expression across the life course. Exposome features are noteworthy for multi-omics as they (1) show where and when biodynamic trajectories of gene x environment interactions meet; (2) move beyond single-environmental-factor-centric views; (3) integrate exposomic measurements during and outside of critical windows of susceptibility; (4) provide agnostic discovery and hypothesis-generating studies; and (5) are biodynamic over time. Upon applying these unique features of the human exposome, future human studies are anticipated to revolutionize the integration of genetics and environmental health sciences.

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PP6.2. RISK ASSESSMENT IN A ONE HEALTH ERA

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Planetary and human health is intrinsically interconnected with the health of animals, plants, and ecosystems, necessitating integrated approaches to protect against health risks. Across Europe, environmental pollution contributes to more than 10% of premature deaths (approx. 270,000). Hazardous pollutants released into the environment can also accumulate in food chains, representing important pathways of human exposure. In 2024, roughly ¾ (172 million tonnes) of the total production of chemicals was hazardous to health in the EU. Climate change further increases health risks through heat exposure. According to WHO 175,000 people die from heat-related causes every year in Europe. In parallel, most known and emerging infectious diseases have zoonotic origins(e.g. COVID is assumed to have), while biodiversity loss and land-use change may increase opportunities for pathogen emergence and transmission. Antimicrobial resistance, driven in part by excessive and inappropriate antimicrobial use, causes approximately 35,000 deaths annually from antibiotic-resistant infections in the EU/EEA. These interconnected challenges cannot be effectively addressed through isolated interventions. The One Health approach should provide a transdisciplinary risk-based framework for integrating human, animal, plant, and ecosystem health into the prevention, prediction, detection, and response to health threats, addressing health determinants at their sources—including environmental degradation, pollution, climate change, and biodiversity loss. Its implementation requires systematic collaboration and knowledge exchange across and action among researchers, risk assessors, policymakers, and risk managers. This integrated approach is therefore essential for effectively addressing complex and interconnected health threats in Europe and needs support from researchers like you and I.

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PP6.3. PLASTIČNI OTISAK FARMACIJE: OD SVAKODNEVNE PRAKSE DO ZDRAVLJA PLANETE

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Plastika je neizostavni deo savremene farmaceutske prakse jer obezbeđuje stabilnost, sterilnost, precizno doziranje i bezbednu distribuciju lekova, ali istovremeno doprinosi rastućem ekološkom i zdravstvenom opterećenju. Cilj ovog p rada bio je da identifikuje glavne izvore plastike u farmaceutskoj praksi, sagleda njihove posledice po životnu sredinu i zdravlje ljudi i izdvoji mere kojima farmaceuti mogu doprineti smanjenju plastičnog otiska.

Izvršena je strukturisana pretraga baze PubMed i dokumenata WHO, UNEP i FIP, objavljenih od 2015. do jula 2026. godine, korišćenjem pojmova koji se odnose na farmaceutsku praksu, plastični otpad, farmaceutsku ambalažu, procenu životnog ciklusa i planetarno zdravlje. Glavni izvori plastičnog otpada obuhvataju blistere i bočice, inhalere i aplikatore, ambalažu hladnog lanca, kese za izdavanje, zaštitnu opremu i laboratorijski potrošni materijal. Višeslojna struktura, mali format i kontaminacija ograničavaju reciklažu, dok proizvodnja i odlaganje doprinose potrošnji fosilnih resursa, emisijama i nastanku mikro- i nanoplastike. Zdravstveni rizici povezani su sa izloženošću hemijskim aditivima, među kojima su supstance sa endokrinim, reproduktivnim i razvojnim efektima, kao i sa potencijalnim inflamatornim i oksidativnim efektima mikro- i nanoplastike, pri čemu klinički značaj ovih čestica još nije u potpunosti razjašnjen. Najvažnije mere uključuju racionalnu nabavku i upravljanje zalihama, optimizaciju veličine pakovanja, smanjenje nepotrebnih jednokratnih proizvoda, pravilnu segregaciju, programe povrata i kriterijume održivosti pri nabavci.

Smanjenje plastičnog otiska zahteva pristup zasnovan na životnom ciklusu i hijerarhiji prevencije, smanjenja, ponovne upotrebe i reciklaže, bez ugrožavanja kvaliteta leka i bezbednosti pacijenta. Doslednim izborima u nabavci, organizaciji rada i edukaciji pacijenata, farmaceuti mogu neposredno doprineti smanjenju plastičnog otiska i očuvanju zdravlja ljudi i planete.

PP6.3. PLASTIC FOOTPRINT OF PHARMACY PRACTICE: FROM DAILY ROUTINES TO PLANETARY HEALTH

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Plastic is indispensable to modern pharmacy practice because it supports medicine stability, sterility, accurate dosing, and safe distribution, while also contributing to a growing environmental and health burden. This review aimed to identify the main sources of plastics in pharmacy practice, examine their environmental and human-health implications, and summarize measures through which pharmacists may reduce the plastic footprint.

A structured search of PubMed and WHO, UNEP, and FIP documents published from 2015 to July 2026 was conducted using terms related to pharmacy practice, plastic waste, pharmaceutical packaging, life-cycle assessment, and planetary health.

The main sources of plastic waste include blister packs and bottles, inhalers and applicators, cold-chain packaging, dispensing bags, protective equipment, and laboratory consumables. Multilayer composition, small size, and contamination limit recycling, while production and disposal contribute to fossil-resource use, emissions, and micro- and nanoplastic generation. Health concerns arise from exposure to plastic-associated chemicals, including substances with endocrine, reproductive, and developmental effects, as well as from the potential inflammatory and oxidative effects of micro- and nanoplastics, although their clinical significance remains incompletely understood. Key interventions include rational procurement and inventory management, pack-size optimization, reduction of avoidable single-use products, correct waste segregation, take-back programmes, and sustainability criteria in purchasing.

Reducing pharmacy's plastic footprint requires a life-cycle approach and a hierarchy of prevention, reduction, reuse, and recycling, without compromising medicine quality or patient safety. Through consistent choices in procurement, workflow organization, and patient education, pharmacists can directly contribute to reducing the plastic footprint and protecting both human and planetary health.

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PP6.4. ODGOVORNOSTI I REGULATORNI ZAHTEVI ZA FARMACEUTE U SMANJENJU NASTANKA OTPADA U APOTEKAMA I BIOHEMIJSKIM LABORATORIJAMA

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Kontinuirano nastajanje otpada u apotekama i biohemijskim laboratorijama predstavlja globalni zdravstveni i izazov za životnu sredinu, a uključuje opasne hemikalije, biološki materijal, i lekove kojima je istekao rok upotrebe. Neefikasna praksa u upravljanju otpadom dovela je do zagađenja zemljišta i voda, ometanja ekosistema i pretnja je javnom zdravlju.

Ovaj sažetak ukazuje na značaj urgentnosti potrebe za pomeranje paradigme ka održivoj praksi, integrišući zelenu laboratoriju i medicinu, kao i principe cirkularne ekonomije.

Profesionalne obaveze farmaceuta su fokusirane na hijerarhiju u upravljanju otpadom, koja kao prioritet postavlja prevenciju nastanka otpada. Profesionalna odgovornost u apoteci se proširuje na racionalno propisivanje i izdavanje lekova, precizno upravljanje inventarom i edukaciju pacijenata o prevenciji neadekvatnog odlaganja neiskorišćenih lekova u otpad iz domaćinstva ili otpadne vode. U biohemijskim laboratorijama upravljanje otpadom obuhvata usvajanje principa zelene hemije, optimizaciju eksperimentalnog dizajna u cilju smanjenja upotrebe reagenasa, kao i implementaciju inovativnih tehnika, poput mikrotalasne sterilizacije ili gasifikacije plazmom.

Usklađenost sa regulatornim okvirom je kritična, vođena je propisima kao što je Zakon o očuvanju i obnovi resursa (SAD), kao i EU Direktivama o standardizaciji rukovanja opasnim materijalom. Efikasno upravljanje zahteva institucionalnu posvećenost obuci osoblja, razvoju standardnih operativnih procedura, planova upravljanja otpadom, kao i postepenoj implementaciji „*take-back*" sistema.

Može se zaključiti da aktivna saradnja između naučne zajednice i donosioca odluka jeste esencijalna za obezbeđenje činjenice da razvoj farmacije ne kompromituje integritet životne sredine. Ovakvi nalazi ukazuju na značaj primene pristupa karakterizacije rizika zasnovanom na izloženosti kada se procenjuje efektivnost farmaceutskih proizvoda i usluga.

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PP6.4. REDUCING WASTE GENERATION IN PHARMACIES AND BIOCHEMICAL LABORATORIES: PROFESSIONAL DUTIES AND REGULATORY REQUIREMENTS

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The continuous generation of waste from pharmacies and biochemical laboratories—including hazardous chemicals, biological materials, and expired pharmaceuticals—represents a multifaceted global environmental health challenge. Inefficient management practices lead to soil and water contamination, disrupting ecosystems and threatening public safety. This abstract emphasizes the urgent need for a paradigm shift toward sustainable practices, integrating "green laboratory" medicine and circular economy principles.

Professional duties for pharmacists and laboratory staff are centered on the waste management hierarchy, which prioritizes waste prevention and reduction at the source. In pharmacies, professional responsibility extends to rational dispensing, precise inventory management, and educating patients to prevent the improper disposal of unused drugs in household trash or sewage systems. In biochemical settings, this involves adopting green chemistry, optimizing experimental designs to reduce reagent consumption, and implementing innovative treatment technologies like microwave sterilization or plasma gasification.

Regulatory compliance is a critical requirement, guided by frameworks such as the Resource Conservation and Recovery Act and EU Directives that standardize the handling of hazardous materials. Effective management requires institutional commitment to staff training, the development of Standard Operating Procedures (SOPs), waste management plan and the implementation of robust take-back schemes.

In conclusion, active collaboration between the scientific community and policymakers is essential to ensure that pharmaceutical progress does not compromise environmental integrity. These findings underline the relevance of exposure-based risk assessment for services and products of pharmacists and medical biochemists.

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Sesija 7
Session 7

Farmaceuti kao partneri u integrisanoj zdravstvenoj zaštiti

Pharmacists as partners in integrated patient care

Farmaceuti kao partneri u integrisanoj zdravstvenoj zaštiti

U okviru ove sesije istaknuta je uloga farmaceuta u okviru integrisanih sistema zdravstvene zaštite i interprofesionalnih zdravstvenih timova. Kroz primere iz kliničke prakse prikazano je kako intervencije farmaceuta doprinose poboljšanju adherence, optimizaciji farmakoterapije, podršci starijim i onkološkim pacijentima, kao i jačanju saradnje na različitim nivoima zdravstvenog sistema. Posebna pažnja je posvećena ulozi farmaceuta u bolničkom i vanbolničkom okruženju, uz akcenat na pacijenta, edukaciju i kontinuitet nege. Prikazano je na koji način savremena farmaceutska praksa doprinosi bezbednijoj, efikasnijoj i održivoj zdravstvenoj zaštiti, pozicionirajući farmaceute kao značajne partnere u unapređenju ishoda lečenja i kvaliteta integrisane zdravstvene zaštite.

Pharmacists as partners in integrated patient care

This session highlights the role of pharmacists within integrated healthcare systems and multidisciplinary patient care. Through real-world clinical practice examples, speakers explore how pharmacist-led interventions improve adherence, optimize pharmacotherapy, support elderly and oncology patients, and strengthen collaboration across healthcare settings. Special attention is given to pharmacist's contribution in both hospital and outpatient care, emphasizing patient-centered approaches, education, and continuity of care. It is demonstrated how modern pharmacy practice contributes to safer, more effective, and sustainable healthcare delivery, positioning pharmacists as essential partners in achieving improved clinical outcomes and higher quality integrated healthcare services.

PP7.1. ADHERENCE AS AN INDICATOR OF QUALITY IN INTEGRATED HEALTHCARE

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Integrated healthcare is an approach to organizing healthcare services that aims to provide continuous, coordinated, and person-centred care by connecting different levels of healthcare delivery and healthcare professionals. The quality of integrated care is evaluated using a range of indicators encompassing the structure, processes, and outcomes of care, including patient-reported outcomes.

Medication adherence is one of the key determinants of successful chronic diseases management, particularly among patients with multimorbidity and polypharmacy. Although adherence is often viewed as an individual's behaviour, it is a complex phenomenon influenced by multiple factors related to patient, treatment, healthcare professionals, and organization of the healthcare system. Consequently, improving adherence cannot be achieved through simple, isolated interventions. Instead, evidence indicates that the most effective strategies are complex, multicomponent interventions incorporating patient education, support for self-management, optimization of pharmacotherapy, and follow-up.

In this context, integrated healthcare models may play an important role in improving medication adherence by facilitating care coordination, enhancing communication among healthcare providers, promoting patient involvement in shared decision-making, and enabling the timely identification and resolution of medication-related problems. However, adherence alone cannot serve as a sufficient indicator of the quality of integrated care. Rather, it should be interpreted alongside other quality indicators, including clinical outcomes, medication safety, health-related quality of life, patient experience, and measures of care coordination.

The aim of this lecture is to discuss the opportunities and limitations of using medication adherence as a quality indicator of integrated healthcare and to highlight the need for a multidimensional approach to evaluating models of care.

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PP7.2. INTERVENCIJE KLINIČKOG FARMACEUTA U BOLNIČKOJ I VANBOLNIČKOJ ZDRAVSTVENOJ ZAŠTITI – ANALIZA PRAKSE

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Klinički farmaceuti imaju značajnu ulogu u unapređenju bezbjednosti primjene lijekova, optimizaciji farmakoterapije i racionalnoj primjeni lijekova, posebno u zdravstvenim sistemima sa ograničenim resursima. Ovaj rad analizira usluge kliničkog farmaceuta opisane u pet studija sprovedenih u Republici Srpskoj, koje obuhvataju antimikrobni nadzor, usklađivanje farmakoterapije, optimizaciju gerijatrijske farmakoterapije, intervencije u intenzivnoj medicini i ambulantno farmakoterapijsko savjetovanje. U elektivnoj ortopedskoj hirurgiji, klinički farmaceuti su identifikovali odstupanja od preporučenih smjernica za antimikrobnu profilaksu u pogledu izbora antibiotika, vremena primjene i trajanja terapije, čime su doprinijeli unapređenju antimikrobnog nadzora. Tokom usklađivanja farmakoterapije pri prijemu u bolnicu otkriven je značajan broj nenamjernih medikacijskih odstupanja, što potvrđuje važnost kliničkih farmaceuta u smanjenju farmakoterapijskih grešaka tokom tranzicije njege. Kod gerijatrijskih hospitalizovanih pacijenata, primjena Beers kriterijuma omogućila je identifikaciju potencijalno neadekvatnih lijekova i unaprjeđenje bezbjednosti propisivanja. Kod kritično oboljelih nehirurških pacijenata, klinički farmaceuti su učestvovali u razvoju alternativnog pristupa liječenju hipofosfatemije prilagođenog uslovima ograničenih resursa. Dodatno, ambulantno farmakoterapijsko savjetovanje pokazalo je značaj edukacije pacijenata, revizije terapije i podrške adherenciji. Sveukupno, analizirane studije pokazuju da integracija kliničkih farmaceuta u multidisciplinarne timove doprinosi većoj bezbjednosti primjene lijekova, racionalnijoj farmakoterapiji i unapređenju kvaliteta zdravstvene zaštite. Potrebna su dodatna multicentrična istraživanja radi procjene dugoročnog kliničkog i ekonomskog efekta intervencija kliničkih farmaceuta.

PP7.2. CLINICAL PHARMACIST INTERVENTIONS IN HOSPITAL AND OUTPATIENT HEALTHCARE SETTINGS – INSIGHTS FROM CLINICAL PRACTICE

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Clinical pharmacists play a critical role in improving medication safety, optimizing pharmacotherapy, and supporting rational prescribing, particularly in low-resource healthcare settings. This text analyzes clinical pharmacist services described in five studies conducted in the Republic of Srpska, covering antimicrobial stewardship, medication reconciliation, geriatric pharmacotherapy optimization, critical care interventions, and ambulatory pharmacotherapy counseling. In elective orthopedic surgery, clinical pharmacists identified deviations from guideline-recommended antimicrobial prophylaxis in antibiotic selection, timing, and duration, thereby contributing to improved antimicrobial stewardship. In hospital admission medication reconciliation, pharmacist-led interventions detected numerous unintended medication discrepancies, underscoring the importance of clinical pharmacists in reducing medication errors during transitions of care. Among hospitalized geriatric patients, the Beers Criteria helped identify potentially inappropriate medications and promote safer prescribing in older adults. In critically ill nonsurgical patients, clinical pharmacists contributed to developing an alternative hypophosphatemia treatment approach adapted to countries with limited healthcare resources, demonstrating the importance of context-specific pharmacotherapeutic strategies. Additionally, services provided through an ambulatory pharmacotherapy counseling unit highlighted the value of pharmacist-led patient education, medication review, and adherence support in optimizing long-term outpatient pharmacotherapy. Collectively, these studies demonstrate that integrating clinical pharmacists into multidisciplinary healthcare teams improves medication safety, rational drug use, and quality of care across hospital and outpatient settings. Their role appears particularly valuable in low-resource environments, where healthcare systems frequently face organizational and financial constraints. Further multicenter studies are needed to evaluate the long-term clinical and economic impact of clinical pharmacist interventions.

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PP7.3. ULOGA FARMACEUTA U MULTIDISCIPLINARNOM PRISTUPU FARMAKOTERAPIJI GERIJATRIJSKIH PACIJENATA

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Cilj studije je da se identifikuju vrste i uzroci terapijskih problema (TP) kod gerijatrijskih pacijenata, kao i intervencije kliničkog farmaceuta tokom primene modela farmaceutske zdravstvene zaštite (MFZZ) i tokom konsultacija koje su tražili lekari, kao i da se istraže razlike u stavovima između lekara i farmaceuta kako bi se postiglo bolje razumevanje i obezbedila bolja saradnja.

Istraživanje je izvedeno kao prospektivna studija na gerijatrijskom odeljenju tercijarne zdravstvene ustanove. Implementiran je MFZZ i definisana lista farmaceutskih usluga, kao i pacijenti i lekovi sa visokim rizikom. Podaci su prikupljeni tokom pregleda terapije od strane kliničkog farmaceuta i tokom konsultacija. Upoređeni su vrste, uzroci terapijskih problema, kao i intervencije farmaceuta.

Farmaceuti su identifikovali 197 TP tokom primene MFZZ. Najčešće detektovan problem bili su potrencijalni neželjeni događaji u vezi sa primenom lekova, zatim nelečene indikacije i nepotrebni lekovi u terapiji. U skladu sa tim, više od polovine intervencija farmaceuta bilo je započinjanje ili prekid uzimanja lekova, nakon čega slede promene doziranja. Tokom 107 konsultacija sa lekarima, najčešće prijavljeni terapijski problem bio je efikasnost lečenja, što je zahtevalo promene lekova ili doze. Antibiotici su najčešće bili povezani sa TP. Nivo prihvatanja intervencija farmaceuta bio je viši kod konsultacija (98,1%) u poređenju sa MFZZ (68,5%).

Lekari su se više konsultovali sa farmaceutima o pitanjima vezanim za efikasnost lečenja, dok su farmaceuti obraćali pažnju na bezbednost lekova. Predstavljeni rezultati mogu pomoći lekarima da bolje razumeju principe farmaceutskih usluga i da pomognu farmaceutim tokom njihove svakodnevne prakse, u cilju postizanja bolje saradnje u multidisciplinarnim timovima i unapređenja farmakoterapije pacijenata.

PP7.3. PHARMACISTS AT THE CORE OF GERIATRIC CARE: ENHANCING OUTCOMES THROUGH MULTIDISCIPLINARY PHARMACOTHERAPY

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The study aimed to identify common drug-related problems (DRP), their causes, and pharmacists' interventions during the pharmaceutical care (PC) model and physician consultations, and to explore the difference in attitudes between physicians and pharmacists to achieve a better understanding and to provide better cooperation.

We conducted a single-center prospective study at the geriatric department of a tertiary academic hospital. A PC model was implemented and defined a list of pharmacy services, high-risk patients, and medications. Data were collected during pharmacists' medication reviews according to the PC model and physician consultations. DRPs, causes and intervention frequency during PC model and physician consultations were compared.

Pharmacists identified 197 DRPs during the PC model, with primarily adverse drug events (possibly) occurring, followed by untreated indication and unnecessary drug treatment. In line with that, more than half of pharmacists' interventions were initiation or discontinuation of the drugs, followed by dosage changes. During 107 physician consultations, the most reported DRP was treatment efficacy, which demanded drug or dosage changes. Antibiotics were the top medicines related to DRPs during the PC model and physician consultations. The level of acceptance of pharmacists' interventions was higher for physician consultations (98.1%) compared to the PC model (68.5%).

Physicians consulted pharmacists more on questions related to treatment effectiveness, while pharmacists paid attention to medication safety. The presented results might help physicians better understand the principles of pharmacy care services and guide pharmacists during their daily practice, achieve better cooperation in multidisciplinary teams, and improve the quality of patient care.

PP7.4. DOPRINOS FARMACEUTA EDUKACIJI ONKOLOŠKIH PACIJENATA I MULTIDISCIPLINARNA SARADNJA

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Savremeni pristupi lečenju malignih bolesti zahtevaju od farmaceuta da preuzmu nove uloge, poput savetovanja i edukacije pacijenata o pravilnoj primeni terapije, kao i da učestvuju u radu multidisciplinarnog zdravstvenog tima. Kroz individualno savetovanje, kontinuiranu podršku i praćenje primene lekova, farmaceuti postaju aktivni učesnici u procesu lečenja pacijenata, zajedno sa drugim zdravstvenim profesionalcima.

Cilj rada je prikaz doprinosa farmaceuta edukaciji onkoloških pacijenata kroz razvoj standardizovane farmaceutske usluge savetovanja prilikom izdavanja oralne onkološke terapije. Usluga se zasniva na strukturiranoj i dokumentovanoj komunikaciji između farmaceuta i pacijenta, sa ciljem unapređenja adherence, smanjenja grešaka u primeni lekova i povećanja efikasnosti i bezbednosti lečenja.

Proces savetovanja obuhvata inicijalnu procenu znanja pacijenta o primeni terapije, edukaciju za pravilnu primenu lekova, kontrolno praćenje i procenu zadovoljstva pruženom uslugom. Poseban akcenat stavljen je na pravilan način upotrebe lekova, postupanje u slučaju propuštene doze, pravilno čuvanje i bezbedno rukovanje lekovima, rano prepoznavanje neželjenih reakcija i potencijalnih interakcija sa drugim lekovima i hranom, kao i identifikaciju faktora koji mogu uticati na smanjenu adherencu. U slučajevima pojave neželjenih efekata ili problema povezanih sa terapijom, ključna je pravovremena komunikacija između pacijenta i celog zdravstvenog tima.

Usluga je namenjena farmaceutima na svim nivoima zdravstvene zaštite i podrazumeva kontinuiranu saradnju farmaceuta sa lekarima i drugim članovima zdravstvenog tima u cilju pružanja kvalitetnije farmaceutske zdravstvene zaštite. Ovakav pristup doprinosi aktivnijem uključivanju onkoloških pacijenata u proces lečenja, kako bi primena terapije bila bezbedna i efikasna.

Zahvalnica

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PP7.4. PHARMACISTS' CONTRIBUTION TO ONCOLOGY PATIENT EDUCATION AND MULTIDISCIPLINARY COLLABORATION

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Modern approaches to cancer treatment require pharmacists to take on new roles, such as patient counselling and education on the appropriate use of medicines, as well as active participation within the multidisciplinary healthcare team. Through individual counselling, continuous support, and medication monitoring, the pharmacists become active participants in the treatment process alongside other healthcare professionals.

This work aims to present pharmacists' contribution to oncology patient education through the development of a standardised pharmaceutical counselling service provided during the dispensing of oral oncology therapy. The service is based on structured and documented communication between the pharmacist and the patient, aiming to improve adherence, reduce medication errors, and increase the effectiveness and safety of therapy.

The counselling process includes an initial assessment of the patient's knowledge regarding therapy, education on proper medication use, follow-up monitoring, and evaluation of patient satisfaction with the service provided. Particular emphasis is placed on proper medication use, management of missed doses, proper storage and safe handling of medicines, early recognition of adverse reactions and potential interactions with other medicines and food, as well as identification of factors contributing to reduced adherence. In cases of adverse effects or therapy-related problems, timely communication between the patient and the healthcare team is crucial.

The service is intended for pharmacists at all levels of healthcare and involves continuous collaboration among pharmacists, physicians, and other healthcare professionals to provide higher-quality pharmaceutical care. This approach contributes to more active involvement of oncology patients in the treatment process, ensuring safe and effective therapy.

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Sesija 8
Session 8

Savremena dostignuća u istraživanju biomarkera

Advances in biomarker science

Savremena dostignuća u istraživanju biomarkera

Istraživanje novih biomarkera značajnih za ranu procenu rizika od razvoja bolesti, preciznu dijagnostiku i praćenje terapijskog odgovora počiva na nekoliko fundamentalnih zahteva: tačnosti, specifičnosti, dostupnosti i pravovremenosti. Savremena nauka o biomarkerima polazi od toga da je za otkriće pouzdanih indikatora bolesti neophodan holistički pristup, u čijem je centru pacijent sa svojim individualnim karakteristikama, te da multimarkerski paneli predstavljaju optimalan model u istraživanju, ali i u kliničkoj praksi. U okviru sesije razmatrani su novi biomarkeri nekih od najvažnijih javnozdravstvenih izazova, kao što su MASLD i kardiovaskularne bolesti, kao i biomarkeri značajni za praćenje toka i unapređenje ishoda trudnoće.

Advances in biomarker science

Investigation of novel biomarkers that are relevant for early risk assessment, precise diagnostics of diseases, and monitoring of therapeutic responses is based on several requirements: accuracy, specificity, accessibility and timeliness. Contemporary science acknowledges that the discovery of reliable biomarkers requires a holistic approach, centered on patients and their individual characteristics, whereas multi-marker panels represent optimal models, both in biomarker research and in their clinical application. This session will address novel biomarkers related to some of the most important public health challenges, such as MASLD and cardiovascular diseases, as well as biomarkers relevant for monitoring pregnancy and improving pregnancy outcomes.

PP8.1. MULTI-OMICS METODE U RAZVOJU BIOMARKERA ZA MASLD – GENOMIKA I TRANSKRIPTOMIKA

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Multifaktorska priroda masne bolesti jetre udružene sa metaboličkom disfunkcijom (*metabolic dysfunction–associated steatotic liver disease*, MASLD) obuhvata interakciju genetičke predispozicije, epigenetičke regulacije i uticaja faktora sredine. Genetički i epigenetički biomarkeri su stoga dragoceni alati za rano dijagnostikovanje, procenu rizika i praćenje progresije od steatoze do naprednijih stadijuma bolesti.

Nekoliko genetičkih varijanti je značajno povezano sa MASLD-om. Među njima su najviše proučavani polimorfizmi gena PNPLA3 (*patatin-like phospholipase domain-containing 3*), TM6SF2 (*transmembrane 6 superfamily member 2*) i MBOAT7 (*membrane-bound O-acyltransferase domain-containing 7*). Ove varijante utiču na metabolizam lipida u jetri, akumulaciju triglicerida i inflamaciju.

Epigenetički mehanizmi, a naročito mikroribonukleinske kiseline (miRNA, miR), igraju ključnu ulogu u posttranskripcionoj regulaciji ekspresije gena i progresiji bolesti. Među njima miR-122 najviše je zastupljena u jetri. Njena ekspresija je povišena u ranoj fazi steatoze, ali opada tokom progresije ka steatohepatitisu i fibrozi, što ukazuje na regulatornu funkciju zavisnu od stadijuma bolesti. Zajedno sa miR-21, miR-34a stimuliše akumulaciju triglicerida u hepatocitima tokom ranih faza bolesti i doprinosi aktivaciji inflamatornih i fibrotičkih puteva kako MASLD napreduje. Inhibicija miR-192, negativnog regulatora metabolizma lipida u jetri, povećava ekspresiju enzima uključenih u sintezu mononezasićenih masnih kiselina, čime se stimuliše deponovanje triglicerida. miR-155 aktivira signalne puteve koji stimulišu sintezu holesterola i triglicerida u jetri, dok miR-375 podstiče ekspresiju gena povezanih sa sintezom triglicerida i formiranjem masnih kapi.

Biomarkeri genomike i transkriptomike predstavljaju važne činioce patoloških procesa u MASLD-u. Njihova kombinovana analiza predstavlja obećavajuću neinvazivnu alternativu biopsiji jetre u dijagnostici, određivanju stadijuma i dugoročnom praćenju bolesti.

PP8.1. MULTI-OMICS METHODS IN DEVELOPING BIOMARKERS OF MASLD - GENOMICS AND TRANSCRIPTOMICS

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The multifactorial nature of metabolic dysfunction–associated steatotic liver disease (MASLD) reflects the interplay of genetic susceptibility, epigenetic regulation, and environmental influences. Genetic and epigenetic biomarkers are therefore valuable for early diagnosis, risk stratification, and monitoring progression from steatosis to more advanced disease stages.

Several genetic variants have been significantly associated with MASLD. Among these, polymorphisms in the patatin-like phospholipase domain-containing 3 (PNPLA3), transmembrane 6 superfamily member 2 (TM6SF2), and membrane-bound O-acyltransferase domain-containing 7 (MBOAT7) genes are the most extensively studied. These variants influence hepatic lipid metabolism, triglyceride accumulation, and inflammatory responses.

Epigenetic mechanisms, particularly microribonucleic acids (miRNA, miR), play a critical role in post-transcriptional gene regulation and disease progression. Among these, miR-122 is the most abundant liver-specific miRNA. It is upregulated in early steatosis but declines during the transition to steatohepatitis and fibrosis, suggesting a stage-dependent regulatory function. Along with miR-21, miR-34a promotes triglyceride accumulation in hepatocytes during early disease stages and contributes to the activation of inflammatory and fibrotic pathways as MASLD advances. Inhibition of miR-192, a negative regulator of hepatic lipid metabolism, increases the expression of enzymes involved in monounsaturated fatty acid synthesis, thereby promoting triglyceride accumulation. miR-155 activates signalling pathways that enhance hepatic cholesterol and triglyceride synthesis, while miR-375 upregulates genes associated with triglyceride synthesis and lipid droplet formation.

Genomic and transcriptomic biomarkers represent important factors in the pathogenic processes of MASLD. Their combined assessment offers promise as a non-invasive alternative to liver biopsy for disease diagnosis, staging, and longitudinal monitoring.

PP8.2. PERSONALIZOVANA DIJAGNOSTIKA I TERAPIJA KOD VASKULARNIH BOLESNIKA

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Vaskularne bolesti predstavljaju vodeći uzrok morbiditeta i mortaliteta u svetu, pri čemu konvencionalni terapijski pristupi često ne uvažavaju značajnu interindividualnu varijabilnost u odgovoru na lečenje. Odluka o invazivnom lečenju najčešće podrazumeva poređenje rizika od bolesti i rizika od intervencije. Personalizovana farmakoterapija, zasnovana na genetskim, biohemijskim i kliničkim karakteristikama bolesnika, omogućava optimizaciju izbora leka i doziranja, čime se povećava efikasnost i smanjuje rizik od neželjenih reakcija. Cilj rada je sagledavanje savremenih dostignuća u oblasti personalizovane farmakoterapije kod vaskularnih bolesnika, sa posebnim osvrtom na primenu farmakogenetike u antikoagulantnoj i antiagregacionoj terapiji.

Sproveden je pregled relevantne literature objavljene u poslednjoj deceniji u bazama PubMed, Scopus i Web of Science, uz analizu kliničkih smernica vodećih svetskih udruženja iz oblasti vaskularne medicine i farmakogenomike.

Polimorfizmi gena *CYP2C9* i *VKORC1* značajno utiču na metabolizam varfarina, dok varijante *CYP2C19* određuju efikasnost klopidogrela. Genotipizacija pre uvođenja terapije omogućava preciznije doziranje i smanjuje učestalost krvarenja i tromboznih komplikacija. Biomarkeri poput D-dimera, hsCRP-a i lipoproteina(a) doprinose stratifikaciji kardiovaskularnog rizika i prilagođavanju terapije statinima i PCSK9 inhibitorima. Postoje brojne druge metode koje doprinose individualnom sagledavanju bolesnika shodno morfologiji aterosklerotskog plaka na karotidnoj arteriji, proceni biomehaničkih karakteristika abdominalne aneurizme. Ove metode najčešće kombinuju imidžing sa biohemijskim parametrima.

Personalizovani pristup u farmakoterapiji vaskularnih bolesnika predstavlja paradigmu savremene medicine. Integracija farmakogenetike, biomarkera i kliničkih parametara u svakodnevnu praksu zahteva multidisciplinarnu saradnju i kontinuiranu edukaciju, ali nudi značajan potencijal za poboljšanje ishoda lečenja i kvaliteta života pacijenata.

PP8.2. PERSONALIZED DIAGNOSTICS AND THERAPY IN VASCULAR PATIENTS

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Vascular diseases represent a leading cause of morbidity and mortality worldwide, while conventional therapeutic approaches often fail to account for substantial interindividual variability in treatment response. The decision on invasive treatment usually balances disease and intervention risks. Personalized pharmacotherapy, based on patient's genetic, biochemical and clinical characteristics, enables optimization of drug selection and dosing, thereby increasing efficacy and reducing the risk of adverse reactions. Herein we review contemporary advances in personalized pharmacotherapy in vascular patients, emphasising application of pharmacogenetics in anticoagulant and antiplatelet therapy.

A review of relevant literature published in the last decade was conducted using PubMed, Scopus and Web of Science databases, including analysis of leading clinical guidelines in the field of vascular medicine and pharmacogenomics.

Polymorphisms of the *CYP2C9* and *VKORC1* genes significantly affect warfarin metabolism, while *CYP2C19* variants determine the efficacy of clopidogrel. Pre-treatment genotyping enables precise dosing and reduces the incidence of bleeding and thrombosis. Biomarkers such as D-dimer, hsCRP and lipoprotein(a) contribute to cardiovascular risk stratification and adjustment of lipid-lowering therapy. Numerous methods contribute to the individualized assessment of patients, including evaluation of atherosclerotic plaque morphology at the carotid artery and assessment of the biomechanical characteristics of abdominal aortic aneurysm. These methods most commonly combine imaging with biochemical parameters.

A personalized approach to pharmacotherapy in vascular patients represents a paradigm of contemporary medicine. Integration of pharmacogenetics, biomarkers and clinical parameters into everyday practice requires multidisciplinary cooperation and continuous education, but offers significant potential for improving treatment outcomes and quality of life of patients.

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US8.1. PRIMENA TRANSKRIPTOMIKE I METODA MAŠINSKOG UČENJA ZA OTKRIVANJE SPECIFIČNIH MOLEKULARNIH OBRAZACA CIRKULIŠUĆIH MIKRO RNK U AKUTNOM INFARKTU MIOKARDA

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Cirkulišuće mikroRNK (miRNK) sve više se prepoznaju kao minimalno invazivni i osetljivi biomarkeri akutnog infarkta miokarda (AIM), ali je njihova klinička primena ograničena varijabilnošću analitičkih pristupa i nedovoljnom primenom integrativnih multivarijantnih modela. Cilj studije bio je razvoj pouzdanog miRNK panela za razlikovanje AIM od stabilne angine pektoris (SAP) na osnovu podataka sekvenciranja malih RNK iz plazme osiromašene trombocitima, uspostavljanje reproduktivnog toka rada od eksplorativne faze do validacije, kao i procena da li odabrane miRNK mogu služiti kao prognostički biomarkeri za ranu predikciju redukcije funkcije leve komore (LVEF<50%) godinu dana nakon AIM.

U studiju je uključeno 574 pacijenta (286 AIM, 288 SAP), raspoređenih u eksplorativnu (n=200) i validacionu kohortu (n=374). U eksplorativnoj fazi sprovedeno je sekvenciranje malih RNK sledeće generacije, praćeno bioinformatičkim analizama u programu R (DESeq2, sPLS-DA, LASSO regresija sa unakrsnom validacijom i bootstrap uzorkovanjem). Dizajnirani paneli su evaluirani ROC analizom i potvrđeni kvantitativnim PCR-om (qPCR). Multivarijabilna logistička regresija korišćena je za procenu sposobnosti odabranih miRNK u predikciji smanjene LVEF.

Panel od pet miRNK (miR-133a-3p, miR-208b-3p, miR-378a-3p, miR-143-3p, miR-99a-5p) pokazao je visoku diskriminativnu sposobnost za razlikovanje AIM i SAP u obe kohorte (AUC=0,95; 95%CI:0,93–0,98 i AUC=0,95; 95%CI:0,92–0,97). Dodatno, miR-143-3p je, zajedno sa inicijalnim LVEF, bila nezavisni prediktor očuvane funkcije leve komore (LVEF≥50%) 12 meseci nakon AIM (AUC=0,847; 95%CI:0,782–0,912).

Predloženi panel miRNK iz plazme osiromašene trombocitima pokazao je visoku dijagnostičku tačnost i međuplatformsku reproduktivnost, dok miR-143-3p pruža dodatnu prognostičku vrednost za oporavak srčane funkcije i može doprineti formiranju klinički primenljivih biomarkerskih panela.

Zahvalnica

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US8.1. TRANSCRIPTOMIC AND INTEGRATIVE MACHINE LEARNING ANALYSIS REVEALS SPECIFIC CIRCULATING MICRORNA SIGNATURES IN ACUTE MYOCARDIAL INFARCTION

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Circulating microRNAs (miRNAs) are increasingly recognized as sensitive, minimally invasive biomarkers for acute myocardial infarction (AMI), but clinical translation is hindered by variability in analytical approaches and limited use of integrative multivariate models. This study aimed to develop a reliable miRNA panel from small RNA sequencing data of platelet-poor plasma for discriminating AMI from stable angina pectoris (SAP), establish a reproducible workflow from discovery to validation, and evaluate whether selected miRNAs may also serve as prognostic biomarkers for early prediction of LVEF reduction (LVEF<50%) one year post-AMI.

574 patients (286 AMI, 288 SAP) were divided into discovery (n=200) and validation (n=374) cohorts. In the discovery phase, platelet-poor plasma samples underwent small RNA sequencing, followed by bioinformatics analyses in R, including DESeq2, sPLS-DA, and LASSO regression with cross-validation and bootstrap resampling. Candidate panels were evaluated using ROC analysis and validated by qPCR. Multivariable logistic regression was applied to assess the ability of selected miRNAs to predict depressed LVEF (LVEF<50%) one year post-AMI.

A five-miRNA panel (miR-133a-3p, miR-208b-3p, miR-378a-3p, miR-143-3p, miR-99a-5p) showed excellent discrimination between AMI and SAP in both cohorts (AUC=0.95; 95%CI:0.93–0.98 and AUC=0.95; 95%CI:0.92–0.97). Additionally, miR-143-3p, with baseline LVEF, independently predicted preserved function (LVEF≥50%) 12 months post-AMI (AUC=0.847, 95%CI:0.782–0.912).

The sequencing-derived miRNA signature in platelet-poor plasma demonstrated high diagnostic accuracy and cross-platform reproducibility, while miR-143-3p added prognostic value, supporting its potential role in clinically applicable biomarker panels.

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US8.2. NOVI BIOMARKERI GESTACIONE GOJAZNOSTI: POTENCIJAL ZA NEONATALNE ISHODE

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Poznato je da su veličina i sastav čestica lipoproteina visoke gustine (HDL) izmenjeni u gojaznosti. Sa druge strane, trudnoća je praćena povećanjem telesne mase i značajnom adaptacijom metabolizma lipida. Zbog toga je cilj ove studije bio ispitati longitudinalne promene u sterolnom sastavu i distribuciji HDL čestica, kao potencijalnih biomarkera gestacione gojaznosti, i njihovu vezu sa neonatalnim ishodima. Istraživanje je obuhvatilo 124 trudnice, 58 sa preporučenim, i 66 sa prekomernim povećanjem težine u toku trudnoće. Za kvantifikaciju neholesterolskih sterola unutar HDL čestica primenjena je HPLC/MS-MS metoda, dok je gradijent gel elektroforeza bila korišćena za separaciju HDL subfrakcija. Nivoi dezmosterola i latosterola unutar HDL čestica su u grupi trudnica sa preporučenim povećanjem težine bili najviši tokom trećeg trimestra (P<0,001; P<0,01). Nasuprot tome, ovaj period trudnoće je kod trudnica sa prekomernim povećanjem težine bio praćen padom koncentracije kampesterola u sklopu HDL-a (P<0,05). Dodatno, u ovoj grupi ispitanica je uočen značajno niži relativni udeo HDL_{3a} subfrakcije u drugom trimestru u odnosu na ostale periode trudnoće (P<0,05). Daljom analizom je pokazana pozitivna asocijacija između HDL_{2b} čestica i APGAR skora, dok je sa druge strane ovaj rani neonatalni ishod bio u negativnoj korelaciji sa manjim HDL_3 subfrakcijama. Rezultati ove studije ukazali su da prekomerno povećanje težine tokom trudnoće može doprineti izmenama metabolizma HDL čestica, što bi posledično moglo imati uticaj na razvoj nepovoljnih neonatalnih ishoda.

US8.2. NOVEL BIOMARKERS OF GESTATIONAL OBESITY: POTENTIAL IMPLICATIONS FOR NEONATAL OUTCOMES

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It is known that the size and composition of high-density lipoprotein (HDL) particles are altered in obesity. On the other hand, pregnancy is accompanied by weight gain and a significant adaptation of lipid metabolism. Therefore, the aim of this study was to examine longitudinal changes in the sterol composition and distribution of HDL particles, as potential biomarkers of gestational obesity, and their relationship with neonatal outcomes. The research included 124 pregnant women, 58 with recommended and 66 with excessive weight gain during pregnancy. For the quantification of non-cholesterol sterols within HDL particles, the HPLC/MS-MS method was applied, while gradient gel electrophoresis was used for the separation of HDL subfractions. The levels of desmosterol and lathosterol within HDL particles were highest in the group of pregnant women with recommended weight gain during the third trimester (P<0.001; P<0.01). In contrast, this period of pregnancy in women with excessive weight gain was accompanied by a decrease in campesterol concentration within HDL (P<0.05). Additionally, a significantly lower relative proportion of the HDL_{3a} subfraction was observed in this group of subjects in the second trimester compared to other periods of pregnancy (P<0.05). Further analysis showed a positive association between HDL_{2b} and APGAR score, whereas this early neonatal outcome was negatively correlated with smaller HDL_3 subfractions. The results of this study indicated that excessive weight gain during pregnancy may contribute to changes in the metabolism of HDL particles, which could consequently have an impact on the development of adverse neonatal outcomes.

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PRO8.1. METABOLIČKI BIOMARKERI – ISKUSTVA SA PROJEKTA „HIGH-DENSITY LIPOPROTEIN METABOLOME RESEARCH TO IMPROVE PREGNANCY OUTCOME (HI-MOM)"

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Projekat HI-MOM bio je usmeren ka ispitivanju potencijalnih metaboličkih biomarkera za unapređenje predikcije i razumevanje komplikacija u trudnoći, sa posebnim fokusom na metabolom lipoproteina visoke gustine (HDL-om). Iako se povećanje koncentracije HDL-holesterola tokom trudnoće tradicionalno smatra zaštitnom metaboličkom adaptacijom, funkcionalnost HDL čestica zavisi od njihovog složenog lipidnog i proteinskog sastava, koji je do sada bio nedovoljno istražen. Primenom HPLC/MS-MS, qPCR, imunoeseja, elektroforeze i spektrofotometrije, analizirane su longitudinalne promene HDL-oma tokom fizioloških trudnoća i kardiometaboličkih komlikacija trudnoće. Rezultati su pokazali značajne promene u veličini HDL čestica, markerima sinteze i apsorpcije holesterola, sfingolipidima, kao i ekspresiji gena za fosfolipidni transferni protein kod trudnica koje su razvile komplikacije. Navedene promene bile su praćene smanjenim antiinflamatornim i antioksidativnim kapacitetom HDL-a, ukazujući na izraženo remodelovanje HDL čestica u trudnoći sa komplikacijama. Jedan od ključnih ciljeva projekta bio je identifikovati nove metaboličke biomarkere za ranu procenu rizika od komplikacija. Multimarkerski prediktivni modeli pokazali su najveću dijagnostičku tačnost kada su tradicionalni klinički i demografski faktori rizika kombinovani sa specifičnim komponentama HDL-oma, posebno sfingozin-1-fosfatom, kao i inflamatornim markerom rezistinom. Dobijeni rezultati potvrđuju značaj integracije konvencionalnih i metabolomskih biomarkera u proceni rizika tokom trudnoće. Pored toga, utvrđena je povezanost između lipidnog metabolizma majke i neonatalnih ishoda, što ukazuje da gestacione adaptacije lipidoma zavise od nutritivnog statusa žene pre trudnoće i mogu uticati na zdravlje novorođenčeta.

Sveukupno, rezultati projekta HI-MOM predstavljaju osnovu za razvoj personalizovanih pristupa u praćenju trudnoće, proceni rizika i predviđanju ishoda.

Zahvalnica

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PRO8.1. METABOLIC BIOMARKERS-EXPERIENCES FROM THE PROJECT „HIGH-DENSITY LIPOPROTEIN METABOLOME RESEARCH TO IMPROVE PREGNANCY OUTCOME (HI-MOM)"

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The HI-MOM project investigated the potential of metabolic biomarkers to improve the prediction and understanding of pregnancy complications, with a particular focus on the high-density lipoprotein metabolome (HDL-ome). While HDL-cholesterol levels are traditionally considered protective during pregnancy, HDL functionality depends on its complex lipid and protein composition, which remains insufficiently explored.

Using HPLC/MS-MS, qPCR, immunoassays, electrophoresis, and spectrophotometry, we characterized longitudinal changes in the HDL-ome during physiological pregnancy and cardiometabolic pregnancy complications. Our findings revealed significant alterations in HDL particle size, cholesterol synthesis and absorption markers, sphingolipids, and phospholipid transfer protein gene expression during cardiometabolic complications of pregnancy. These changes were accompanied by impaired anti-inflammatory and antioxidative functions of HDL, indicating substantial HDL remodeling in adverse pregnancy outcomes. A major objective of the project was the identification of novel metabolic biomarkers for early risk assessment. Multimarker prediction models demonstrated the highest diagnostic accuracy when traditional clinical and demographic risk factors were combined with specific HDL-ome components, particularly sphingosine-1-phosphate, and the inflammatory marker resistin. These findings highlight the added value of integrating conventional and metabolomic biomarkers in pregnancy risk stratification. The project also demonstrated associations between maternal lipid metabolism and neonatal outcomes, suggesting that gestational lipid adaptations are influenced by pre-pregnancy nutritional status and may affect newborn health.

Overall, the HI-MOM project supports the future development of personalized approaches for pregnancy monitoring, risk prediction, and outcome evaluation

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PRO8.2. PREEKLAMPSIJA KROZ PRIZMU ĆELIJSKE SENESCENCIJE: ISKUSTVA PEMPNET PROJEKTA

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Preeklampsija (PE) predstavlja jedan od vodećih uzroka maternalnog i fetalnog morbiditeta i mortaliteta, a njena kompleksna patofiziologija i dalje nije u potpunosti razjašnjena. Projekat *Preeclampsia Metabolic Phenotype Network* – PEMPNet, realizovan u okviru poziva „Saradnja srpske nauke sa dijasporom" Fonda za nauku RS, imao je za cilj ispitivanje serumskih markera ćelijske senescencije kod trudnica koje su tokom trudnoće razvile PE, kao i transfer znanja i ovladavanje multipleks metodologijom.

Ćelijska senescencija predstavlja zaustavljanja ćelijskog ciklusa, najčešće u G1 fazi, kao odgovor na različite stimuluse i ćelijska oštećenja. Koncept senescencije potiče iz istraživanja Leonarda Hayflicka, koji je pokazao da normalne humane ćelije imaju ograničen replikativni kapacitet (Hayflickov limit). Danas se zna da senescencija ima ambivalentnu ulogu, jer sa jedne strane sprečava proliferaciju oštećenih ćelija i učestvuje u tumorskoj supresiji, regeneraciji i remodelovanju tkiva, dok sa druge strane senescentne ćelije pokazuju složeni proinflamatorni odgovor poznat kao sekretorni fenotip povezan sa starenjem (engl. *Ssenescence-Associated Secretory Phenotype* - SASP), koji sudeluje u hroničnoj inflamaciji i oštećenju tkiva.

Na Odeljenju za nefrologiju i hipertenziju Klinike *Mayo* prethodno je uspostavljen jedinstven životinjski model PE, u kojem su detektovane promene u koncentracijama markera senescencije. PEMPNet je osmišljen sa ciljem da se ovi nalazi ispitaju u nezavisnoj humanoj kohorti prikupljenoj u Srbiji, kroz analizu 60 markera senescencije multipleks metodom u serumu trudnica sa PE i kontrolnoj grupi trudnica.

Rezultati ovog projekta mogli bi doprineti boljem razumevanju metaboličkog i inflamatornog fenotipa PE, kao i identifikaciji potencijalnih biomarkera za ranu procenu rizika i razvoj novih terapijskih pristupa.

Zahvalnica

Projekat PEMPNet realizovan je uz podršku Fonda za nauku Republike Srbije, u okviru programa „Saradnja srpske nauke sa dijasporom" (br. 6498707).

PRO8.2. PREECLAMPSIA FROM THE PERSPECTIVE OF CELLULAR SENESCENCE: INSIGHTS FROM THE PEMPNET PROJECT

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Preeclampsia (PE) is one of the leading causes of maternal and fetal morbidity and mortality, while its pathophysiology remains unclear. The Preeclampsia Metabolic Phenotype Network – PEMPNet project, implemented within the "Serbian Science and Diaspora Collaboration" programme of Science Fund of the Republic of Serbia, aimed to investigate cellular senescence serum markers in pregnant women who developed PE during pregnancy, as well as to support knowledge transfer and training in multiplex methodology.

Cellular senescence is characterized by G1 cell-cycle arrest in response to cellular stress or damage. The concept of senescence stems from Leonard Hayflick's work, which showed that normal human cells have a limited replicative capacity, known as the Hayflick limit. Senescence has an ambivalent role: it limits the proliferation of damaged cells and supports tumour suppression, regeneration, and tissue remodelling, while senescent cells may also promote chronic inflammation and tissue damage through the senescence-associated secretory phenotype – SASP.

A unique PE animal model established at the Division of Nephrology and Hypertension, Mayo Clinic, revealed changes in senescence marker concentrations. PEMPNet was designed to investigate these findings in an independent human cohort collected in Serbia, through multiplex analysis of 60 senescence markers in the serum of pregnant women with PE and pregnant controls.

The results of this project may contribute to a better understanding of the metabolic and inflammatory phenotype of PE, as well as to the identification of potential biomarkers for early risk assessment and the development of new therapeutic approaches.

Acknowledgement

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Sesija 9
Session 9

Savremeni pristupi u psihofarmakologiji:
od novih mehanizama delovanja do personalizovane terapije

Contemporary approaches in psychopharmacology:
from novel mechanisms of action to personalized therapy

Savremeni pristupi u psihofarmakologiji: od novih mehanizama delovanja do personalizovane terapije

Rezultati savremenih istraživanja dovode do intenzivnih promena u oblasti psihofarmakologije. Ova sesija posvećena je savremenim pristupima u razvoju i primeni lekova u psihijatriji: od novih mehanizama delovanja sagledanih sa farmakološkog i kliničkog stanovišta, preko mesta biljnih lekovitih proizvoda kod psihijatrijskih poremećaja, do optimizacije terapije escitalopramom primenom farmakogenetskih, farmakokinetičkih i psihometrijskih biomarkera. Sesija povezuje fundamentalna istraživanja sa svakodnevnom kliničkom praksom i teži da odgovori na pitanje kako personalizovani pristup može unaprediti efikasnost i bezbednost farmakoterapije psihijatrijskih oboljenja.

Contemporary approaches in psychopharmacology: from novel mechanisms of action to personalized therapy

Rapid development and transformation are being observed in the field of psychopharmacology.This session is focused on contemporary approaches to the development and clinical use of psychiatric medications: from novel mechanisms of action examined through pharmacological and clinical perspectives, to the role of herbal medicinal products in psychiatric disorders and the optimization of escitalopram therapy based on pharmacogenetic, pharmacokinetic, and psychometric biomarkers. The session connects fundamental research with everyday clinical practice and aims to answer the question of how a personalized approach can improve the efficacy and safety of pharmacotherapy in psychiatric diseases.

PP9.1. NOVI MEHANIZMI DELOVANJA U RAZVOJU LEKOVA U PSIHIJATRIJI: DOKAZI SA FARMAKOLOŠKOG STANOVIŠTA

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Teško da je postojao paradoksalniji razvoj lekova u bilo kojoj oblasti farmakoterapije nego u psihijatriji. U prve dve decenije posle drugog svetskog rata, kada se vrlo malo znalo o osnovnim neurohemijskim i receptorskim supstratima, uvedene su desetine lekova namenjenih ublažavanju afektivnih, neurotičnih i psihotičnih simptoma. U isto vreme, uprkos mnogo većem znanju u drugim oblastima, razvijen je samo ograničeni broj novih lekova koji deluju na unutrašnje organe. Tokom poslednjih 60 godina, istraživanja u neuronaukama i neuropsihofarmakologiji rasla su eksponencijalno, ali to je dovelo samo do ograničene optimizacije postojećih mehanizama delovanja psihofarmaka, kao što su selektivni inhibitori preuzimanja serotonina ili hipnotici koji deluju dominantno preko $GABA_A$ receptora koji sadrže α1 podjedinicu. Akumulacija novih saznanja bila je manja u gotovo svim drugim organskim sistemima, ali je dovela do daleko dubljih proboja u terapijskim mogućnostima u poređenju sa centralnim nervnim sistemom. Trenutno stanje otkrića i razvoja u psihofarmakologiji ograničeno je manjkom velikih ulaganja, ali, srećom, ne i manjkom ideja i novih pristupa. Modulacija receptora povezanih sa aminima u tragovima, β_3 adrenoreceptora, različitih populacija $GABA_A$ receptora ili NMDA receptora za glutamat samo su neke od molekularnih strategija koje se u skorije vreme istražuju u potrazi za novim lekovima za lečenje depresije, manije, shizofrenije, anksioznosti i drugih psihijatrijskih poremećaja. Kao komplementaran pristup, neki od ovih i drugih koncepata usmereni su na specifične niše, poput ublažavanja kognitivnih oštećenja u depresiji. Dokazivanje translacijske validnosti novih mehanizama delovanja verovatno je najveća prepreka efikasnijem razvoju lekova u psihijatriji, što zahteva potpunije integrisanje prekliničkih i kliničkih pristupa.

Zahvalnica
Autor izražava zahvalnost na naučnom i intelektualnom doprinosu više od 20 studenata doktorskih studija koji su bili deo zajedničkog istraživačkog tima u prethodne dve decenije.

PP9.1. NOVEL MECHANISMS OF ACTION IN DRUG DEVELOPMENT IN PSYCHIATRY: EVIDENCE FROM A PHARMACOLOGICAL STANDPOINT

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There has hardly been a more paradoxical trajectory of drug development in any field of pharmacotherapy than in psychiatry. In the first two decades after World War II, when very little was known about the underlying neurochemical and receptor substrates, dozens of drugs indicated for relieving affective, neurotic, and psychotic symptoms were introduced. At the same time, despite a much larger body of basic knowledge in other areas, only a limited number of novel drugs were developed that act on internal organs. Over the last 60 years, neuroscience and neuropsychopharmacological research have grown exponentially, yet this has led to only limited optimization of existing psychopharmacological mechanisms of action, such as selective serotonin reuptake inhibitors or hypnotics that act predominantly through $GABA_A$ receptors containing the α1 subunit. In almost all organ systems other than the central nervous system, the accumulation of new knowledge has been less extensive but has produced far more profound improvements in therapeutic modalities. The current state of discovery and development in psychopharmacology is hampered by a scarcity of large investments but fortunately not by a lack of ideas and new approaches. Modulation of trace amine–associated receptors, β_3 adrenoceptors, distinct subpopulations of $GABA_A$ receptors, or NMDA receptors for glutamate are only a few of the molecular strategies pursued recently in the quest for novel drugs to treat depression, mania, schizophrenia, anxiety, and other psychiatric disorders. As a complementary approach, some of these and other concepts target specific niches, such as alleviating cognitive impairment in depression. Demonstrating the translational validity of novel mechanisms of action is arguably the greatest hurdle to more efficacious drug development in psychiatry and calls for more complete integration of preclinical and clinical approaches.

Acknowledgement
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PP9.2. NOVI MEHANIZMI DELOVANJA U RAZVOJU ANTIPSIHOTIKA: DOKAZI SA KLINIČKOG STANOVIŠTA

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Od otkrića antipsihotika pre više od 60 godina njihov mehanizam dejstva je povezan sa blokadom dopaminskih D2 receptora. Nova saznanja iz neuronauka su uslovila pojavu antipsihotika sa drugačijim mehnizmom dejstva, ali još uvek vezanih za dopaminske D2 receptore. U tu grupu spadaju takozvani antipsihotici II generacije koji, pored značajnog afiniteta za dopaminske D2 receptore, imaju i značajan afinitet za serotoninske 5HT2 receptore. Novi napredak je ostvaren razvojem parcijalnih D2 dopaminskih agonista. Ovi lekovi bi praktično činili III generaciju antipsihotika. Na ovaj način priča o antipsihoticima koji deluju prevashodno putem dejstva na dopaminske receptore je kompletirana. Ipak, značajan procenat pacijenata koji nezadovoljavajuće reaguju na ove antipsihotike, zatim značajni neželjeni efekti i, konačno, praktično odsustvo dejstva na negativne i pre svega kognitivne simptome shizofrenije uslovljava razvoj novih antipsihotika. Uz sve to, svi do sada poznati mehanizmi dejstva na dopaminske receptore su praktično postsinaptičke lokalizacije, dok naučna sazanja ukazuju da je dominantna disfunkcija lokalizovana presinaptički, na telu dopaminskog neurona. Sve ovo zahteva razvoj novih antipsihotika sa drugačijim mehanizom dejstva.

Ovo predavanje daje kritički pregled novih farmakoloških pristupa i dostupnih kliničkih dokaza. Posebna pažnja posvećena je muskarinskim agonistima, pre svega kombinaciji ksanomelin–trospijum. Njena efikasnost u kratkotrajnim studijama kod akutne šizofrenije je potvrđena, uz drugačiji profil neželjenih efekata, koji su pretežno gastrointestinalni i holinergički. Razmatraju se i agonisti TAAR1 receptora, modulatori glutamatergičke neurotransmisije, uključujući inhibitore transportera glicina, kao i lekovi usmereni na serotoninske receptore.

PP9.2. NEW MECHANISMS OF ACTION IN THE DEVELOPMENT OF ANTIPSYCHOTICS: EVIDENCE FROM A CLINICAL PERSPECTIVE

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For 60 years since the discovery of antipsychotics, their action has been linked to blockade of dopamine D2 receptors. New neuroscientific insights have led to antipsychotics with different mechanisms of action, yet still related to dopamine D2 receptors. This group includes the second-generation antipsychotics, which, in addition to affinity for dopamine D2 receptors, also have affinity for serotonin 5-HT2 receptors. Further progress came with partial dopamine D2 agonists. These drugs constitute the third generation of antipsychotics. In this way, the story of antipsychotics that act primarily through effects on dopamine receptors has been completed.

Nevertheless, many patients show an unsatisfactory response to these antipsychotics, together with substantial adverse effects and, ultimately, a virtual lack of efficacy against negative and, above all, cognitive symptoms of schizophrenia, which necessitates the development of new antipsychotics. In addition, all mechanisms of action on dopamine receptors are practically of postsynaptic localization, whereas scientific evidence indicates that the dominant dysfunction is localized presynaptically, on the cell body of the dopamine neuron. All of this calls for the development of new antipsychotics with different mechanisms of action.

This lecture provides a critical review of novel pharmacological approaches and the available clinical evidence. Particular attention is devoted to muscarinic agonists, primarily the combination of xanomeline–trospium. Its efficacy in short-term studies in acute schizophrenia has been confirmed, along with a different adverse-effect profile that is predominantly gastrointestinal and cholinergic. TAAR1 receptor agonists, modulators of glutamatergic neurotransmission (including glycine transporter inhibitors), and agents targeting serotonin receptors are also discussed.

PP9.3. PRIMENA BILJNIH LEKOVITIH PROIZVODA KOD PSIHIJATRIJSKIH POREMEĆAJA

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Psihijatrijski poremećaji predstavljaju značajan problem današnjeg društva. Primena sintetskih lekova sa sobom nosi i znatne neželjene efekte te stoga raste interes za biljne lekovite proizvode, koji deluju višestrukim terapijskim mehanizmima i omogućavaju relativno bezbednu primenu.

Radi olakšanja simptoma depresije mogu se primenjivati biljni lekovi na bazi herbe kantariona (*Hypericum perforatum*). Meta-analize su potvrdile da biljni lekoviti proizvodi na bazi žiga i cveta šafrana (*Crocus sativus*) značajno smanjuju simptome depresije. Slično, klinički je potvrđeno da rizom kurkume (*Curcuma longa*) ublažava simptome depresije, naročito kada se koristi u formulacijama sa visokom bioraspoloživošću.

Biljni lekoviti proizvodi na bazi korena valerijane (*Valeriana officinalis*), cvasti hmelja (*Humulus lupulus*) i etarskog ulja cveta lavande (*Lavandula angustifolia*) su pokazali značajan anksiolitički efekat. Smanjenje nivoa stresa i anksioznosti uočeno je i prilikom primene proizvoda na bazi lista matičnjaka (*Melissa officinalis*), herbe pasiflore (*Passiflora incarnata*), korena ašvagande (*Withania somnifera*) i cvasti kamilice (*Matricaria recutita*).

Efikasnost u smanjenju hiperaktivnosti i poboljšanju pažnje i koncentracije, u kliničkim studijama, ispoljili su proizvodi na bazi ekstrakta kore primorskog bora (*Pinus pinaster*), korena žen-šena (*Panax ginseng*) i lista ginka (*Ginkgo biloba*). Klinički značajno smanjenje opsesivno-kompulzivnih simptoma i prateće anksioznosti pokazao je proizvod na bazi cveta boražine (*Echium amoenum*).

Biljni lekoviti proizvodi imaju različite mehanizme delovanja, poput antioksidativnog, antiinflamatornog i neuroprotektivnog. Prilikom primene neophodan je oprez zbog blagih ali ipak mogućih neželjenih delovanja i interakcija sa drugim lekovima. Buduća istraživanja treba da se fokusiraju na validaciju bezbednosti prilikom njihove dugoročne primene i optimizaciju doziranja.

PP9.3. APPLICATION OF HERBAL MEDICINAL PRODUCTS IN PSYCHIATRIC DISORDERS

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Psychiatric disorders represent a significant problem in contemporary society. The use of synthetic drugs is also associated with substantial side effects. Therefore, there is growing interest in herbal medicinal products, which act through multiple therapeutic mechanisms and allow relatively safe use.

Herbal medicines based on St John's wort aerial parts (*Hypericum perforatum*) can be used to relieve symptoms of depression. Meta-analyses showed that products based on saffron and flower (*Crocus sativus*) significantly reduce symptoms of depression. Similarly, rhizome of turmeric (*Curcuma longa*), was clinically proven to alleviate symptoms of depression, especially when used in formulations with high bioavailability.

Herbal medicinal products based on valerian root (*Valeriana officinalis*), hop flowers (*Humulus lupulus*) and essential oil of lavender flower (*Lavandula angustifolia*) showed a significant anxiolytic effect. A reduction in stress and anxiety levels was observed with products based on lemon balm leaf (*Melissa officinalis*), passionflower aerial parts (*Passiflora incarnata*), ashwagandha root (*Withania somnifera*) and chamomile flower (*Matricaria recutita*).

Clinical studies demonstrated that products based on extracts of pine bark (*Pinus pinaster*), ginseng root (*Panax ginseng*) and ginkgo leaf (*Ginkgo biloba*) are effective in reducing hyperactivity and improving attention and concentration. A product based on borage flower (*Echium amoenum*) showed a clinically significant reduction in obsessive-compulsive symptoms and associated anxiety.

Herbal medicinal products exhibit various mechanisms of action, including antioxidant, anti-inflammatory and neuroprotective effects. When using them, caution is required because mild but still possible side effects and interactions may occur. Future research should focus on validating their long-term safety and dosage optimisation.

PP9.4. OPTIMIZACIJA TERAPIJE ESCITALOPRAMOM NA OSNOVU FARMAKOGENETSKIH, FARMAKOKINETIČKIH I PISHOMETRIJSKIH BIOMARKERA

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Interindividualna varijabilnost nivoa escitaloprama u plazmi tokom započinjanja terapije dozom od 10 mg/dan može dovesti do subterapijskih koncentracija i neuspešnog lečenja. Cilj studije je bio da se proceni da li uzrast i *CYP2C19/CYP2D6* genotip mogu identifikovati pacijente sa povećanim rizikom od subterapijske izloženosti, kao i da li prilagođavanje terapije vođeno terapijskim praćenjem koncentracija leka (TDM) smanjuje nedovoljnu izloženost. Retrospektivna studija preseka TDM baze podataka pacijenata u Norveškoj sa poznatim *CYP2C19/CYP2D6* genotipom obuhvatila je 1.999 osoba tretiranih escitalopram u dozi od 10 mg/dan. Prospektivna kohortna studija u Srbiji, u kojoj je nakon četiri nedelje terapije escitalopramom u dozi od 10 mg/dan sprovedeno TDM-vođeno prilagođavanje doze, obuhvatila je 121 ambulantnog pacijenta, od kojih je 92 završilo praćenje. Pacijenti su stratifikovani u kategorije sa predviđenom niskom, srednjom i visokom izloženosti na osnovu uzrasta i genotipa. Primarni ishod bio je udeo pacijenata sa koncentracijama nižim od 15 ng/mL. Mlađi uzrast i viša aktivnost enzima su nezavisno uslovljavali niže koncentracije escitaloprama i objašnjavali su 26% varijabilnosti koncentracije. Subterapijske koncentracije zabeležene su kod 77% (95% CI, 73–82%) pacijenata u kategoriji niske izloženosti, 54% (51–57%) u kategoriji srednje izloženosti i 37% (33–42%) u kategoriji visoke izloženosti. Dve nedelje nakon započinjanja terapije, subterapijske koncentracije utvrđene su kod 63% (22/35) pacijenata u kategoriji predviđene niske izloženosti. TDM-vođeno prilagođavanje doze smanjilo je učestalost nedovoljne izloženosti sa 48% (44/92) na 14% (13/92). Uzrast i CYP2C19/CYP2D6 genotip mogu pomoći u identifikaciji pacijenata sa povećanim rizikom od subterapijske izloženosti tokom započinjanja terapije escitalopramom, dok TDM može usmeravati individualizovano prilagođavanje terapije.

Zahvalnica
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PP9.4. ESCITALOPRAM TREATMENT OPTIMIZATION BY USING PHARMACOGENETIC, PHARMACOKINETIC, AND PSYCHOMETRIC BIOMARKERS

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High inter-individual variability in escitalopram exposure during initiation at 10 mg/day may result in subtherapeutic concentrations and treatment failure. The objective was to assess whether age and *CYP2C19/CYP2D6* genotypes identify patients at increased risk of subtherapeutic exposure, and whether therapeutic drug monitoring (TDM)- guided adjustment reduces underexposure. Method: A retrospective cross-sectional study of TDM records from *CYP2C19/CYP2D6*-genotyped patients in Norway included 1,999 individuals receiving escitalopram 10 mg/day. An independent prospective cohort from Serbia, with TDM-guided dose adjustment after four weeks of 10 mg/day treatment, included 121 outpatients, of whom 92 completed follow-up. Patients were stratified into age- and genotype-predicted low-, intermediate-, and high-exposure categories. The primary outcome was the proportion of patients with concentrations below 15 ng/mL. Secondary outcomes were ln-transformed concentration and the proportion of patients with concentrations above 40 ng/mL. Results: Younger age and higher CYP2C19 and CYP2D6 activity scores were independently associated with lower escitalopram concentrations, explaining 26% of the variability. Subtherapeutic concentrations were observed in 77% (95% CI, 73–82%) of low-, 54% (51–57%) of intermediate-, and 37% (33–42%) of highexposure categories. Two weeks after initiation, subtherapeutic concentrations were found in 63% (22/35) of patients in the predicted low-exposure category compared with 39% (22/57) in the intermediate/high-exposure category. TDM-guided dose adjustment reduced underexposure from 48% (44/92) to 14% (13/92). Conclusion: Age and *CYP2C19/CYP2D6* genotype may help identify patients at increased risk of subtherapeutic exposure during initiation at 10 mg/day, while TDM can guide individualized adjustment.

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Sesija 10
Session 10

Farmacija u doba veštačke inteligencije

Pharmacy in the age of artificial intelligence

Farmacija u doba veštačke inteligencije

Veštačka inteligencija (AI) dovodi do promene farmaceutske nauke i prakse, menjajući ne samo raspoložive alate, već i način na koji stičemo znanja i donosimo odluke. Primena AI ubrzava otkriće i razvoj lekova, dizajn i evaluaciju rezultata kliničkih ispitivanja, pripremu i evaluaciju regulatorne dokumentacije, a sve veću ulogu dobija i u savetovanju pacijenata i komunikaciji sa stručnom i opštom javnošću. U okviru ove sesije, istaknut je značaj različitih tehnoloških, etičkih i regulatornih aspekata za dalji razvoj farmacije u doba veštačke inteligencije. Kroz prikaz odabranih studija slučaja, razmatrani su metodološki aspekte primene AI u različitim fazama razvoja leka, uključujući strukturisanje upita, povezivanje modela sa proverljivim izvorima podataka, procenu pouzdanosti generisanih odgovora, kvalitet ulaznih podataka, reproduktivnost i neophodnost eksperimentalne validacije u regulatornim i GxP okvirima.

Pharmacy in the age of artificial intelligence

Artificial intelligence (AI) is transforming pharmaceutical science and practice, changing not only available tools, but also the way we acquire knowledge and make decisions. AI is accelerating drug discovery and development, the design and evaluation of clinical trials, and the preparation and evaluation of regulatory documentation, including an increasing role in patient counselling and in communication with professional and general audiences. This session highlights the importance of different technological, ethical and regulatory aspects for further advancement of pharmacy in the age of artificial intelligence. Through selected case studies, the session addresses methodological aspects of AI application in different stages of pharmaceutical development, including prompt structuring, linking models to verifiable data sources, assessing the reliability of generated outputs, input data quality, reproducibility, and the necessity of experimental validation within regulatory and GxP frameworks.

PP10.1. FARMACIJA U DOBA VEŠTAČKE INTELIGENCIJE: GDE SMO I KUDA IDEMO?

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Farmacija se, kao i druge zdravstvene profesije, prema tehnološkim inovacijama oduvek odnosila sa mešavinom nade i opreza: od prvih farmakopeja i industrijske proizvodnje lekova do digitalizacije zdravstvenog sistema, svaka nova tehnologija dočekivana je sa sumnjom, da bi vremenom postala profesionalni standard. Veštačka inteligencija (AI) postavlja ovo pitanje radikalnije nego ikada, jer ne menja samo alate, već i način na koji dolazimo do znanja i donosimo odluke. Odgovor na pitanje gde smo obuhvata sve segmente farmacije: AI ubrzava otkrivanje i razvoj lekova, dizajn i analizu kliničkih ispitivanja, razvoj digitalnih blizanaca pacijenta, farmakovigilancu, kao i pripremu i evaluaciju regulatorne dokumentacije, gde EMA i FDA već sprovode pilot-projekte podrške proceniteljima, a sve veću ulogu dobija i u savetovanju pacijenata i komunikaciji sa stručnom i opštom javnošću. Pitanje kuda idemo nije, međutim, samo tehnološko, već i etičko i regulatorno. Tehnologija nije sama po sebi neprijateljska prema čoveku, ali nikada nije ni neutralna, jer poprima obeležja onih koji je stvaraju, finansiraju i koriste, te mora ostati u službi ljudskog dostojanstva i dobrobiti pacijenata. Evropski Akt o veštačkoj inteligenciji (EU AI Act), prvi sveobuhvatni pravni okvir za AI, usvojen 2024. godine sa faznom primenom do 2027, uvodi pristup zasnovan na proceni rizika, klasifikaciju AI sistema u medicini i farmaciji kao visokorizičnih i obaveze transparentnosti, objašnjivosti (*explainability*), ljudskog nadzora, kvaliteta i sledljivosti podataka kroz sve faze životnog ciklusa leka. Kuda ćemo stići zavisiće manje od tehnologije, a više od spremnosti struke da ekspertizu, etičke principe i standarde razvija istim tempom kojim se razvija AI.

PP10.1. PHARMACY IN THE AGE OF ARTIFICIAL INTELLIGENCE: WHERE ARE WE AND WHERE ARE WE HEADED?

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Pharmacy, like other health professions, has always approached technological innovation with a mixture of hope and caution: from the first pharmacopoeias and the industrialisation of medicines manufacturing to the digitalisation of the health system, each new technology was initially met with scepticism, only to become part of the professional standard over time. Artificial intelligence (AI) raises this question more radically than ever, because it changes not only our tools but also the way we acquire knowledge and make decisions. The answer to the question of where we are encompasses every segment of pharmacy: AI is accelerating drug discovery and development, the design and analysis of clinical trials, the development of patient digital twins, pharmacovigilance, and the preparation and evaluation of regulatory documentation, where the EMA and FDA are already running pilot projects to support human assessors, while it is also playing an ever greater role in patient counselling and in communication with professional and general audiences. The question of where we are headed, however, is not merely technological, but also ethical and regulatory. Technology is not inherently hostile to humanity, yet it is never neutral, for it bears the imprint of those who create, fund and use it, and it must therefore remain in the service of human dignity and patient wellbeing. The European Artificial Intelligence Act (EU AI Act), the first comprehensive legal framework for AI, adopted in 2024 with phased application until 2027, introduces a risk-based approach, the classification of AI systems in medicine and pharmacy as high-risk, and obligations of transparency, explainability, human oversight, and data quality and traceability across the entire lifecycle of a medicine. Where we arrive will depend less on the technology itself than on the readiness of the profession to develop its expertise, ethical principles and standards at the same pace at which AI evolves.

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PP10.2. PRIMENA GENERATIVNE VEŠTAČKE INTELIGENCIJE U FARMACEUTSKOJ NAUCI I PRAKSI

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Generativna veštačka inteligencija (GenAI), zasnovana na velikim jezičkim, multimodalnim i drugim *foundation* modelima, otvara nove mogućnosti za prikupljanje, obradu i interpretaciju podataka u farmaceutskim naukama. Njena primena je trenutno najizraženija u ranim fazama otkrivanja lekova, uključujući *de novo* dizajn molekula, optimizaciju vodećih jedinjenja, predviđanje fizičko-hemijskih, biofarmaceutskih i farmakokinetičkih karakteristika, virtuelni skrining i integraciju eksperimentalnih i literaturnih skupova podataka. Sve značajnija primena GenAI očekuje se u farmaceutskoj tehnologiji, gde doprinosi racionalnijem dizajnu farmaceutskih oblika, izboru funkcionalnih ekscipijenasa, razvoju nosača lekova, optimizaciji procesa izrade ili proizvodnje i povezivanju sastava, procesa i performansi formulacije. U predavanju će biti razmotrena primena GenAI alata u savremenom formulacionom razvoju i dizajnu preparata, sistematizaciji farmaceutsko-tehnoloških podataka iz literature, preformulacionoj proceni aktivnih supstanci, izboru ekscipijenasa, razvoju nosača i sistema isporuke, predviđanju kompatibilnosti i stabilnosti, kao i primeni QbD zasnovanih razvojnih strategija i procene rizika. Kroz odabrane studije slučaja biće prikazano kako se GenAI modeli mogu koristiti za istraživanje formulacionog prostora, poređenje tehnoloških pristupa, povezivanje kritičnih atributa kvaliteta sa svojstvima formulacije i procesa i racionalno planiranje eksperimentalne potvrde razvojnih hipoteza. Biće razmotrena i hibridizacija generativnih i mehanističkih modela u konceptu digitalnih blizanaca (*digital twins*). Poseban akcenat biće stavljen na metodološke aspekte primene GenAI, uključujući strukturisanje upita, povezivanje modela sa proverljivim izvorima podataka, procenu pouzdanosti generisanih odgovora, kvalitet ulaznih podataka, reproduktivnost i neophodnost eksperimentalne validacije u regulatornim i GxP okvirima. GenAI ne zamenjuje farmaceutsku ekspertizu, već je proširuje kroz sistematičnije mapiranje formulacionog prostora, generisanje razvojnih hipoteza i preciznije usmeravanje eksperimenata ka potvrdi kvaliteta, stabilnosti i očekivanih bioperformansi preparata.

Zahvalnica
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PP10.2. APPLICATIONS OF GENERATIVE ARTIFICIAL INTELLIGENCE IN PHARMACEUTICAL SCIENCE AND PRACTICE

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Generative artificial intelligence (GenAI), based on large language, multimodal and other foundation models, opens new possibilities for data collection, processing and interpretation in pharmaceutical sciences. Its application is currently prominent in early drug discovery, including de novo molecular design, lead optimization, prediction of physicochemical, biopharmaceutical and pharmacokinetic properties, virtual screening and integration of experimental and literature-based datasets. GenAI is also gaining relevance in pharmaceutical technology, where it can support rational design of dosage forms, selection of functional excipients, development of carriers, process optimization and linking composition, process parameters and performance. The lecture will discuss the application of GenAI tools in formulation development and product design, including systematization of pharmaceutical-technological data from literature, preformulation assessment of active substances, excipient selection, development of carriers and delivery systems, prediction of compatibility and stability, and implementation of QbD-based strategies and risk assessment. Selected case studies will demonstrate how GenAI models can be used to explore the formulation space, compare technological approaches, link critical quality attributes with formulation and process properties, and plan experimental confirmation of development hypotheses. The hybridization of generative and mechanistic models within the concept of digital twins will also be considered. Special emphasis will be placed on methodological aspects of GenAI application, including prompt structuring, verifiable data sources, reliability of generated outputs, input data quality, reproducibility and experimental validation within regulatory and GxP frameworks. GenAI does not replace pharmaceutical expertise, but extends it through systematic formulation-space mapping, hypothesis generation and more precise guidance of experiments confirming quality, stability and expected bioperformance.

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Sesija 11
Session 11

Izazovi radne snage u zdravstvenom sistemu
Workforce challenges in healthcare

Izazovi radne snage u zdravstvenom sistemu

Bez adekvatnog broja farmaceuta i farmaceutskih tehničara odgovarajućeg znanja, iskustva i veština nema ni bezbednosti pacijenta u zdravstvenom sistemu.

U okviru ove sesije, po prvi put će biti predstavljeni rezultati panevropskog istraživanja o radnoj snazi u bolničkim apotekama, u kontekstu bezbednosti pacijenata i održivosti zdravstvenog sistema. Povećano opterećenje, starenje radne snage, odlazak zdravstvenih radnika u druge zemlje, ograničene mogućnosti napredovanja i neusklađenost broja zaposlenih sa rastućim potrebama pacijenata, ugrožavaju dostupnost i kvalitet farmaceutske zdravstvene zaštite. Kroz primere iz evropskih zdravstvenih sistema, biće predstavljen značaj strateškog kadrovskog planiranja, preraspodele zadataka, digitalizacije, i razvoja novih kompetencija koje obezbeđuju održivost zdravstvene radne snage.

Budućnost farmacije zavisi od toga koliko danas ulažemo u ljude koji će je voditi sutra.

Workforce challenges in healthcare

Can there be patient safety within the healthcare system without an adequate number of pharmacists and pharmacy technicians possessing the necessary knowledge, experience, and skills?

In this session, the first presentation of results from a pan-European study on the hospital pharmacy workforce, viewed through the lens of patient safety and healthcare system sustainability will be presented. Increased workloads, aging workforce, cross-border mobility of healthcare professionals, limited career advancement opportunities, and a mismatch between staffing levels and growing patient needs are all jeopardizing the accessibility and quality of pharmaceutical care. Drawing on examples from European healthcare systems, the session will highlight the importance of strategic workforce planning, task redistribution, digitalization, and the development of new competencies to ensure the sustainability of the healthcare workforce.

The future of pharmacy starts with investing today in the people who will lead it tomorrow.

PP11.1. ZDRAVSTVO I RADNA SNAGA – PROMENE KOJE DOLAZE

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Zdravstveni sistemi širom sveta suočavaju se sa istovremenim izazovima starenja stanovništva i radne snage u zdravstvu, porasta hroničnih bolesti, ubrzanog razvoja zdravstvenih tehnologija i nedostatka zdravstvenih radnika.

Cilj ovog rada je da se, na osnovu analize aktuelnih trendova i pokazatelja, ukaže na ključne promene koje će oblikovati zdravstvenu radnu snagu, kao i da se identifikuju prioriteti za planiranje ljudskih resursa u zdravstvu.

Analizirani su aktuelni izveštaji o radnoj snazi u zdravstvu ključnih međunarodnih organizacija, poput *Organisation for Economic Co-operation and Development (OECD), World Health Organisation (WHO)*, kao i drugih udruženja zdravstvenih radnika, poput *Advanced Pharmacy Australia (AdPhA) i American Society of Health-System Pharmacists (ASHP)* koji se odnose na razvoj zdravstvene radne snage, digitalnu transformaciju u zdravstvu i unapređenje kompetencija zdravstvenih radnika.

Ukupna radna snaga u zdravstvu, koju čine lekari, medicinske sestre i babice, stomatolozi i farmaceuti povećala se globalno za 52%, sa 44,8 na 10.000 stanovnika, koliko je zabeleženo 2006. godine, na 67,9 na 10.000 stanovnika u 2025. godini. Najveći porast zabeležen je u kategoriji medicinskih sestara, za gotovo 60%. Između 2013. i 2023. godine, prosečan broj farmaceuta, po glavi stanovnika u zemljama OECD-a povećao se za 10%, dostigavši 86 farmaceuta na 100.000 stanovnika. S druge strane, nestašice bolničkih farmaceuta u Australiji su samo u 2025. godini, dovele do smanjenja kliničkih aktivnosti farmaceuta za 75%. Zdravstveni sistemi koji budu uspešno uskladili tehnološki napredak sa razvojem kompetencija zaposlenih biće otporniji, efikasniji i sposobniji da odgovore na rastuće potrebe stanovništva.

PP11.1. HEALTHCARE WORKFORCE – CHANGES AHEAD

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Healthcare systems worldwide are facing simultaneous challenges: aging population and healthcare workforce, a rise in chronic diseases, the rapid development of health technologies, and shortages of healthcare professionals.

This review aims to highlight the key changes that will shape the healthcare workforce and to identify priorities for human resource planning in healthcare, based on current trends and indicators.

An analysis was conducted of recent reports on the healthcare workforce from key international organizations—such as the Organisation for Economic Co-operation and Development (OECD) and the World Health Organization (WHO)—as well as professional associations like Advanced Pharmacy Australia (AdPhA) and the American Society of Health-System Pharmacists (ASHP). These reports address workforce development, digital transformation in healthcare, and the enhancement of healthcare professionals' competencies.

The total healthcare workforce—comprising physicians, nurses and midwives, dentists, and pharmacists—has increased globally by 52%, rising from 44.8 per 10,000 inhabitants in 2006 to 67.9 per 10,000 inhabitants in 2025. The largest increase was observed in the nursing category, rising by nearly 60%. Between 2013 and 2023, the average number of pharmacists per capita in OECD countries increased by 10%, reaching 86 pharmacists per 100,000 inhabitants. Conversely, shortages of hospital pharmacists in Australia led to a 75% reduction in pharmacists' clinical activities in 2025 alone. Healthcare systems that successfully align technological progress with the development of employee competencies will be more resilient, efficient, and capable of meeting the growing needs of the population.

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PP11.2. FROM BLAME TO LEARNING IN CHALLENGING TIMES

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Healthcare systems are under increasing pressure from workforce shortages, rising workload, technological complexity, fragmented care pathways and emotional exhaustion. Pharmacy is directly exposed to these pressures because pharmacists play a central role in medication safety, continuity of care, transitions between care settings and the prevention of avoidable harm. When a safety incident occurs, however, many organisations still react by asking who made the mistake rather than what system conditions allowed the harm to reach the patient.

This conference argues for a shift from blame to learning, without removing accountability. Just Culture offers a fair framework for distinguishing honest mistakes, at-risk behaviours and reckless behaviours, while recognising the organisational duty to design safer systems. In continental European legal contexts, this shift requires legally sound and ethically robust incident response systems that protect patients' rights, support professionals and enable learning.

The updated London Protocol, the ERNST five-level pyramid and the RESCUE certification framework provide complementary tools for this transition. They emphasise systems analysis, patient and family involvement, psychological safety, proportional support for second victims, trained peer support, confidentiality, governance and continuous improvement.

For pharmacy services, this integrated approach is essential. Medication-related harm can affect patients, families and professionals, and may trigger complaints, formal investigations or legal procedures. Safer care therefore requires organisations able to respond simultaneously to the patient's need for truth and repair, the professional's need for support and fairness, and the system's need for learning. Moving from blame to learning is a condition for safer patients, safer professionals and safer organisations.

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PP11.3. THE EAHP HOSPITAL PHARMACY PROJECT - WHAT THE DATA SHOW ABOUT SERBIA AND CZECHIA

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As global healthcare demands evolve due to demographic changes, technological advancements, and increasingly complex treatments, the need for a robust hospital pharmacy workforce grows more urgent. Yet, workforce capacity and availability data remained fragmented and sometimes barely available across the European region. The EAHP workforce project was initiated to address this urgent knowledge gap.

The project gathered 3172 responses from members of hospital pharmacy teams across EAHP membership. Respondents represented all expertise/experience levels, leadership positions, hospital types, and urban and rural areas. 75% of respondents were pharmacists.

More than 80% of respondents in Serbia and Czechia reported encountering some kind of workforce shortage in their daily practice. The shortage problem seems more pronounced in Serbia, as respondents report higher levels of shortage. The Serbian colleagues also reported lower satisfaction with their working conditions. The shortage of pharmacy technicians is even more pressing than the shortage of hospital pharmacists in Czechia, with a balanced result in Serbia. A growing number of administrative tasks, increased workload due to personalisation of care and insufficient wages were considered the most important factors contributing to the workforce shortage, resulting in higher stress levels and burnout among staff, delayed implementation of new services/clinical roles and a negative impact on multidisciplinary/multi-professional cooperation, to name the most frequently mentioned impacts.

Both countries will have to consider short-, mid- and long-term plans for preventing the workforce shortage problem and building a more resilient workforce to address their population's health needs.

Acknowledgement

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Sesija 12
Session 12

Inovativni pristup otkriću lekova za ciljanu terapiju: od molekulskog dizajna do terapijske primene

Innovative approaches to targeted drug discovery: From molecular design to therapeutic application

Inovativni pristup otkriću lekova za ciljanu terapiju: od molekulskog dizajna do terapijske primene

Računarska hemija i napredne analitičke tehnike menjaju način na koji pristupamo dizajnu, analitici i praćenju terapijskih koncentracija lekova. U okviru ove sesije predstavljene su inovativne aktivne farmaceutske supstance razvijene primenom savremenijih metodologija. Poseban fokus stavljen je na analitičke pristupe za određivanje ciljanih lekova i njihovih nečistoća, što je osnova za podršku strategijama personalizovanog doziranja i bezbednu primenu lekova.

Innovative approaches to targeted drug discovery: From molecular design to therapeutic application

Computational chemistry and advanced analytical techniques are changing approaches to drug design, analysis and therapeutic monitoring. This session highlights innovative active pharmaceutical ingredients developed using state-of-the-art methodologies. Special focus is placed on the novel analytical approaches for determination of targeted drugs and their impurities, forming the foundation for personalized dosing strategies and safe administration of medicines.

PP12.1. KOVALENTNI INHIBITORI U SAVREMENOJ MEDICINSKOJ HEMIJI

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Kovalentna inhibicija postaje sve značajnija strategija u savremenoj medicinskoj hemiji i razvoju novih lekova. Iako su kovalentni lekovi dugo bili povezivani sa nespecifičnom reaktivnošću i potencijalnom toksičnošću, napredak u medicinskoj hemiji omogućio je razvoj visoko selektivnih jedinjenja sa značajnom kliničkom primenom. Brojni kovalentni lekovi odobreni su za lečenje malignih i drugih bolesti, dok se mnoga dodatna jedinjenja trenutno nalaze u kliničkim ispitivanjima. Mehanizam dejstva kovalentnih inhibitora zasniva se na selektivnoj ireverzibilnoj ili reverzibilnoj kovalentnoj modifikaciji nukleofilnih aminokiselinskih ostataka u ciljnim proteinima, najčešće cisteinskih ostataka smeštenih u vezivnim mestima, nakon inicijalnog nekovalentnog koraka molekulskog prepoznavanja. Shodno tome, savremeni dizajn kovalentnih lekova zahteva pažljivu optimizaciju reaktivnosti elektrofila kako bi se postigla odgovarajuća ravnoteža između potentnosti, selektivnosti i bezbednosti Među elektrofilnim reaktivnim grupama koje se danas koriste, akrilamidi predstavljaju najzastupljeniju klasu u odobrenim lekovima i kliničkim kandidatima. Ostali važni reaktivni motivi uključuju aldehide, α-ketoamide, nitrile, vinil-sulfone, boronske kiseline i sulfonil-fluoride. Reaktivnost i selektivnost ovih grupa mogu se precizno podešavati strukturnim i elektronskim modifikacijama, zbog čega sintetska organska hemija predstavlja ključni element u otkrivanju kovalentnih lekova. Očekuje se da će kontinuirani napredak u dizajnu reaktivnih grupa, optimizaciji zasnovanoj na strukturi i proteomskim metodama za otkrivanje novih ciljnih proteina dodatno proširiti terapijski potencijal i kliničku primenu ovog pristupa.

PP12.1. COVALENT INHIBITORS IN MODERN MEDICINAL CHEMISTRY

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Covalent inhibition has become an increasingly important strategy in modern medicinal chemistry and drug discovery. Although covalent drugs were historically associated with non-specific reactivity and potential toxicity, advances in medicinal chemistry have enabled the development of highly selective compounds with substantial clinical success. Numerous covalent drugs have been approved for the treatment of cancer and other diseases, while many additional compounds are undergoing clinical evaluation. The mechanism of action of covalent inhibitors involves the selective irreversible or reversible covalent modification of nucleophilic amino acid residues within target proteins, most commonly cysteine residues located in binding sites, following an initial noncovalent recognition step. As a result, modern covalent drug design requires careful optimisation of electrophile reactivity to achieve an appropriate balance between potency, selectivity, and safety. Among currently used electrophilic warheads, acrylamides represent the most common class in approved drugs and clinical candidates. Other important reactive motifs include aldehydes, α-ketoamides, nitriles, vinyl sulfones, boronic acids, and sulfonyl fluorides. The reactivity and selectivity of these moieties can be fine-tuned through structural and electronic modifications, making synthetic organic chemistry a key element of covalent drug discovery. Continued advances in warhead design, structure-based optimization, and proteomic methods for identifying new targets are expected to further broaden the therapeutic potential and clinical applications of this approach.

PP12.2. FROM BIOANALYSIS TO INDIVIDUALIZED DOSING: INNOVATIVE APPROACHES IN THE ANALYSIS OF TARGETED ANTICANCER DRUGS

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Targeted anticancer drugs, including CDK4/6 inhibitors, PARP inhibitors and PI3K inhibitors, have considerably improved outcomes in cancer treatment. However, their clinical application is still challenged by significant interindividual pharmacokinetic variability. This may lead to differences in drug efficacy and toxicity among patients, resulting in suboptimal therapeutic outcomes. Therapeutic drug monitoring is therefore becoming and increasingly important tool for treatment individualization and optimization of clinical outcomes.

This lecture will give an overview of recently developed innovative analytical and bioanalytical approaches for the determination of selected targeted anticancer drugs in pharmaceutical formulations and biological samples. Special attention will be given on liquid chromatography and capillary electrophoresis methods coupled with tandem mass spectrometry. Innovative electrophoretic approaches coupled with mass spectrometry, including sweeping MEKC-MS/MS methods enabling highly sensitive analysis with very low sample consumption, will also be discussed.

Different advanced sample preparation strategies will also be presented, including solid-phase extraction, phospholipid removal, dispersive liquid–liquid microextraction and surfactant-enhanced microextraction approaches. The approaches were compared regarding analytical performance and clinical applicability using real patient plasma samples. The lecture will additionally cover clinically relevant aspects of targeted therapy, including adherence assessment, and metabolic interactions potential.

Combining advanced bioanalytical methodologies with pharmacokinetic and clinical data enables better interpretation of drug exposure in individual patients and supports more precise dosing of targeted anticancer therapies in clinical practice.

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PP12.3. TRANSLACIONA SARADNJA AKADEMIJE I BIOTECH-A U RAZVOJU SELEKTIVNIH INHIBITORA HISTON DEACETILAZE 6 ZA FIBROZU JETRE

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Produženo oštećenje jetre izazvano hroničnom inflamacijom dovodi do fibroze, koja bez adekvatnog lečenja može napredovati do ciroze i hepatocelularnog karcinoma. Fibroza jetre i dalje predstavlja veliki klinički izazov, budući da trenutno ne postoje registrovani lekovi koji sprečavaju ili modifikuju tok bolesti. U ovom istraživanju dizajnirana su dva nova selektivna inhibitora histon deacetilaze 6 (HDAC6), FDR-2 (derivat difenilhidantoina) i DR-3 (derivat morfolina). Jedinjenja su sintetisana i ispitana u enzimskim testovima na panelu humanih HDAC izoformi, pri čemu je potvrđena njihova selektivnost prema HDAC6. U saradnji sa Univerzitetom Newcastle i spin-off kompanijom FibroFind, njihova aktivnost je dalje ispitana u ćelijskim modelima fibroze jetre i u humanom *ex vivo* modelu fibroze, koji sadrži precizno isečene uzorke fibrotičnog tkiva jetre pacijenata (hPCLS). Dobijeni rezultati potvrđuju da je HDAC6 validno ciljno mesto dejstva za lečenje fibroze jetre, kao i da su molekuli DR-3 i FDR-2 obećavajući kandidati za dalji preklinički razvoj. Istraživanje ujedno ilustruje značaj uspešne akademsko-industrijske saradnje u translaciji akademskih otkrića u razvoju novih lekova.

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PP12.3. TRANSLATIONAL ACADEMIA-BIOTECH COLLABORATION IN THE DEVELOPMENT OF SELECTIVE HDAC6 INHIBITORS FOR LIVER FIBROSIS

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A protracted wound-healing process in liver tissue, caused by chronic inflammation, leads to fibrosis, which if left unresolved, can progress to cirrhosis and hepatocellular carcinoma. Liver fibrosis remains a worldwide clinical burden, with no approved treatments available to prevent or reverse the disease. In this study, two novel selective histone deacetylase 6 (HDAC6) inhibitors were designed, FDR-2 (a diphenylhydantoin derivative) and DR-3 (a morpholine derivative). The compounds were synthesized and evaluated in enzymatic assays against a panel of human HDAC isoforms, confirming their selectivity for HDAC6. In collaboration with Newcastle University and the spin-off company FibroFind, their activity was further investigated in cellular models of liver fibrosis and in a human *ex vivo* fibrosis model comprising human precision cut liver slices (hPCLS). The results confirm HDAC6 as a valid therapeutic target for liver fibrosis and identify DR-3 and FDR-2 as promising candidates for further preclinical development. This study also highlights the importance of successful academic–industry collaboration in the translation of academic discoveries into drug development.

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US12.1. INTEGRACIJA HIRALNE HROMATOGRAFIJE I ALGORITAMA MAŠINSKOG UČENJA SA CILJEM PREDVIĐANJA RETENCIJE I ENANTIOSELEKTIVNOSTI NA OVOMUKOIDNOJ HIRALNOJ STACIONARNOJ FAZI

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Mehanizmi odgovorni za enantioprepoznavanje u hiralnoj hromatografiji su složeni, a napori usmereni ka njihovom boljem razumevanju intenzivirani su poslednjih decenija. Mnogi izazovi su i dalje prisutni, uključujući brojne eksperimente zasnovane na principu "pokušaj–greška", neizvesnu efikasnost razdvajanja i ograničenu reproduktivnost rezultata. Integracija hiralne hromatografije sa metodologijom algoritama mašinskog učenja predstavlja savremeniji pristup u rešavanju i prevazilaženju ovih nedostataka, čime se sprovodi postepena tranzicija iz tradicionalnog pristupa "pokušaj –greška" na primenu inteligentnih pristupa u kojima se koriste dostupni podaci u svrhu predviđanja retencije i enantioseparacije. U ovom istraživanju kao alat mašinskog učenja primenjene su veštačke neuronske mreže u cilju mešovitog modelovanja retencionog ponašanja i enantioselektivnosti na ovomukoidnoj hiralnoj stacionarnoj fazi za 50 hiralnih analita različitih strukturnih i fizičko-hemijskih karakteristika. Rezultati su dobijeni izvođenjem seta eksperimenata prema centralnom kompozicionom dizajnu kroz ukupno 18 eksperimentalnih tačaka, pri čemu su varirani: udeo acetonitrila u mobilnoj fazi, pH vrednost vodenog dela mobilne faze i koncentracija amonijum-hlorida u vodenom delu mobilne faze. Od ulaznih podataka za modelovanje pored hromatografskih parametara, korišćen je i set pažljivo odabranih 35 molekulskih deskriptora. Odgovori koji su praćeni su logaritamski transformisani – t_r za predviđanje retencionog ponašanja, α i Δt_r za predviđanje enantioselektivnosti. Snaga prediktivnih performansi mreža procenjivana je na osnovu dobijenih vrednosti R^2 i RMSE za trening, validacioni i test set. Dobijeni modeli su pokazali dobre performanse, za log t_r – $R^2_{training}$>0.90, R^2_{CV}>0.80, R^2_{test}>0.90, i nešto niže performanse za log α – $R^2_{training}$>0.75, R^2_{CV}>0.60, R^2_{test}>0.75 i za Δt_r – $R^2_{training}$>0.85, R^2_{CV}>0.75, R^2_{test}>0.80.

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US12.1. INTEGRATION OF CHIRAL CHROMATOGRAPHY WITH MACHINE LEARNING ALGORITHMS FOR RETENTION AND ENANTIOSELECTIVITY PREDICTION ON OVOMUCOID CHIRAL STATIONARY PHASE

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The mechanisms responsible for enantiorecognition in chiral chromatography are highly complex, and efforts to better understand them have intensified over the past decades. Many uncertainties remain, including the need for numerous "trial-and-error" experiments, questionable separation efficiency, and poor reproducibility of results. The integration of chiral chromatography with the methodology of machine learning algorithms represents modern attempts to solve and overcome these shortcomings, through gradual transition from the traditional approach "trial-and-error" to the application of intelligent approaches that use available data for predicting retention and enantioseparation. In this research, artificial neural networks were used for mixed modelling of the retention behavior and enantioselectivity on the ovomucoid chiral stationary phase for 50 chiral analytes with different structural and physicochemical characteristics. The experimental results were obtained by performing the central composite design with 18 experimental points, in which the acetonitrile content in the mobile phase, the pH value and the concentration of ammonium chloride in the aqueous part of the mobile phase were varied. In addition to the chromatographic parameters, a carefully selected 35 molecular descriptors were used as input data for modeling. Output variables were logarithmically transformed – to predict retention t_r and enantioselectivity α and Δt_r. The strength of the predictive networks performance was estimated based on the obtained R^2 and RMSE values for the training, validation and test set. The obtained models showed good performance for output log t_r – $R^2_{training}$>0.90, R^2_{CV}>0.80, R^2_{test}>0.90, and slightly lower for log α – $R^2_{training}$>0.75, R^2_{CV}>0.60, R^2_{test}>0.75 and for Δt_r – $R^2_{training}$>0.85, R^2_{CV}>0.75, R^2_{test}>0.80.

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US12.2. AMINO- I MORFOLINO-HALKONI KAO POTENCIJALNI ANTIKANCERSKI AGENSI NA ĆELIJSKIM LINIJAMA KOLOREKTALNOG KANCERA

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Rastuća globalna zastupljenosti kolorektalnog karcinoma usmerava fokus savremenih istraživanja ka multi-target strategijama u terapijama koje istovremeno inhibiraju inflamatorne puteve i proliferaciju malignih ćelija. U ovom kontekstu povećana ekspresija *COX-2* enzima ima važnu ulogu u progresiji tumorskih ćelija. Halkoni, strukturno klasifikovani kao 1,3-diaril-2-propen-1-oni, su prepoznati kao obećavajuća grupa jedinjenja zbog posedovanja širokog spektra bioloških aktivnosti: zbog sposobnosti da inhibiraju *COX-2* enzim, ova jedinjenja mogu pokazati dualni mehanizam delovanja koji omogućava supresiju inflamatornih puteva uz ustovremeno ispoljavanje direktnog citotoksičnog efekta na kancerskim ćelijama. Cilj ovog istraživanja je bio da se ispita *in-vitro* antikancerski potencijal 16 strukturno različitih amino- i morfolinohalkona koji poseduju različite supstituente u drugom aromatičnom prstenu. Citotoksičnost je ispitana na četiri ćelijske linije kolorektalnog karcinoma (*HCT116, HT29, SW480 i MC38*) i jednoj zdravoj ćelijskoj liniji (MRC-5). Nakon inkubacije od 72 sata, viabilnost ćelija je određena *MTT* i *crystal violet* (*CV*) testovima, uz izračunavanje IC_{50} vrednosti. Sva jedinjenja su pokazala dozno-zavisnu citotoksičnost, a linija *SW480* se izdvojila kao najosetljivija. Značajno više IC_{50} vrednosti zabeležene su na nemalignim *MRC-5* ćelijama, što ukazuje na visoku selektivnost svih derivata prema tumorskom fenotipu. Kao najpotentniji izdvojili su se halkoni sa *meta*-supstituentima u drugom aromatičnom prstenu koji ostvaruju negativni induktivni efekat: aminohalkon označen kao 23 (*m-F*) i morfolinohalkon 51 (*m-CN*). Ističući se svojom izraženom diferencijalnom citotoksičnošću, ovi derivati su se pokazali kao najperspektivniji vodeći molekuli za buduća ispitivanja mehanizma delovanja i razvoj novih hemioterapeutika za tretman kolorektalnog karcinoma.

US12.2. AMINO- AND MORPHOLINO-CHALCONES: POTENTIAL ANTICANCER AGENTS ON COLORECTAL CANCER CELL LINES

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Driven by the high incidence of colorectal cancer (CRC) globally, current research is focused on a multitarget strategy to inhibit inflammatory pathways and malignant cell proliferation simultaneously. In this context, elevated expression of the COX-2 enzyme plays a critical role in tumor progression. Chalcones (1,3-diaryl-2-propen-1-ones) stand out as highly promising scaffolds due to their diverse biological activities; by inhibiting COX-2, these compounds operate through a dual-action mechanism that effectively suppresses inflammatory pathways while exerting a direct cytotoxic effect on cancer cells. This study aimed to evaluate the *in vitro* anticancer effect of 16 structurally diverse amino- and morpholino-chalcones with various substituents on the second aromatic ring. Cytotoxicity was assessed using four CRC cell lines (HCT116, HT29, SW480, and MC38) and one healthy cell line (MRC-5). Following 72-hour incubation, cell viability was measured using MTT and crystal violet (CV) assays to determine IC_{50} values. All derivatives demonstrated dose-dependent cytotoxicity, and the SW480 line exhibited the highest sensitivity. Significantly higher IC_{50} values in non-malignant MRC-5 cells confirmed favourable tumor selectivity for all compounds. The most potent derivatives were chalcones possessing groups with a negative inductive effect in the *meta* position of the second ring: aminochalcone labelled as 23 (*m-F*) and morpholinochalcone 51 (*m-CN*). Due to their pronounced differential cytotoxicity and lowest IC_{50}, these derivatives represent the most promising leads for subsequent studies of their mechanism of action and the development of novel chemotherapeutic agents for colorectal cancer.

Sesija 13
Session 13

Lekovi po meri najmlađih pacijenata: unapređenje terapije kroz personalizaciju

Tailoring medicines for children: enhancing medication through personalization

Lekovi po meri najmlađih pacijenata: unapređenje terapije kroz personalizaciju

Primena lekova u pedijatriji predstavlja veliki izazov zbog značajnih razlika između starosnih grupa pacijenata, ograničenih kliničkih dokaza i individualnih sklonosti koji utiču na prihvatljivost lekova, posebno u slučaju konvencionalnih farmaceutskih oblika. Stoga se sve više pažnje posvećuje razvoju pristupa koji omogućavaju prilagođavanje lekova kako bi se obezbedila fleksibilnost i preciznost doziranja u skladu sa uzrastom, fiziološkim stanjem i specifičnim potrebama najmlađih pacijenata. U okviru ove sesije upoznaćete se sa strategijama personalizovanog lečenja urođenih bolesti metabolizma kod dece i kardiometaboličkim posledicama gojaznosti u detinjstvu, kao i naprednim pristupima zasnovanim na model-informisanom doziranju i razvoju formulacija lekova u cilju poboljšanja prihvatljivosti, unapređenja adherencije i zdravstvenih ishoda kod pedijatrijskih pacijenata.

Tailoring medicines for children – enhancing medication through personalization

Pediatric pharmacotherapy is challenging due to variability among patient subgroups, limited clinical evidence, and individual preferences that affect medicine acceptability, especially when using conventional dosage forms. Therefore, tailoring medicines for the youngest patients to align with age, physiological status, and specific patient needs is increasing, supporting flexible and accurate dosing. In this session, you will learn about personalized treatment strategies for inborn errors of metabolism and the cardiometabolic consequences of childhood obesity, as well as advances in model-informed dosing and formulation design to improve medication use, adherence, and health outcomes in pediatric patients.

PP13.1. ZNAČAJ PERSONALIZOVANE FARMAKOTERAPIJE U LEČENJU UROĐENIH BOLESTI METABOLIZMA KOD DECE

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Farmakoterapija urođenih bolesti metabolizma (UBM) predstavlja specifičnu oblast kliničke farmacije i pedijatrije, jer se terapija zasniva na razumevanju metaboličkog poremećaja koji je u osnovi bolesti. Za razliku od mnogih drugih bolesti, cilj ove terapije nije samo ublažavanje simptoma, već i sprečavanje nakupljanja toksičnih metabolita ili nadoknada nedostajućih proizvoda metabolizma. Urođene bolesti metabolizma obuhvataju više stotina retkih genetskih poremećaja kod kojih nedostaje određeni enzim, transporter ili kofaktor. Iako dve osobe mogu imati istu dijagnozu, klinička slika i odgovor na terapiju mogu biti veoma različiti. Farmakoterapija ima ulogu u lečenju poremećaja metabolizma ugljenih hidrata, masnih kiselina, aminokiselina, ciklusa ureje, složenih molekula, ali kod grešaka u lancu transporta elektrona. Osnovni principi faramakoterapije su: terapija dijetom (fenilketonurija), supsticiona terapija (enzimska supsticiona terapija kod Gošeove bolesti), primena vitamina i kofaktora vitamina (piridoksin zavisne konvulzije), eliminacija toksičnih metabolita (natrijum benzoat u odstranjvanju amonijaka), suplementacija specifičnih jedinjenja (L-karnitin kod organskih acidemija). Individualizovana farmakoterapija kod dece sa urođenim bolestima metabolizma predstavlja jedan od najvažnijih pravaca savremene pedijatrijske medicine. Suština je da se terapija prilagodi konkretnom detetu na osnovu njegove genetičke greške, biohemijskog profila, uzrasta, nutritivnog statusa i odgovora na lečenje.

PP13.1. THE IMPORTANCE OF PERSONALIZED PHARMACOTHERAPY IN THE TREATMENT OF INBORN ERRORS OF METABOLISM IN CHILDREN

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Pharmacotherapy of inborn errors of metabolism (IEM) represents a specific field within clinical pharmacy and pediatrics, as treatment is based on a thorough understanding of the underlying metabolic defect. Unlike many other diseases, the goal of therapy is not only to alleviate symptoms but also to prevent the accumulation of toxic metabolites or to replace deficient metabolic products. Inborn errors of metabolism comprise several hundred rare genetic disorders caused by deficiencies of specific enzymes, transporters, or cofactors. Although two individuals may have the same diagnosis, their clinical presentation and response to treatment can vary considerably. Pharmacotherapy plays an important role in the management of disorders of carbohydrate, fatty acid, amino acid, and urea cycle metabolism, as well as disorders of complex molecules and defects of the electron transport chain. The main principles of pharmacotherapy include: dietary therapy (e.g., phenylketonuria); replacement therapy (e.g., enzyme replacement therapy in Gaucher disease); administration of vitamins and vitamin cofactors (e.g., pyridoxine-dependent seizures); elimination of toxic metabolites (e.g., sodium benzoate for ammonia scavenging); supplementation with specific compounds (e.g., L-carnitine in organic acidemias). Individualized pharmacotherapy in children with inborn errors of metabolism represents one of the most important directions of modern pediatric medicine. The essence of this approach is to tailor treatment to the individual child based on the specific genetic defect, biochemical profile, age, nutritional status, and response to therapy.

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PP13.2. PREVAZILAŽENJE EMPIRIJSKIH OKVIRA: MODEL-INFORMISANO DOZIRANJE I RAZVOJ FORMULACIJE LEKOVA U TERAPIJI PEDIJATRIJSKIH PACIJENATA

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Farmakoterapija pedijatrijskih pacijenata se tradicionalno oslanjala na empirijske pristupe, uključujući ekstrapolaciju doze i prilagođavanje formulacija razvijenih za odrasle. Međutim, promene u fiziologiji i raspodeli leka tokom rasta i razvoja dece, kao i preferencije u pogledu prihvatljivosti terapije, stvaraju specifične izazove koji se ne mogu u potpunosti rešiti konvencionalnim strategijama. Posebno osetljive grupe čine novorođenčad i mala deca, kao i deca na terapiji lekovima za retke bolesti ili lekovima uske terapijske širine, kod kojih su klinički podaci često ograničeni. U tom kontekstu, regulatorne agencije sve više ističu značaj model-informisanih pristupa, posebno fiziološki zasnovanog modelovanja (PBM), kao podrške razvoju pedijatrijskih formulacija, planiranju kliničkih studija i definisanju individualizovanih preporuka za doziranje lekova.

Fiziološki zasnovano modelovanje pruža mehanistički okvir za predviđanje složenih interakcija između osobina lekovite supstance, karakteristika formulacije i promena u fiziologiji dece tokom rasta i razvoja. Na taj način omogućava predviđanje sistemske raspoloživosti leka u različitim starosnim grupama i podržava donošenje klinički opravdanih terapijskih odluka.

U ovom izlaganju će, kroz odabrane primere, biti ilustrovana primena PBM za pedijatrijsku populaciju. Biće predstavljeno nekoliko studija koje pokazuju kako se PBM može koristiti za procenu bioperformansi različitih intraoralnih formulacija, kao uzrastu-prilagođenih farmaceutskih oblika lekova. Zatim, biće prikazana primena PBM u razvoju granula obloženih lipidima, namenjenih poboljšanju palatabilnosti i fleksibilnom doziranju kod dece različitog uzrasta. Dodatno, PBM hidroksiuree će služiti kao primer racionalne optimizacije doziranja kod dece sa srpastom anemijom. Zajedno, ovi primeri pokazuju kako prevazilaženje empirijskih okvira primenom model-informisanih prediktivnih alata može podržati razvoj formulacija i doprineti bezbednijoj, efikasnijoj i personalizovanoj farmakoterapiji u pedijatrijskoj populaciji.

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PP13.2. MOVING BEYOND EMPIRICAL FRAMEWORKS: MODEL-INFORMED DOSING AND FORMULATION DESIGN IN PEDIATRIC DRUG THERAPY

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Pediatric drug therapy has traditionally relied on empirical approaches, including dose extrapolation and formulation adaptation from adult medicines. However, age-dependent changes in physiology, drug disposition and patient acceptability preferences create unique challenges that cannot be fully addressed using conventional strategies. Particularly vulnerable groups are newborns and young children, as well as children taking orphan drugs or drugs with a narrow therapeutic index, where conventional clinical evidence is often limited. In this context, model-informed approaches, especially physiologically based modeling (PBM), have been increasingly emphasized by regulatory agencies to support pediatric formulation development, clinical study design, and patient-tailored dosing recommendations.

Physiologically based modeling provides a mechanistic framework to predict the complex interplay between drug and formulation properties, and growth-related changes in pediatric physiology, thereby enabling the prediction of drug exposure across different age groups and supporting clinically relevant pharmacotherapy decisions.

This presentation will illustrate the utility of PBM through selected examples relevant to pediatric population. Several case studies will demonstrate how PBM can be used to estimate bioperformance of different intraoral formulations as age-appropriate dosage forms for pediatric use. Another example will address PBM-guided development of lipid-coated granules designed to improve palatability and enable flexible dosing across pediatric age groups. In addition, PBM of hydroxyurea will be discussed as an example of rational dose optimization in children with sickle cell disease. Together, these examples demonstrate how moving beyond empirical frameworks toward model-informed prediction tools can support formulation design and contribute to safer, more effective and personalized pediatric pharmacotherapy.

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PP13.3. UNAPREĐENJE PRIMENE LEKOVA U PEDIJATRIJI KROZ PERSONALIZACIJU, PALATABILNOST I PRECIZNOST DOZIRANJA

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Pristup inovativnim lekovima je, zbog nedostatka specifičnih bezbednosnih podataka i regulatornih odobrenja, često ograničen za populaciju pedijatrijskih pacijenata. Rane faze kliničkih ispitivanja pedijatrijskih lekova karakteriše velika varijabilnost u pogledu potrebnih doza i formulacija, što je potrebno imati u vidu pri planiranju i pripremi setova uzoraka i pratećih materijala za primenu leka.

Neprijatan ukus često predstavlja prepreku za oralnu primenu lekova kod dece, što može dovesti do smanjene adherence i slabih ishoda lečenja. Uprkos unapređenjima u razvoju pedijatrijskih lekova, njihova prihvatljivost kod dece i adolescenata i dalje predstavlja veliki izazov. Primena lekova kod dece često zahteva njihovo prilagođavanje, o čemu svedoči velika zastupljenost *off-label* i *unlicensed* primene. Prepoznata je hitna potreba za obezbeđenje ciljanih terapija prilagođenih deci različitog uzrasta, kako bi se poboljšali ishodi lečenja i smanjila neželjena dejstva lekova.

Platforme za 3D štampanje omogućavaju prilagodljivu, decentralizovanu izradu lekova u skladu sa potrebama pacijenata. Ovi sistemi usklađeni su sa zahtevima Dobre proizvođačke prakse, i omogućavaju brzu i fleksibilnu proizvodnju malih serija lekova, uključujuće setove uzoraka za kliničke studije. Međutim, njihova primena je praćena i određenim izazovima s obzirom da još uvek nisu uspostavljeni odgovarajući regulatorni okviri, kao i potrebom za usaglašavanje sa smernicama za izradu lekova u zdravstvenim ustanovama (*point-of-care manufacture*).

Budućnost terapije predstavljaju lekovi usmereni na pacijenta (*patient-centric*) izrađeni decentralizovano, koristeći "*smart*" sisteme za fleksibilnu, preciznu proizvodnju malih serija. Primena ovih inovativnih sistema obezbeđuje automatizovanu, agilnu i održivu izradu lekova, u skladu sa standardima kvaliteta, uz osiguranje bezbednosti pacijenata i uspešnosti lečenja što je prepoznato i podržano u bolničkim apotekama.

PP13.3. ENHANCING MEDICATION USE IN PEDIATRICS THROUGH PERSONALIZATION, PALATABILITY AND DOSING PRECISION

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Children often have limited access to innovative treatments due to a lack of pediatric-specific safety data and regulatory approval. Early-phase pediatric trials involve high variability in dose requirements and formulation needs, which directly impacts clinical supply planning assumptions, packaging flexibility, and kit configuration strategies.

Poor-tasting pediatric medicine is a common barrier to oral medicine administration in children, which may lead to lack of adherence and suboptimal treatment outcomes. The intake of oral medicines by children and adolescents remains challenging despite advances in the development of pediatric dosage forms. In routine practice, oral medicine administration frequently requires modification of formulations. This is mirrored by the high prevalence of off-label and unlicensed prescribing across pediatric settings. There is an urgent need for child-friendly, age-appropriate, targeted therapies to improve outcomes and reduce treatment-related harm in pediatric patients.

3D printing platforms enable resilient, decentralized, patient-centric pharmaceutical production. Smart manufacturing brings production closer to patients and allows rapid, flexible, GMP-compliant small-scale production of innovative medicines directly supporting supply chain decentralization and kit customization. However, implementing this technique faces many challenges, such as the lack of regulatory frameworks and the need to synchronize with new point-of-care manufacturing guidelines.

The future of therapy is patient-centric, decentralized, and driven by smart manufacturing in precise, flexible small batches. Clinical pharmacy welcomes and supports the implementation of innovative manufacturing approaches, – including decentralized and bedside production, which bring greater automation, flexibility, agility, and sustainability to clinical supply while ensuring patient safety, treatment success, and compliance with international quality standards.

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PP13.4. GOJAZNOST U DETINJSTVU: RANI METABOLIČKI MEHANIZMI I KARDIOMETABOLIČKE POSLEDICE

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Gojaznost u detinjstvu predstavlja jedan od vodećih globalnih zdravstvenih izazova usled rastuće prevalencije i snažne povezanosti sa ranim kardiometaboličkim poremećajima. Pored neposrednih zdravstvenih posledica, gojaznost u detinjstvu može pokrenuti niz kardiometaboličkih komplikacija koje često perzistiraju i u odraslom dobu. Sve veći broj dokaza ukazuje na to da osnove metaboličke disfunkcije povezane sa gojaznošću mogu nastati još tokom prenatalnog i perinatalnog perioda, kao posledica epigenetskog programiranja uslovljenog metaboličkim statusom majke. U tom smislu, gojaznost majke pre i tokom trudnoće, gestacijski dijabetes, gestacijska hipertenzija i dislipidemija u trudnoći mogu dovesti do dugoročnih promena fetalnog metabolizma, osetljivosti na insulin i lipidne homeostaze, čime se povećava rizik da dete kasnije u životu razvije gojaznost i kardiometaboličke bolesti. Gojaznost u dečjem uzrastu usko je povezana sa hroničnom inflamacijom niskog stepena, oksidativnim stresom, insulinskom rezistencijom i akumulacijom ektopičnog masnog tkiva. Prekomerno nakupljanje visceralnog i hepatičnog masnog tkiva doprinosi razvoju dislipidemije, endotelne disfunkcije i masne bolesti jetre udružene sa metaboličkom disfunkcijom, koji se sve češće otkrivaju i u pedijatrijskoj populaciji. Udruženo, ovi mehanizmi formiraju začarani krug koji podstiče razvoj dijabetes melitusa tip 2 i kardiovaskularnih bolesti u kasnijem životnom dobu. Bolje razumevanje ranog metaboličkog programiranja i pravovremeno prepoznavanje faktora rizika povezanih sa gojaznošću putem sveobuhvatne procene biomarkera, uz preventivne strategije usmerene na očuvanje metaboličkog zdravlja majke pre i tokom trudnoće i promociju zdravih životnih navika tokom detinjstva, može doprineti smanjenju rizika od gojaznosti i unapređenju dugoročnih kardiometaboličkih ishoda budućih generacija.

PP13.4. CHILDHOOD OBESITY: EARLY METABOLIC MECHANISMS AND CARDIOMETABOLIC CONSEQUENCES

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Childhood obesity has emerged as one of the leading global health challenges, due to its rapidly increasing prevalence and strong association with early cardiometabolic disturbances. Beyond immediate health effects, obesity in early life may initiate a cascade of cardiometabolic complications that often persist into adulthood. Recent evidence suggests that the origins of obesity-related metabolic dysfunction may begin already during prenatal and perinatal life through epigenetic programming, induced by maternal metabolic status. In this regard, maternal obesity, gestational diabetes, gestational hypertension and dyslipidemia in pregnancy may induce long-lasting alterations in fetal metabolism, insulin sensitivity and lipid homeostasis, thereby increasing the susceptibility of offspring to obesity and cardiometabolic diseases later in life. The development of childhood obesity is strongly associated with chronic low-grade inflammation, oxidative stress, insulin resistance and ectopic fat accumulation. Excessive deposition of visceral and hepatic fat contributes to dyslipidemia, endothelial dysfunction and metabolic dysfunction-associated steatotic liver disease, which are increasingly recognized even in pediatric populations. Together, these mechanisms create a vicious cycle that promotes the development of type 2 diabetes mellitus and cardiovascular disease later in life. A better understanding of early metabolic programming and timely identification of obesity-associated risk factors through comprehensive biomarker assessment, together with preventive strategies focused on maternal metabolic health before and during pregnancy, as well as the promotion of healthy lifestyle habits during childhood, may help reduce obesity risk and improve long-term cardiometabolic outcomes in future generations.

Sesija 14
Session 14

Farmacija i održivi razvoj

Sustainable development in pharmacy

Farmacija i održivi razvoj

Sesija pruža uvid u širi koncept održivosti u oblasti farmacije koji obuhvata racionalno korišćenje resursa, pravičnost u dostupnosti zdravstvene zaštite, ekonomsku održivost i odgovorno upravljanje resursima. Posebno su predstavljeni principi obrazovanja za održivi razvoj (*Education for Sustainable Development*) i uloga visokoškolskih ustanova u uključivanju principa održivosti i održivog razvoja u obrazovanje budućih farmaceuta. Značaj napora za održivost farmacije kao profesije predstavljen je kroz inovativne uloge i usluge farmaceuta u apotekama u oblasti farmaceutske tehnologije i izrade lekova u apoteci, te pomeranje od tradicionalne „izrade po receptu" ka standardizovanoj, dokumentovanoj i rizikom vođenoj farmaceutskoj usluzi, kao i u oblasti medicinsko-biohemijskih analiza (*Point of Care Testing)* i oblasti farmaceutske toksikologije.

Sustainable development in pharmacy

The session provides insight into the broader concept of sustainability in the field of pharmacy, which includes rational use of resources, equity in access to health care, economic sustainability and responsible management of resources. In particular, the principles of Education for Sustainable Development and the role of higher education institutions in including the principles of sustainability and sustainable development in the education of future pharmacists are presented. The importance of efforts for the sustainability of pharmacy as a profession is presented through the innovative roles and services of pharmacists in the field of pharmaceutical technology and compounding including the shift from traditional "prescription-based compounding" to standardized, documented and risk-driven pharmaceutical service, as well as in the field of medical-biochemical analyses (Point of Care Testing) and pharmaceutical toxicology.

PP14.1. ODRŽIVOST U FARMACIJI: PREISPITIVANJE OBRAZOVANJA, PRAKSE I UTICAJA

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Održivost se sve više prepoznaje kao jedan od ključnih izazova savremene zdravstvene zaštite koji prevazilazi pitanja zaštite životne sredine i obuhvata racionalno korišćenje resursa, pravičnost u dostupnosti zdravstvene zaštite, ekonomsku održivost i odgovorno upravljanje resursima kako bi se očuvali i za buduće generacije. Kao jedna od zdravstvenih profesija koja je najdostupnija pacijentima i široko zastupljena u različitim segmentima zdravstvenog sistema, farmacija ima značajan potencijal da doprinese njegovoj održivosti kroz obrazovanje, profesionalnu praksu, javno zdravlje i stručno liderstvo.

U predavanju će biti razmotrena uloga visokoškolskih ustanova u uključivanju principa održivosti i održivog razvoja u obrazovanje budućih farmaceuta, kako bi ih adekvatno pripremile za složene izazove savremene zdravstvene zaštite. Polazeći od principa obrazovanja za održivi razvoj (*Education for Sustainable Development*), održivost se ne posmatra kao zasebna ili dodatna tema u studijskim programima farmacije, već kao širi okvir kroz koji budući farmaceuti mogu sagledati posljedice svojih profesionalnih odluka na pacijente, društvo, zdravstveni sistem, ekonomiju i životnu sredinu.

Kroz primjere i studije slučaja iz farmaceutskog obrazovanja, istraživanja i prakse biće prikazani različiti načini integrisanja principa održivosti u razvoj nastavnih programa, profesionalno donošenje odluka, racionalnu i odgovornu upotrebu lijekova, kao i inovacije u pružanju farmaceutskih usluga u različitim oblastima farmaceutske djelatnosti. Integrisanjem ovih principa u obrazovanje i profesionalnu praksu, farmaceuti mogu dodatno unaprijediti ishode liječenja, doprinijeti očuvanju javnog zdravlja i jačanju otpornosti zdravstvenog sistema, uz istovremeno odgovorno korišćenje resursa u interesu sadašnjih i budućih generacija.

PP14.1. SUSTAINABILITY IN PHARMACY: RETHINKING EDUCATION, PRACTICE, AND IMPACT

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Sustainability is increasingly recognised as a defining challenge for healthcare, extending beyond environmental concerns to encompass responsible resource use, health equity, economic resilience, and the stewardship of healthcare resources for future generations. As one of the most accessible healthcare professions, pharmacy is uniquely positioned to contribute to sustainable healthcare through education, clinical practice, public health, and leadership.

This presentation explores how higher education institutions can engage with sustainability and sustainable development while preparing pharmacists to address complex healthcare challenges. Drawing on the principles of Education for Sustainable Development, it proposes that sustainability should not be viewed as an additional topic within pharmacy curricula, but rather as a foundational perspective that enables pharmacists to understand the broader patient, societal, economic, and environmental implications of their professional decisions.

Through a series of case studies from pharmacy education, research, and practice, the presentation will illustrate how sustainability principles can be integrated into curriculum design, professional decision-making, medicines stewardship, and service innovation across diverse pharmacy settings. By embedding sustainability within pharmacy education and practice, pharmacists can strengthen their impact on patient outcomes, public health, and healthcare system resilience, while helping to meet the needs of current and future generations.

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PP14.2. MAGISTRALNI LEKOVI U SAVREMENOJ FARMACEUTSKOJ PRAKSI: MOGU LI INOVACIJE UNAPREDITI KVALITET I BEZBEDNOST?

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Magistralni lekovi zadržavaju važnu ulogu u savremenoj farmaceutskoj praksi, naročito kada potrebe pacijenta ne mogu biti zadovoljene lekovima dostupnim na tržištu (npr. kod pedijatrijskih i gerijatrijskih pacijenata, pojedinih dermatoloških stanja/oboljenja, u terapiji retkih bolesti, pri nestašicama lekova i kod pacijenata sa specifičnim ograničenjima u pogledu doze/koncentracije lekovite supstance, odabira pomoćnih supstanci ili farmaceutskog oblika). Istovremeno, izrada magistralih lekova nosi izvesne rizike koji se najčešće ogledaju u varijabilnom kvalitetu leka, nepreciznim farmaceutskim proračunima, paušalno određenim rokovima upotrebe i nedovoljno dokumentovanim postupcima. Savremene međunarodne prakse, opisane u nemačkom Deutscher Arzneimittel-Codex/Neues Rezeptur-Formularium, francuskom Bonnes pratiques de préparation, holandskom Formularium der Nederlandse Apothekers i američkom USP Compounding Compendium, pokazuju pomeranje od tradicionalne „izrade po receptu" ka standardizovanoj, dokumentovanoj i rizikom vođenoj farmaceutskoj usluzi. Inovacije se mogu prepoznati na tri nivoa. Prvi obuhvata racionalan izbor farmaceutskih supstanci (lekovitih supstanci i ekscipijenasa), uz proveru kvaliteta, kompatibilnosti, terapijske opravdanosti/funkcionalnosti i izbegavanje opsolentnih ili potencijalno rizičnih sastojaka. Drugi nivo odnosi se na razvoj pacijentu prilagođenih formulacija. Treći nivo čine tehnološke inovacije: elektronski alati za procenu rizika ili standardizovani obrasci/check-liste, standardne operativne procedure za izradu lekova, pouzdana oprema za mešanje, automatski sistemi za punjenje i doziranje, i dr. Poseban značaj imaju kontinuirana obuka osoblja, kvalifikacija opreme, kontrola procesa u toku same izrade magistralnog leka i jasna komunikacija sa lekarom i pacijentom, jer personalizacija mora ostati zasnovana na dokazima, a ne na improvizaciji. Zaključuje se da inovacije ne umanjuju značaj farmaceutske ekspertize, već je čine merljivom i proverljivom.

PP14.2. COMPOUNDED MEDICINES IN MODERN PHARMACEUTICAL PRACTICE: BALANCING INNOVATION, QUALITY AND PATIENT SAFETY

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Extemporaneously compounded medicines continue to play an important role in contemporary pharmaceutical practice, particularly when patients' needs cannot be met by medicinal products available on the market, for example in paediatric and geriatric patients, in certain dermatological conditions/diseases, in the treatment of rare diseases, during medicine shortages, and in patients with specific requirements regarding the dose/concentration of the active pharmaceutical ingredient, the selection of excipients and pharmaceutical dosage form. At the same time, the preparation of extemporaneously compounded medicines is associated with certain risks, most commonly reflected in variable product quality, inaccurate pharmaceutical calculations, empirically assigned expiry dates, and insufficiently documented procedures. Current international practices, described in the German Deutscher Arzneimittel-Codex/Neues Rezeptur-Formularium, the French Bonnes pratiques de préparation, the Dutch Formularium der Nederlandse Apothekers, and the American USP Compounding Compendium, demonstrate a shift from traditional "prescription-based compounding" towards a standardised, documented and risk-based pharmaceutical service. Innovations may be identified at three levels. The first comprises the rational selection of pharmaceutical substances (active pharmaceutical ingredients and excipients), with verification of their quality, compatibility, therapeutic justification/functionality, as well as the avoidance of obsolete or potentially hazardous ingredients. The second level relates to the development of patient-tailored formulations. The third level encompasses technological innovations, including electronic risk-assessment tools or standardised templates/checklists, standard operating procedures for the preparation of compounded medicines, reliable mixing equipment, automated filling and dosing systems, etc. Particular importance should be given to continuous staff training, equipment qualification, in-process control during the preparation, and clear communication with physicians and patients, since personalisation must remain evidence-based rather than improvisational. Therefore, it may be concluded that innovation does not diminish the importance of pharmaceutical expertise - rather, it renders it measurable and verifiable.

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PP14.3. ZNAČAJ I IZAZOVI IZVOĐENJA MEDICINSKO-BIOHEMIJSKIH ANALIZA U APOTECI

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Apoteke u zdravstvenom sistemu značajno doprinose primarnom skriningu i daljoj adekvatnoj selekciji pacijenata ka višim nivoima zdravstvene zaštite. Zato testiranje pored pacijenta u apoteci ima izuzetan potencijal da omogući farmaceutu da pravovremeno donose odgovarajuću odluku. Na ovaj način bi se značajno pomoglo u smanjenju kašnjenja povezanih sa složenim laboratorijskim procesom, minimizovala potreba za dodatnim terminima i često eliminisala nepotrebna upućivanja ka sekundarnom ili tercijarnom nivou specijalizovane zdravstvene zaštite. Ovo je posebno od koristi u situacijama gde je ograničena dostupnost zdravstvenom sistemu, bilo zbog neadekvatne pristupačnosti, nedostatka radne snage ili neadekvatne infrastrukture.

U tom smislu ovo istraživanje ima za cilj da prikaže značaj i izazove izvođenja medicinsko-biohemijskih analiza u apoteci. Osnovu ovih analiza podrazumeva testiranje pored pacijenta (*Point of Care Testing*, POCT). POCT se izvodi uz minimalnu invazivnost, sa minimalnom pripremom uzorka, jednostavnom metodologijom i ne zahteva visoko stručni zdravstveni kadar za izvođenje i tumačenje rezultata. Osnovni testovi koji mogu obezbediti efikasnu zdravstvenu zaštitu uključuju: testiranje glukoze u krvi, testove urina pomoću traka, merenje hemoglobina za skrining anemije, procena lipidnog statusa, statusa inflamacije ili infekcije. Pored blagovremene intervencije farmaceuta, i efikasnog upućivanja pacijenta na specijalističke preglede, testiranje pored pacijenta u apotekama značajno bi smanjilo troškove zdravstvene zaštite.

Međutim, za sigurno izvođenje medicinsko-biohemijskih analiza u apoteci i održivu implementaciju potrebno je obezbediti odgovarajuću regulativu, stručnu obuku, integraciju zdravstvenog tima i angažovanje javnosti. Važno je da se obezbedi adekvatna edukacija farmaceuta u oblasti metodologije određivanja parametara, kontrole kvaliteta, analitičkih i ekstra-analitičkih koraka izvođenja testa, i pravilnog tumačenja rezultata.

PP14.3. MEDICAL BIOCHEMISTRY TESTING IN PHARMACIES: OPPORTUNITIES, CHALLENGES, AND CLINICAL IMPACT

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Pharmacies play a significant role in the healthcare system by contributing to primary screening and appropriately directing patients to higher levels of care. Testing at the point of care in pharmacies offers exceptional potential for pharmacists to make timely and appropriate decisions. This approach can greatly reduce delays associated with complex laboratory processes, minimize the need for additional appointments, and often eliminate unnecessary referrals to secondary or tertiary specialized healthcare. It is especially valuable in situations where access to the health system is limited due to inadequate accessibility, workforce shortages, or insufficient infrastructure.

This research aims to highlight the importance and challenges of conducting medical-biochemical analyses in pharmacies. These analyses are based on Point of Care Testing (POCT). POCT is performed with minimal invasiveness, requires little sample preparation, uses simple methodologies, and does not require highly skilled medical personnel to perform or interpret the results. Basic tests that can provide effective healthcare include blood glucose testing, urine dipstick tests, hemoglobin measurement for anemia screening, and assessment of lipid, inflammation, or infection status. In addition to enabling timely pharmacist intervention and efficient patient referral to specialist examinations, point-of-care testing in pharmacies can significantly reduce healthcare costs.

However, to ensure the safe and sustainable implementation of medical-biochemical analyses in pharmacies, it is necessary to establish appropriate regulations, provide professional training, integrate the healthcare team, and engage the public. Adequate education of pharmacists is essential in parameter determination methodology, quality control, analytical and extra-analytical steps of test performance, and correct interpretation of results.

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PP14.4. FARMACEUTSKA TOKSIKOLOGIJA - IZBOR ZA FARMACEUTE KOJI ŽELE DA ZNAJU VIŠE

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Farmaceuti imaju veoma važnu ulogu u savetovanju pacijenata o toksikološkim temama, kao i u prevenciji trovanja, zloupotrebi lekova i štetnih uticaja zagađenja životne sredine na zdravlje ljudi. Iz tog razloga, cilj ovog istraživanja je ispitivanje percepcije i stavova farmaceuta u vezi sa ključnim temama iz oblasti toksikologije, od značaja za korisnike njihovih usluga.

Ukupno 343 licencirana farmaceuta dobrovoljno su popunila upitnik sa 26 pitanja, kojim su procenjivani njihovi stavovi, percepcija i razumevanje najvažnijih toksikoloških pitanja u svakodnevnom radu.

Rezultati istraživanja ukazuju na nekoliko ključnih nalaza. Značajan deo ispitanika, naročito onih sa više od 20 godina profesionalnog iskustva, smatra da se oseća sigurno u savetovanju pacijenata o trovanjima, posebno u vezi zloupotrebe lekova i psihoaktivnih supstanci. Međutim, uočeno je ograničeno znanje u oblastima kao što su trovanja hemikalijama za domaćinstvo i izloženost endokrinim ometačima, pri čemu je značajan procenat ispitanika svoje znanje ocenio kao nedovoljno. Na kraju, više od 90% učesnika izrazilo je potrebu za dodatnom edukacijom iz toksikologije, naročito iz oblasti trovanja lekovima, trovanja dece i izloženosti hemikalijama.

Farmaceuti su iskazali veliko interesovanje za proširenje svoje uloge u savetovanju pacijenata o pitanjima vezanim za toksikologiju. Ovo je od izuzetnog značaja jer su upravo farmaceuti zdravstveni radnici koji najlakše i najčešće dolaze u neposredan kontakt sa pacijentima, a dodatno, poseduju visok nivo stručnog znanja iz toksikologije. Razumevanje njihovih stavova i nivoa znanja pomoći će u osmišljavanju ciljanih programa edukacije radi unapređenja stručnosti farmaceuta u oblasti toksikologije.

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PP14.4. PHARMACEUTICAL TOXICOLOGY - A CHOICE FOR PHARMACISTS WHO WANT TO KNOW MORE

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Pharmacists play crucial role in advising patients on toxicological issues and in preventing poisoning, drug abuse, and the adverse health effects of environmental pollution. Accordingly, this study aimed to investigate pharmacists' perceptions, attitudes, and understanding of key issues related to toxicology topics that are most relevant to the population using their services.

A total of 343 licensed pharmacists voluntarily completed a 26-item questionnaire to assess attitudes, perceptions, and understanding of the most important toxicological issues encountered in professional practice.

The findings revealed several important observations. A substantial proportion of respondents, particularly those with more than 20 years of professional experience, reported confidence in advising patients on poisoning, especially in relation to drug abuse and psychoactive substances. However, limited knowledge with a notable percentage rating as poor, was evident in areas such as household chemical poisoning and exposure to endocrine disruptors. Finally, over 90% of participants expressed a need for additional training in toxicology, particularly regarding drug poisoning, poisoning in children, and chemical exposure.

Pharmacists also demonstrated a strong interest in expanding their role in counselling patients on toxicology-related issues. This is particularly important because pharmacists are among the most accessible healthcare professionals and are uniquely positioned to provide timely toxicological advice due to their expertise in medicines and toxicology. A better understanding of their attitudes and knowledge may facilitate the development of targeted educational programmes aimed at strengthening pharmacists' competencies in toxicology.

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Sesija 15
Session 15

Ka održivoj budućnosti – novi pristupi u razvoju i proizvodnji lekova

Transforming pharmaceutical development for a sustainable future

Ka održivoj budućnosti - novi pristupi u razvoju i proizvodnji lekova

Održivost je postala strateški prioritet u svim fazama životnog ciklusa leka. Regulatorni zahtevi, očekivanja društva i rastuća zabrinutost za životnu sredinu podstiču farmaceutsku zajednicu da traži načine kako da razvija, proizvodi i primenjuje lekove koji unapređuju zdravlje ljudi, bez ugrožavanja dobrobiti budućih generacija. Ova paradigma podrazumeva primenu inovativnih pristupa koji obezbeđuju bezbednost pacijenata i proizvodnju lekova visokog kvaliteta, uz istovremeno smanjenje potrošnje resursa i količine generisanog otpada, kao i njegovu ponovnu upotrebu. U okviru sesije su predstavljeni savremeni koncepti procene bezbednosti lekova, održivog razvoja i proizvodnje farmaceutskih proizvoda, kontrole kvaliteta zasnovane na principima održivosti integrisanim u sam proces razvoja, kao i mogućnosti transformacije biljnog otpada u vredne farmaceutske resurse.

Transforming pharmaceutical development for a sustainable future

Sustainability has become a strategic priority across all stages of the pharmaceutical lifecycle. Regulatory and societal expectations, together with growing environmental concerns, are driving the pharmaceutical community to find new ways to develop, manufacture, and use medicines that improve human health without compromising the well-being of future generations. This new paradigm involves innovative solutions that ensure patient safety and the production of high-quality medicines while minimizing resources consumption, reducing waste generation, and promoting resources recovery and reuse. This session highlights emerging concepts in drug safety assessment, sustainable pharmaceutical development and manufacturing, quality control from a Sustainability-by-Design perspective, and opportunities for transforming plant waste into valuable pharmaceutical resources.

PP15.1. PROCENA BEZBEDNOSTI LEKA U KONCEPTU ODRŽIVOG RAZVOJA

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Farmaceutske nauke su neizostavno deo Cilja br. 3 od 17 ciljeva održivog razvoja Ujedinjenih nacija u okviru Agende za održivi razvoj do 2030. godine. Glavna poruka Agende jeste osigurati zdrav život i promovisati blagostanje za sve u svim uzrastima. Ovaj koncept uključuje izazove u procesu dizajniranja i proizvodnje lekova, njihovog transporta, primene i odlaganja tokom celog životnog ciklusa.

Procena bezbednosti je ključna komponenta razvoja leka, koja osigurava razvoj efikasnih, kvalitetnih i bezbednih lekova, i koncipirana je tako da istovremeno podržava opšte ciljeve održivosti. Održivi pristup bezbednosti lekova uključuje smanjenje testiranja na životinjama kroz primenu metodologija novog pristupa (NAM), kao što su *in vitro* modeli, računarska toksikologija i prediktivni alati zasnovani na veštačkoj inteligenciji. Validirane *in silico* metode su od posebnog značaja, jer se široko koriste ne samo za dizajniranje inteligentnih strategija testiranja, već i za predviđanje toksičnosti u regulatornom kontekstu.

Ekološki aspekti su takođe od velikog značaja. Procene bezbednosti podrazumevaju i razmatranja potencijalnih uticaja primene i proizvodnje lekova na životnu sredinu, uključujući njihovu perzistentnost, bioakumulaciju i toksičnost, čime se doprinosi razvoju ekološki prihvatljivijih lekova i smanjuje zagađenje životne sredine.

Integracija procene bezbednosti lekova sa principima održivog razvoja obezbeđuje odgovoran pristup inovacijama, zaštitu zdravlje ljudi i životne sredine i doprinosi postizanju globalnih ciljeva, uključujući one navedene u Agendi održivog razvoja.

PP15.1. DRUG SAFETY ASSESSMENT WITHIN A SUSTAINABLE DEVELOPMENT FRAMEWORK

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The pharmaceutical sciences are inherently part of Goal no. 3 of the 17 United Nation's Sustainable Development Goals (SDGs) of the 2030 Agenda for Sustainable Development: "ensure healthy lives and promote well-being for all at all ages". This concept includes challenges in the process of designing and manufacturing medicines, their transport, administration and disposal throughout the entire life cycle.

Safety assessment is a key component of drug development, which ensures the development of effective, quality and safe drugs while supporting broader sustainability goals.

A sustainable approach to drug safety emphasizes the reduction of animal testing through the adoption of New Approach Methodologies (NAMs) such as *in vitro* models, computational toxicology, and artificial intelligence-based predictive tools. Validated *in silico* methods are of particular importance, as they are extensively used not only for designing intelligent testing strategies but also for predicting toxicity in regulatory contexts.

Environmental considerations are also increasingly important. Safety assessments evaluate the potential ecological effects of pharmaceutical compounds, including their persistence, bioaccumulation, and toxicity in ecosystems. This supports the development of greener medicines and reduces environmental contamination.

Integrating drug safety assessment with sustainable development principles supports responsible innovation, protects human and environmental health, and contributes to achieving global sustainability objectives, including those outlined in the SDGs.

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PP15.2. NOVE PARADIGME I PRISTUPI ZA ODRŽIVI RAZVOJ I PROIZVODNJU LEKOVA

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Sve izraženija svest i zabrinutost u vezi sa uticajem farmaceutske industrije na životnu sredinu pokrenula je detaljna razmatranja iz aspekta održivosti, uzevši u obzir sve korake počev od istraživanja i razvoja do kraja životnog ciklusa leka. Nedavno je uvedeno nekoliko novih koncepata, kao što su „Održivost kroz dizajn" (engl. *Sustainability by Design*, SbD) i „Bezbedan i održiv kroz dizajn" (engl. *Safe and Sustainable by Design*, SSbD), sa ciljem da se održivost ugradi u farmaceutski proizvod integrišući je kao vodeći princip tokom celog životnog ciklusa proizvoda. Integracija principa održivosti i uloga farmaceuta u industriji su, takođe, naglašeni u dokumentu Internacionalne federacije farmaceuta „*FIP Call to Action Pharmacists for Environmental Sustainability*", objavljenom u 2025. godini. Dok su ekološki uticaj rezidua aktivnih supstanci u životnoj sredini i ekološki otisak njihove proizvodnje razmatrani prethodnih godina, uticaj ekscipijenasa je smatran zanemarljivim. Međutim, nedavna istraživanja ističu značaj pažljivog razmatranja njihovog uticaja na životnu sredinu, uzevši u obzir ceo životni ciklus svakog ekscipijensa. Prepoznato je da održivi pristup razvoju formulacije leka treba da uzme u obzir i ukupne količine ekscipijenasa i aktivnih supstanci po farmaceutskom obliku. Napredni pristupi razvoju formulacije sa poboljšanom bioraspoloživošću i pristupi usmereni na pacijenta mogu doprineti održivosti. Ističe se da odluke vođene održivošću pri izboru postupka za proizvodnju farmaceutskog oblika leka mogu biti složene i da su, pored brojnih uključenih faktora, dodatno otežane nedostatkom literaturnih podataka o ekološkom aspektu konvencionalnih postupaka. Uporedo sa razvojem novih, ekološki prihvatljivijih postupaka, novi pristupi kao što su kontinuirana i agilna proizvodnja usmeravaju pravac ka održivijoj proizvodnji lekova.

Zahvalnica

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PP15.2. NEW PARADIGMS AND APPROACHES FOR SUSTAINABLE PHARMACEUTICAL DEVELOPMENT AND MANUFACTURING

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Growing awareness and concern about the environmental impacts of the pharmaceutical industry have prompted a comprehensive, sustainability-focused rethinking of all stages, from research and development to the end-of-life of medicines. Several concepts, such as Sustainability by Design (SbD) and Safe and Sustainable by Design (SSbD), have recently been introduced to embed sustainability into pharmaceutical products by integrating it as a guiding principle throughout the entire product life cycle. The integration of sustainability principles and the role of industrial pharmacists are also strongly emphasized in the FIP Call to Action Pharmacists for Environmental Sustainability, published in 2025. While the environmental impact of residual active pharmaceutical ingredients (APIs) and the environmental footprint of API manufacturing have been addressed in recent years, the impact of excipients has been neglected. However, recent studies highlight the importance of carefully considering their environmental impact, taking into account each excipient's entire life cycle. It has been recognized that sustainability-driven formulation development should also consider the total quantities of excipients and APIs required per dosage form. Enabling formulations that improve bioavailability and a patient-centric approach to dosage form development have been recognized as contributing to better sustainability performance. It has been acknowledged that sustainability-guided decisions about the dosage form manufacturing process may not be straightforward and, beyond the multiple factors involved, are further complicated by the lack of literature addressing environmental aspects of conventional processes. Along with emerging environmentally friendly technologies, novel approaches such as continuous and agile manufacturing are shaping the direction toward more sustainable pharmaceutical manufacturing.

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PP15.3. KONTROLA KVALITETA LEKOVA SAGLEDANA IZ PERSPEKTIVE PRISTUPA „ODRŽIVOSTI KROZ DIZAJN“

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Koncept „Održivost kroz dizajn“ (eng. *Sustainability by Design,* SbD) u farmaceutskoj industriji podrazumeva sistematsko ugrađivanje principa održivosti u proizvod definisanjem parametara koji su kritični i za njegov kvalitet i za zaštitu životne sredine. Za razliku od tradicionalnog pristupa, gde se ekološki aspekti razmatraju naknadno, SbD integriše principe održivost paralelno sa zahtevima za kvalitet, bezbednost i efikasnost. U kontroli lekova, ovaj pristup podrazumeva racionalno projektovanje analitičkih procedura, unapređeno upravljanje životnom ciklusom proizvoda uz potpuno usklađivanje sa regulatornim zahtevima. Ključnu ulogu imaju ICH smernice, prvenstveno ICH Q14 i ICH Q2(R2) čija primena podrazumeva uvođenje *Analytical Quality by Design* (AQbD) koncepta. Integracija SbD i AQbD principa uvodi strukturiran, naučni i na proceni rizika zasnovan pristup razvoju analitičkih procedura, precizniju procenu stabilnosti aktivnih supstanci i gotovih proizvoda, kao i pouzdanije određivanje roka upotrebe. Primena principa upravljanja životnim ciklusom i analize rizika smanjuje potrebu za naknadnim regulatornim izmenama i doprinosi smanjenju otpada. Istovremeno, principi zelene hemije, poput miniaturizacije metoda, smanjenja upotrebe organskih rastvarača i optimizacije eksperimentalnih postupaka, doprinose ekološkoj održivosti bez narušavanja kvaliteta dobijenih podataka. Studije stabilnosti predstavljaju ključni element SbD pristupa jer direktno utiču na definisanje roka upotrebe proizvoda, generisanje otpada i efikasnost lanca snabdevanja. Digitalizacija, primena naprednih alata i savremenih prediktivnih metoda omogućavaju bolje razumevanje puteva degradacije i precizniju procenu stabilnosti što dodatno unapređuje donošenje održivih odluka. Sveobuhvatna integracija SbD, AQbD i ICH regulatornih okvira predstavlja osnovu za razvoj održivog, robusnog i efikasnog sistema koji istovremeno unapređuje kvalitet, regulatornu fleksibilnost i smanjuje negativan uticaj na životnu sredinu.

PP15.3. RETHINKING DRUG QUALITY CONTROL FROM THE SUSTAINABILITY-BY-DESIGN PERSPECTIVE

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The concept of “Sustainability by Design” (SbD) in the pharmaceutical industry refers to the systematic integration of sustainability principles into products by defining parameters critical to both their quality and environmental protection. Unlike the traditional approach, which considers environmental aspects retrospectively, SbD incorporates sustainability principles alongside requirements for quality, safety, and efficacy. In pharmaceutical quality control, this approach involves the rational design of analytical procedures and enhanced lifecycle management of products, aligned with regulatory requirements. ICH guidelines, primarily ICH Q14 and ICH Q2(R2), play a key role, as their implementation requires adopting the Analytical Quality by Design (AQbD) concept. Integrating SbD and AQbD principles introduce structured, science-based, risk-based approach to developing analytical procedures, precise assessment of the stability of active pharmaceutical ingredients and finished products, and more reliable determination of shelf life. Applying lifecycle management principles and risk analysis reduces the need for post-approval regulatory changes and helps minimize waste. At the same time, principles of green chemistry, such as method miniaturization, reducing the use of organic solvents, and optimizing experimental procedures, support environmental sustainability without compromising data quality. Stability studies are a key element of the SbD approach, as they directly affect shelf-life determination, waste generation, and supply chain efficiency. Digitalization, advanced tools and modern predictive methods, enable a better understanding of degradation pathways and a more accurate assessment of stability, further supporting sustainable decision-making. Comprehensive integration of SbD, AQbD, and ICH regulatory frameworks provides a foundation for developing a sustainable, robust, and efficient system that simultaneously enhances quality, regulatory flexibility, and reduces environmental impact.

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PP15.4. TRANSFORMACIJA BILJNOG OTPADA U FARMACEUTSKE RESURSE: MOGUĆNOSTI ZA ODRŽIVI RAZVOJ

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Poljoprivredna proizvodnja i prerada hrane generišu ogromne količine biljnog otpada, što dovodi do ekonomskih gubitaka i značajnih ekoloških posledica. Međutim, ovi biljni ostaci predstavljaju bogate i nedovoljno iskorišćene izvore bioaktivnih jedinjenja i tehnološki vrednih sastojaka. U najistraživanije biljne sporedne proizvode spadaju komina i seme grožđa, spoljašnji delovi plodova citrusa i nara, komine bobičastog voća, listovi i komina masline, kao i ostaci žitarica. Ovi materijali sadrže raznovrsna vredna jedinjenja, uključujući polifenole (fenolkarboksilne kiseline, flavonoide, tanine i antocijane), karotenoide, polisaharide, proteine, fitosterole i vitamine. Takođe, mogu predstavljati izvore farmaceutskih pomoćnih supstanci, posebno celuloze i pektina. Brojna istraživanja su pokazala da jedinjenja dobijena iz biljnih nusproizvoda ispoljavaju antioksidantne, antimikrobne, antiinflamatorne, kardiometaboličke i antiproliferativne efekte, zbog čega imaju značajan potencijal za razvoj biljnih lekovitih proizvoda i dodataka ishrani. Nedavni napredak u tehnologijama ekstrakcije, naročito ekstrakciji potpomognutoj ultrazvukom i mikrotalasima, kao i ekstrakciji superkritičnim fluidima, učinio je dobijanje bioaktivnih jedinjenja efikasnijim i održivijim, time što je omogućio veće prinose ekstrakcije, kraće vreme ekstrakcije, manju potrošnju rastvarača i bolje očuvanje termolabilnih sastojaka. Ipak, i dalje su prisutni značajni izazovi, posebno u pogledu standardizacije agroindustrijskih nusproizvoda za farmaceutsku primenu i kontrole kontaminanata poreklom iz poljoprivredne proizvodnje. Stoga biljni otpad više ne bi trebalo posmatrati kao ekološki i ekonomski izazov, već kao obnovljiv i strateški važan resurs za razvoj održivih farmaceutskih proizvoda.

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PP15.4. TRANSFORMATION OF PLANT WASTE INTO PHARMACEUTICAL RESOURCES: OPPORTUNITIES FOR SUSTAINABLE DEVELOPMENT

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Agricultural production and food processing generate enormous quantities of plant waste, leading to economic losses and considerable environmental burden. However, these discarded materials represent abundant and underutilized sources of bioactive compounds and technologically valuable constituents. Among the most extensively investigated plant by-products are grape pomace and seeds, citrus and pomegranate peels, berry pomaces, olive leaves and pomace, as well as cereal residues. These materials contain a wide range of valuable compounds, including polyphenols (phenolic acids, flavonoids, tannins, and anthocyanins), carotenoids, polysaccharides, proteins, phytosterols, and vitamins. They may also serve as sources of pharmaceutical excipients, particularly cellulose and pectin. Numerous studies have demonstrated that compounds recovered from plant by-products exert antioxidant, antimicrobial, anti-inflammatory, cardiometabolic, and antiproliferative effects, making them promising candidates for the development of herbal medicinal products and dietary supplements. Recent advances in extraction technologies, particularly ultrasound-assisted, microwave-assisted, and supercritical fluid extraction, have made the recovery of bioactive compounds more efficient and sustainable by providing higher extraction yields, shorter extraction times, lower solvent consumption, and improved preservation of thermolabile constituents. Nevertheless, major challenges remain, particularly the standardization of agro-industrial by-products for pharmaceutical applications and the control of agricultural contaminants. Plant waste should therefore no longer be regarded as a burden, but rather as a renewable and strategically important resource for the development of sustainable pharmaceutical products.

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Sesija 16
Session 16

Savremena dostignuća u kliničkoj farmaciji i farmakoterapiji

Advances in clinical pharmacy and pharmacotherapy

Savremena dostignuća u kliničkoj farmaciji i farmakoterapiji

Savremena klinička farmacija i farmakoterapija sve više se oslanjaju na individualizovane pristupe, integraciju kliničkih podataka i primenu savremenih istraživačkih metoda u cilju unapređenja efikasnosti i bezbednosti terapije. Sesija uključuje teme koje se odnose na hepatotoksičnost lekova, terapijske izazove kod pacijenata sa inflamatornim bolestima creva, primenu populacionog farmakokinetičkog modelovanja u optimizaciji doziranja kod dece, racionalnu primenu antibiotika, kao i rezultate savremenih istraživanja u terapiji bola i nove terapijske strategije zasnovane na nukleinskim kiselinama u lečenju kardiovaskularnih bolesti.

Advances in clinical pharmacy and pharmacotherapy

Contemporary clinical pharmacy and pharmacotherapy increasingly rely on individualized approaches, integration of clinical data, and application of modern research methodology to improve medicines efficacy and safety. The session includes topics related to drug-induced liver injury, drug-related problems in patients with inflammatory bowel disease, application of population pharmacokinetic modelling for dose optimization in children, rational use of antibiotics, as well as contemporary research of pain management and novel therapeutic strategies based on nucleic acids for the treatment of cardiovascular diseases.

PP16.1. HEPATOTOKSIČNOST U KLINIČKOJ PRAKSI: FARMACEUT KAO STUB BEZBEDNE TERAPIJE

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Hepatotoksičnost je najčešći razlog povlačenja lekova sa tržišta nakon registracije, a u kliničkoj praksi ostaje dijagnoza isključivanja, bez potvrdnog biomarkera. Podaci Prospektivnog evropskog registra oštećenja jetre izazvanog lekovima (engl. *drug-induced liver injury, DILI*) pokazuju da su najčešće implicirani antibakterijski lekovi (40%) i antineoplastici/imunomodulatori (27%), pre svega amoksicilin-klavulanat, flukloksacilin, atorvastatin, nitrofurantoin, infliksimab i inhibitori kontrolnih tačaka imunskog odgovora, dok je 7% slučajeva povezano sa biljnim preparatima i dijetetskim suplementima (uz podatke da taj udeo u drugim prospektivnim mrežama dostiže 20%). Predavanje ovom problemu pristupa iz perspektive kliničkog farmaceuta i povezuje realne prikaze pacijenata sa alatima primenljivim na primarnom i sekundarnom/tercijarnom nivou zdravstvene zaštite. Odabrani slučajevi ilustruju hepatocelularni, holestatski i mešoviti obrazac oštećenja klasifikovan pomoću *R* vrednosti, pri čemu svaki vodi kroz po jedan korak dijagnostičkog puta prema *EASL* smernicama: rekonstrukciju kompletne terapijske istorije uključujući *OTC* preparate i suplemente, procenu latencije i odgovora na obustavu leka, prepoznavanje *Hy*-jevog zakona i strukturiranu procenu uzročnosti primenom *RUCAM/RECAM* skale. Posebna pažnja posvećena je razlikovanju *DILI* od pogoršanja osnovne bolesti jetre i od prolaznog porasta transaminaza u okviru adaptacije, jer pogrešna atribucija jednako često vodi nepotrebnom ukidanju efikasne terapije koliko i propuštenom oštećenju. Biće predstavljeni dostupni resursi (*LiverTox, DILIrank*), kriterijumi za obustavu leka, intervali laboratorijskog praćenja i prilagođavanje doza prema sažetku karakteristika leka, uz osvrt na ograničenja *Child-Pugh* klasifikacije. Cilj je da farmaceut izađe sa primenljivim algoritmom za rano prepoznavanje i zbrinjavanje *DILI*.

PP16.1. DRUG-INDUCED LIVER INJURY IN CLINICAL PRACTICE: PHARMACIST AS A PILLAR OF MEDICATION SAFETY

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Hepatotoxicity is the most frequent reason for post-marketing withdrawal of medicines, yet in clinical practice drug-induced liver injury (DILI) remains a diagnosis of exclusion with no confirmatory biomarker. In the Prospective European DILI Registry, antibacterials (40%) and antineoplastic/immunomodulating agents (27%) were most often implicated, chiefly amoxicillin-clavulanate, flucloxacillin, atorvastatin, nitrofurantoin, infliximab and immune checkpoint inhibitors, while 7% of cases were attributable to herbal and dietary supplements (a share reaching 20% in other prospective networks). The lecture takes the perspective of a clinical pharmacist, linking real cases to tools applicable at primary and secondary/tertiary levels of care. Selected cases illustrate hepatocellular, cholestatic and mixed patterns of injury classified by the R value, each covering one step of the EASL diagnostic pathway: reconstruction of the complete medication history including over-the-counter products and supplements, assessment of latency and dechallenge, recognition of Hy's law, and structured causality assessment using the RUCAM/RECAM scales. Particular attention is given to distinguishing DILI from decompensation of underlying liver disease and from transient transaminase elevation reflecting adaptation, since misattribution leads as often to unnecessary withdrawal of effective therapy as to missed injury. Available resources, drug-stopping criteria, laboratory monitoring intervals and dose adjustment based on the summary of product characteristics will be presented, together with the limitations of the Child-Pugh classification. The aim is that pharmacists leave with an applicable algorithm for early recognition and management of DILI.

US16.1. BEZBEDNOST ADALIMUMABA KOD INFLAMATORNIH BOLESTI CREVA: ISKUSTVA IZ KLINIČKE KOHORTE

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Podaci o bezbednosti adalimumaba iz kliničke prakse su od ključnog značaja za kontinuirano praćenje bezbednosti leka, dok su dugoročni podaci i dalje ograničeni. Cilj ove studije bio je da se procene neželjeni događaji (ND) i njihovi vremenski obrasci u kohorti pacijenata sa zapaljenjskim bolestima creva. Retrospektivna opservaciona studija obuhvatila je 217 odraslih pacijenata sa zapaljenjskim bolestima creva lečenih adalimumabom u Univerzitetskom kliničkom centru „Zvezdara" u Beogradu, Republika Srbija. ND su identifikovani iz medicinske dokumentacije i kodirani korišćenjem MedDRA terminologije. Stope incidencije ND su izračunate na 100 pacijent-godina (PG) izloženosti. Analiza vreme do događaja korišćena je za procenu pojave prvog ND. Ukupna izloženost adalimumabu iznosila je 591,29 PG, uz 630 prijavljenih ND (106,55/100 PG). Najčešće prijavljeni ND pripadali su MedDRA sistemskim organskim klasama infekcija i infestacija, ispitivanja, opštih poremećaja i reakcija na mestu primene, kao i bolesti kože i potkožnog tkiva. Najčešći pojedinačni ND bili su COVID-19, nazofaringitis, infekcija respiratornog trakta, povišena telesna temperatura i povišeni jetreni enzimi. Adalimumab je obustavljen zbog ND kod 17 pacijenata, najčešće zbog infekcija, reakcija na mestu injekcije i dermatoloških reakcija, lupus-sličnog sindroma i neuroloških događaja. Nisu zabeleženi smrtni ishodi. Weibullova distribucija najbolje je opisala pojavu prvog ND, sa medijanom vremena do prvog ND od 12,7 meseci (95% interval pouzdanosti, CI: 10,6–15,2). Bezbednosni profil adalimumaba u kliničkoj kohorti pacijenata bio je u skladu sa dostupnim podacima. Prvi ND su se javljali tokom celokupnog perioda lečenja, što ukazuje na potrebu za kontinuiranim praćenjem bezbednosti tokom dugotrajne terapije.

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US16.1. SAFETY OF ADALIMUMAB IN INFLAMMATORY BOWEL DISEASE: INSIGHTS FROM A CLINICAL COHORT

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Real-world data on the safety of adalimumab are essential for ongoing pharmacovigilance, while long-term evidence remains limited. This study aimed to evaluate adverse events (AEs) and their temporal patterns in a cohort of patients with inflammatory bowel disease (IBD). A retrospective observational study included 217 adult patients with IBD treated with adalimumab at University Medical Center "Zvezdara" in Belgrade, Republic of Serbia. AEs were identified from medical records and coded using MedDRA terminology. Incidence rates were calculated per 100 patient-years (PY) of exposure. Time-to-event (TTE) analysis was performed to evaluate the occurrence of the first AE. The total adalimumab exposure was 591.29 PY, with 630 AEs (106.55/100 PY) recorded. The most frequently reported AEs belonged to the MedDRA system organ classes of infections and infestations, investigations, general disorders and administration-site conditions, and skin and subcutaneous tissue disorders. The most commonly reported individual AEs were COVID-19, nasopharyngitis, respiratory tract infection, pyrexia, and elevated liver enzymes. Adalimumab was discontinued due to AEs in 17 patients, most commonly infections, injection-site and dermatological reactions, lupus-like syndrome, and neurological events, consistent with its known safety profile. No deaths were recorded. TTE analysis showed that the Weibull distribution provided the best fit for the occurrence of the first AE, with an estimated median time of 12.7 months (95% confidence interval, CI: 10.6–15.2). Adalimumab safety profile in this real-world IBD cohort was consistent with the available data. First AEs occurred throughout treatment exposure, highlighting the need for ongoing safety monitoring during long-term treatment.

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US16.2. TERAPIJSKI PROBLEMI PACIJENATA SA ANEMIJOM PROUZROKOVANOM INFLAMATORNOM BOLEŠĆU CREVA

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Pacijenti sa inflamatornim bolestima creva (IBC) neretko obole i od različitih pridruženih komorbiditeta koji se manifestuju ekstraintestinalno. Jedna od najčešćih ekstraintestinalnih manifestacija je upravo anemija, koja se može javiti usled hroničnog zapaljenja, upotrebe pojedinih lekova, krvarenja usled pogoršanja ili malnutricije. Iako je protokol lečenja anemije prilično jasan, ova indikacija često ostaje zanemarena, a kako može dovesti i do pogoršanja IBC, neophodno je blagovremeno stabilizovati krvne parametre. Stoga, cilj ovog istraživanja bio je da se sprovede pregled terapije kod pacijenata sa IBC i anemijom na Odeljenju za gastroeneterologiju i hepatologiju Univerzitetsko-bolničkog medicinskog centra „Zvezdara“, identifikuju terapijski problemi, kao i njihovi uzroci, te predlože intervencije koje bi klinički farmaceut mogao da sprovede. Iz baze restrospektivno prikupljenih podataka identifikovano je ukupno 52 pacijenta sa anemijom (40,30% muškaraca, starosti 39 (18-65) godina, telesne mase 68 (43-95) kg). Terapijski problemi klasifikovani su po klasifikaciji Cippole i saradnika. Pregledom terapije identifikovan je 151 terapijski problem, najveći broj u kategorijama bezbednost (33.77%) i efikasnost (31.13%). Najčešći uzroci identifikovanih problema bili su doziranje preparata gvožđa (27), interakcija azatioprina kako sa infliksimabom (25), tako i sa aminosalicilatima (16) koja zapravo može biti potencijalni uzrok anemije kod pacijenta, kao i nedostatak terapije za anemiju (22). Intervencije farmaceuta u vidu uvođenja/predlaganja doziranja leka za anemiju, praćenja potencijalnih interakcija, isključivanja nepotrebnih lekova, savetovanja tokom lečenja i na otpustu mogu dovesti do smanjenja ponovnih hospitalizacija i povećanja ušteda zdravstvenog sistema. Farmaceut na odeljenju bi mogao da bude značajan deo zdravstvenog tima pružajući veliku podršku medicinskom osoblju u zbrinjavanju pacijenata.

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US16.2. DRUG-RELATED PROBLEMS IN PATIENTS WITH ANAEMIA CAUSED BY INFLAMMATORY BOWEL DISEASE

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Inflammatory bowel disease (IBD) patients often suffer additionally from various comorbidities manifested extraintestinally. One of the most common extraintestinal manifestations is anaemia caused by chronic inflammation, certain drug co-administration, bleeding from the gut or malnutrition. Although anaemia treatment protocol is rather straightforward, this indication is often overlooked, and since it can cause IBD relapse, it is necessary to timely stabilize blood parameters. Therefore, the aim of this research was to perform a medical review of anaemic IBD patients on the gastroenterology and hepatology ward of the University Hospital Centre "Zvezdara", identify drug-related problems as well as their causes, and propose pharmacists' interventions that could be implemented. A total of 52 anaemic patients (40,30% males, aged 39 (18-65) years, weighing 68 (43-95) kg) were identified from the retrospectively gathered database. Drug-related problems were classified according to Cippole and associates' classification. Medical review identified 151 drug-related problems, the most in the categories safety (33.77%) and efficacy (31.13%). Most frequent causes of the identified problems were dosing of iron preparations (27), interaction of azathioprine with both infliximab (25) and aminosalicylates (16) which could potentially cause anaemia in patients, as well as absence of anaemia treatment (22). Pharmacists' interventions in the form of introducing/suggesting the dose of anaemia medication, monitoring potential interactions, excluding unnecessary drugs, counselling during treatment and at discharge can reduce the number of re-hospitalizations and increase healthcare system savings. A ward pharmacist could be an important part of the health care team providing great support to the medical staff in patient care.

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US16.3. POPULACIONI FARMAKOKINETIČKI MODEL KAO ALAT ZA SIMULACIJU IZLOŽENOSTI CIKLOSPORINU KOD DECE

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Terapijski monitoring ciklosporina (TDM) se sprovodi zbog njegove varijabilne farmakokinetike. Demografski, klinički i TDM podaci koriste se za razvoj populacionog farmakokinetičkog modela (popPK). Ovi modeli omogućavaju identifikaciju faktora koji uzrokuju varijabilnost u parametrima izloženosti organizma leku: maksimalna (C_{max}), minimalna koncentracija (C_{min}) i površina ispod krive (PIK). Na osnovu podataka od 58 pacijenata iz Univerzitetske dečje klinike, razvijen je popPK model koji uključuje telesnu masu i hemoglobin kao identifikovane faktore varijabilnosti. Razvijeni model je iskorišćen za simulaciju C_{max}, C_{min} i PIK u programu *e-campsis®* (*Calvagone, France*) u virtuelnoj populaciji pacijenata u dva različita klinička scenarija: kada pacijenti imaju normalnu vrednost hemoglobina i sniženu vrednost hemoglobina, a svaki od dva scenarija u dve vremenske tačke. Medijalna vrednost C_{min}, C_{max} i PIK u grupi sa sniženim vrednostima hemoglobina u prvoj i drugoj vremenskoj tački su respektivno: 215 ng/mL, 1851 ng/mL i 6343 ngh/mL, odnosno 221 ng/mL, 1918 ng/mL i 6687 ngh/mL, a u grupi pacijenata sa normalnim vrednostima hemoglobina 331 ng/mL, 2265 ng/mL i 7857 ngh/mL, odnosno 318 ng/mL, 2035 ng/mL i 7210 ngh/mL. Najizraženiji uticaj hemoglobina je na C_{min}, gde je grupa sa normalnim vrednostima hemoglobina imala 53.95% veće vrednosti C_{min}, odnosno 43.89% u odnosu na grupu sa sniženim vrednostima. Primena simulacija zasnovanih na popPK modelima predstavlja koristan alat za predviđanje izloženosti leku. Na ovaj način, optimizuje se balans između efikasnosti i bezbednosti terapije, **čime** se omogućava precizna i blagovremena korekcija doziranja u cilju postizanja maksimalnog terapijskog odgovora.

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US16.3. POPULATION PHARMACOKINETIC MODEL AS A TOOL FOR SIMULATING CYCLOSPORINE EXPOSURE IN CHILDREN

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Therapeutic drug monitoring (TDM) of cyclosporine is indicated due to its variable pharmacokinetics. Demographic, clinical and TDM data are used to develop a population pharmacokinetic (popPK) model. These models identify factors causing variability in drug exposure parameters like maximum (C_{max}), minimum concentration (C_{min}) and area under the curve (AUC). Based on data from 58 patients from the University Children's Hospital, a popPK model was developed with body mass and haemoglobin as variability factors. The model was used to simulate C_{max}, C_{min} and AUC in the e-campsis® program (Calvagone, France) in a virtual population of patients in two different clinical scenarios: when patients have normal and reduced haemoglobin levels, and each of the two scenarios at two time points. The median values of C_{min}, C_{max} and AUC in the low-level haemoglobin group at the first and second time points were, respectively: 215 ng/mL, 1851 ng/mL and 6343 ng/mL, and 221 ng/mL, 1918 ng/mL and 6687 ng/mL; and in normal- level haemoglobin group 331 ng/mL, 2265 ng/mL and 7857 ngh/mL, and 318 ng/mL, 2035 ng/mL and 7210 ngh/mL. The most pronounced effect of haemoglobin is on C_{min}, where the group with normal haemoglobin had 53.95% higher C_{min} levels, i.e. 43.89% compared to the group with reduced levels. Application of simulations based on popPK models is a useful tool for predicting drug exposure. Thus, the balance between the efficacy and safety of the therapy is optimized, which enables precise and timely correction of the dosage in order to achieve the maximum therapeutic response.

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US16.4. NEODGOVARAJUĆE PROPISIVANJE ANTIBIOTIKA INDIKOVANIH ZA LEČENJE POSTOPERATIVNIH INFEKCIJA U NEUROHIRURGIJI

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Neodgovarajuće propisivanje antibiotika predstavlja najznačajniji prediktor za manifestne negativne kliničke i ekonomske ishode lečenja. Problem je složeniji kod pacijenata sa ispoljenim postoperativnim infekcijama u neurohirurgiji čija prevalencija je u porastu uprkos sprovedenoj profilaksi.

Cilj rada je bio da se izvrši deskriptivna analiza neodgovarajućeg propisivanja empirijskih antibiotika za lečenje infekcija centralnog nervnog sistema i infekcija operativne rane nastalih nakon neurohirurškog zahvata.

Studija je dizajnirana kao retrospektivna studija preseka. Iz ukupne uključene populacije (n=136), analizirani su slučajevi (n=78) kojima je identifikovan minimalno jedan obrazac neodgovarajućeg propisivanja antibiotika – *misprescribing*, odnosno propisivanje leka koji nije indikovan ili *underprescribing,* odnosno izostanak propisivanja leka koji je indikovan.

Uključeno je 26 ispitanika sa meningitisom, 17 sa intrakranijalnim apscesom i 35 sa infekcijama operativne rane. Primenom *Medication Appropriateness Index* instrumenta, *misprescribing* je identifikovan kod 69 (88,5%) ispitanika kojima je primena minimalno jednog antibiotika ocenjena sa MAI skorom ≥4, dok je *underprescribing* opserviran kod 52 (66,7%) ispitanika. Najčešći neodgovarajuće propisani antibiotici bili su meropenem u 16 slučajeva kao i kolistin, metronidazol i ceftriakson u 11 slučajeva. Najčešći razlozi neodgovarajućeg propisivanja uključili su neodgovarajuću dužinu lečenja n=78 (50,3%), neadekvatan izbor leka n=77 (49,7%), i neadekvatne troškove n=75 (48,4%). *Underprescribing* je potvrđen kod 36 slučajeva za primenu vankomicina i kod 19 za primenu meropenema.

Na osnovu navedenih rezultata možemo da zaključimo da postoji potreba za povećanom pažnjom prilikom procene empirijske antimikrobne terapije. Takođe, postoji potreba za kreiranjem lokalnih smernica za empirijsku terapiju na osnovu epidemioloških podataka o uzročnicima opserviranih infekcija i njihovim usaglašavanjem sa međunarodnim preporukama.

Zahvalnica

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US16.4. INNAPROPRIATE PRESCRIBING OF ANTIBIOTICS WHICH ARE INDICATED FOR THE TREATMENT OF POSTOPERATIVE INFECTIONS IN NEUROSURGERY

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Inappropriate antibiotic prescribing is the most important predictor for manifested negative clinical and economic treatment outcomes. The problem is more complex in the population with postoperative infections in neurosurgery, prevalence is increasing despite the implemented prophylaxis.

The aim of this study was to perform a descriptive analysis of inappropriate prescribing of empiric antibiotics for treatment of central nervous system infections and surgical wound infections after neurosurgery.

The study was designed as a retrospective cross-sectional study. From the total included population (n=136), cases were analyzed (n=78) in which at least 1 pattern of inappropriate antibiotic prescribing – misprescribing or underprescribing – was identified.

Patients with meningitis (n=26), intracranial abscess (n=17) and surgical wound infections (n=35) were included. Misprescribing was identified by *Medication Appropriateness Index* tool in 69 (88.5%) patients whose use at least one antibiotic was evaluated with MAI score ≥4, while underprescribing was observed in 52 (66.7%) respondents. The most common inappropriately prescribed antibiotics were meropenem in 16 cases, and colistin, metronidazole and ceftriaxone in 11 cases. The most common reasons for inappropriate prescribing included inadequate choice of drug 77 (49.7%), inappropriate length of treatment 78 (50.3%), and inadequate costs 75 (48.4%). Underprescribing was confirmed in 36 cases for use of vancomycin and in 19 for the use of meropenem.

Based on above results we can conclude that there is need for increased attention when evaluating empiric antimicrobial therapy and need to create local guidelines for empiric therapy based on epidemiological data on causative agents of observed infections and their harmonization with international recommendations.

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US16.5. UTICAJ POLA NA BOLNU PREOSETLJIVOST, KOGNITIVNE PERFORMANSE I MOTIVACIJU U MODELU GLAVOBOLJE PREKOMERNE UPOTREBE ANALGETIKA IZAZVANE PRIMENOM KODEINA

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Glavobolja prekomerne upotrebe lekova (GPUL) je hronična sekundarna glavobolja uzrokovana preteranom upotrebom analgetika za lečenje akutnih napada glavobolje, koja se češće javlja kod žena. Povezana je sa smanjenim kvalitetom života i kognitivnim deficitima. Lekovi koji se najčešće dovode u vezu sa razvojem GPUM su triptani i opioidi. Iako se primena opioida ne preporučuje za lečenje glavobolja, kodein, u sastavu kombinovanih analgetičkih preparata (u Srbiji i regionu), se relativno često primenjuje.

Cilj rada je bio da se uspostavi model GPUL indukovane kodeinom kod miševa oba pola i ispita uticaj na bolnu preosetljivost, opštu dobrobit/motivaciju i kognitivne performanse eksperimentalnih životinja

GPUL je indukovana primenom kodeina (15 mg/kg/dan p.o. tokom 10 dana) kod ženki i mužjaka miševa C57BL/6 soja. Periorbitalna alodinija je procenjena u von Frey testu. Kognitivne performanse su ispitane korišćenjem testa prepoznavanja novog objekta, a opšta dobrobit korišćenjem testa ukopavanja. Nakon 12 dana od prestanka primene kodeina, procenili smo razvoj ponovne pojave periorbitalne alodinije izazvane malom dozom gliceril trinitrata (fenomen latentne senzitizacije).

Kodein je izazvao sličan nivo periorbitalne alodinije kod ženki i mužjaka. Nakon obustave kodeina, mehanička preosetljivost se postepeno povukla kod životinja oba pola. Kodein je smanjio kognitivne performanse kod miševa oba pola, dok je aktivnost kopanja bila smanjena samo kod ženki u poređenju sa odgovarajućom kontrolnom grupom. Gliceril trinitrat je izazvao ponovnu pojavu periorbitalne preosetljivosti kod oba pola, sa izraženijim efektom kod ženki.

Kodein je izazvao kutanu alodiniju i kognitivno oštećenje kod životinja oba pola, dok su smanjena motivacija/opšta dobrobit i latentna senzitizacija bile izraženije kod ženki.

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US16.5. INFLUENCE OF SEX ON PAIN HYPERSENSITIVITY, COGNITIVE PERFORMANCE AND MOTIVATION IN A CODEINE-INDUCED MEDICATION OVERUSE HEADACHE MODEL

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Medication overuse headache (MOH) is a chronic secondary headache disorder caused by excessive use of analgesics for acute headache treatment, predominantly affecting women. It is associated with reduced quality of life and cognitive deficits. The drugs most strongly linked to the development of MOH are triptans and opioids. Although opioid use is discouraged in headache treatment, codeine, as a component of combined analgesic preparations (in Serbia and the surrounding region), is used relatively often.

We aimed to establish a codeine-induced MOH model in female and male mice, and to assess pain-related behaviour, general well-being/motivation, and cognitive performance.

MOH was induced by administering codeine (15 mg/kg/day p.o. for 10 days) to female and male C57BL/6 mice. Periorbital allodynia was assessed using von Frey test. Cognitive performance was evaluated using the novel object recognition test, and general well-being using the burrowing test. After 12 days of codeine withdrawal, we assessed the recurrence of periorbital allodynia induced by a low dose of glyceryl trinitrate (latent sensitisation phenomenon).

Codeine caused a comparable level of periorbital allodynia in both sexes. After discontinuation of codeine, mechanical hypersensitivity gradually resolved in both males and females. Codeine reduced cognitive performance in both sexes, whereas burrowing activity was reduced only in codeine-treated females compared to the vehicle control group. Glyceryl trinitrate induced a recurrence of periorbital allodynia in both sexes, with a more pronounced effect in females.

Codeine induced cutaneous allodynia and cognitive impairment in both sexes, whereas decreased motivation/general well-being and latent sensitisation were more pronounced in females.

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US16.6. DULAGLUTID SMANJUJE MEHANIČKU BOLNU PREOSETLJIVOST I POBOLJŠAVA KOGNITIVNU FUNKCIJU U MODELU HRONIČNE MIGRENE SA EFEKTIMA ZAVISNIM OD POLA

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Hronična migrena (HM) je onesposobljavajući poremećaj praćen bolom i kognitivnim smetnjama. Dostupne preventivne terapijske opcije pokazuju ograničenu efikasnost. Agonisti GLP-1 receptora (GLP-1RA) ispoljavaju antinociceptivna i prokognitivna svojstva, ali dejstva dulaglutida (dugodelujući GLP-1RA) nisu ispitana. Cilj rada je bio ispitati da li dulaglutid smanjuje mehaničku preosetljivost i poboljšava kognitivne performanse u modelu HM, sa osvrtom na polne razlike. HM je indukovana ponavljanom primenom nitroglicerina (10 mg/kg, intraperitonealno, svakog drugog dana tokom 9 dana) kod C57BL/6 miševa oba pola. Dulaglutid (30, 150 i 300 μg/kg/na svaka 3 dana, supkutano) i propranolol (20 mg/kg/dan, intraperitonealno; pozitivna kontrola) primenjivani su tokom celog protokola. Mehanička preosetljivost je procenjivana von Frey testom (VFT), a kognitivna funkcija testom prepoznavanja novog objekta (NORT). Nitroglicerin je izazvao bazalnu i akutnu preosetljivost, kao i kognitivne deficite kod oba pola ($p < 0,05$). U VFT, dulaglutid je smanjio bolnu preosetljivosti ($p < 0,05$), poredbeno propranololu. Polne razlike uočene su pri najnižoj i najvišoj dozi ($p = 0,003$, $p = 0,013$; redom), uz izraženiji efekat kod ženki. U NORT-u, dulaglutid (150 i 300 μg/kg) je poboljšao kognitivne performanse kod oba pola ($p < 0,05$). Dalja analiza indeksa diskriminacije nije pokazala značajne polne razlike ($p > 0,05$). Lokomotorna aktivnost nije bila izmenjena. Zaključno, dulaglutid je smanjio mehaničku bolnu preosetljivost i poboljšao kognitivnu funkciju bez uticaja na lokomotornu aktivnost u modelu HM, podržavajući dalja ispitivanja dulaglutida u prevenciji migrenozne glavobolje i udruženih kognitivnih poremećaja.

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US16.6. DULAGLUTIDE REDUCES MECHANICAL PAIN HYPERSENSITIVITY AND IMPROVES COGNITION IN A CHRONIC MIGRAINE MODEL WITH SEX-DEPENDENT EFFECTS

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Chronic migraine (CM) is a disabling disorder characterised by pain and cognitive impairment. Current preventive therapies show limited efficacy. GLP-1 receptor agonists (GLP-1RAs) exhibit antinociceptive and procognitive properties, yet the effects of the long-acting GLP-1RA dulaglutide remain unexamined. We assessed whether dulaglutide attenuates mechanical hypersensitivity and improves cognitive performance in a nitroglycerin-induced CM model, with focus on sex differences. CM was induced by repeated nitroglycerin injections (10 mg/kg, i.p., every other day over 9 days) in C57BL/6 mice of both sexes. Dulaglutide (30, 150 and 300 μg/kg/every 3 days, s.c.) and propranolol (20 mg/kg/day, i.p.; positive control) were administered throughout the protocol. Mechanical hypersensitivity was assessed by the von Frey test (VFT) and cognition by the novel object recognition test (NORT). Nitroglycerin induced basal and acute hypersensitivity, as well as cognitive deficits in both sexes ($p < 0.05$). In the VFT, dulaglutide reduced pain hypersensitivity ($p < 0.05$), comparably to propranolol. Sex differences appeared at the lowest and highest doses ($p = 0.003$, $p = 0.013$; respectively), with greater effects in females. In the NORT, dulaglutide (150 and 300 μg/kg) improved performance in both sexes ($p < 0.05$). Further analysis of the discrimination index revealed no significant sex differences ($p > 0.05$). Locomotor activity was unaffected. Taken together, dulaglutide reduced mechanical pain hypersensitivity and improved cognitive function without affecting locomotion in a CM model, supporting further investigation of dulaglutide in migraine prevention and associated cognitive disorders.

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US16.7. NUKLEINSKE KISELINE KAO OSNOVA NOVIH TERAPIJSKIH STRATEGIJA U LEČENJU KARDIOVASKULARNIH BOLESTI

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Kardiovaskularne bolesti (KVB) nastaju kao posledica delovanja genetičkih i negenetičkih faktora i predstavljaju vodeći uzrok smrtnosti u razvijenim zemljama. Ova grupa bolesti obuhvata različite poremećaje (arterijska hipertenzija, aritmije, venska i arterijska tromboza, bolesti srčanih zalistaka, oboljenja miokarda i perikarda itd.), dok prisustvo pridruženih oboljenja dodatno usložnjava dijagnostiku i terapijski pristup. Zbog toga, postoji stalno traganje za novim terapijskim strategijama koje će unaprediti lečenje i prevenciju KVB. Značajan napredak po ovom pitanju se očekuje od inovativnih pristupa koji podrazumevaju da se nukleinske kiseline koriste kao mete lekova i kao aktivne supstance leka. Ovi pristupi zasnovani su na principima strukture i funkcije nukleinskih kiselina gde komplementarnost, hibridizacija i interferencija RNK imaju presudan značaj.

Cilj ovog rada bio je sistematizacija i analiza savremenih dostignuća u razvoju lekova zasnovanih na nukleinskim kiselinama namenjenih lečenju KVB.

Podaci su prikupljeni pretraživanjem relevantnih regulatornih i naučnih baza, uključujući *European Medicines Agency* (*EMA*), *U.S. Food and Drug Administration* (*FDA*), *ClinicalTrials.gov*, *DrugBank* i *PubMed*.

Prema dostupnim podacima, isključujući iRNK vakcine i gensku terapiju, *FDA* i/ili *EMA* odobrile su 24 leka zasnovana na nukleinskim kiselinama, od kojih se šest primenjuje u lečenju i prevenciji KVB. Najzastupljeniji terapijski modaliteti su antisens oligonukleotidi i male interferirajuće RNK, dok se ciljana isporuka najčešće ostvaruje konjugacijom sa N-acetilgalaktozaminom, koji omogućava vezivanje za asijaloglikoproteinski receptor 1 na hepatocitima.

Brojni kandidati, koji bi se mogli koristiti za tretman KVB, su i dalje u različitim fazama kliničkih ispitivanja, a glavni izazovi su vezani za poboljšanje farmakodinamičkih i farmakokinetičkih karakteristika, procenu dugoročne bezbednosti, kao i troškove lečenja.

US16.7. NUCLEIC ACIDS AS THE FOUNDATION OF NOVEL THERAPEUTIC STRATEGIES IN THE TREATMENT OF CARDIOVASCULAR DISEASES

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Cardiovascular diseases (CVDs) arise from the effects of genetic and non-genetic factors and remain the leading cause of mortality in developed countries. They encompass a broad spectrum of disorders (arterial hypertension, arrhythmias, venous and arterial thrombosis, valvular heart disease, myocardial and pericardial diseases etc.), while comorbidities further complicate both diagnostics and therapeutic management. Consequently, there is a continuous need for novel therapeutic strategies to improve the prevention and treatment of CVDs. Innovative strategies involving nucleic acids, either as drug targets or as therapeutic agents, are expected to become increasingly important. These strategies use the structural and functional properties of nucleic acids, relying on molecular complementarity, hybridization, and RNA interference as key principles.

The aim of this work was to summarize and present recent advances in the development of nucleic acid-based therapeutics for the treatment of CVDs.

Data were collected through searches of relevant regulatory and scientific databases, including the European Medicines Agency (EMA), the US Food and Drug Administration (US FDA), ClinicalTrials.gov, DrugBank, and PubMed.

Excluding mRNA vaccines and gene therapies, the US FDA and/or EMA have approved 24 nucleic acid-based drugs, six of which are indicated for the treatment or prevention of CVDs. Antisense oligonucleotides and small interfering RNAs represent the predominant therapeutic modalities, while targeted delivery is most commonly achieved through N-acetylgalactosamine conjugation, enabling binding to the asialoglycoprotein receptor 1 expressed on hepatocytes.

Numerous candidates remain under clinical investigation, with key challenges including optimization of pharmacodynamic and pharmacokinetic properties, evaluation of long-term safety, and treatment costs.

Sesija 17
Session 17

Individualizacija terapije: moć preciznosti u savremenoj farmaciji

Tailoring therapy: The power of precision in modern pharmacy

Individualizacija terapije: moć preciznosti u savremenoj farmaciji

Precizna medicina sve više oblikuje savremenu farmaciju kroz ciljane, na dokazima zasnovane i tehnološki unapređene pristupe. Prezentacije u ovoj sesiji obuhvataju dizajn, razvoj i kliničku primenu terapija malim molekulima, koje omogućavaju planiranje specifičnih terapijskih ishoda, kao i rastuću ulogu farmakogenomike u dostizanju ciljeva personalizovane zdravstvene nege. Sesija se bavi lekovima za napredne terapije, novim farmakometrijskim pristupima i inovativnim tehnologijama koje doprinose većoj preciznosti i poboljšanju ishoda terapije. Cilj sesije je da ukaže na značaj najnovijih naučno-tehnoloških dostignuća za optimalan terapijski pristup, odnosno da učesnicima pruži integrisano razumevanje strategija i alata kao pokretača precizno vođene farmaceutske prakse.

Tailoring therapy: The power of precision in modern pharmacy

Precision medicine is increasingly transforming modern pharmacy through targeted, evidence-based, and technologically advanced approaches. Presentations in this session cover the design, development, and clinical application of small-molecule therapies, as well as the increasing role of pharmacogenomics in achieving personalised healthcare goals. The session also addresses advanced therapy medicinal products (ATMPs), emerging pharmacometric methods, and innovative technologies that improve treatment outcomes. This session highlights the importance of recent scientific advancements for optimal therapeutic strategies, providing participants with an integrated understanding of the tools driving precision-guided pharmaceutical practice.

PP17.1. THE DESIGN, SYNTHESIS AND ANTITUMOUR EVALUATION OF BCL3 INHIBITORS TARGETING ADVANCED COLORECTAL AND BREAST CANCERS

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The B-cell lymphoma 3 protein (BCL3) is a transcriptional facilitator protein and anti-cancer drug target driving intracellular cancer signalling pathways including NF-κB (advanced breast) and Wnt-β-catenin (colorectal). BCL3 governs pro-oncogenic processes such as tumour initiation, metastasis, and therapy resistance.

The purpose of this study was twofold:

- to extend our previously published work on a BCL3-p50 interface protein-protein inhibitor (JS6) and a structurally related orally bioavailable preclinical candidate, to synthesise new JS6 chemical analogues for structure-activity relationship (SAR)-based optimisation, alongside novel conformationally restricted analogues.
- to design and synthesise the first BCL3 PROTACs (PROteolysis TArgeted Chimeras), to compare and contrast therapeutic activity between BCL3 inhibitors and PROTAC-based targeted degraders.

Our previously published computational model of the BCL3/p50 interface was updated for the new inhibitor target molecules, through the use of AlphaFold, Schrödinger's Maestro and Molecular Operating Environment (MOE). New JS6 analogues and pomalidomide-based PROTACs were synthesised using established chemical synthetic methods. New compounds were purified and characterised using NMR spectroscopy and mass spectrometry, and initially tested for efficacy and cytotoxicity within established cellular models of advanced breast and colorectal cancer.

The design and synthesis of a series of new BCL3 inhibitors and BCL3 PROTAC degraders has been successfully accomplished. *In vitro* evaluation indicates that the new compounds are devoid of general cytotoxicity in normal and triple-negative breast cancer cell models, and induce BCL3 degradation (PROTACs).

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PP17.2. PRECIZNA MEDICINA U PRAKSI: KAKO PERSONALIZOVANE TERAPIJE MENJAJU ZDRAVSTO

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Terapijska paradigma u savremenoj medicini pomera se od empirijskog pristupa ka molekularno stratifikovanom modelu, u kome se intervencije biraju prema genomskoj arhitekturi bolesti pojedinačnog pacijenta. Ova transformacija je najuočljivija u onkologiji, gde je integracija sveobuhvatne molekularne dijagnostike sa terapijama vođenim biomarkerima redefinisala kliničke ishode. Farmaceuti svih specijalnosti imaju sve značajniju ulogu u operacionalizaciji ovog pristupa.

Ovo predavanje razmatra centralnu ulogu sveobuhvatnog genomskog profilisanja u savremenom lečenju karcinoma. Sekvenciranje nove generacije (NGS) omogućava paralelnu detekciju varijanti, insercija/delecija, promena broja kopija i genskih fuzija, kao i složenih potpisa poput tumorskog mutacionog opterećenja i mikrosatelitske nestabilnosti, iz ograničenog uzorka tkiva ili cirkulišuće tumorske DNK. Standardizovano i analitički validirano molekularno testiranje predstavlja neophodan preduslov za izbor terapije u savremenoj onkologiji. Dijagnostička preciznost direktno određuje terapijsku efikasnost, jer se delotvorne alteracije ne mogu iskoristiti u lečenju ukoliko nisu pouzdano identifikovane.

Ciljane terapije usmerene protiv definisanih onkogenih pokretača ostvarile su neke od najdugotrajnijih koristi po pitanju ukupnog preživljavanja zabeleženih u modernoj onkologiji, pretvarajući pojedine maligne bolesti u hronična, kontrolisana stanja.

Veštačka inteligencija i mašinsko učenje danas predstavljaju veliku prekretnicu u preciznom zdravstvu. Integracijom multimodalnih genomskih, histopatoloških, radioloških i kliničkih podataka, ovi alati unapređuju dijagnostičku rezoluciju, usavršavaju prediktivno i prognostičko modelovanje i otkrivaju biološki relevantne obrasce izvan domašaja konvencionalne analize, naročito u onkologiji.

Za farmaceute, ova evolucija zahteva veštinu tumačenja molekularnih podataka, izbor terapije zasnovan na dokazima i upravljanje sve složenijim terapijskim režimima u okviru integrisanog dijagnostičko-terapijskog okvira.

PP17.2. PRECISION MEDICINE IN ACTION: HOW PERSONALIZED THERAPIES ARE CHANGING HEALTHCARE

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The therapeutic paradigm in modern medicine is shifting from empirical, population-based treatment toward a molecularly stratified model in which interventions are selected according to the genomic architecture of each patient's disease. Nowhere is this transformation more evident than in oncology, where the integration of comprehensive molecular diagnostics with biomarker-matched therapeutics has redefined clinical outcomes. Pharmacists across all specialties are increasingly pivotal in operationalizing this approach.

This lecture examines the central role of comprehensive genomic profiling in contemporary cancer care. Next-generation sequencing (NGS) permits high-throughput, parallel detection of single-nucleotide variants, insertions/deletions, copy-number alterations, and gene fusions, as well as complex signatures such as tumor mutational burden and microsatellite instability, from limited tissue or circulating tumor DNA. Standardized, analytically validated molecular testing is the indispensable gateway to therapy selection. Diagnostic precision directly determines therapeutic efficacy, as actionable alterations cannot inform treatment unless they are reliably identified.

The clinical outcomes are substantial. Targeted agents directed against defined oncogenic drivers have produced some of the most durable overall survival benefits documented in modern oncology, transforming select malignancies into chronic, manageable conditions.

Artificial intelligence and machine learning now represent a major inflection point in precision health. By integrating multimodal genomic, histopathological, radiological, and clinical datasets, these tools enhance diagnostic resolution, refine predictive and prognostic modeling, and reveal biologically relevant patterns beyond conventional analysis, particularly in oncology.

For pharmacists, this evolution demands fluency in molecular data interpretation, evidence-based therapy selection, and stewardship of increasingly complex regimens within an integrated diagnostics–therapeutics framework.

PP17.3. ADVANCED THERAPY MEDICINAL PRODUCTS AND PRECISION MEDICINE: CHALLENGES AND OPPORTUNITIES FOR PHARMACISTS

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Advanced therapy medicinal products (ATMPs) and pharmacogenetics are transforming clinical practice, positioning pharmacists as key actors in delivering precision medicine. In Spain, hospital pharmacy services have progressively assumed a central role in the management of ATMPs, particularly CAR-T cell therapies, coordinating procurement, traceability, preparation, and clinical follow-up within multidisciplinary units. This evolution has been shaped by a complex regulatory framework, including European ATMP legislation and the hospital exemption (Article 28, RD 1090/2015), which demand significant investment in sterile preparation infrastructure and specialised training.

In parallel, pharmacogenetics is increasingly embedded in hospital pharmacy practice, supporting individualised dosing and therapeutic decision-making across oncology, transplantation, and chronic disease management. Spanish pharmacy services are developing pharmacogenetic consultation models that combine genomic data interpretation with clinical pharmacology expertise, reinforcing the pharmacist's role as the professional best placed to translate genetic information into safe, effective treatment plans.

This presentation will address the main challenges pharmacists face when implementing ATMPs and pharmacogenetics in hospital settings: regulatory complexity, infrastructure and resource constraints, the need for new competencies, and coordination across multidisciplinary teams. It will also explore the opportunities these innovations create for the profession, including new advanced practice roles, closer integration with biomarker-driven prescribing, and a stronger pharmacist contribution to national and European policy discussions on precision medicine.

Drawing on practical experience from a Spanish university hospital pharmacy service, this talk offers a realistic, forward-looking perspective on how pharmacists can lead the integration of ATMPs and pharmacogenetics into routine clinical care.

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PP17.4. POPULACIONO FARMAKOKINETIČKO MODELOVANJE: KORAK KA PRECIZNOM DOZIRANJU

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Precizna medicina omogućava optimizaciju strategija prevencije i lečenja bolesti uzimajući u obzir individualne karakteristike pacijenta, sa ciljem primene odgovarajuće terapije kod pravog pacijenta u pravo vreme. Precizno doziranje zasniva se na kliničkim alatima koji omogućavaju integraciju genotipskih i fenotipskih karakteristika u cilju definisanja strategija individualizovanog doziranja lekova. Tradicionalno terapijsko praćenje lekova (*Therapeutic Drug Monitoring*, *TDM*) i dalje ima značajnu ulogu za mnoge lekove sa uskim terapijskim opsegom, izraženom farmakokinetičkom varijabilnošću i jasno utvrđenom vezom između koncentracije i efekta leka. Pored toga, populacioni farmakokinetički modeli su široko implementirani u kliničkoj praksi u okviru *TDM*-a, posebno kao podrška pristupu modelom informisano precizno doziranje (*Model Informed Precision Dosing*, *MIPD*).

Populaciono farmakokinetičko modelovanje i strategije preciznog doziranja biće prikazane na primeru odraslih psihijatrijskih pacijenata koji su lečeni antipsihotikom klozapinom. Klozapin je antipsihotik druge generacije sa superiornom efikasnošću kod pacijenata sa terapijski rezistentnom shizofrenijom; međutim, i dalje je nedovoljno zastupljen u kliničkoj praksi zbog bezbednosnih razloga i uskog terapijskog opsega. Brojni faktori utiču na njegovu farmakokinetiku, što dovodi do izražene inter- i intraindividualne varijabilnosti koncentracija leka i njegovih metabolita, uključujući demografske i patološke karakteristike, pušački status i istovremenu terapiju. Prema Konsenzusu smernica za terapijsko praćenje lekova u neuropsihofarmakologiji, *TDM* se strogo preporučuje za klozapin. Stoga, optimizacija terapije putem preciznog doziranja i *MIPD* predstavlja obećavajuću strategiju za unapređenje efikasnosti i bezbednosti terapije klozapinom.

Farmaceuti, u saradnji sa drugim zdravstvenim profesionalcima, imaju značajnu ulogu u individualizaciji režima doziranja, posebno u okviru tradicionalnog *TDM*-a i naprednih strategija preciznog doziranja.

PP17.4. POPULATION PHARMACOKINETIC MODELING: A STEP TOWARD PRECISION DOSING

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Precision medicine is an approach to tailoring disease prevention and treatment based on individual patient characteristics, aiming to deliver the right treatment to the right patient at the right time. Precision dosing relies on clinical tools capable of integrating genotypic and phenotypic characteristics to inform individualized dosing strategies. Traditional Therapeutic Drug Monitoring (TDM) remains important for many drugs with a low therapeutic index, high pharmacokinetic variability, and a well-established relationship between drug concentration and effect. Moreover, population pharmacokinetic models have been widely implemented in clinical practice within the context of TDM, particularly to support model-informed precision dosing (MIPD).

Population pharmacokinetic modeling and precision dosing strategies will be demonstrated in adult psychiatric patients treated with the antipsychotic clozapine. Clozapine is a second-generation antipsychotic drug with superior efficacy in patients with treatment-resistant schizophrenia; however, it remains underused in clinical practice due to safety concerns and low therapeutic index. Multiple factors influence its pharmacokinetics, contributing to marked inter- and intra-individual variability in drug and metabolite levels, including demographic and pathological characteristics, smoking status, and co-therapy. According to the Consensus Guidelines for Therapeutic Drug Monitoring in Neuropsychopharmacology, TDM is strongly recommended for clozapine. Thus, optimizing therapy through precision dosing and MIPD is a promising strategy to enhance both the efficacy and safety of clozapine treatment.

Pharmacists, in collaboration with other healthcare professionals, play a significant role in individualizing dosing regimens, particularly within traditional TDM and more advanced precision dosing strategies.

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Sesija 18
Session 18

Od molekula do optimalnog doziranja u digitalnom okruženju

From molecules to optimal dosing in a digital environment

Od molekula do optimalnog doziranja u digitalnom okruženju

Digitalna transformacija donosi nove pristupe istraživanju, razvoju i primeni lekova, povezujući napredne računarske tehnologije sa razumevanjem dejstva lekova i optimizacijom terapije. Sesija obuhvata prikaz primene digitalnih tehnologija u celokupnom ciklusu istraživanja i razvoja lekova: od otkrića molekula, preko ispitivanja efikasnosti, bezbednosti i biofarmaceutskih karakteristika, do optimizacije terapije u kliničkoj praksi. Predavanja o molekulskom dokingu, FK/FD i biofarmaceutskom modelovanju i simulacijama, kao i mašinskom učenju, pružaju uvid u mogućnosti savremenih računarskih alata za unapređenje ispitivanja i razumevanje interakcija leka i ciljnog mesta delovanja, predviđanja ponašanja lekova u prekliničkim i kliničkim fazama istraživanja, kao i optimizacije režima doziranja. Realni primeri iz prakse ilustruju mogućnosti koje digitalno okruženje pruža za transformaciju razvoja lekova i kliničkoj optimizaciji primene lekova.

From molecules to optimal dosing in digital environment

Digital transformation brings new approaches to drug research, development and administration, connecting advanced computational technologies with the understanding of drug action and therapy optimization. This session provides an overview of the application of digital technologies across the entire drug research and development continuum: from molecular discovery, via the evaluation of efficacy, safety and biopharmaceutical properties, to therapy optimization in clinical practice. Presentations on molecular docking, PK/PD and biopharmaceutic modelling and simulations, as well as machine learning, provide insight into the potential of modern computational tools to enhance the research and understanding of drug–target interactions, improve prediction of drug behaviour in preclinical and clinical research, and support optimization of dosing regimens. Real-world examples illustrate the opportunities offered by the digital environment for transforming pharmaceutical development and clinical optimization.

PP18.1. MODELLING AND SIMULATION IN BIOPHARMACEUTICS, FOCUSSING ON INJECTABLES – AN EVOLVING JOURNEY

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Modelling and Simulation (M&S) in biopharmaceutics can involve computational simulation of tests (e.g. dissolution test environment), processes (e.g. in vitro dissolution, coating), in vivo dissolution and absorption steps, and simulation of full pharmacokinetic (PK) profiles. Recently, developments in M&S and relevant regulatory guidance such as ICH M15 suggest a more comprehensive role in model-informed drug development going forward. Current M&S and Physiologically-Based PK (PBPK) in particular support advanced applications in biopharmaceutics research such as special populations and virtual bioequivalence studies.

With respect to long-acting injectables (LAIs), where performance tests via pharmacopoeial dissolution methods are specified, the flow through dissolution apparatus (USP IV) is frequently used. Furthermore, tools facilitating PBPK modelling for subcutaneous and intramuscular administration are increasingly available.

This presentation will focus on application of a range of M&S tools with relevance to biopharmaceutics of injectable preparations. Insight into in vitro dissolution of poorly soluble LAI suspensions in the USP IV dissolution apparatus will be presented from computational fluid dynamics simulations of hydrodynamics, simulations of particle motion and dissolution, artificial intelligence-based image analysis of dissolution processes and PBPK modelling of LAIs.

Additionally, M&S can be considered from the perspective of dose optimisation in special populations. Using Population PK (PopPK), patient factors impacting PK can be identified informing dose adjustment. Some brief examples will be presented of PopPK analysis applied to injectable therapies in specific clinical situations.

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I would like to acknowledge the many collaborations with colleagues over the years who made this work possible, in particular colleagues in: The School of Pharmacy and Pharmaceutical Sciences, Trinity College Dublin and in Tallaght University Hospital; also Prof Tim Persoons in the Dept of Mechanical, Manufacturing and Biomedical Engineering, School of Engineering, Trinity College Dublin and Professor Nikoletta Fotaki, University of Bath, UK.

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PP18.2. MOLEKULSKI DOKING KAO ALAT U OTKRIĆU LEKOVA I ANALIZI INTERAKCIJA LIGANDA SA PROTEINOM

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Molekulski doking je postala nezamenljiva tehnika dizajna lekova zasnovanog na strukturi, i od svog uvođenja 1980-ih godina revolucionarno je izmenila rane faze procesa modernog razvoja lekova. Doking se široko primenjuje u racionalnom razvoju lekova kako bi se procenio afinitet vezivanja novodizajniranih jedinjenja za aktivna mesta izabranih receptora ili enzima, kao i njihove konformacije u aktivnom mestu. Na osnovu rezultata doking studija mogu se odabrati jedinjenja sa najnižom vezivnom energijom za sintezu i dalju eksperimentalnu evaluaciju.

Ključno je da se primena molekulskog dokinga ne ograničava samo na vezivanje za makromolekul koji će proizvesti farmakološki odgovor. Ovaj alat može da se koristi i za predviđanje vezivanja za proteine plazme, kao što je humani serumski albumin (HSA), čime se dobija uvid u distribuciju leka. U okviru farmakokinetičkih studija, doking je takođe koristan za ispitivanje interakcija sa enzimima koji metabolišu lekove, posebno CYP450 kompleksom koji katalizuje metabolizam približno 70–80% klinički relevantnih lekova. Pored toga, doking se može primeniti za procenu potencijalnih interakcija sa membranskim transporterima, uključujući P-glikoprotein, koji su važni faktori u apsorpciji i raspodeli lekova. Konačno, integracija ovih in silico izračunavanja omogućava efikasniji odabir optimizovanih kandidata, povezujući računarska predviđanja sa uspešnom eksperimentalnom evaluacijom.

Jedan od primera gde je korisna uporeba doking izračunuvanja je za dizajniranje selektivnih COX-2 inhibitora koji bi imali antiinflamatorni efekat i manje neželjenih efekata na nivou gastrointestinalnog trakta. Za grupu konvencionalnih NSAIL je karakteristično vezivanje u visokom procentu za protein plazme, pa je kod novodizajniranih jedinjenja vrlo korisno predvideti i njihovu interakciju sa HSA.

PP18.2. MOLECULAR DOCKING AS A TOOL IN DRUG DISCOVERY AND PROTEIN–LIGAND INTERACTION ANALYSIS

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Molecular docking emerged as an irreplaceable technique of structure-based drug design, revolutionizing the early stages of modern drug discovery since its introduction in the 1980s. Docking is widely used in the rational drug development to estimate binding affinity of newly designed compounds to active sites of selected receptors or enzymes as well as their conformations in the active site. Based on docking studies results, compounds with the lowest binding energy can be selected for synthesis and further experimental evaluation.

Crucially, the utility of molecular docking extends far beyond binding affinity for target that will produce pharmacological response. This tool can be used to predict binding to plasma proteins, such as human serum albumin (HSA). providing insight into drug distribution characteristics. Within pharmacokinetic studies, docking is also useful for investigating interactions with drug-metabolizing enzymes, particularly CYP450 complex which catalyzes the metabolism of approximately 70 % to 80 % of clinically relevant drugs. Furthermore, docking can be applied to assess potential interactions with membrane transporters, including P-glycoprotein, which are important determinants of drug absorption and disposition. Ultimately, integrating these in silico calculations allows for the streamlined selection of optimized candidates, bridging the gap between computational prediction and successful experimental evaluation.

One example where docking calculations are useful is in the design of selective COX-2 inhibitors with anti-inflammatory effect and reduced gastrointestinal side effects. Conventional NSAIDs are characterized by a high degree of plasma protein binding; therefore, for newly designed compounds it is also highly useful to predict their interaction with HSA.

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PP18.3. ULOGA PK/PD MODELOVANJA I *IN SILICO* PRISTUPA U RAZVOJU LEKOVA IZ PERSPEKTIVE FARMACEUTSKE INDUSTRIJE

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Farmakokinetičko/farmakodinamičko (PK/PD) modelovanje i in silico pristupi dobijaju centralno mesto u savremenom razvoju lekova, pružajući kvantitativni okvir za donošenje odluka zasnovanih na dokazima u svim fazama razvoja. Razvoj lekova vođen modelima integriše pristupe kao što su populaciono PK/PD modelovanje, fiziološki zasnovano farmakokinetičko i biofarmaceutsko modelovanje (PBPK/PBBM), analiza odnosa izloženosti i odgovora, kvantitativna sistemska farmakologija i toksikologija, modeli progresije bolesti, kao i metode veštačke inteligencije i mašinskog učenja.

Populaciono PK/PD modelovanje široko se primenjuje tokom razvoja lekova. U ranim fazama, ovi modeli podržavaju izbor kandidata definišući stepen vezivanja za target, željeni profil koncentracija u krvi i dozu potrebnu za kliničku efikasnost. Takođe, ovi modeli unapređuju toksikološke programe informišući dizajn studije, poboljšavajući interpretaciju rezultata i podržavajući implementaciju 3R principa (zamena, redukcija i poboljšanje).

Jedna od vodećih primena PBPK modela je mehanističko modelovanje apsorpcije, posebno za lekove za peroralnu primenu. To je dovelo do razvoja fiziološki zasnovanog biofarmaceutskog modelovanja (PBBM), koji integriše fiziologiju gastrointestinalnog trakta, osobine aktivne farmaceutske supstance i karakteristike formulacije sa ciljem predviđanja apsorpcije i optimizacije razvoja formulacije.

Za farmaceutske kompanije, vrednost modelovanja prevazilazi operativnu efikasnost i prelazi u poboljšano generisanje dokaza. Modeli mogu objediniti fragmentisane skupove podatka, opravdati izbor doze i režima doziranja, podržati regulatornu dokumentaciju leka i omogućiti strategije razvoja u kojima je pacijent u fokusu. Uprkos izazovima kao što su kvalitet podataka, neizvesnost u procenama i predviđanjima koje daje model i oslanjanje na pretpostavke, PK/PD i in silico metode se razvijaju od pratećih analiza do strateških platformi za donošenje odluka koje ubrzavaju i jačaju razvoj lekova.

PP18.3. THE ROLE OF PK/PD MODELING AND *IN SILICO* APPROACHES IN DRUG DEVELOPMENT: A PHARMACEUTICAL INDUSTRY PERSPECTIVE

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Pharmacokinetic/pharmacodynamic (PK/PD) modeling and in silico approaches have become central to modern drug development, providing a quantitative framework for evidence-based decisions across non-clinical, translational, and clinical stages. Model-informed drug development integrates approaches such as population PK/PD, physiologically based pharmacokinetic and biopharmaceutics modeling (PBPK/PBBM), exposure-response analyses, quantitative systems pharmacology and toxicology, disease progression models, and artificial intelligence/machine learning methods.

Population PK/PD modeling is widely applied throughout development. In discovery, these models support candidate selection by defining the degree of target engagement, exposure profile, and dose required for clinical efficacy. They also strengthen toxicology programs by informing study design, improving interpretation of findings, and supporting implementation of the 3Rs principles (replacement, reduction, and refinement).

One of the major applications of PBPK is mechanistic absorption modeling, particularly for orally administered drugs. This led to the development of physiologically based biopharmaceutics modeling (PBBM), which integrates gastrointestinal physiology, active pharmaceutical ingredient properties, and formulation characteristics to predict absorption performance and guide formulation development.

For pharmaceutical companies, the value of modeling extends beyond operational efficiency to improved evidence generation. Models can integrate fragmented datasets, justify dose and regimen selection, support regulatory labeling, and enable more patient-centered development strategies. Despite challenges such as data quality, model uncertainty, and reliance on assumptions, PK/PD and in silico methods are evolving from supportive analyses into strategic decision-making platforms that accelerate and strengthen drug development.

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PP18.4. PRIMENA MAŠINSKOG UČENJA U OPTIMIZACIJI TERAPIJSKIH REŽIMA IMUNOSUPRESIVA

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Takrolimus predstavlja okosnicu savremene imunosupresivne terapije nakon transplantacije bubrega i drugih solidnih organa. Izražena farmakokinetička (FK) varijabilnost i uzak terapijski indeks zahtevaju terapijski monitoring leka (TDM) i prilagođavanje doziranja. Međutim, tradicionalni TDM ima ograničenja, uključujući retko uzorkovanje i određivanje samo jedne koncentracije (Ctrough, C_0) tokom doznog intervala, koja ne odražava ukupnu izloženost leku i slabo je povezana sa ishodima lečenja. Primena populacionih farmakokinetičkih (popFK) modela uz Bajesovu procenu predstavlja najbolji pristup za procenu individualnih FK parametara i optimizaciju režima doziranja, ali izbor odgovarajućeg modela ostaje izazov zbog njihove složenosti i zahtevne identifikacije kovarijata. Integracija popFK modelovanja sa mašinskim učenjem (ML) omogućava efikasnu obradu velikih skupova podataka i precizniju procenu parametara, kao što je klirens leka. ML algoritmi mogu da prepoznaju nelinearne odnose i kompleksne interakcije bez unapred definisane mehanističke strukture. Kod takrolimusa najčešće korišćeni ML algoritmi uključuju Extreme Gradient Boosting (XGBoost) i veštačke neuronske mreže, pri čemu su najvažniji prediktori izloženosti i doze: CYP3A5 genotip, prethodne vrednosti C_0 i istorija doziranja, hematokrit, postoperativni dani, telesna masa, starost, pol, serumske koncentracije albumina i kreatinina, kao i istovremena primena azolnih antimikotika. Za razliku od ML modela, koji su manje interpretabilni, popFK modeli imaju parametre sa jasnom kliničkom interpretacijom i omogućavaju procenu interindividualne varijabilnosti, dok je ML prvenstveno namenjen poboljšanju prediktivne tačnosti. Stoga ML ne predstavlja zamenu, već komplementarni alat popFK pristupu, a unapređenje transparentnosti i interpretabilnosti modela, uz primenu eksterne validacije, moglo bi doprineti optimizaciji doziranja takrolimusa u transplantacionoj praksi.

Zahvalnica
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PP18.4. APPLICATION OF MACHINE LEARNING IN OPTIMIZING IMMUNOSUPPRESSIVE THERAPY REGIMENS

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Tacrolimus is the cornerstone of immunosuppressive therapy following kidney and other solid organ transplantation. Its pronounced pharmacokinetic (PK) variability and narrow therapeutic index require therapeutic drug monitoring (TDM) and dose adjustment. However, conventional TDM is limited by infrequent sampling and reliance on a single trough concentration (Ctrough, C_0), which inadequately reflects overall drug exposure and is weakly associated with clinical outcomes. Population pharmacokinetic (popPK) models combined with Bayesian estimation provide an effective approach for individual PK parameter estimation and dose optimization, although model selection remains challenging because of their complexity and covariate identification. The integration of popPK modeling with machine learning (ML) enables efficient analysis of large datasets and more accurate estimation of PK parameters, such as drug clearance. ML algorithms can identify nonlinear relationships and complex interactions without predefined mechanistic assumptions. In tacrolimus therapy, the most widely used ML methods include Extreme Gradient Boosting (XGBoost) and artificial neural networks. Key predictors of drug exposure and dose include: CYP3A5 genotype, previous C_0 values and dosing history, hematocrit, postoperative days, body weight, age, sex, serum albumin and creatinine concentrations, and concomitant use of azole antifungal agents. Unlike ML models, which are generally less interpretable, popPK models provide clinically meaningful parameters and characterize interindividual variability, whereas ML primarily aims to improve predictive accuracy. Thus, ML should be viewed as a complementary rather than a replacement tool for popPK modeling, and improved model transparency, interpretability, and external validation may further optimize tacrolimus dosing in transplantation practice.

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Sesija 19
Session 19

Savremena istraživanja u oblasti farmaceutske prakse

Modern trends in pharmacy practice research

Savremena istraživanja u oblasti farmaceutske prakse

Savremena farmaceutska praksa sve više se oslanja na istraživanja koja omogućavaju bolje razumevanje potreba pacijenata, unapređenje kvaliteta farmaceutskih usluga i efikasnije odgovore na izazove zdravstvenog sistema. Ova sesija donosi pregled aktuelnih istraživanja u različitim oblastima farmaceutske prakse - od kvaliteta farmaceutskih usluga i značaja praćenja, evidentiranja i analize pokazatelja kvaliteta, aktuelnih doprinosa farmaceuta u oblasti racionalne upotrebe lekova i smanjenja antimikrobne rezistencije, edukacija o pravilnoj primeni terapije i upravljanju farmaceutskim otpadom, preko istraživanja nivoa zdravstvene pismenosti na populacionom nivou u kontekstu prilagođavanja farmaceutskih usluga realnom nivou zdravstvene pismenosti građana, do praćenja i analize potrošnje i prometa lekova.

Modern trends in pharmacy practice research

Contemporary pharmaceutical practice increasingly relies on research that enables a better understanding of patients' needs, enhances the quality of pharmaceutical services, and supports more effective responses to the challenges facing healthcare systems. This session provides an overview of current research across various areas of pharmaceutical practice, ranging from the quality of pharmaceutical services and the importance of monitoring, recording and analyzing quality indicators, current contributions of pharmacists in the area of rational drug use and reduction of antimicrobial resistance, education on the correct application of therapy and management of pharmaceutical waste, through health literacy research at the population level in the context of adapting pharmaceutical services to the real level of health literacy of citizens, to the monitoring and analyzing the drugs utilization.

US19.1. POKAZATELJI KVALITETA FARMACEUTSKE ZDRAVSTVENE ZAŠTITE U REPUBLICI SRBIJI: PUT KA UNAPREĐENJU

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Kvalitet zdravstvene zaštite je stepen u kom zdravstvene usluge za pojedinca i populaciju povećavaju verovatnoću željenih zdravstvenih ishoda, a u skladu su sa stručnim znanjem zasnovanom na dokazima.

Cilj istraživanja bio je analiza pokazatelja kvaliteta farmaceutske zdravstvene zaštite na svim nivoima zdravstvene zaštite. Kao izvor podataka korišćen je Servisa javnog zdravlja.

Analizom prikupljenih podataka, uočava se trend porasta broja prijava za sledeće pokazatelje poredeći 2022. i 2025: „broj prijava neželjenih reakcija na lek ili medicinsko sredstvo", 87 prema 152, „usklađivanje terapije sa lekarom za pacijente sa pet i više lekova" 1149 prema 3118, redom. Pokazatelji kvaliteta koji se odnose na pružanje saveta i demonstraciju pravilne primene leka pacijentima na insulinskoj terapiji, kao i pacijentima sa inhalacionom terapijom pokazuju trend porasta vrednosti u istom periodu i kreću se u rasponu 5,4%- 6,7%, i 4,2%-5,0%, konsekutivno. Bolničke apoteke dodatno prate i pregled i usklađivanje intrahospitalne primene antimikrobne terapije na odeljenju intenzivne nege i ovaj pokazatelj je sa 12,6% u 2022. povećan na 39,6% u 2025. Na osnovu uvida u Servis javnog zdravlja uočava se da jedan broj apotekarskih ustanova, odnosno apoteka privatne prakse ne dostavlja izveštaje o pokazateljima kvaliteta.

Načelo stalnog unapređenja kvaliteta i bezbednosti u pružanju zdravstvene zaštite jedno je od postulata zdravstvene zaštite. Ipak, podaci o porastu trendova pojedinih pokazatelja ne mogu uzeti sa sigurnošću, znajući da izveštavanjem nisu obuhvaćene sve apotekarske ustanove. Imajući u vidu značaj pokazatelja koji se prikupljaju jasno je da je redovno i potpuno izveštavanje neophodno za adekvatnu analizu i pružanje kvalitetne zdravstvene zaštite.

US19.1. PHARMACEUTICAL CARE QUALITY INDICATORS IN THE REPUBLIC OF SERBIA: THE WAY TOWARDS IMPROVEMENT

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Quality of health care is the degree to which health services for individuals and populations increase the likelihood of desired health outcomes, based on evidence-based professional knowledge.

The aim of the study was to analyze pharmaceutical care quality indicators at all levels of health care. The Public Health Service was used as a data source.

A trend of increasing number of reports for the following indicators was observed between 2022 and 2025: "the number of reports of adverse reactions to drug or medical device" 87 vs. 152, "coordinating therapy with a doctor for patients with five or more medicines " 1149 vs. 3118, respectively. The quality indicators related to the provision of advice and demonstration of correct applications of medicine to patients on insulin therapy, and to patients with inhalation therapy, show increasing trend in the same period, ranging 5.4%-6,7%, and 4.2%-6.7%, consecutively. Hospital pharmacies also monitor reviews and coordination of intrahospital use of antimicrobial therapy in the intensive care unit, and this indicator has increased from 12.6% to 39.6%, respectively. Based on the Public Health Service, it is observed that a number of pharmacies do not submit reports on quality indicators.

However, the data on the increasing trends of certain indicators cannot be taken with certainty, knowing that not all pharmacy establishments are included in the reporting. Bearing in mind the importance of the indicators that are collected, it is clear that regular and complete reporting is necessary for adequate analysis and provision of quality health care.

US19.2. ULOGA FARMACEUTA U U ODGOVORU NA ANTIMIKROBNU REZISTENCIJU SA ASPEKTA ŽIVOTNE SREDINE: BRZO MAPIRANJE LITERATURE I KVALITATIVNA ANALIZA STAVOVA ZAINTERESOVANIH STRANA NAKON RADIONICE UNEP-a

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U odgovoru na antimikrobnu rezistenciju (AMR), aspekti životne sredine (ŽS) dobijaju sve veći značaj. Ciljevi rada bili su mapiranje uloga farmaceuta na ovom polju prepoznatih u naučnoj literaturi i kvalitativna eksploratorna analiza stavova međunarodne grupe zainteresovanih strana o tim ulogama.

Sprovedeno je mapiranje literature o ulozi farmaceuta i farmaceutskog sektora u odgovoru na AMR sa aspekta ŽS. Radovi identifikovani u bazi PubMed za period 2006-2026. su sistematizovani u strukturiranu matricu i narativno analizirani prema godini objavljivanja, ulozi farmaceuta, tematskoj oblasti i nivou dokaza (1-5). Jasnoća upitnika je validirana od strane pet stručnjaka u javnom zdravlju. Upitnik je distribuiran elektronski učesnicima radionice UNEP-a o aspektima ŽS u AMR. Odgovori na otvorena pitanja ručno su kodirani i tematski analizirani.

Uključeno je 25 od 91 rada (28%), uglavnom deskriptivnih i opservacionih (nivo dokaza 4; 56%), a 52% radova je objavljeno tokom 2025-2026. godine. Uloge farmaceuta uključivale su pristup „Jedno zdravlje", veterinarsku farmaciju i profesionalnu edukaciju, bezbedno odlaganje i programe prikupljanja neiskorišćenih antimikrobnih lekova (po 32%). Validacija upitnika ukazala je na moguće nedovoljno poznavanje aspekata ŽS u AMR i kompetencija farmaceuta. Od 18 pozvanih učesnika, šest (33%) je popunilo upitnik. Identifikovane su tri teme: percipirani doprinos farmaceuta na različitim nivoima delovanja u odgovoru na AMR sa aspekta ŽS, njihova interdisciplinarna stručnost (prepoznata, ali neujednačeno shvaćena) i potreba za sistemskim mehanizmima koji omogućavaju njihovo veće uključivanje.

Istraživanje uloge farmaceuta u odgovru na AMR sa aspekta ŽS predstavlja novo istraživačko područje. Buduća istraživanja trebalo bi da obuhvate šire i različite grupe učesnika.

US19.2. PHARMACISTS' ROLE IN ENVIRONMENTAL DIMENSIONS OF AMR: A RAPID SCOPING REVIEW AND QUALITATIVE ANALYSIS OF STAKEHOLDER PERCEPTIONS FOLLOWING A UNEP WORKSHOP

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In addressing antimicrobial resistance (AMR), environmental dimensions (ED) are increasingly considered. In this emerging field, we aimed to map the roles of pharmacists recognised in scientific literature and to qualitatively explore an international stakeholder group's perceptions on such pharmacist roles.

A rapid scoping review of pharmacists' and pharmacy sector roles in addressing ED of AMR was conducted. Articles extracted from PubMed for the period 2006-2026 into a structured matrix were narratively synthesised by publication year, pharmacist role, thematic domain, and evidence levels (1-5). The survey was validated for clarity by 5 public health professionals and circulated online among stakeholders who participated in a UNEP workshop on ED of AMR. The answers to open-ended questions were coded and thematically analysed manually.

Included articles (N=25/91 [28%]) were mainly descriptive and observational (evidence Level 4, [56%]), while 52% of records were published during 2025-2026. Included literature demonstrated that pharmacist roles were related to One Health, veterinary pharmacy and professional education and safe disposal and pharmacy-led-take-back of unused antimicrobials (32% each). Survey validation highlighted potential low awareness of environmental AMR dimensions and pharmacists' competencies. Of 18 invited participants, six (33%) completed the survey. Three main themes were identified: perceived pharmacist contributions across multiple levels of environmental AMR action, pharmacists' interdisciplinary expertise (recognised but not uniformly understood) and the need for system-level enabling mechanisms for pharmacists' involvement.

Exploring pharmacists' roles in ED of AMR is a recent research field. Further research could focus on wider participant groups.

US19.3. PODRŠKA DECI SA HRONIČNIM NEZARAZNIM BOLESTIMA U ŠKOLSKOM OKRUŽENJU: ULOGA FARMACEUTA U EDUKACIJI PROSVETNIH RADNIKA

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Deca sa hroničnim nezaraznim bolestima zahtevaju kontinuiranu podršku u školskom okruženju, gde nastavnici imaju važnu ulogu u prepoznavanju zdravstvenih potreba, reagovanju u hitnim situacijama i očuvanju bezbednosti učenika. Farmaceuti, kao dostupni zdravstveni stručnjaci, mogu doprineti edukaciji školskog osoblja i jačanju intersektorske saradnje.

Cilj istraživanja bio je da se ispita informisanost i iskustvo prosvetnih radnika u radu sa decom obolelom od hroničnih nezaraznih bolesti, kao i njihov stav o ulozi farmaceuta u dodatnoj edukaciji i podršci u školskom okruženju.

Studija preseka sprovedena je među 256 prosvetnih radnika zaposlenih u osnovnim školama u Srbiji. Podaci su prikupljeni anonimnim *online* upitnikom koji je sadžao 22 pitanja, kojim su obuhvaćene socio-demografske karakteristike, iskustva u radu sa hronično obolelom decom i stavove u vezi sa potrebom za edukacijom i saradnjom sa farmaceutima u apotekama.

Ukupno 59% ispitanika navelo je da u odeljenju trenutno ima dete sa hroničnim oboljenjem, dok se 36,3% našlo u situaciji da pruži pomoć učeniku tokom akutizacije bolesti. Većina ispitanika nije imala prethodnu obuku o postupanju sa decom obolelom od hroničnih bolesti (91,4%), a 64,1% se samo delimično osećalo sigurno u postupanju sa takvim učenicima. Većina je smatrala da farmaceuti mogu imati značajnu ulogu u edukaciji nastavnika, posebno u oblasti hitnog reagovanja i pravilne primene terapije.

Rezultati ukazuju na izraženu potrebu za struktuiranom edukacijom prosvetnih radnika i većim uključivanjem farmaceuta u podršku školama u radu sa decom sa hroničnim nezaraznim bolestima.

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US19.3. SUPPORTING CHILDREN WITH CHRONIC NON-COMMUNICABLE DISEASES IN THE SCHOOL ENVIRONMENT: THE ROLE OF PHARMACISTS IN EDUCATING SCHOOL STAFF

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Children with chronic non-communicable diseases require continuous support in the school setting, where teachers play an important role in recognizing health needs, responding to acute events, and maintaining student safety. Pharmacists, as accessible healthcare professionals, may contribute to the education of school staff and strengthen intersectoral collaboration.

This study aimed to examine the awareness and experience of school employees in working with children with chronic non-communicable diseases, as well as their views on the role of pharmacists in education and support within the school environment.

A cross-sectional study was conducted among 256 educational professionals employed in primary schools in Serbia. Data were collected using an anonymous online questionnaire comprising 22 items covering socio-demographic characteristics, experience with chronically ill children, educational needs, and attitudes toward collaboration with pharmacists.

Overall, 59% of respondents reported having a child with a chronic disease in their class, while 36.3% had experienced a situation requiring assistance during an acute exacerbation. Most participants had not received prior training on chronic diseases in children (91.4%), and 64.1% felt only partially confident in dealing with such students. Most respondents considered pharmacists to have a potentially important role in teacher education, particularly in emergency response and proper therapy-related guidance.

The findings indicate a substantial need for structured education of school staff and greater involvement of pharmacists in supporting schools in the care of children with chronic non-communicable diseases.

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US19.4. ZDRAVSTVENA PISMENOST U SRBIJI: STUDIJA PRESEKA PRIMENOM INSTRUMENTA HLS-Q12

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Zdravstvena pismenost je sposobnost pronalaženja, razumevanja i korišćenja zdravstvenih informacija i usluga radi donošenja informisanih odluka. Cilj istraživanja je procena nivoa zdravstvene pismenosti i faktora koji na nju utiču. Validiran instrument HLS-Q12 je distribuiran opštoj populaciji u Srbiji tehnikom "snežne grudve". Definisani su nivoi pismenosti: neadekvatan (≤26 poena), marginalan (27–32 poena), srednji (33–38 poena) i napredan (39–48 poena). Podaci su obrađeni pomoću programa IBM SPSS Statistics, sa granicom statističke značajnosti $p<0,05$. Učestvovalo je 304 ispitanika, prosečne starosti 35,0 ± 12,4 godine. Većinu su činile žene (87,0%), osobe sa fakultetskim obrazovanjem (74,1%) i zaposleni (67,9%). Najviše ispitanika imalo je srednji nivo zdravstvene pismenosti (45,5%), zatim napredan (22,6%), pa marginalan (19,9%) i neadekvatan (12,0%). Faktori povezani sa nivoom zdravstvene pismenosti ($p<0,05$) bili su: izvor zdravstvenih informacija ($\chi^2=31,67$), učestalost vežbanja u prethodnom mesecu ($\chi^2=28,73$), zdravstveno obrazovanje ($\chi^2=22,93$), mesečna primanja domaćinstva ($\chi^2=25,48$) i korišćenje interneta za zdravstvene informacije ($\chi^2=8,01$). Viši nivoi pismenosti najčešći su među onima koji se za informacije obraćaju farmaceutu, koji vežbaju skoro svakodnevno, koji su po zanimanju medicinske sestre/tehničari, koji imaju primanja 120.001–160.000 dinara i koji koriste internet za zdravstvene informacije. Ispitanicima je bilo najteže da procene pouzdanost medijskih informacija o medicinskim rizicima, i prednosti i mane različitih načina lečenja.

Kako nivoi zdravstvene pismenosti zavise od načina informisanja, navika vezanih za fizičku aktivnost i socioekonomskog statusa, pri čemu osobe koje se informišu kod farmaceuta i redovno vežbaju imaju viši nivo pismenosti, preporučuje se osnaživanje uloge farmaceuta, kao i promocija zdravih navika i pouzdanih izvora informacija.

Zahvalnica

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US19.4. HEALTH LITERACY IN SERBIA: CROSS-SECTIONAL STUDY USING HLS-Q12 INSTRUMENT

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Health literacy is the ability to find, understand, and use health information and services to make informed decisions. This research aimed to assess health literacy levels and factors that influence them. The validated instrument HLS-Q12 was distributed to the general population in Serbia using the *snowball* technique. Defined literacy levels were: inadequate (≤26 points), marginal (27–32 points), intermediate (33–38 points) and advanced (39–48 points). Data were analyzed using IBM SPSS Statistics, with statistical significance at $p<0.05$. The study included 304 respodents, mean age 35.0 ± 12.4 years. Majority were women (87.0%), university-educated (74.1%) and employed (67.9%). Most respondents had an intermediate health literacy level (45.5%), followed by advanced (22.6%), marginal (19.9%) and inadequate (12.0%). Health literacy level associated factors ($p<0.05$) were: health information source ($\chi^2=31.67$), exercise frequency in the previous month ($\chi^2=28.73$), health education ($\chi^2=22.93$), monthly household income ($\chi^2=25.48$) and Internet use for health information ($\chi^2=8.01$). Higher literacy was most common among those who consulst a pharmacist, exercise almost daily, work as a nurse/technician, have 120,001–160,000 dinars income and use the Internet for health information. Respondents found it most difficult to assess the reliability of media information on medical risks, and the advantages and disadvantages of different treatments.

Since health literacy levels depend on information sources, physical activity habits and socioeconomic status, where people who get information from pharmacists and exercise regularly show a higher literacy level, it is recommended to strengthen the role of pharmacists, and to promote healthy habits and reliable sources of information.

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US19.5. REVIEW OF THE DEVELOPMENT OF RARE DISEASE TREATMENT IN NORTH MACEDONIA: ANALYSIS OF THE AVAILABILITY OF ORPHAN DRUGS IN THE PERIOD 2009–2025

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The systematic recognition and institutional approach to rare disease treatment in North Macedonia began in 2009 with the establishment of the Program for Rare Diseases. Initially characterized by limited coverage and financial resources, the program has significantly developed and expanded, especially in provision of orphan drugs and improving patient's access to therapy.

The objective of this work is to provide review and analysis of the development of orphan drug coverage in North Macedonia, with a focus on the availability of orphan therapies, changes in budgetary allocations, the number of diagnosed and treated patients, and the evolution of institutional support through the Program for Rare Diseases, by analyzing corresponding programs introduced in 2009, 2015, 2020, and 2025.

The analysis demonstrated significant and continuous progress in rare disease treatment. From therapy provided for only two patients in 2009, the coverage reached approximately 420 patients in 2025, while funding increased from approximately EUR 448 thousand in 2009 to about EUR 20 million in 2025. The data show significant institutional and financial transformation, evolving into a development-oriented system that strives to provide equitable, timely, and high-quality treatment for all individuals with rare diseases. The increase in budget resources, the expansion of the rare disease registry, the introduction of new therapies, and the strengthening of regulatory mechanisms contribute to improved access to treatment and enhanced patient protection. It is to be expected that the program, as well as patient coverage will continue to expand, following the evolving trends regarding treatment of rare diseases.

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US19.6. ANALIZA TRENDOVA PROMETA I POTROŠNJE LEKOVA ZA HUMANU UPOTREBU U REPUBLICI SRBIJI U PERIODU OD 2006. DO 2024. GODINE

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Starenjem stanovništva i produženjem životnog veka povećava se i upotreba lekova. Cilj je bio da se analizira trend prometa i potrošnje humanih lekova u Republici Srbiji u periodu 2006 – 2024. Korišćeni su javno-dostupni podaci iz godišnjih publikacija o prometu i potrošnji lekova Agencije za lekove i medicinska sredstva Srbije. Podaci o prometu izraženi su u dinarima (RSD), a podaci o potrošnji kao DDD (dnevno definisana doza)/1000 stanovnika/dan. Statistička obrada podataka izvršena je u programima Microsoft Office Excel i Joinpoint Regression Software (ver. 6.0.1.0), rezultati su izraženi kao procenat (%) i Annual Percent Change (APC), a statistički značajnim smatrani su rezultati gde je p<0,05.

U posmatranom periodu, promet i potrošnja lekova beležili su trend rasta (p<0,05). Promet je rastao po stopama APC=24,01 (2006-2008), APC =6,23 (2008-2017) i APC = 10,42 (2017-2024), uz porast ukupnog prometa sa 42,4 na 223,2 milijarde RSD godišnje. Trend potrošnje lekova je prosečno rastao po stopi APC =4,60, uz udvostručenu upotrebu u posmatranom periodu. Najveći udeo u prometu imali su lekovi koji deluju na kardiovaskularni sistem (17,6-25,3%), a od 2020. godine antineoplastici i imunomodulatori (26,5% udela u 2024). Najveću potrošnju imali su lekovi koji deluju na kardiovaskularni sistem (384,73 – 921,36 DDD/1000 stanovnika/dan), a zatim lekovi za lečenje bolesti krvi i krvotvornih organa (151,14 – 362,31 DDD/1000 stanovnika/dan).

Promet i potrošnja lekova u Srbiji pokazali su kontinuiran rast tokom posmatranog perioda, što može da ukazuje na starenje populacije, porast prevalencije hroničnih nezaraznih bolesti, ali i na unapređenje dostupnosti terapije, što je potrebno dodatnim istraživanjima potvrditi.

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US19.6. TREND ANALYSIS OF THE TURNOVER AND CONSUMPTION OF HUMAN MEDICINAL PRODUCTS IN THE REPUBLIC OF SERBIA FROM 2006 TO 2024

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Population aging and longer life expectancy are increasing the use of medicinal products (medicines). The aim was to analyse trends in the turnover and consumption of human medicines in the Republic of Serbia between 2006 and 2024. Publicly available data from the annual turnover and consumption reports published by the Medicines and Medical Devices Agency of Serbia were used. Turnover was expressed in dinars (RSD) and consumption in DDD (defined daily dose)/1,000 inhabitants/day. Data were analyzed in Microsoft Office Excel and Joinpoint Regression Software (ver. 6.0.1.0). Results are presented as percentages (%) and Annual Percent Change (APC), with statistical significance set at p<0.05.

In the observed period, both turnover and consumption followed a rising trend (p<0.05). Turnover increased at APC=24.01 (2006–2008), APC=6.23 (2008–2017) and APC=10.42 (2017–2024), with total turnover increase from 42.4 to 223.2 billion RSD per year. Consumption rose at an average rate of APC=4.60, doubling over the same period. The largest share of turnover belonged to medicines for the cardiovascular system (17.6–25.3%), and from 2020 onwards to antineoplastic and immunomodulating agents (26.5% in 2024). Consumption was highest for medicines for the cardiovascular system (384.73–921.36 DDD/1,000 inhabitants/day), followed by medicines acting on blood and blood forming organs (151.14–362.31 DDD/1,000 inhabitants/day).

Medicines' turnover and consumption in Serbia showed a continuous increase throughout the study period. This may reflect population aging, increasing prevalence of chronic non-communicable diseases, as well as improved treatment access, though further research is needed to confirm these findings.

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US19.7. FARMACEUTSKI OTPAD U JAVNIM APOTEKAMA U SRBIJI: PRAKSA, IZAZOVI I POTREBA ZA ODRŽIVIM I STANDARDIZOVANIM SISTEMOM UPRAVLJANJA

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Nepropisno odlaganje lekova je značajan ekološki i zdravstveni problem jer vodi zagađenju životne sredine i predstavlja rizik po javno zdravlje. Ključni izazov je farmaceutski otpad, a apoteke su važna tačka za njegovo prikupljanje od građana. Ipak, praksa pokazuje različito postupanje javnih apoteka, što ukazuje na potrebu unapređenja sistema.

Cilj ovog rada je da se ispita trenutna praksa prikupljanja farmaceutskog otpada i problemi sa kojima se farmaceuti susreću u njegovom upravljanju u javnim apotekama u Srbiji.

Sprovedena je studija preseka među farmaceutima zaposlenim u javnim apotekama u Srbiji korišćenjem anonimnog online upitnika. Za statističku analizu su korišćeni deskriptivni pokazatelji i hi-kvadrat test, uz nivo značajnosti $p<0,05$.

U istraživanju je učestvovalo 334 farmaceuta, od kojih je 34,6% navelo da apoteka u kojoj rade prikuplja farmaceutski otpad od građana. Uprkos tome, gotovo svi ispitanici (94,4%) podržali su uspostavljanje nacionalnog sistema za sakupljanje i uništavanje farmaceutskog otpada. Utvrđene su statistički značajne razlike između ogranaka Farmaceutske komore Srbije u vezi sa praksom prikupljanja otpada ($p=0,001$), pri čemu je najmanji procenat u Beogradu (20,0%), a najveći u Kragujevcu (47,2%). Farmaceuti u apotekama koje prikupljaju farmaceutski otpad češće su prijavljivali umeren ili visok finansijski teret u odnosu na one koje ne prikupljaju (40,2% vs. 18,4%; $p=0,003$). Najčešće prepreke za prikupljanje farmaceutskog otpada bile su nedostatak infrastrukture i kontejnera (65,7%), nedostatak znanja i interesovanja pacijenata (62,0%) i visoki troškovi (51,2%).

Neophodno je postojeću podršku farmaceuta nacionalnom sistemu integrisati u standardizovanu praksu upravljanja farmaceutskim otpadom, uz obezbeđivanje infrastrukture, finansijske podrške apotekama i kontinuirane edukacije farmaceuta i pacijenata.

Zahvalnica

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US19.7. PHARMACEUTICAL WASTE IN PUBLIC PHARMACIES IN SERBIA: PRACTICES, CHALLENGES AND NEEDS FOR A SUSTAINABLE AND STANDARDIZED MANAGEMENT SYSTEM

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Environmental pollution and public health risks make improper medicine disposal a significant environmental and health problem. Pharmaceutical waste is a key challenge, and pharmacies are an important point for its collection from citizens. However, practice shows different behavior of public pharmacies, which indicates the need to improve the system.

The aim of this work is to examine the current practices of pharmaceutical waste collection and problems pharmacists encounter in its management in public pharmacies in Serbia.

A cross-sectional study was conducted among pharmacists employed in public pharmacies in Serbia using an anonymous online questionnaire. Descriptive indicators and chi-square test were used, with a significance level of $p<0.05$.

The survey included 334 pharmacists, of whom 34.6% reported that their pharmacy collects pharmaceutical waste from citizens. Almost all respondents (94.4%) supported a national system for the collection and destruction of pharmaceutical waste. Significant differences were found between branches of the Pharmaceutical Chamber of Serbia regarding collection practices ($p=0.001$), with the lowest percentage in Belgrade (20.0%) and the highest in Kragujevac (47.2%). Pharmacists in pharmacies that collect waste more often reported a moderate or high financial burden compared with those in pharmacies that do not (40.2% vs 18.4%; $p=0.003$). The main barriers were lack of infrastructure and containers (65.7%), lack of patient knowledge and interest (62.0%), and high costs (51.2%).

It is necessary to integrate pharmacists' support for a national system into standardized pharmaceutical waste management practices, along with infrastructure provision, financial support for pharmacies, and continuous education of pharmacists and patients.

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PRO19.1. KNOWLEDGE, PRACTICES AND ATTITUDES OF COMMUNITY PHARMACISTS TOWARDS PHARMACEUTICAL WASTE MANAGEMENT IN CROATIA: A NATIONAL SURVEY WITHIN THE ERASMUS+ PHARMWASTE PROJECT

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Pharmaceutical waste is an increasing environmental and public health concern, particularly due to inappropriate disposal of unused and expired medicines. Community pharmacies represent accessible healthcare settings for patient counselling, collection of pharmaceutical waste and promotion of environmentally responsible medicine use. This study aimed to assess Croatian community pharmacists' knowledge, practices and attitudes regarding pharmaceutical waste management, with emphasis on education, patient-directed materials and perceived system-level needs. A cross-sectional study used a structured self-administered questionnaire. Data included sociodemographic and professional characteristics, previous education, self-assessed knowledge, availability of educational materials and motivating factors for improving pharmaceutical waste management. Descriptive statistics and chi-square tests were applied ($p < 0.05$). Most of 207 participants were women (87.9%), with a mean age of 42.3 years and mean professional experience of 16.9 years. The majority had completed pharmacy studies (86.0%) and worked in community pharmacies (95.7%). Only 6.8% had received formal education or training in pharmaceutical waste management, while 82.1% reported that this topic had not been included in their pharmacy curriculum. Adequate self-assessed knowledge was reported by 37.7%, while 44.4% reported deficient knowledge. Self-assessed knowledge differed significantly by workplace role ($p = 0.036$). Patient-directed educational materials were absent in 87.9% of pharmacies, with significant differences according to education level, workplace role, pharmacy location, region and number of employees. Findings indicate substantial educational and communication gaps in pharmaceutical waste management. Structured continuing education, standardized patient materials and a coordinated national framework are needed to strengthen pharmacists' role in safe medicine disposal and environmental public health.

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Sesija 20
Session 20

Od prirodnih resursa do proizvoda sa dodatom vrednošću: održive inovacije

From natural resources to value-added products: sustainable innovations

Od prirodnih resursa do proizvoda sa dodatom vrednošću: održive inovacije

Prirodni proizvodi i bioaktivna jedinjenja biljnog porekla predstavljaju značajan izvor novih mogućnosti za farmaceutsku, prehrambenu i kozmetičku industriju. Istovremeno, održivi razvoj i primena zelenih tehnologija postaju ključni pokretači istraživanja usmerenih ka efikasnijem korišćenju prirodnih resursa. Savremeni pristupi, između ostalog, obuhvataju valorizaciju sporednih i otpadnih materijala i stvaranje proizvoda sa dodatom vrednošću. U okviru ove sesije su predstavljeni primeri primene zelenih tehnologija i drugih pristupa koji doprinose racionalnoj i održivoj upotrebi prirodnih resursa i omogućavaju njihovu transformaciju u funkcionalne proizvode.

From natural resources to value-added products: sustainable innovations

Natural products and plant bioactive compounds represent an important source of new opportunities for the pharmaceutical, food and cosmetic industries. At the same time, sustainable development and the implementation of green technologies are becoming key drivers of research aimed at the more efficient utilization of natural resources. Current approaches include, among others, the valorization of by-products and waste materials, as well as the development of value-added products. This session presents examples of green technologies and other approaches that contribute to the rational and sustainable use of natural resources and enable their transformation into functional products.

PP20.1. POLYMERIC CARRIERS OF NATURAL BIOACTIVE COMPOUNDS AND PLANT EXTRACTS AS INNOVATIVE FOOD PRESERVATIVES

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Increasing consumer awareness of food safety and sustainability has driven the search for natural alternatives to synthetic preservatives. Plant-derived bioactive compounds - including essential oil constituents, polyphenols, and crude botanical extracts - exhibit well-documented antimicrobial and antioxidant properties, yet their direct application to food is often constrained by volatility, poor aqueous solubility, and sensitivity to processing conditions. Embedding these compounds within biopolymer-based carrier systems addresses these limitations by enhancing stability and enabling precise formulation of the active phase. Among available biopolymers, chitosan stands out as a particularly attractive matrix due to its inherent antimicrobial activity, film-forming capacity, biodegradability, and compatibility with a wide range of bioactive guests.

Two delivery formats are presented as illustrative examples. The first involves chitosan particles crosslinked with sodium tripolyphosphate, loaded with ginger extract. Encapsulation efficiency and structural characterisation by ATR-FTIR confirmed successful incorporation of the extract, and antimicrobial evaluation demonstrated meaningful activity against selected food-relevant microorganisms.

The second example concerns active packaging films based on chitosan crosslinked with citric acid, incorporating a β-cyclodextrin/thymol inclusion complex at varying concentrations. ATR-FTIR analysis confirmed complex formation and its integration into the polymer network. The films were further characterised in terms of water vapour transmission rate, water absorption, solubility, optical transparency, and surface wettability, providing a comprehensive picture of their physicochemical suitability as food packaging materials.

Together, these systems illustrate how biopolymer matrices can be tailored to specific application needs, offering a flexible platform for the development of natural preservation strategies in food technology.

PP20.2. HIDROLATI - OD OTPADNIH MATERIJALA DO DRAGOCENIH FARMACEUTSKIH I KOZMETIČKIH SIROVINA

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Hidrolati su nusproizvodi destilacije eterskih ulja. Iako je upotreba hidrolata u kozmetici i tradicionalnoj medicini u porastu, njihovi fitohemijski profili i biološki efekti su nedovoljno istraženi.

Testirali smo sastav i farmakološke aktivnosti hidrolata dobijenih iz cveta *Anthemis nobilis*, semena *Daucus carota*, *Hyssop officinalis* herba, cveta *Lavandula* x *intermedia*, herbe *Melissa officinalis*, herbe *Ocimum basilicum*, herbe *Origano vulgare* i herbe *Thymus vulgaris* (svi sakupljeni u prvom satu procesa destilacije).

Primenjene su metode: GC/MS za fitohemijsku karakterizaciju; testovi uklanjanja DPPH radikala, FRAP i obezbojavanja β-karotena za procenu antioksidativne aktivnosti; test sa goveđim serumskim albuminom za određivanje antiinflamatorne aktivnosti; mikrodiluciona metoda (jedan kvasac i šest bakterijskih ATCC sojeva) za procenu antimikrobne aktivnosti; *in vitro* testiranje spazmolitičkog efekta u eksperimentalnom modelu u tkivnom kupatilu; i merenja biofizičkih parametara kože (transepidermalni gubitak vlage, eritema indek i pH) radi *in vivo* procene bezbednosti i efikasnosti.

Hidrolati su pokazali određenu antimikrobnu aktivnost, umerene do izražene antioksidativne i antiinflamatorne efekte i *in vitro* su na dozno-zavisan način izazivali smanjenje tonusa spontanih kontrakcija izolovanog fundusa pacova. *In vivo* studija na koži zdravih dobrovoljaca je utvrdila njihovu bezbednost i umirujuće dejstvo na kožu.

Među testiranim uzorcima, hidrolatl timijana je najperspektivniji, jer je pokazao najjače antioksidativne, antimikrobne i antispazmodične efekte. Hidrolati timijana i lavanina ispoljili su najjače efekte u *in vivo* studiji.

Hidrolati su dragoceni proizvodi odmah spremni za upotrebu i ne treba ih više posmatrati kao otpadne materijale već kao farmaceutske i kozmetičke sirovine.

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PP20.2. HYDROLATES - FROM WASTE PRODUCTS TO VALUABLE PHARMACEUTICAL AND COSMETIC RAW MATERIALS

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Hydrolates are aqueous by-products of essential oil distillation. Although their use in cosmetics and traditional medicine is increasing, their phytochemical profile and biological effects remain insufficiently investigated.

We tested the composition and pharmacological activities of hydrolates obtained from *Anthemis nobilis* flower, *Daucus carota* seed, *Hyssop officinalis* herba, *Lavandula* x *intermedia* flower, *Melissa officinalis* herba, *Ocimum basilicum* herba, *Origano vulgare* herba, and *Thymus vulgaris* herba (all taken in the first hour of the distillation process).

Applied methods were: GC/MS for phytochemical characterization, DPPH radical scavenging, FRAP and β-carotene bleaching assays for assessment of antioxidant activity; bovine serum albumin test for determination of anti-inflammatory activity; microdilution test (one yeast and six bacterial ATCC strains) for antimicrobial bioassays; *in vitro* test of spasmolytic effect in isolated tissue bath experimental model; and measurements of biophysical skin parameters (transepidermal water loss, erythema index, and pH) to assess *in vivo* the safety and efficacy.

Hydrolates exhibited certain antimicrobial activity, moderate to pronounced antioxidant and anti-inflammatory effects, and produced a decrease in the tone of isolated rat fundus spontaneous contractions in a dose-dependent manner *in vitro*. *An in vivo* study on the skin of healthy volunteers demonstrated their safety and skin-soothing effects.

Among the samples tested, Thyme hydrolate is the most promising, as it exerted the strongest antioxidant, antimicrobial, and antispasmodic effects. Thyme and Lavanine hydrolates showed the strongest effects in *the in vivo* study.

Hydrolates are valuable, ready-to-use products and should no longer be viewed as waste but as pharmaceutical and cosmetic raw materials.

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PP20.3. EKSTRAKTI VINOVE LOZE DOBIJENI ZELENIM TEHNOLOGIJAMA: OD NUSPROIZVODA DO FUNKCIONALNIH SASTOJAKA

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Proizvodnja vina predstavlja značajnu agroindustrijsku granu tokom koje nastaju velike količine organskog otpada. Odlaganje ovih nusproizvoda predstavlja značajan izazov, ali i mogućnost za razvoj održivih rešenja. Ostaci nastali preradom grožđa, poput komine, semenki, pokožice i peteljki, su izvor brojnih biološki aktivnih jedinjenja koja mogu imati primenu u različitim industrijskim oblastima. Posebnu pažnju privlače polifenoli, poput flavonoida, antocijana i fenolnih kiselina, zbog svojih antioksidativnih, antiinflamatornih i drugih povoljnih bioloških efekata. Ekstrakti bogati ovim jedinjenjima mogu predstavljati izvor prirodnih antioksidanasa i funkcionalnih sastojaka za razvoj inovativnih prehrambenih proizvoda, dodataka ishrani i kozmetičkih formulacija. Umesto posmatranja nusproizvoda vinske industrije kao otpada, savremeni pristupi usmereni su ka njihovoj valorizaciji i dobijanju proizvoda sa dodatnom vrednošću.

Poslednjih nekoliko decenija sve veća pažnja posvećuje se primeni zelenih tehnologija ekstrakcije koje omogućavaju efikasno izdvajanje bioaktivnih jedinjenja uz smanjen uticaj na životnu sredinu. Metode poput ultrazvučne, mikrotalasne i pulsne ekstrakcije, ekstrakcije superkritičnim fluidima, kao i primena ekološki prihvatljivijih rastvarača, doprinose razvoju održivih procesa. Ovi pristupi doprinose smanjenju energetske potrošnje, poboljšanju procesa ekstrakcije i očuvanju funkcionalnih svojstava izdvojenih komponenti.

Valorizacija nusproizvoda nastalih preradom grožđa kroz primenu zelenih tehnologija predstavlja značajan primer cirkularne ekonomije, jer omogućava smanjenje otpada, racionalnije korišćenje resursa i razvoj funkcionalnih sastojaka sa potencijalnom primenom u različitim industrijskim oblastima.

Zahvalnica

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PP20.3. GRAPEVINE EXTRACTS OBTAINED BY GREEN TECHNOLOGIES: FROM BY-PRODUCTS TO FUNCTIONAL INGREDIENTS

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Wine production is an important agro-industrial sector that generates large amounts of organic by-products. The management of these residues represents a significant challenge, but also an opportunity for the development of sustainable solutions. By-products generated during grape processing, such as pomace, seeds, skins, and stems, are valuable sources of diverse bioactive compounds with potential applications in various industrial fields. Particular attention has been given to polyphenolics, including flavonoids, anthocyanins, and phenolic acids, due to their antioxidant, anti-inflammatory, and other beneficial biological properties. These compounds can serve as a source of natural antioxidants and functional ingredients for the development of innovative food products, dietary supplements, and cosmetic formulations. Rather than being considered waste, these residues are increasingly recognized as valuable resources that can be valorized into high-value products.

In recent decades, growing interest has been focused on the application of green extraction technologies that enable the efficient recovery of bioactive compounds while reducing environmental impact. Techniques such as ultrasound-assisted, microwave-assisted, and pulsed extraction, supercritical fluid extraction, as well as the use of more environmentally friendly solvents, contribute to the development of sustainable processes. These approaches lead to lower energy consumption, enhanced extraction performance, and preservation of the functional properties of the recovered compounds.

The valorization of grape by-products through the application of green technologies represents an important example of circular economy principles, as it promotes waste reduction, more efficient resource utilization, and the development of functional ingredients with potential applications across various industrial sectors.

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US20.1. MOGUĆNOST PRIMENE NADES EKSTRAKATA U POLUČVRSTIM PREPARATIMA ZA KOŽU: *IN VIVO* ISTRAŽIVANJA

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Prirodne eutektičke smeše (*Natural Deep Eutectic Solvents*, NaDES) predstavljaju smeše prirodnih metabolita koje pri mešanju formiraju tečnosti sa nižom tačkom topljenja od pojedinačnih komponenti. Odlikuju se biorazgradivošću, neisparljivošću, stabilnošću pri povišenim temperaturama i jednostavnom pripremom. Dosadašnja istraživanja pokazala su da NaDES-i kao ekstrakciona sredstva omogućavaju dobijanje ekstrakata sa većim sadržajem bioaktivnih jedinjenja i izraženijim biološkim aktivnostima u odnosu na konvencionalne ekstrakte, uključujući antioksidantnu, UV-protektivnu aktivnost i inhibiciju enzima. Cilj ovog rada bio je da se u *in vivo* studiji ispita uticaj emulgelova sa NaDES ekstraktima na normalizaciju biofizičkih parametara kože narušenih veštački izazvanom iritacijom pomoću 6% natrijum-lauril-sulfata. U studiji su korišćeni ekstrakt lista borovnice dobijen primenom NaDES sistema jabučna kiselina-glicerol i ekstrakt lista zelenog čaja dobijen primenom NaDES sistema vinska kiselina-sorbitol. Ekstrakti su u koncentraciji 12% inkorporirani u emulgelove stabilisane kombinacijom cetearil-olivata i sorbitan-olivata. Tokom sedmodnevne studije, u kojoj je učestvovalo 20 zdravih dobrovoljaca, pomoću uređaja Multiprobe Adapter MPA 9 praćene su promene eritema indeksa (EI), transepidermalnog gubitka vode (TEWL) i pH vrednosti kože na netretiranim kontrolnim mestima sa izazvanom iritacijom (NKO) i bez iritacije (NK), kao i na mestima tretiranim placebo (P) i aktivnim emulgelom (A). Na svim iritiranim mestima zabeležen je porast EI, TEWL i pH vrednosti. Na NKO mestu bilo je potrebno pet ili više dana da se parametri vrate na bazalne vrednosti, dok su se na mestu tretiranom aktivnim emulgelom svi parametri normalizovali već nakon prvog dana primene. Dobijeni rezultati potvrđuju izražen antiiritacioni potencijal NaDES ekstrakata i ukazuju na njihov značaj za razvoj efikasnih dermokozmetičkih formulacija.

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US20.1. THE POTENTIAL APPLICATION OF NADES EXTRACTS IN TOPICAL SKINCARE PRODUCTS: *IN VIVO* STUDIES

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Natural Deep Eutectic Solvents (NaDES) are biodegradable, non-volatile, thermostable, and easily-prepared mixtures of natural metabolites that form liquids with melting points lower than those of their individual components. As extraction media, they enable the production of extracts with higher contents of bioactive compounds and enhanced biological activities (antioxidant, UV-protective, and enzyme-inhibitory) compared to conventional extracts. The aim of this study was to investigate the effects of emulgels containing NaDES-based extracts on the restoration of skin biophysical parameters impaired by 6% sodium lauryl sulfate-induced irritation. The extracts - bilberry leaf extract obtained using a malic acid-glycerol NaDES and a green tea leaf extract obtained using a tartaric acid-sorbitol NaDES, were incorporated at a concentration of 12% into emulgels stabilized with a combination of cetearyl olivate and sorbitan olivate. During the seven-day *in vivo* study, using Multiprobe Adapter MPA 9, changes in erythema index (EI), transepidermal water loss (TEWL), and skin pH were monitored at untreated control sites with induced irritation (NCO) and without irritation (NC), as well as at sites treated with placebo (P) and active (A) emulgels were observed on 20 healthy volunteers. An increase in EI, TEWL, and pH was observed at all irritated sites. At the NCO site, five or more days were required for these parameters to return to baseline values, whereas at the A site, all parameters normalized after only one day of application. These findings indicate the pronounced anti-irritant potential of NaDES-based extracts and highlight their significance in the development of effective dermocosmetic formulations.

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PRO20.1. BioCompWaterClean: OD BILJNOG BIO-OTPADA DO NOVIH MATERIJALA I ODRŽIVOG PROCESA PREČIŠĆAVANJA OTPADNIH VODA

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Zagađenje voda predstavlja jedan od ključnih globalnih ekoloških izazova. Projekat BioCompWaterClean usmeren je na primenu biljnog biootpada u dizajnu i razvoju novih materijala za prečišćavanje otpadnih voda, u skladu sa principima zelene hemije i tehnologije i cirkularne ekonomije.

U okviru projekta razvijeni su biofunkcionalizovani kompozitni materijali na bazi magnetnih geopolimera, koji su primenjeni kao adsorbensi i katalizatori za uklanjanje fenolnih jedinjenja i jona metala iz vode. Biofunkcionalizacija se odvija *in situ*, tokom sinteze kompozita u prisustvu biljnih ekstrakata. Za tu namenu korišćeni su ekstrakti dobijeni iz kore jabuke, limuna i mandarine, kao i ljuske crnog luka, primenom ekstrakcije vodom u subkritičnom stanju, ultrazvučne i mikrotalasne ekstrakcije, kao i maceracije prirodnim eutektičkim rastvaračima. Bioaktivne komponente ekstrakata, pre svega polifenoli, doprinose modifikaciji površine materijala i povećanju njegove funkcionalnosti, čime se stvaraju povoljni uslovi za kovalentnu imobilizaciju enzima peroksidaze i dobijanje stabilnih biokatalizatora.

Dobijeni biokatalizatori pokazali su visoku enzimsku aktivnost, stabilnost i mogućnost ponovne upotrebe. Njihovom primenom ostvareno je uklanjanje fenola i hlorovanih derivata sa efikasnošću većom od 90%, uključujući i realne uzorke otpadnih voda. Biofunkcionalizovani magnetni geopolimeri pokazali su potencijal i u Fenton procesima, kao i za uklanjanje jona mangana (85-96%). Biološko ispitivanje primenom *Allium cepa* testa pokazalo je značajno smanjenje toksičnosti (za 34%) tretiranih uzoraka vode, što potvrđuje potencijal razvijenih materijala za primenu u održivim procesima prečišćavanja otpadnih voda.

Zahvalnica

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PRO20.1. BioCompWaterClean: FROM PLANT BIOWASTE TO NOVEL MATERIALS AND SUSTAINABLE WASTEWATER TREATMENT

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Water pollution represents one of the key global environmental challenges. The BioCompWaterClean project focuses on the use of plant-derived biowaste in the design and development of novel materials for wastewater treatment, in accordance with the principles of green chemistry and technology and the circular economy.

Within the project, biofunctionalized composite materials based on magnetic geopolymers were developed and applied as adsorbents and catalysts for the removal of phenolic compounds and metal ions from water. Biofunctionalization takes place *in situ* during composite synthesis in the presence of plant extracts. For this purpose, extracts obtained from apple, lemon, and mandarin peels, as well as onion skins, were prepared using subcritical water extraction, ultrasound-assisted extraction, microwave-assisted extraction, and maceration with natural deep eutectic solvents. The bioactive components of the extracts, primarily polyphenols, contribute to surface modification of the materials and enhancement of their functionality, thereby providing favorable conditions for the covalent immobilization of peroxidase and the production of stable biocatalysts.

The resulting biocatalysts demonstrated high enzymatic activity, stability, and reusability. Their application enabled the removal of phenols and chlorinated derivatives with efficiencies exceeding 90%, including from real wastewater samples. The biofunctionalized magnetic geopolymers also demonstrated potential for use in Fenton processes, as well as for the removal of manganese ions (85–96%). Biological testing using the *Allium cepa* assay demonstrated a significant reduction in the toxicity of the treated water samples (34%), confirming the potential of the developed materials for application in sustainable wastewater treatment processes.

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Sesija 21
Session 21

Zdravlje žena u različitim životnim dobima: endokrini, metabolički i farmakoterapijski aspekti

Women's health across the lifespan: endocrine, metabolic and pharmacotherapeutic perspectives

Zdravlje žena u različitim životnim dobima: endokrini, metabolički i farmakoterapijski aspekti

Zdravlje žena oblikuju dinamične promene u različitim životnim dobima: od puberteta, kroz reproduktivne godine, do menopauze, a svako doba nosi endokrine, metaboličke i farmakoterapijske specifičnosti. Predavanja u ovoj sesiji usmerena su na osvetljavenje upravo tog kontinuuma: od racionalne primene hormona zasnovane na dokazima, preko endokrinog profila smanjene rezerve jajnika, do metaboličkih aspekata neplodnosti kao jednim od ključnih izazova u savremenoj reproduktivnoj medicini. Posebna je posvećena farmaceutskim strategijama za prenošenje naučnih dokaza u svakodnevnu praksu i bezbednu primenu lekova tokom trudnoće i dojenja, uz naglašavanje značajne uloge farmaceuta u savetovanju, optimizaciji terapije i zdravstvenoj zaštiti usmerenoj ka pacijentkinji.

Women's health across the lifespan: endocrine, metabolic and pharmacotherapeutic perspectives

Women's health is shaped by dynamic changes across different life stages: from puberty, through the reproductive years, to menopause, with each stage bringing its own endocrine, metabolic, and pharmacotherapeutic specificities. The talks in this session are aimed at illuminating this continuum: from evidence-based, rational use of hormones, through the endocrine profile of diminished ovarian reserve, to the metabolic aspects of infertility as a key challenge in modern reproductive medicine. Particular attention is given to pharmaceutical strategies for translating scientific evidence into everyday practice and ensuring the safe use of medications during pregnancy and breastfeeding, with emphasis on the important role of pharmacists in counselling, therapy optimisation, and patient-centred healthcare.

PP21.1. ENDOKRINI KONTINUUM SMANJENE REZERVE JAJNIKA

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Termin smanjena rezerva jajnika (DOR) nastao je u reproduktivnoj medicini radi prepoznavanja žena sa očekivano slabijim odgovorom na stimulaciju jajnika. Međutim, svođenje DOR-a na koncentraciju anti-Milerovog hormona (AMH) i ishode asistirane reprodukcije zanemaruje njegovu endokrinu dimenziju. Rezerva jajnika opada tokom čitavog reproduktivnog života, dok se osovina hipotalamus-hipofiza-jajnik postepeno prilagođava gubitku folikula: AMH i inhibin B opadaju, a folikulostimulišući hormon (FSH) raste, često mnogo pre neredovnih ciklusa i klinički prepoznatljivog gubitka funkcije jajnika. Između DOR-a u kontekstu infertiliteta, smanjene rezerve nesrazmerne uzrastu, prevremene insuficijencije jajnika, rane menopauze i perimenopauze postoji biološki kontinuitet, kliničko preklapanje ali ne i dijagnostička istovetnost.

Tumačenje nalaza biomarkera rezerve jajnika zato mora biti integrisano sa uzrastom, karakteristikama menstrualnog ciklusa, tegobama, reproduktivnim planovima, porodičnom anamnezom i mogućim etiološkim činiocima. Nizak AMH dobro predviđa odgovor na stimulaciju, ali sam po sebi ne određuje kvalitet oocita, trenutnu prirodnu plodnost niti vreme menopauze kod pojedinačne žene. Posebnu kliničku pažnju zaslužuju mlađe žene kod kojih je rezerva značajno niža od očekivane za uzrast uz redovne menstrualne cikluse i odsustvo tegoba.

Predavanje prikazuje DOR kao deo kontinuuma reproduktivnog starenja i razmatra granice postojećih biomarkera, odnos AMH i FSH, te rizik progresije ka prevremenoj insuficijenciji jajnika i ranoj menopauzi, kao i mesto individualizovanog savetovanja i praćenja.

PP21.1. THE ENDOCRINE CONTINUUM OF DIMINISHED OVARIAN RESERVE

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The term diminished ovarian reserve (DOR) emerged in reproductive medicine to identify women expected to have a poorer response to ovarian stimulation. However, reducing DOR to anti-Müllerian hormone (AMH) concentrations and assisted reproductive technology outcomes overlooks its endocrine dimension. Ovarian reserve declines throughout the reproductive lifespan, while the hypothalamic-pituitary-ovarian axis progressively adapts to follicular depletion: AMH and inhibin B decline, whereas follicle-stimulating hormone (FSH) rises, often long before menstrual cycles become irregular and loss of ovarian function becomes clinically apparent. Biological continuity and clinical overlap exist between DOR in the infertility setting, ovarian reserve that is lower than expected for age, premature ovarian insufficiency, early menopause and perimenopause; however, these conditions are not diagnostically equivalent.

The interpretation of ovarian reserve biomarkers must therefore be integrated with age, menstrual cycle characteristics, symptoms, reproductive plans, family history and potential etiological factors. Low AMH reliably predicts ovarian response to stimulation, but does not, by itself, determine oocyte quality, current natural fertility or the timing of menopause in an individual woman. Specifically, clinical attention should be given to younger women whose ovarian reserve is substantially lower than expected for age despite regular menstrual cycles and the absence of symptoms.

This lecture presents DOR as part of the reproductive ageing continuum and examines the limitations of current biomarkers, the relationship between AMH and FSH, and the risk of progression to premature ovarian insufficiency and early menopause, as well as the role of individualized counselling and follow-up.

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PP21.2. RACIONALNA PRIMENA HORMONA: OD ADOLESCENCIJE DO MENOPAUZE

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Hormonska terapija ima značajno mesto u očuvanju i unapređenju zdravlja žena tokom različitih životnih faza. Njena primena prevazilazi kontraceptivnu i supstitucionu ulogu i obuhvata lečenje poremećaja menstrualnog ciklusa, akni i hirzutizma, sindroma policističnih ovarijuma (PCOS), endometrioze i osteoporoze. Razvoj novih hormonskih preparata, uz kontinuirano praćenje savremenih saznanja o efikasnosti i bezbednosti postojećih terapijskih opcija, omogućavaju racionalnu primenu hormona prilagođenu potrebama svake korisnice/pacijentkinje. U adolescenciji, hormoni se najčešće primenjuju u hitnoj kontracepciji, regulaciji poremećaja menstrualnog ciklusa, kao i lečenju akni i PCOS-a. Kombinacija estetrola, prirodnog estrogena fetalnog porekla, i drospirenona ostvarila je dobru kontrolu ciklusa i prihvatljivu podnošljivost kod devojaka uzrasta 12–17 godina, čime je proširen izbor kombinovanih hormonskih preparata u ovoj populaciji. U reproduktivnom periodu, posebno se ističe značaj personalizovanog pristupa, uz procenu rizika od tromboembolijskih događaja i estrogen-zavisnih maligniteta, kao i prisutnih komorbiditeta pri izboru kontraceptivne metode i terapije ginekoloških poremećaja. U tom kontekstu, širenje repertoara progestagene kontracepcije, uključujući preparate sa drospirenonom, olakšava terapijski izbor. Noviji opservacioni podaci ukazuju na malu povezanost primene intrauterinog dostavnog sistema sa levonorgestrelom sa rizikom od raka dojke. Najznačajnije novine u hormonskoj terapiji odnose se na menopauzu. Američka agencija za hranu i lekove ublažila je upozorenja o riziku od kardiovaskularnih bolesti, raka dojke i demencije na deklaracijama preparata za hormonsku terapiju u menopauzi. Lokalna hormonska terapija ostaje racionalan izbor u lečenju genitourinarnog sindroma menopauze. Očuvanje i unapređenje zdravlja žena zahteva da farmaceutska struka prati novine vezane za racionalnu primenu hormona i prevodi ih u jasne, bezbedne i personalizovane terapijske intervencije.

PP21.2. EVIDENCE-BASED HORMONE THERAPY ACROSS WOMEN'S LIFESPAN

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Hormonal therapy has an important role in preserving and improving women's health across the lifespan. Its use extends beyond contraception and hormone replacement therapy to the management of menstrual disorders, acne, hirsutism, polycystic ovary syndrome (PCOS), endometriosis, and osteoporosis. The development of new hormonal products, together with ongoing appraisal of evidence on the efficacy and safety of existing therapies, supports rational hormone use tailored to each woman. In adolescence, hormones are most commonly used for emergency contraception, management of menstrual disorders, acne, and PCOS. The combination of estetrol, a natural estrogen of fetal origin, and drospirenone provided good cycle control and acceptable tolerability in girls aged 12–17 years, expanding the available combined hormonal options for this population. During the reproductive age, a personalized approach is essential, with particular attention to thromboembolic risk, estrogen-sensitive malignancies, and comorbidities when selecting contraceptives or treatments for gynecological disorders. In this regard, the expanding range of progestogen-only contraceptives, including drospirenone-only products, allows more individualized treatment selection. Recent observational data also suggest a small association between levonorgestrel-releasing intrauterine system use and breast cancer risk. The most markable novelties in hormonal therapy concern menopause. The US Food and Drug Administration has eased warnings in the labeling of menopausal hormone therapy products regarding cardiovascular disease, breast cancer, and dementia. Local hormonal therapy remains a rational treatment option for genitourinary syndrome. Preserving and improving women's health requires pharmacists to keep up with advances in rational hormone use and translate them into clear, safe, and personalized therapeutic interventions.

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PP21.3. METABOLIČKI ASPEKTI NEPLODNOSTI: SAVREMENI IZAZOVI U REPRODUKTIVNOJ MEDICINI

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Metaboličko zdravlje se sve više smatra jednim od ključnih faktora koji određuju reproduktivni potencijal žena i muškaraca. Rastuća prevalencija gojaznosti, insulinske rezistencije, metaboličkog sindroma i sindroma policističnih jajnika (PCOS) dovela je do intenzivnijeg proučavanja njihovog uticaja na reproduktivno zdravlje i ishode asistirane reprodukcije. Patofiziološki efekti ovih metaboličkih poremećaja zasnivaju se na složenoj interakciji poremećaja hormonskog statusa, hronične inflamacije niskog stepena, oksidativnog stresa i izmenjene sekrecije adipokina. Gojaznost je povezana sa smanjenim kvalitetom jajnih ćelija i spermatozoida, poremećajem ovulacije, izmenjenom receptivnošću endometrijuma i povećanim rizikom od nepovoljnih reproduktivnih ishoda. Insulinska rezistencija i prateća hiperinsulinemija doprinose poremećaju steroidogeneze, hiperandrogenizmu i narušenoj folikulogenezi, dok metabolički sindrom dodatno pogoršava reproduktivni potencijal usled udruženog delovanja abdominalne gojaznosti, dislipidemije i poremećene glikoregulacije. Poseban značaj pripisuje se PCOS-u, heterogenom endokrino-metaboličkom poremećaju koji povezuje reproduktivne, metaboličke i inflamatorne faktore i predstavlja vodeći uzrok anovulatorne neplodnosti. Metabolički poremećaji ne utiču samo na reproduktivnu funkciju žena, već mogu nepovoljno delovati i na muški fertilitet kroz promene hormonske regulacije, poremećenu spermatogenezu i oksidativna oštećenja spermatozoida. Savremeni pristupi lečenju neplodnosti zahtevaju integraciju metaboličke procene u rutinsku reproduktivnu dijagnostiku i primenu multidisciplinarnih terapijskih strategija. Sveobuhvatnije sagledavanje uticaja metaboličkih poremećaja na reproduktivnu funkciju može omogućiti razvoj ciljanih preventivnih i terapijskih pristupa usmerenih ka očuvanju fertiliteta i poboljšanju reproduktivnih ishoda.

PP21.3. METABOLIC DISORDERS AND INFERTILITY: CURRENT CHALLENGES IN REPRODUCTIVE MEDICINE

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Metabolic health is increasingly recognized as one of the key determinants of reproductive potential in both women and men. The rising prevalence of obesity, insulin resistance, metabolic syndrome, and polycystic ovary syndrome (PCOS) has intensified research into their impact on reproductive health and assisted reproductive technology outcomes. The pathophysiological effects of these metabolic disorders are mediated through a complex interplay of hormonal dysregulation, chronic low-grade inflammation, oxidative stress, and altered adipokine secretion. Obesity has been associated with reduced oocyte and sperm quality, ovulatory dysfunction, impaired endometrial receptivity, and an increased risk of adverse reproductive outcomes. Insulin resistance and the accompanying hyperinsulinemia contribute to disrupted steroidogenesis, hyperandrogenism, and impaired folliculogenesis, while metabolic syndrome further compromises reproductive potential through the combined effects of abdominal obesity, dyslipidemia, and impaired glucose homeostasis. Particular attention has been focused on PCOS, a heterogeneous endocrine–metabolic disorder that integrates reproductive, metabolic, and inflammatory abnormalities and represents the leading cause of anovulatory infertility. Metabolic disorders affect not only female reproductive function but may also impair male fertility through alterations in hormonal regulation, disrupted spermatogenesis, and increased oxidative damage to spermatozoa. Contemporary approaches to infertility management require the integration of metabolic assessment into routine reproductive evaluation and the implementation of multidisciplinary therapeutic strategies. A more comprehensive understanding of the impact of metabolic disorders on reproductive function may facilitate the development of targeted preventive and therapeutic interventions aimed at preserving fertility and improving reproductive outcomes.

PP21.4. OD DOKAZA DO PRAKSE: FARMACEUTSKE STRATEGIJE ZA BEZBEDNU UPOTREBU LEKOVA U TRUDNOĆI I DOJENJU

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Zbog nedovoljne informisanosti o bezbednoj primeni lekova i stalnog pada stope dojenja, odgovarajuća farmakoterapija trudnica i dojilja, kao i podrška dojenju postali su javnozdravstveni prioritet. Mnoge žene odlučuju da izbegnu neophodno lečenje ili prekinu dojenje zbog neopravdanog straha od potencijalne štetnosti po plod ili odojče, što može imati negativne posledice po zdravstvene ishode majke i deteta. Kao odgovor na to, projekat "*Mama Friendly* Apoteka"- za bezbednu primenu lekova u toku dojenja – Vaš farmaceut", koji su podržalo Ministarstvo zdravlja Republike Srbije i UNICEF (2022–2023), a potom i Erasmus+ program „Apoteka – prijatelj zdravog potomstva" (2023–2025), imali su za cilj da osnaže farmaceute kao najdostupnije zdravstvene radnike sposobne da pruže uputstva zasnovana na dokazima ovim osetljivim populacionim grupama.

Kratkoročni ciljevi projekata bili su fokusirani na edukaciju farmaceuta o posebnim zdravstvenim potrebama trudnica i dojilja, kao i na pružanje direktne edukacije pacijentkinjama o bezbednoj upotrebi lekova i dodataka ishrani. Ključna strategija uključivala je promociju Nacionalnih smernica za primenu lekova u periodu dojenja, kao resursa od nacionalnog značaja pri Ministarstvu zdravlja. Dugoročni ciljevi inicijativa uključuju povećanje stope dojenja, unapređenje zdravstvenog potencijala budućih generacija i poboljšanje informisanosti o samolečenju tokom trudnoće i dojenja. Integracijom farmaceutske zdravstvene zaštite i stručnih resursa, osigurava se da trudnice i dojilje dobiju neophodnu podršku unutar zdravstvenog sistema, čime se poboljšavaju dugoročni zdravstveni ishodi i za majku i za dete. Tokom trajanja projekta, farmaceuti su pružili i dokumentovali savetovanje za 145 trudnica i 1243 dojilja.

Zahvalnica

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PP21.4. FROM EVIDENCE TO PRACTICE: PHARMACEUTICAL STRATEGIES FOR ENSURING SAFE MEDICATION USE IN PREGNANCY AND BREASTFEEDING

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Due to insufficient information regarding safe medication use and continuous decline in breastfeeding rates, supporting breastfeeding and appropriate pharmacotherapy for pregnant and lactating women has become a public health priority. Many women choose to avoid essential treatment or discontinue breastfeeding due to an unjustified fear of potential harm to the infant. In response, the project "Mama Friendly Pharmacy" supported by the Ministry of Health of the Republic of Serbia and UNICEF (2022-2023), followed by Erasmus+ program "Pharmacy – A Friend of Healthy Offspring" (2023-2025), aimed to empower pharmacists as the most accessible healthcare providers capable of offering evidence-based guidance to these sensitive populations. The projects' short-term objectives focus on educating pharmacists about the special health needs of pregnant and lactating women, as well as providing direct education to patients on the safe use of medications and dietary supplements. A key strategy involved promoting the National Guidelines for Medication Use During Breastfeeding, an official national resource developed under the auspices of the Ministry of Health.

The long-term goals of the initiative include increasing breastfeeding rates, enhancing the health potential of future generations, and improving overall awareness regarding self-medication during pregnancy and lactation. By integrating pharmaceutical care and professional resources, the project ensures that pregnant and lactating women receive essential support within the healthcare system, ultimately improving long-term health outcomes for both mother and child. During the project duration , pharmacists provided and documented counseling for 145 pregnant women and 1243 breastfeeding mothers.

Acknowledgement

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Sesija 22
Session 22

Zdravo starenje i dugovečnost: savremeni pristupi i uloga farmaceuta

Healthy aging and longevity: Contemporary approaches and the role of pharmacists

Zdravo starenje i dugovečnost: savremeni pristupi i uloga farmaceuta

Zdravo starenje i dugovečnost predstavljaju savremene koncepte usmerene na očuvanje funkcionalnih sposobnosti, kvaliteta života i produženje životnog veka uz smanjenje rizika od hroničnih bolesti. U okviru ove sesije predstavljeni su savremeni pristupi unapređenju zdravog starenja i dugovečnosti, uključujući značaj pravilne ishrane i povezanost crevne mikrobiote i procesa starenja. Posebna pažnja je posvećena sve značajnijoj ulozi farmaceuta u promociji zdravog načina života, podršci informisanom izboru i savetovanju zasnovanom na dokazima o racionalnoj i bezbednoj upotrebi dijetetskih suplemenata i kozmetičkih proizvoda u cilju očuvanja vitalnosti i dugovečnosti.

Healthy aging and longevity: Contemporary approaches and the role of pharmacists

Healthy aging and longevity are modern concepts aimed at preserving functional abilities and quality of life, extending lifespan, and reducing the risk of chronic diseases. This session explores contemporary approaches to supporting healthy aging and longevity, including relevant nutritional strategies, and the molecular mechanisms linking gut microbiota to aging. Particular attention is given to the evolving role of pharmacists in promoting healthy lifestyles, supporting informed choices and providing evidence-based counselling on the rational and safe use of dietary supplements and cosmetic products to support vitality and longevity.

PP22.1. NUTRITIONAL STRATEGIES FOR ENHANCING LONGEVITY AND HEALTHY AGING

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Aging is the progressive deterioration of biological functions; through cumulative mechanisms, molecular, cellular and tissue functionalities are lost at the same time and the risk of death increases. The rate of aging varies between species, among individuals within a species and, even within an individual, across different organs and cells. Aging has been presented through four theories: (1) Theory of programmed or genetic aging. (2) Theory of natural wear and tear. (3) Theory of immunological senescence. (4) Theory of cumulative damage, mitochondrial or oxidative stress or free radicals. All of them could be nutritionally covered.

The nutritional needs of older adults must cover not only their baseline energy expenditure but also the energy demands associated with their physical activity levels or any underlying physiological or medical conditions. Dietary strategies for older adults focus on ensuring the intake of high-quality nutrients without excessive calories, modifying food textures to facilitate chewing and digestion, preventing malnutrition and dehydration, and maintaining muscle mass to avoid both obesity and sarcopenia.

This talk outlines recommended nutrient and food intakes to help older adults enjoy a healthy diet that enhances their quality of life and reduces the risk of serious cardiovascular and metabolic diseases; it also addresses the weaknesses, threats, strengths, and opportunities associated with nutrition in this population. Finally, it shows nutritional and dietary recommendations, the factors that need dietary adaptations for this group, and a ten-point guide to healthy eating and nutrition for older adults.

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PP22.2. ULOGA MIKROBIOTE CREVA U PROCESU STARENJA: MOLEKULARNI MEHANIZMI I POTENCIJALNE INTERVENCIJE

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Starenje je kompleksan biološki proces praćen progresivnim promenama u metabolizmu, imunskom odgovoru, funkciji nervnog sistema i homeostazi u crevima. Sve više dokaza ukazuje da mikrobiota creva predstavlja važan modulator ovih procesa, ne samo kroz promene u svom sastavu, već i putem bioaktivnih molekula koje proizvode njeni članovi. Promene mikrobiote creva tokom starenja često uključuju pad raznovrsnosti mikroorganizama, dok je kod stogodišnjaka opisana povećana zastupljenost pojedinih korisnih bakterija, uključujući laktobacile i mikroorganizme sposobne za metabolizam žučnih kiselina.

Određene bakterije mikrobiote creva, uključujući vrste *Lactobacillus plantarum*, *Phocaeicola vulgatus*, *Ruminococcoides intestinale* i *Blautia fusiformis*, pokazuju potencijal da utiču na dugovečnost i očuvanje funkcionalnog integriteta domaćina. Njihovi efekti mogu biti posredovani različitim bakterijskim produktima, među kojima se izdvajaju egzopolisaharidi, GABA i drugi neuroaktivni metaboliti, uključujući holat i nikotinat. Eksperimentalni modeli fiziološkog starenja i neurodegeneracije u nematodi *Caenorhabditis elegans* pokazuju da ovakvi mikrobni signali mogu produžiti životni vek, očuvati fiziološke i kognitivne funkcije i aktivirati više evolutivno konzervisanih puteva domaćina. Među njima se izdvajaju NHR-49/PPARα–FMO-2/FMO5 signalizacija, HLH-30/TFEB-zavisna autofagija, putevi odgovora na nepravilno savijene proteine, kao i GABAergička signalizacija. U eksperimentalnom modelu Alchajmerove bolesti zasnovanom na tauopatiji kod *C. elegans*, aktivacija pojedinih programa poput autofagije povezana je i sa očuvanjem asocijativnog učenja, ukazujući na moguću funkcionalnu vezu između mikrobiote, starenja i neurodegeneracije.

Razumevanje specifičnih mikrobnih molekula i puteva domaćina koje oni regulišu otvara mogućnost razvoja ciljano odabranih probiotika, postbiotika i bakterijskih metabolita kao novih strategija za promociju zdravog starenja.

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PP22.2. THE ROLE OF GUT MICROBIOTA IN AGING: MOLECULAR MECHANISMS AND THERAPEUTIC INTERVENTIONS

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Aging is a complex biological process accompanied by progressive changes in metabolism, immune responses, nervous system function, and intestinal homeostasis. Growing evidence indicates that the gut microbiota is an important modulator of these processes, not only through changes in its composition but also through bioactive molecules produced by its members. Age-associated alterations in the gut microbiota often include a decline in microbial diversity, whereas centenarians have been reported to display an increased abundance of certain beneficial bacteria, including lactobacilli and microorganisms capable of bile acid metabolism.

Certain gut microbiota members, including *Lactobacillus plantarum*, *Phocaeicola vulgatus*, *Ruminococcoides intestinale*, and *Blautia fusiformis*, have the potential to influence longevity and preserve host functional integrity. Their effects may be mediated by various bacterial products, including exopolysaccharides, GABA, and other neuroactive metabolites such as cholate and nicotinate. Experimental models of physiological aging and neurodegeneration in the nematode *Caenorhabditis elegans* show that such microbial signals can extend lifespan, preserve physiological and cognitive functions, and activate multiple evolutionarily conserved host pathways. These include NHR-49/PPARα–FMO-2/FMO5 signaling, HLH-30/TFEB-dependent autophagy, the unfolded protein response, and GABAergic signaling. In an experimental *C. elegans* model of Alzheimer's disease based on tauopathy, activation of specific cellular programs, including autophagy, was also associated with preservation of associative learning, supporting a potential functional link between the gut microbiota, aging, and neurodegeneration.

Understanding the specific microbial molecules and host pathways they regulate may enable the development of targeted probiotics, postbiotics, and bacterial metabolites as novel strategies to promote healthy aging.

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PP22.3. SUPLEMENTACIJA ZA VITALNOST I DUGOVEČNOST: TREND ILI POTREBA?

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Poslednjih godina koncept zdravog starenja sve se više pomera od tradicionalnog pristupa usmerenog na usporavanje procesa starenja ka produženju perioda života provedenog u dobrom zdravlju. Ovaj trend praćen je rastućim interesovanjem potrošača za suplementaciju koja bi, osim zadovoljavanja nutritivnih potreba, mogla doprineti očuvanju kognitivnih sposobnosti, metaboličkih i imunskih funkcija, mišićne mase, funkcionalnog kapaciteta i kvaliteta života tokom starenja. U tom kontekstu, adekvatan unos proteina, vitamina, minerala i omega-3 masnih kiselina dobija sve veći značaj. Posebnu pažnju privlače i prekursori NAD+, poput nikotinamid ribozida i nikotinamid mononukleotida, koenzim Q10, urolitin A, spermidin, kreatin, kurkumin, resveratrol i drugi bioaktivni sastojci koji potencijalno mogu uticati na oksidativni stres, inflamaciju, mitohondrijalnu disfunkciju i ćelijsku senescenciju. Međutim, rastuća popularnost dijetetskih suplemenata nameće pitanje opravdanosti njihove primene, odnosno da li ona odražava stvarne potrebe ili pre svega trend usmeren na očuvanje vitalnosti. Za mnoge nenutritivne bioaktivne sastojke još uvek ne postoje dovoljno snažni klinički dokazi koji bi opravdali njihovu rutinsku primenu. Biološka aktivnost pojedinih sastojaka i obećavajući rezultati pretkliničkih istraživanja zahtevaju potvrdu u dobro dizajniranim kliničkim studijama, uz procenu dugoročne efikasnosti i bezbednosti. Takođe, buduća istraživanja treba da definišu optimalne režime doziranja i ispitaju efikasnost i bezbednost upotrebe kombinacija različitih bioaktivnih sastojaka. Stoga suplementaciju usmerenu na očuvanje vitalnosti i dugovečnosti treba procenjivati na osnovu kvaliteta naučnih dokaza, bezbednosti i individualnih potreba, pri čemu ona treba da predstavlja dopunu, a ne zamenu za zdrave životne navike, uključujući uravnoteženu ishranu i redovnu fizičku aktivnost.

PP22.3. DIETARY SUPPLEMENTATION FOR VITALITY AND LONGEVITY: TREND OR NECESSITY?

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In recent years, the concept of healthy aging has increasingly shifted from the traditional approach of slowing the aging process to extending the period of life spent in good health. This trend has been accompanied by growing consumer interest in supplements that, beyond meeting nutritional needs, could help preserve cognitive abilities, metabolic and immune function, muscle mass, functional capacity, and quality of life during aging. In this context, adequate intake of protein, vitamins, minerals, and omega-3 fatty acids is increasingly important. Particular attention is also focused on NAD+ precursors, such as nicotinamide riboside and nicotinamide mononucleotide, coenzyme Q10, urolithin A, spermidine, creatine, curcumin, resveratrol, and other bioactive compounds that may potentially influence oxidative stress, inflammation, mitochondrial dysfunction, and cellular senescence. However, the growing popularity of dietary supplements raises questions about the rationality of their use and whether it reflects actual needs or primarily a trend focused on maintaining vitality. For many non-nutritional bioactive compounds, clinical evidence remains insufficient to justify routine use. The biological activity of individual compounds and promising preclinical findings require confirmation in well-designed clinical trials, along with assessment of long-term efficacy and safety. Future research should also define optimal dosing regimens and investigate the efficacy and safety of combining different bioactive compounds. Therefore, supplementation for vitality and longevity should be evaluated based on the quality of scientific evidence, safety, and individual needs, as part of a healthy lifestyle that includes a balanced diet and regular physical activity.

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PP22.4. DOPRINOS SAVREMENE KOZMETOLOGIJE UNAPREĐENJU ZDRAVOG ŽIVOTNOG VEKA

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Savremena kozmetologija prolazi kroz duboku transformaciju. Nekada dominantan fokus na estetsku korekciju se zamenjuje holističkim pristupom koji kožu posmatra kao aktivan, funkcionalan organ povezan sa opštim zdravljem, emocionalnim stanjem i biološkom ravnotežom organizma. Ova promena prati šire biomedicinske paradigme koje naglašavaju očuvanje zdravog životnog veka (*healthspan*) umesto samo produžavanja životnog veka (*lifespan*). Napredak u biomedicinskim istraživanjima, kao što su kontrola zaraznih bolesti, napredak u medicinskoj tehnologiji, istraživanje genetike i razumevanje načina života, značajno su povećali očekivani životni vek i poboljšali kvalitet života starijih osoba. Ključne oblasti istraživanja u kozmetologiji obuhvataju funkciju zaštitne barijere kože, istraživanje kolagena i elastina, oksidativni stres, foto starenje, inflamaging, mikrobiom kože, neurokozmetiku i regenerativne pristupe. Kozmetički proizvodi danas se smatraju bitnim za dugovečnost kože kroz očuvanje njene funkcionalnosti i otpornosti. Održavanje zdravlja kože uključuje smanjenje oksidativnog stresa, prevenciju foto starenja, modifikaciju inflamaginga i podršku mikrobiomu. Sve ove prakse doprinose ne samo estetskom izgledu, već i opštem blagostanju, emocionalnoj stabilnosti i kvalitetu života starijih osoba. S obzirom na sve veće preklapanje između kozmetologije i drugih oblasti zdravstva, moderni pristupi kombinuju znanja dermatologije, psihodermatologije, ishrane i regenerativne medicine, naglašavajući važnost holističkog pristupa zdravlju i dugovečnosti.

PP22.4. THE CONTRIBUTION OF MODERN COSMETOLOGY TO THE IMPROVEMENT OF A HEALTHY LIFESPAN

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Modern cosmetology is undergoing a profound transformation. The once dominant focus on aesthetic correction is being replaced by a holistic approach that views the skin as an active, functional organ connected to overall health, emotional state and the biological balance of the organism. This shift follows broader biomedical paradigms that emphasize the preservation of healthspan rather than merely extending lifespan. Advances in biomedical research, such as the control of infectious diseases, progress in medical technology, research in genetics, and a better understanding of lifestyle factors, have significantly increased life expectancy and improved the quality of life of older adults. Key research areas in cosmetology include skin barrier function, collagen and elastin research, oxidative stress, photoaging, inflammaging, the skin microbiome, neurocosmetics and regenerative approaches. Today, cosmetic products are considered essential for skin longevity through the preservation of its functionality and resilience. Maintaining skin health involves reducing oxidative stress, preventing photoaging, modulating inflammaging, and supporting the skin microbiome. All of these practices contribute not only to aesthetic appearance but also to overall well-being, emotional stability, and the quality of life of older individuals. Given the increasing overlap between cosmetology and other health-related fields, modern approaches integrate knowledge from dermatology, psychodermatology, nutrition and regenerative medicine, emphasizing the importance of a holistic approach to health and longevity.

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Sesija 23
Session 23

Profesionalni razvoj farmaceuta:
od profesionalizma do globalnih prioriteta

Professional development for pharmacists:
from professionalism to global priorities

Profesionalni razvoj farmaceuta: od profesionalizma do globalnih prioriteta

U okviru sesije biće obrađena dva aspekta jačanja profesije, kroz istorijski značaj i doprinos farmaceuta u izazovnim vremenima, od primera koji su pokazale kolege u Turskoj tokom velikog zemljotresa 2023. godine organizujući se u vanrednim uslovima kako bi podržali svoj narod i obezbedili farmaceutsku zdravstvenu zaštitu, do kolega iz nešto ranije prošlosti koji su potekli, radili i delovali u Srbiji i van granica naše zemlje pomažući i podržavajući svoj narod na različite načine, kao aktivni i istaknuti članovi društva.

Tema sesije je i značaj profesionalizma i mentorstva za kontinuirani profesionalni razvoj farmaceuta i unapređenje profesije, kao i globalni prioriteti profesionalnog razvoja farmaceuta iz ugla Međunarodne farmaceutske federacije (FIP).

Professional development for pharmacists: from professionalism to global priorities

The session will cover two aspects of profession empowerment, highlighting historical importance and vital contributions of pharmacists in challenging times, from the efforts of colleagues in Turkey during the great earthquake of 2023 who organized themselves in emergency conditions to support their people and provide pharmaceutical care, to our colleagues from a slightly earlier past who practiced and served in Serbia and abroad, helping and supporting our people in various ways, as active and prominent members of the society.

The session topic also includes the importance of professionalism and mentoring for continuing professional development of pharmacists and growth of the profession, as well as the global priorities of pharmacists' professional development from the perspective of the International Pharmaceutical Federation (FIP).

PP23.1. PHARMACISTS IN TIMES OF CRISIS: HISTORICAL PERSPECTIVES AND PROFESSIONAL LESSONS FROM THE EARTHQUAKES OF 6 FEBRUARY 2023 IN TÜRKİYE

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Crises have repeatedly reshaped the scope of pharmacy practice by requiring pharmacists to assume expanded responsibilities in the supply of medicines, public-health communication, interprofessional coordination, and continuity of care. This lecture adopts a historical perspective as a framework for understanding professional learning in crisis contexts with particular reference to the earthquakes of 6 February 2023 in southern and southeastern Türkiye. Rather than treating history as background alone, it uses selected crisis episodes to identify recurring patterns in pharmacists' responsibilities under conditions of disruption. The two major earthquakes, measuring Mw 7.8 and Mw 7.5, affected 11 provinces in Türkiye, caused more than 50,000 deaths, and severely disrupted healthcare services. According to the Turkish Pharmacists' Association, 44 pharmacists and 21 pharmacy students lost their lives, and approximately 1,200 community pharmacies were destroyed or rendered non-operational. Pharmacy services were sustained through volunteer mobilization and the establishment of 26 temporary pharmacies, including one mobile unit. These human and institutional losses also show why pharmacists' field-based adaptations should be documented and incorporated into disaster-healthcare history and professional learning. By examining this experience, the lecture highlights how emergency pharmacy practice can inform competency-based continuing professional development in disaster preparedness, emergency medicine supply, interprofessional coordination, risk communication, ethical decision-making, and professional resilience. Such an approach may help transform crisis experience into structured professional learning and offer transferable lessons for pharmacy practice in Europe and beyond.

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PP23.2. FARMACEUTI U VREME IZAZOVA: ISTAKNUTI POJEDINCI U SRBIJI

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Istorija farmacije u Srbiji svedoči da se uloga farmaceuta u kriznim vremenima nije ograničavala na obezbeđivanje lekova i zdravstvene zaštite. U ratovima, epidemijama i društvenim previranjima pojedinci su svojim profesionalnim, naučnim i humanitarnim delovanjem potvrđivali širu društvenu odgovornost profesije.

Cilj rada je da se kroz odabrane biografske primere prikaže doprinos pojedinaca razvoju farmacije i očuvanju javnog zdravlja, uz ukazivanje na značaj stručnosti, lične etike i građanske odgovornosti u vremenu velikih izazova.

Analizirani su dostupni istorijski i arhivski izvori, literatura iz oblasti istorije farmacije i dokumentovana svedočanstva o delovanju istaknutih farmaceuta i stručnjaka povezanih sa farmaceutskom delatnošću.

Posebno mesto zauzima Svetolik Trajković, beogradski apotekar koji je, zajedno sa porodicom, pomagao partizanski pokret lekovima i sanitetskim materijalom. Porodica je uhapšena, a Svetolik, supruga i deca, stradali su 9. maja 1942. godine. Marko Stojanović, poslednji vlasnik obrenovačke apoteke i učesnik oba svetska rata, tokom Drugog svetskog rata biva uhapšen i odveden u nemački logor. Svojim testamentom ostavio je fond za nagrađivanje radova iz istorije farmacije. Mateja Ivanović i njegov brat pripadaju pionirima farmaceutske delatnosti i učesnicima u suzbijanju kolera, dok primer Milana Uskokovića, organskog hemičara, ukazuje na značaj interdisciplinarnog doprinosa razvoju svetske farmacije.

Navedeni primeri potvrđuju zajednički princip – znanje u službi čoveka – i pokazuju da je istorija farmacije istovremeno istorija stručnosti, odgovornosti, solidarnosti i hrabrosti.

PP23.2. PHARMACISTS IN CHALLENGING TIMES: PROMINENT INDIVIDUALS IN SERBIA

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The history of pharmacy in Serbia demonstrates that the role of pharmacists in times of crisis extended beyond the provision of medicines and healthcare. During wars, epidemics, and social upheaval, individuals demonstrated the broader social responsibility of the profession through professional, scientific, and humanitarian activities.

This paper aims to illustrate, through selected biographical examples, the contribution of individuals to the development of pharmacy and the preservation of public health, emphasizing the importance of professional expertise, personal ethics, and civic responsibility in times of crisis.

The analysis is based on historical and archival sources, literature on the history of pharmacy, and documented accounts of prominent pharmacists and professionals associated with the pharmaceutical field.

Svetolik Trajković, a Belgrade pharmacist, supported the Partisan movement with medicines and medical supplies. He and his family were arrested, and Svetolik, his wife, and their children were killed on 9 May 1942. Marko Stojanović, the last owner of a pharmacy in Obrenovac and a participant in both World Wars, was arrested during the Second World War and deported to a German concentration camp. His will established a fund for scholarly works in the history of pharmacy. Mateja Ivanović and his brother were pioneers of pharmaceutical practice in Serbia and contributed to efforts to combat cholera. Organic chemist Milan Uskoković exemplifies the importance of interdisciplinary contributions to global pharmacy.

These examples embody a common principle—knowledge in the service of humanity—and demonstrate that the history of pharmacy is also a history of expertise, responsibility, solidarity, and courage.

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PP23.3. MESTO I ULOGA PROFESIONALIZMA U KONTINUIRANOM PROFESIONALNOM RAZVOJU FARMACEUTA

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Postoji prilično obimna literatura sa definicijama profesionalizma u farmaciji, ali ne i „prihvaćena" definicija, jer je to aktivan, višedimenzioni koncept kontinuiranog razvoja. U ovom radu prihvatili smo polazište *Dane Hammer* (2000) koja definiše „Profesionalizam po načinu na koji se pokazuje u praksi, po njegovim strukturnim elementima, po stavovima koji imaju oni u profesiji ili na osnovu vrednosti."

Naš cilj je da analiziramo niz elemenata koji su potrebni da bi se farmaceut ponašao profesionalno, koristeći metod narativnog pregleda literature. Sličnosti i razlike u različitim crtama profesionalizma predstavljene su kroz dublju analizu profesionalnog identiteta. Dva glavna teorijska okvira, „kišobran model profesionalizma" i „model biciklističkog točka" poznati su kao prikladni za procenu profesionalizma u farmaceutskoj praksi kroz ponašanje. Profesionalizam je neophodno razvijati kroz sistem obrazovanja farmaceuta i već na samom početku kontinuiranog profesionalnog razvoja. S obzirom na brojne i raznovrsne aspekte koncepta profesionalizma, važno je istaknuti one aspekte koji su suštinski. Analiziraćemo osnovna prihvatljiva ponašanja i poželjne kompetencije u profesiji (autonomno ponašanje, donošenje kliničkih odluka, ponašanje usmereno na pacijenta…). Jedan od puteva ka profesionalizmu uključuje i mentorsku podršku koju iskusnije kolege pružaju manje iskusnim, a kroz prenos specifičnih znanja, veština i stavova, pružajući podršku u razvoju manje iskusnog kolege, istovremeno unapređujući sebe. Perspektive i prioriteti koje definišu globani autoriteti poput *FIP*-a, u domenu profesionalizma i profesionalnog razvoja farmaceuta od strateškog su značaja, te je neophodno pažljivo ih slediti.

Potrebna su dalja istraživanja na ovu temu kako bi se uloge farmaceuta stavile u kontekst profesionalnog razvoja koji se veoma brzo menja.

Zahvalnica

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PP23.3. THE PLACE AND ROLE OF PROFESSIONALISM IN THE CONTINUOUS PROFESSIONAL DEVELOPMENT OF PHARMACISTS

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There is a rather extensive literature on definitions of professionalism in pharmacy, but not an "accepted" one, as it is an active, multi-domain concept of continuous development. We adopted Dana Hammers' (2000) position that: "Professionalism can be defined by the way it is demonstrated in practice, by its structural items, by the views held by those in the profession or in a values-based manner".

The aim was to analyze a range of elements needed to become professional pharmacist, using method of narrative literature review. Similarities and differences in several traits of professionalism are represented by in-depth analysis of professional identity. Two main theoretical frameworks, "umbrella model" and "the bicycle wheel model" are identified as suitable for assessment of professionalism in pharmacy practice through behaviors. Professionalism needs to be taught as part of pharmacy education from the very begging of the continuous professional development. Given the substantial multifaceted aspects of the concept, there is a need to point out those aspects that are essential. We completed a list of profession's behaviors and competences (autonomous behavior, clinical-decision making, patient-focused behavior…). One of the paths to professionalism includes mentoring support and transfer of specific knowledge, skills and attitudes contributing to the development of both mentor and mentee. Perspectives and priorities defined by global authorities such as FIP, in the domain of professionalism and professional development of pharmacists, are of strategic importance, and it is necessary to carefully follow them.

Further research is needed to place pharmacists' roles in the scope of professional development which evolves very fast.

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Sesija 24
Session 24

Inovativni terapijski sistemi: istraživanja koja pokreću promene

Drug delivery innovation: Research driving change

Inovativni terapijski sistemi: istraživanja koja pokreću promene

Intenzivna istraživanja u oblasti inovativnih terapijskih sistema dovode do promena u razvoju lekova kojima se, kroz poboljšanu bioraspoloživost, smanjenje rizika od neželjenih i toksičnih efekata, unapređenu prihvatljivost za pacijenta i adherenciju, prevazilaze ograničenja konvencionalnih farmaceutskih oblika. Kroz prikaz aktuelnih istraživanja koja obuvataju razvoj nanotehnologija, mikroigle kao nosače lekova, primenu ekscipijenasa sa poboljšanim funkcionalnim osobinama i 3D štampanja, pokazano je kako novi materijali, tehnološka rešenja i napredne strategije doprinose unapređenju biološke raspoloživosti, bezbednosti, ciljne isporuke lekova i personalizacije terapije. Povezujući fundamentalna istraživanja sa inovacijama u oblasti farmaceutske tehnologije, istaknut je značaj naučnoistraživačkog rada kao pokretača promena koje oblikuju lekove budućnosti.

Drug delivery innovation: Research driving change

Innovations in drug delivery are transforming the way medicines are designed, overcoming the limitations of conventional dosage forms through enhanced bioavailability, reduced risks of side effects and toxicity, and improved patient experience and adherence. Innovative approaches based on novel materials and technologies emerging from research in nanotechnology, microneedle-based delivery, enhanced functionality of excipients and 3D printing, are presented demonstrating how novel materials, manufacturing technologies, and advanced delivery strategies address challenges in drug targeting, bioavailability, safety, and personalized therapy. By bridging fundamental research with pharmaceutical innovation, the session highlights the power of research to drive change shaping the medicines of the future.

PP24.1. RAZVOJ RASTVORLJIVIH MIKROIGALA SA LIPID-POLIMER HIBRIDNIM NANOČESTICAMA ZA INTRADERMALNU ISPORUKU NOVIH GABAKINA

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U cilju prevazilaženja izazova u isporuci lekova u mozak uslovljenih prisustvom krvno-moždane barijere, nedavne studije ukazale su na potencijal inovativnog pristupa zasnovanog na retrogradnom transportu nanočestica kroz cervikalne i meningealne limfne sudove nakon supkutane injekcije u predelu vrata. Zahvaljujući jedinstvenim strukturnim i funkcionalnim karakteristikama, lipid-polimer hibridne nanočestice (LPHNPs) izdvojile su se kao perspektivni nosači za ciljanu isporuku u mozak novih modulatora $GABA_A$ receptora (GABAkina), namenjenih ublažavanju poremećaja raspoloženja, anksioznosti i kognitivnih simptoma karakterističnih za različite bolesti mozga. Međutim, imajući u vidu ograničenja povezana sa supkutanom primenom u predelu vrata, rastvorljive mikroigle (MAPs) prepoznate su kao minimalno invazivna platforma za limfotropnu isporuku nanočestica, koja omogućava bolju prihvatljivost od strane pacijenata i eliminiše nastanak oštrog medicinskog otpada. Ipak, efikasnost intradermalne isporuke LPHNPs primenom rastvorljivih MAPs zavisi od brojnih faktora, uključujući osobine nanočestica, sastav mikroigala, procesne parametre i geometriju mikroigala. Dodatno, nakon aplikacije mikroigala, nanočestice moraju da difunduju kroz gusti intersticijalni matriksa dermisa kako bi dospele do limfnih sudova. Prevazilaženje ove prepreke zahteva pažljivu optimizaciju formulacije mikroigala, uključujući inkorporiranje hijaluronidaze radi privremene modulacije ekstracelularnog matriksa i unapređenja pokretljivosti nanočestica. Otuda, razvoj rastvorljivih MAPs sa LPHNPs zahteva sveobuhvatnu procenu kritičnih atributa kvaliteta, uključujući kinetiku rastvaranja, mehaničku čvrstinu, morfologiju mikroigala, sposobnost penetracije kroz kožu i fizičku stabilnost sistema. Kako ovi hibridni sistemi predstavljaju izuzetno specifičnu i kompleksnu platformu za isporuku lekova, intenzivna istraživanja su usmerena i na prilagođavanje postojećih metodologija, kao i na razvoj novih metoda karakterizacije koje bi omogućile pouzdanu procenu kvaliteta, performansi i isporuke LPHNPs u limfni sistem.

Zahvalnica
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PP24.1. DEVELOPMENT OF DISSOLVABLE MICRONEEDLES WITH LIPID–POLYMER HYBRID NANOPARTICLES FOR INTRADERMAL DELIVERY OF NOVEL GABAKINES

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To address the hurdles of brain drug delivery imposed by the blood–brain barrier, recent studies have highlighted a novel nanoparticle-mediated approach that exploits retrograde transport through the cervical and meningeal lymphatic vasculature following subcutaneous injection in the neck region. Owing to their unique structural and functional characteristics, lipid–polymer hybrid nanoparticles (LPHNPs) have emerged as attractive carriers for the targeted brain delivery of novel $GABA_A$ receptor modulators (GABAkines) intended to alleviate mood, anxiety or cognitive symptoms typical for various brain disorders. Given the limitations associated with subcutaneous administration, dissolving microneedle array patches (MAPs) have been recognized as a minimally invasive platform for the lymphotropic delivery of nanoparticles, providing improved patient acceptability and eliminating sharps waste. The successful intradermal delivery of LPHNPs using dissolving MAPs depends on the interplay of multiple factors, including nanoparticle properties, microneedle composition, manufacturing parameters, and array design. Additionally, following microneedle insertion, nanoparticles must diffuse through the dense dermal extracellular matrix to reach lymphatic vessels. Addressing this issue requires careful optimization of the microneedle formulation, including the incorporation of hyaluronidase to transiently modulate the extracellular matrix and enhance nanoparticle mobility. The development of LPHNP-loaded dissolving MAPs therefore requires comprehensive evaluation of critical quality attributes, including dissolution kinetics, mechanical strength, needle morphology, puncture performance, and physical stability. As these hybrid systems represent highly specific and complex drug delivery platform, considerable research efforts have been directed toward adapting existing methodologies and developing novel characterization approaches that enable reliable assessment of the quality, performance, and lymphatic delivery of LPHNPs.

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US24.1. LIMFOTROPNA ISPORUKA GL-II-73 U MOZAK POMOĆU LIPID-POLIMERNIH HIBRIDNIH NANOČESTICA – STUDIJA BIODISTRIBUCIJE

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Retrogradni transport nanočestica putem cervikalnih i meningealnih limfnih sudova može da poboljša njihovu isporuku u mozak. Shodno tome, razvijene su lipid-polimerne hibridne nanočestice (LPHNP) za limfotropnu isporuku GL-II-73, pozitivnog alosternog modulatora α5GABA$_A$ receptora. LPHNP su pripremljene pomoću mikrofluidne tehnologije, korišćenjem PLGA kao polimera, sojinog lecitina i PEG2000-DSPE kao stabilizatora, pri čemu su dobijene Z-ave vrednosti od 85,15 ± 1,32 nm i PDI od 0,15 ± 0,00. U cilju procene uticaja mesta primene, u *in vivo* farmakokinetičkoj studiji na pacovima, LPHNP su primenjene subkutanom injekcijom u vrat ili intraperitonealno. Za procenu doprinosa nanosistema u isporuci lekovite supstance u mozak, korišćen je i rastvor GL-II-73 iste koncentracije kao u LPHNP (1,25 mg/ml). Uzorci krvi, mozga, jetre, slezine, cerebrospinalne tečnosti, vratnih i poplitealnih limfnih čvorova su prikupljeni 0,5, 3, 6, 24 i 48 sati nakon primene i analizirani na sadržaj GL-II-73 i njegovog metabolita MP-III-022. Najveća koncentracija GL-II-73 je primećena u limfnim čvorovima vrata. Veće koncentracije su postignute sa rastvorom, posebno u poplitealnim limfnim čvorovima, plazmi i slezini nakon 0,5 h (t-test, $p<0,05$), što ukazuje da je deo čestica eliminisan pre nego što je dospeo do analiziranih organa. Niže koncentracije MP-III-022 su primećene u svim analiziranim tkivima. Zanimljivo je da su u limfnim čvorovima veće koncentracije MP-III-022 primećene nakon potkožne primene LPHNP u poređenju sa rastvorom. LPHNP obeležene kumarinom-6 su pružile dodatne informacije o distribuciji LPHNP u mozgu. Potrebna su dalja prilagođavanja formulacije kako bi se povećala koncentracija u mozgu i smanjila brza distribucija u periferne organe.

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US24.1. LYMPHOTROPIC DELIVERY OF GL-II-73 TO THE BRAIN USING LIPID-POLYMER HYBRID NANOPARTICLES - BIODISTRIBUTION STUDY

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Retrograde transport of nanoparticles via cervical and meningeal lymphatic vessels was reported to improve their delivery to the brain. Accordingly, lipid-polymer hybrid nanoparticles (LPHNPs) were developed for the lymphotropic delivery of GL-II-73, a positive allosteric modulator of the α5GABAA receptors. LPHNPs were prepared using microfluidic technology with PLGA as polymer, soybean lecithin and PEG2000-DSPE as stabilisers, yielding Z-ave of 85.15 ± 1.32 nm and PDI of 0.15 ± 0.00. To assess the impact of the administration route, in an in vivo pharmacokinetic study in rats, the LPHNP formulation was administered via subcutaneous injection to the neck or intraperitoneally (n=15). To evaluate the contribution of the nanodelivery system, a GL-II-73 solution at the same concentration (1.25 mg/ml) was also used. Samples of blood, brain, liver, spleen, cerebrospinal fluid, neck and popliteal lymph nodes were collected at 0.5, 3, 6, 24, and 48 hours after administration and analysed for the content of GL-II-73 and its metabolite MP-III-022. The highest concentration of GL-II-73 was observed in the neck nodes. Higher concentrations were obtained using the solution, especially in popliteal nodes, plasma and spleen after 0.5 h (t-test, $p<0.05$), indicating some particles were eliminated before reaching the analysed organs. Lower MP-III-022 concentrations were observed in all of the analysed tissues. Interestingly, in the lymphatic nodes, higher concentrations of MP-III-022 were observed after subcutaneous administration of LPHNPs compared to the solution. Coumarin-6-labelled LPHNPs provided additional data regarding brain distribution. Further formulation adjustments are needed to increase brain concentration and decrease rapid distribution to peripheral organs.

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This research was supported by the Science Fund of the Republic of Serbia, grant no. 17811, Development of an innovative platform consisting of lipid-polymer hybrid nanoparticles and microneedles for targeted brain delivery of novel GABAkines favored by reverse transport – MiNe2Brain.

US24.2. PROCENA HEMOKOMPATIBILNOSTI INTRAVENSKIH NANOEMULZIJA NA BAZI FOSFOLIPIDNIH KOMPLEKSA

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Intravenske nanoemulzije na bazi fosfolipidnih kompleksa predstavljaju atraktivnu strategiju za efikasno prekliničko testiranje hidrofobnih lekova kandidata, međutim njihova sudbina *in vivo* i dalje predstavlja značajan izazov. Budući da njihovo kompleksno biološko ponašanje zavisi od sastava formulacije i fizičko-hemijskih karakteristika koje određuju potencijalne interakcije sa proteinima plazme i komponentama krvi, cilj rada bio je da se proceni kompatibilnost lipidnih nanoemulzija na bazi CW-02-79-fosfolipidnih kompleksa sa elementima humane krvi, radi procene njihovog potencijala za intravensku primenu. Nedekorisane i PEGilovane placebo i nanoemulzije na bazi CW-02-79-fosfolipidnih kompleksa koje sadrže *DSPE-PEG2000* sa/bez *DSPE-PEG2000-mannose* pripremljene su metodom tople homogenizacije pod visokim pritiskom. Uticaj na hemolizu eritrocita, agregaciju trombocita i vreme koagulacije ispitan je primenom specifično prilagođenih protokola za lipidne nanoemulzije sa uzorcima krvi zdravih dobrovoljaca (n=3), dok je analiza sprovedena primenom ANOVA testa. Sve formulacije pokazale su prosečnu veličinu kapi <200 nm, PDI<0,25 i zeta potencijal <-30 mV. Pri testiranim koncentracijama (90; 9; 1,8 i 0,36 mg/mL), nanoemulzije ne pokazuju hemolitički potencijal (<2%) niti utiču na vreme koagulacije u odgovoru na induktore koagulacije. PEGilovane nanoemulzije nisu indukovale agregaciju trombocita (<20%), dok su nedekorisane formulacije dovele do umerene agregacije (~25%), što ukazuje na moguće interakcije između membrane trombocita i nanokapi. Interesantno je da dodatak CW-02-79-fosfolipidnog kompleksa nije doveo do interakcija sa eritrocitima, trombocitima i faktorima koagulacije što ukazuje na obećavajuću hematološku inertnost. Sprovedeni testovi ukazuju na dobru podnošljivost intravenskih nanoemulzija, pri čemu dekoracija nanokapi sa PEGilovanim fosfolipidima smanjuje nespecifične interakcije sa elementima humane krvi, što doprinosi njihovoj poboljšanoj hemokompatibilnosti, i ukazuje na potencijal za dalju prekliničku karakterizaciju.

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US24.2. HEMOCOMPATIBILITY ASSESSMENT OF INTRAVENOUS NANOEMULSIONS BASED ON PHOSPHOLIPID COMPLEXES

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Intravenous nanoemulsions based on phospholipid complexes offer an attractive strategy for the preclinical testing of hydrophobic drug candidates; however, their in vivo fate remains a key challenge. Since their biological behavior is governed by formulation composition and physicochemical properties, which may influence potential interactions with plasma proteins and blood components, this study aimed to evaluate the compatibility of lipid nanoemulsions based on CW-02-79-phospholipid complexes with human blood components and thereby assess their suitability for intravenous administration. Undecorated and PEGylated blanks, as well as nanoemulsions based on CW-02-79-phospholipid complexes containing DSPE-PEG2000 with/without DSPE-PEG2000-mannose, were prepared using the hot high-pressure homogenisation method. The effects on hemolysis, platelet aggregation and coagulation time were investigated using specific protocols for lipid nanoemulsions in blood samples collected from healthy human donors (n=3), and data were analyzed by ANOVA. All formulations exhibited a mean droplet size <200 nm, PDI<0.25 and zeta potential <-30 mV. At the tested concentrations (90, 9, 1.8 and 0.36 mg/mL), all nanoemulsions showed negligible hemolytic potential (<2%) and did not affect plasma coagulation in response to coagulation inducers. PEGylated nanoemulsions did not induce platelet aggregation (<20%), whereas undecorated formulations caused moderate aggregation (~25%), indicating possible interactions between the platelet membrane and nanodroplets. Interestingly, incorporation of the CW-02-79-phospholipid complex did not induce interaction with erythrocytes, platelets, or coagulation factors, indicating a promising hematologically inert profile. Overall, the screening assays indicate favorable hemotolerability of intravenous nanoemulsions, while PEGylation improves their hemocompatibility by reducing non-specific interactions with blood components, supporting their potential for further preclinical assessment.

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US24.3. PRIMENA 3D ŠTAMPE U PERSONALIZOVANOJ TERAPIJI: MINI TABLETE SA ZOLPIDEM-TARTARATOM

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Poslednjih godina intenzivno se istražuju mogućnosti izrade lekova zasnovane na principima aditivne proizvodnje, kao i potencijal 3D štampe u personalizovanoj terapiji. Razvoj farmaceutskih oblika, zasnovan na preciznom oblikovanju njihovih strukturnih karakteristika, pruža mogućnost prilagođavanja doze individualnim potrebama pacijenata. Cilj rada bio je ispitivanje potencijala primene 3D štampe u izradi višečestičnih sistema – mini tableta, primenom pristupa zasnovanog na preciznom dizajnu 3D modela i izradi mini tableta u slojevima. Kao model aktivna supstanca odabran je zolpidem-tartarat (ZT).

Pripremljena je formulacija sa 5% m/m ZT, uz dodatak 3% m/m Candurin®Gold Sheen, koji ima ulogu da poboljša apsorptivna svojstva smeše tokom procesa sinterovanja, dok je protočnost smeše unapređena dodatkom 0,5% m/m koloidnog, bezvodnog silicijum-dioksida (Aerosil®). Kao osnovni polimer korišćen je polivinil-alkohol (Parteck® MXP 4-88), koji poseduje termoplastična svojstva pogodna za proces štampe. Primenom tehnike fuzije u sloju praška pomoću laserskog snopa, poznate i kao selektivno lasersko sinterovanje (SLS), uz optimizaciju procesnih parametara, uspešno su izrađene mini-tablete prečnika 3 i 5 mm, i deljine 1, 2, odnosno 3 mm.

Rezultati su pokazali da porastom dimenzija mini tableta dolazi do povećanja količine inkorporiranog ZT, uz istovremeno smanjenje brzine rastvaranja usled smanjenja odnosa površine i zapremine (SA/V). Kod mini tableta debljine 1 mm uočeno je vrlo brzo oslobađanje ZT (>85% u 15 min). Dodatno, DSC i XRPD analize ukazale su da je došlo do amorfizacije ZT tokom procesa sinterovanja. Dobijeni rezultati potvrđuju potencijal 3D štampe u preciznom prilagođavanju doze i profila oslobađanja, uz mogućnost razvoja personalizovanih farmaceutskih oblika, kao i poboljšanja biološke raspoloživosti nisko rastvorljivih supstanci.

Zahvalnica

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US24.3. APPLICATION OF 3D PRINTING IN PERSONALIZED THERAPY: ZOLPIDEM TARTRATE MINI-TABLETS

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In recent years, interest has grown in drug production based on additive manufacturing principles and in exploring the potential of 3D printing for personalised therapy. The development of pharmaceutical dosage forms with precisely designed structural characteristics offers opportunities to adjust doses to individual patient needs. The aim of this study was to investigate the potential of 3D printing for producing multiparticulate systems–mini-tablets – using an approach based on precise 3D model design and layer-by-layer fabrication. Zolpidem tartrate (ZT) was selected as the model active pharmaceutical ingredient.

The formulation contained 5% w/w ZT and 3% w/w Candurin®Gold Sheen to enhance absorptive properties during the sintering process, while flowability was improved by adding 0.5% w/w colloidal anhydrous silicon dioxide (Aerosil®). Polyvinyl alcohol (Parteck®MXP 4-88) was used as the main polymer, providing thermoplastic properties suitable for printing. Mini-tablets with diameters of 3 and 5 mm and heights of 1, 2 and 3 mm were successfully fabricated using selective laser sintering (SLS) after optimisation of the process parameters.

The results showed that increasing mini-tablet dimensions led to higher ZT loading, while the drug release rate decreased due to a reduced surface area-to-volume (SA/V) ratio. The 1 mm high mini-tablets exhibited rapid ZT release (>85% within 15 min). DSC and XRPD analyses confirmed amorphisation of ZT during the sintering process. These findings demonstrate the potential of 3D printing for precise tailoring of dose and release profile, offering new opportunities for the development of personalised dosage forms and improved bioavailability of poorly soluble compounds.

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US24.4. NOVI NOSAČI UNAPREĐENE FUNKCIONALNOSTI KAO OSNOVA ZA RAZVOJ TEČNO-ČVRSTIH SISTEMA SA VELIKIM UDELIMA TEČNOSTI

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Uspešan razvoj tečno-čvrstih sistema zavisi od fizičko-hemijskih karakteristika i adsorpcionog kapaciteta nosača, kao i od karakteristika tečne faze. Cilj ovog ispitivanja bio je da se definiše maksimalna količina hidrofilne, odnosno lipofilne tečne faze koju FujiSil®, novi nosač na bazi silicijum-dioksida, može da adsorbuje uz očuvanje zadovoljavajuće protočnosti i tabletabilnosti tečno-čvrste smeše.

Tečno-čvrste smeše sa rastućim udelom (Lf=0,8-1,6) tečne faze (polietilenglikol 400/trigliceridi srednje dužine lanca) i koloidnim silicijum-dioksidom kao sredstvom za oblaganje (R=10) pripremljene su pomoću tarionika i pistila. Najpre su određene protočnost i Karov indeks, a zatim je izvršeno komprimovanje na laboratorijskom simulatoru kompakcije (pri opterećenju 200–500 kg). Kompaktima je određena zatezna čvrstina.

Protočnost ispitivanih smeša iznosila je 2,02–2,86 g/s i povećavala se sa porastom udela tečnosti. Za sve ispitivane smeše vrednosti Karovog indeksa su bile ispod 21%. Nešto bolja protočna svojstva su uočena kod smeša sa lipofilnom tečom fazom. Tečno-čvrsti kompakti sa polietilenglikolom 400 pokazali su bolja mehanička svojstva (zatezna čvrstina do 4,5 MPa), dostižući vrednosti zatezne čvrstine >1 MPa čak i pri udelu tečne faze preko 59%. Nasuprot tome, najveći udeo triglicerida srednje dužine lanca pri kojem su kompakti posedovali odgovarajuću zateznu čvrstinu iznosio je 56%. Povećanje pritiska kompresije dovelo je do povećanja zatezne čvrstine pri nižim udelima tečnosti, dok je pri udelima tečne faze iznad 52% uticaj pritiska kompresije bio zanemarljiv.

Dobijeni rezultati ukazuju da je FujiSil® dobar kandidat za izradu tečno-čvrstih sistema sa izuzetno visokim udelima i hidrofilne i lipofilne tečne faze, pri čemu je pokazao veći kapacitet adsorpcije za polietilenglikol 400.

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US24.4. NOVEL CARRIERS WITH ENHANCED FUNCTIONALITY AS A PREREQUISITE FOR THE DEVELOPMENT OF LIQUISOLID SYSTEMS WITH HIGH LIQUID LOADS

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Successful development of liquisolid systems depends on the physicochemical characteristics and adsorption capacity of the carrier, as well as properties of liquid phase. The aim of this study was to determine the maximum amount of hydrophilic or lipophilic liquid phase that FujiSil®, new silicon dioxide based carrier, can adsorb while liquisolid mixtures maintain satisfactory flowability and tabletability.

Liquisolid mixtures with increasing content of polyethylene glycol 400 or medium-chain triglycerides (Lf=0.8–1.6) and colloidal silica as coating agent (R=10) were prepared using mortar and pestle. First, flow rates and Carr index were determined, followed by compression on a laboratory compaction simulator at a load of 200–500 kg. Compact tensile strength was then determined.

Flowability of tested mixtures was 2.02-2.86 g/s and increased with higher liquid content. For all tested mixtures, Carr's index values were below 21%. Slightly better flow properties were observed for mixtures containing a lipophilic liquid phase. Liquisolid compacts with polyethylene glycol 400 exhibited better mechanical properties (tensile strength up to 4.5 MPa), maintaining tensile strength values >1 MPa even at liquid fractions greater than 59%. In contrast, the highest proportion of medium-chain triglycerides at which the compacts maintained adequate tensile strength was 56%. Increasing compression pressure resulted in higher tensile strength at lower liquid fractions, while at fractions above 52%, the effect of compression pressure was negligible.

Results indicate that FujiSil® is a good candidate for producing liquisolid systems with very high contents of both hydrophilic and lipophilic liquids, showing a higher adsorption capacity for polyethylene glycol 400.

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US24.5. PROCENA UTICAJA *IN SITU* FORMIRANIH FILMOVA SA HIPROMELOZOM NA BIOFIZIČKE PARAMETRE KOŽE

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Film-formirajući rastvori (FFR) polimera u smeši isparljivih i neisparljivih rastvarača formiraju tanak polimerni film na površini kože, čime predstavljaju perspektivne inovativne formulacije za topikalnu primenu lekovitih supstanci. Relativno visok sadržaj isparljivog rastvarača (izopropanol, 31–48% m/m) u ispitivanim FFR sa hipromelozom može uticati na funkciju kožne barijere, zbog čega je neophodna procena iritacionog potencijala i kompatibilnosti sa mestom primene. Nakon inicijalnog *in vivo* ispitivanja 24-časovne neokluzivne primene, u ovom radu je procenjen uticaj FFR na biofizičke parametre kože (hidratacija *stratum corneum*-a, transepidermalni gubitak vode (TEGV) i eritema indeks (EI)) pod različitim uslovima izlaganja. Radi ispitivanja kratkoročne kompatibilnosti sa kožom, merenja su sprovedena tokom prisustva filma na koži u trajanju od 1 h nakon aplikacije, kao i 1 h nakon uklanjanja filma. Dodatno, FFR su ispitani pod okluzijom nakon 24 h kako bi se povećala osetljivost za detekciju potencijalnih kožnih reakcija. Tokom kratkotrajnog izlaganja uočen je blagi okluzivni efekat, koji se manifestovao smanjenjem TEGV (25–42%), dok su promene hidratacije pripisane artefaktima merenja. Nakon uklanjanja filma registrovane su blage promene, sa smanjenjem hidratacije i povećanjem TEGV, bez kliničkog značaja, dok je EI ostao nepromenjen. U uslovima 24-časovne okluzije, sve vrednosti biofizičkih parametara ostale su u fiziološkim granicama uprkos uočenom privremenom porastu TEGV. Ovi rezultati, kao i oni dobijeni *in vivo* ispitivanjem nakon 24 h neokluzivne primene, potvrđuju dobru kompatibilnost FFR na bazi hipromeloze sa kožom uprkos relativno visokom sadržaju izopropanola. Sam polimer pokazao je blaga okluzivna svojstva, što predstavlja prednost za efikasno formiranje filma bez značajnog narušavanja funkcije kožne barijere.

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US24.5. EVALUATION OF THE INFLUENCE OF *IN SITU* FORMED HYPROMELLOSE-BASED FILMS ON SKIN BIOPHYSICAL PARAMETERS

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Film-forming solutions (FFSs) of polymers in a mixture of volatile and non-volatile solvents, form a thin polymeric film on the skin surface, representing promising innovative formulations for topical application. The relatively high content of volatile solvent (isopropanol, 31–48% w/w) in the investigated hypromellose-based FFSs may influence skin barrier function, requiring evaluation of potential irritancy and compatibility with the application site. Following an initial *in vivo* study of 24-hour non-occlusive application, this work evaluated the effects of FFSs on skin biophysical parameters (*stratum corneum* hydration (SCH), transepidermal water loss (TEWL), and erythema index (EI)) under different exposure conditions. Short-term compatibility was assessed during 1 h of film presence on the skin after application, as well as 1 hour after film removal. In addition, FFSs were evaluated under occlusion after 24 h to increase sensitivity for detecting potential skin reactions. During short-term exposure, a mild occlusive effect was observed, reflected by reduced TEWL (25–42%), while changes in SCH were attributed to measurement artifacts. After film removal, only minor changes were recorded, including decreased SCH and increased TEWL, without clinical significance, whereas EI remained unchanged. Under 24-hour occlusive conditions, all biophysical parameters remained within physiological ranges despite an observed transient increase in TEWL. These findings, along with those obtained in the *in vivo* study after 24 h of non-occluded application, confirm good skin compatibility of hypromellose-based FFSs despite relatively high isopropanol content. The polymer itself exhibited only mild occlusive properties, which is advantageous for effective film formation without significant barrier disruption.

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PRO24.1. IZAZOVI U LEČENJU HRONIČNIH RANA I RAZVOJ PERSONALIZOVANIH TERAPIJSKIH STRATEGIJA KROZ PROJEKAT CHRONOWOUND

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Hronične rane predstavljaju značajan izazov za savremenu medicinu zbog dugotrajnog procesa zarastanja, narušenog kvaliteta života pacijenata i značajnih troškova zdravstvene zaštite, što zahteva individualizovan pristup zasnovan na unapređenom razumevanju biologije rana. Projekat CHRONOWOUND usmeren je na integraciju kliničkih i eksperimentalnih istraživanja radi unapređenja dijagnostike i lečenja hroničnih rana, oslanjajući se na personalizovan pristup. Analizom faktora rizika i evaluacijom standardnih protokola, projekat omogućava predikciju zarastanja rana pomoću metoda mašinskog učenja. Poseban fokus je na razvoju inovativnih multikomponentnih hidrogelova i testiranju njihove efikasnosti na ćelijskim modelima *in vitro*.

Dosadašnji rezultati pokazuju da kardiovaskularni komorbiditeti, upotreba određenih lekova (poput nesteroidnih antiinflamatornih lekova, antibiotika, oralnih antikoagulanasa), kao i neadekvatna toaleta rana i nepridržavanje propisane terapije, značajno usporavaju proces zarastanja rana, što dodatno naglašava potrebu za primenom individualizovanog pristupa i uvođenjem specifičnih terapijskih modaliteta uz standardnu terapiju.

Primenom *in vitro* ćelijskih modela ispitani su odabrani bioaktivni agensi i formulacije hidrogelova sa antioksidativnim, antiinflamatornim i regenerativnim potencijalom za obradu i tretman rana. Metodama 3D štampe i modelima mašinskog učenja zasnovanih na analizi baze podataka i analizi slika, razvijene su personalizovane obloge za rane, dok su se algoritmi mašinskog učenja pokazali ključnim u proceni karakteristika rana, predikciji toka zarastanja i odabiru terapijskih modaliteta.

Rezultati projekta će značajno doprineti razvoju personalizovanih terapijskih strategija i naprednih sistema za predikciju, kao i za stimulaciju zarastanja hroničnih rana.

Zahvalnica

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PRO24.1. CHALLENGES IN THE TREATMENT OF CHRONIC WOUNDS AND THE DEVELOPMENT OF PERSONALIZED THERAPEUTIC STRATEGIES THROUGH THE CHRONOWOUND PROJECT

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Chronic wounds represent a significant challenge for modern medicine due to the prolonged healing process, impaired patient quality of life, and substantial healthcare costs, demanding an individualized approach based on an advanced understanding of wound biology. The CHRONOWOUND project integrates clinical and experimental research to improve the diagnosis and treatment of chronic wounds through a personalized approach. By analyzing risk factors and evaluating standard protocols, the project enables wound healing prediction using machine learning methods. A special focus is placed on developing innovative multicomponent hydrogels and the evaluation of their efficacy using in vitro cell models.

Current results indicate that cardiovascular comorbidities, the use of certain medications (such as nonsteroidal anti-inflammatory drugs, antibiotics, and oral anticoagulants), as well as inadequate wound care and a lack of patient adherence to prescribed therapy, significantly delay the healing process. This further emphasizes the need for an individualized approach and the introduction of specific therapeutic modalities alongside standard care.

Selected bioactive agents and hydrogel formulations with antioxidant, anti-inflammatory, and regenerative potential for wound management and treatment were evaluated using in vitro cell models. Personalized wound dressings were developed using 3D printing and machine learning data-based and image-based models, while the machine learning algorithms themselves proved to be a key in assessing wound characteristics, predicting the healing trajectory, and selecting therapeutic modalities.

Project outcomes will significantly contribute to the development of personalized therapeutic strategies and advanced systems for the prediction, as well as the stimulation of chronic wound healing.

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Poster sesija 1
Poster session 1

FARMACEUTSKA ZDRAVSTVENA ZAŠTITA
PHARMACEUTICAL CARE

BOLNIČKA FARMACIJA
HOSPITAL PHARMACY

MEDICINSKA BIOHEMIJA
MEDICAL BIOCHEMISTRY

TOKSIKOLOGIJA
TOXICOLOGY

FZZ-P1 POVEZANOST STEPENA ADHERENCE I KONTROLE BOLESTI KOD PACIJENATA SA HRONIČNIM BOLESTIMA U PRIMARNOJ ZDRAVSTVENOJ ZAŠTITI

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Nizak stepen adherence prema propisanoj terapiji predstavlja jedan od glavnih razloga loše kontrole hroničnih bolesti. Cilj istraživanja bio je ispitati stepen adherence pacijenata sa hroničnim bolestima, kao i povezanost adherence sa kontrolom bolesti i dužinom trajanja bolesti. Sprovedeno je prospektivno opservaciono istraživanje u javnoj apoteci, na uzorku od 107 odraslih pacijenata (≥18 godina) sa najmanje jednom hroničnom bolesti i najmanje jednim propisanim lekom u hroničnoj terapiji. Prikupljeni su demografski podaci, podaci o dijagnozama i trajanju bolesti, kao i podaci o adherenci primenom MARS-5 upitnika. Statistička analiza izvršena je u softveru SPSS (ver.28). Prosečna starost pacijenata iznosila je 45,5 ± 15,8 godina (opseg 21–91), a većinu su činile žene (84; 78,5%). Najčešće indikacije bile su hipertenzija (36; 33,6%), dijabetes (13; 12,1%), aritmije (13; 12,1%), insulinska rezistencija (11; 10,3%), Hašimoto tireoiditis (10; 9,3%), hiperlipidemija (6; 5,6%) i anemija (6; 5,6%). Prosečan MARS-5 skor iznosio je 22,1 ± 3,2 (opseg 5-25), pri čemu veća vrednost ukazuje na viši stepen adherence. Pacijenti sa kontrolisanom bolešću imali su statistički značajno viši skor MARS-5 upitnika u odnosu na pacijente bez kontrole bolesti (22,8 vs. 20,6; p=0,016). Nije utvrđena statistički značajna korelacija između skora MARS-5 upitnika i dužine trajanja bolesti (*Spearman*-ov koeficijent korelacije -0,074; p=0,567). Dobijeni rezultati ukazuju na važnu ulogu farmaceuta kao najdostupnijih zdravstvenih profesionalaca, koji mogu značajno doprineti poboljšanju adherence kroz prepoznavanje problema povezanih sa primenom lekova, individualizovano savetovanje i praćenje terapijskih ishoda.

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FZZ-P1 ASSOCIATION BETWEEN MEDICATION ADHERENCE AND DISEASE CONTROL IN PATIENTS WITH CHRONIC DISEASES IN PRIMARY CARE

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Low adherence to prescribed therapy is one of the main reasons for poor control of chronic diseases. The aim of this study was to assess the level of adherence among patients with chronic diseases, as well as to explore the association between adherence, disease control, and disease duration. A prospective observational study was conducted in a community pharmacy in 107 adult patients (≥18 years) with at least one chronic disease and at least one prescribed chronic medication. Demographic data, diagnoses, disease duration, and adherence data were collected using the MARS-5 questionnaire. Statistical analysis was performed using SPSS software (version 28). The mean age of patients was 45.5 ± 15.8 years (range 21–91), and most participants were female (84; 78.5%). The most common indications were hypertension (36; 33.6%), diabetes (13; 12.1%), arrhythmias (13; 12.1%), insulin resistance (11; 10.3%), Hashimoto's thyroiditis (10; 9.3%), hyperlipidemia (6; 5.6%), and anemia (6; 5.6%). The mean MARS-5 score was 22.1 ± 3.2 (range 5–25), where higher values indicate a higher level of adherence. Patients with controlled disease had a statistically significantly higher MARS-5 score compared to patients without disease control (22.8 vs. 20.6; p=0.016). No statistically significant correlation was found between the MARS-5 score and disease duration (Spearman correlation coefficient -0.074; p=0.567). The obtained results highlight the important role of pharmacists as the most accessible healthcare professionals, who can significantly contribute to improving adherence through identification of medication-related problems, individualized patient counseling, and monitoring of therapeutic outcomes.

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FZZ-P2 PROCENA ADHERENCE PACIJENATA OBOLELIH OD DIJABETES MELITUSA PRIMENOM UPITNIKA MARS-5

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Adherenca kod pacijenata obolelih od dijabetesa je važna jer se pravilnom primenom terapije i savetovanjem pacijenata preveniraju komplikacije bolesti i postižu se bolji terapijski ishodi.

Cilj istraživanja bio je procena stepena adherence kod pacijenata obolelih od dijabetesa tokom pružanja farmaceutske zdravstvene zaštite. 30-dnevno istraživanje sprovedeno je u šest apoteka AU „Lilly drogerije" u vidu intervjua, primenom upitnika MARS-5 i dodatnih pitanja otvorenog tipa, prilagođene pacijentima koji primenjuju peroralne hipoglikemike i pacijentima sa insulinskom terapijom.

Dodatna pitanja odnosila su se na pravilnu primenu terapije, kontrolu glikemijskih parametara, krvnog pritiska, lipidnog statusa, načinu ishrane i mogućim komplikacijama dijabetesa. U istraživanju je učestvovalo 50 pacijenata : 25 na oralnoj hipoglikemijskoj terapiji i 25 na insulinu, od toga 64% pacijenata su bili stariji od 65 godina 32% starosti 40-60 godina i 4% starosti 30-40 . Rezultati ukazuju da 14% pacijenata (7) ponekad zaborave da primene lek, 20% pacijenata (10) retko, dok 66% pacijenata (33) nikad ne zaboravlja da primeni lekove. Dozu leka ponekad promeni 15 pacijenata (30%) , retko 7 pacijenta (14%) dok 28 pacijenata (56%) ne menja dozu leka. Polovina ispitanika (25) ne kontroliše redovno HbA1c. Većina pacijenata koristi glukometar, zna da prepozna simptome hiper i hipoglikemije, upoznata je sa hroničnim komplikacijama, kontroliše krvni pritisak i status lipida i sprovodi nefarmakološke mere.

Rezultati ukazuju na visok stepen potrebe za proverom stepena adherence i njenog unapređenja kroz farmaceutsku zdravstvenu zaštitu.

FZZ-P2 ASSESSMENT OF ADHERENCE IN PATIENTS WITH DIABETES MELLITUS USING THE MARS-5 QUESTIONNAIRE

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Medication adherence in patients with diabetes mellitus is essential for preventing disease-related complications and achieving optimal therapeutic outcomes through appropriate pharmacotherapy and patient counseling.

The aim of this study was to assess the level of medication adherence among patients with diabetes mellitus during the provision of pharmaceutical care. A 30-day cross-sectional study was conducted in six community pharmacies of the AU "Lilly Drogerie" pharmacy chain using face-to-face interviews, using the Medication Adherence Report Scale (MARS-5), supplemented with open-ended questions tailored to patients receiving either oral antihyperglycemic or insulin therapy. Additional questions addressed appropriate medication use, glycemic control, blood pressure, lipid monitoring, dietary habits and diabetes-related complications. A total of 50 patients participated, including 25 receiving oral antihyperglycemic agents and 25 treated with insulin. Most participants were older than 65 years (64%), followed by those aged 40–60 years (32%) and 30–40 years (4%). The results showed that 14% of patients (7) occasionally forgot to take their medication, 20%(10) rarely forgot, while 66%(33) reported never forgetting their therapy. Dose modification without professional consultation was reported occasionally by 30% of patients (15), rarely by 14%(7), whereas 56%(28) never changed the prescribed dose.Half of the participants 50%(25) did not undergo regular HbA1c monitoring. Most patients regularly used a glucometer, recognized symptoms of hypo and hyperglycemia, were aware of chronic diabetes complications, monitored blood pressure and lipid levels, and followed recommended non-pharmacological measures.

The results indicate a high degree of need for checking the degree of adherence and its improvement through pharmaceutical health care.

FZZ-P3 PROCENA ADHERENCE ZA TERAPIJU SARTANIMA PRIMENOM *MARS-5* UPITNIKA

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Adherenca kod pacijenata koji u terapiji koriste lek iz grupe sartana je važna jer se pravilnom primenom terapije sprečavaju komplikacije bolesti i postižu se bolji terapijski ishodi. Cilj istraživanja bio je procena adherence kod pacijenata koji u terapiji koriste lek iz grupe sartana i predloži načine za rešavanje i unapređenje adherence. Istraživanje je sprovedeno u vidu intervjua u toku jednog meseca u 4 apoteke, primenom MARS-5 upitnika. U okviru upitnika su dodata i pitanja koja se odnose na pridržavanje pacijenata preporučenim nefarmakološkim merama koje smanjuju ukupan kardiovaskularni rizik. U istraživanju je učestvovalo 50 pacijenata, 22 (44%) muškog pola. Od toga 66% pacijenata starijih od 65 godina, 30% pacijenata 45-65 godina i 4% mlađih od 45 godina. Većina je imala neki od komorbiditeta (80%), a najzastupljenija je bila dislipidemija. Najveći broj ispitanika koristio je valsartan u terapiji (58%). Analizom upitnika 18% pacijenata je imalo stepen adherence 100% za terapiju sartanom. Sumirajući sve odgovore iz upitnika i njihove zastupljenosti (metodom bodovanja odgovora) prosečan procenat adherence za sartane iznosio je 84,8%. Žene su bile adherentnije od muškaraca (86,42% u odnosu na 82,6%). Većina pacijenata je redovno merila krvni pritisak, vodila računa o unosu soli, ograničeno konzumirala alkohol, nisu bili pušači, 50% pacijenata je vodilo računa o telesnoj masi. Većina pacijenata se nije pridržavala preporuka o načinu ishrane i fizičkoj aktivnosti. Rezultati istraživanja ukazuju na to da je stepen adherence kod upotrebe sartana visok ali da postoji potreba da farmaceuti identifikuju pacijente sa niskim stepenom adherence i učestvuju u njenom unapređenju.

FZZ-P3 ASSESSMENT OF ADHERENCE TO SARTAN THERAPY USING THE *MARS-5* QUESTIONNAIRE

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Adherence in patients who use drugs from the sartan group in the treatment is important because the correct use od therapy prevents complications of the disease and achieves better therapeutic outcomes. The aim of the research was to assess adherence in patients who use drugs from sartan group in the treatment and suggestions for solving and improving adherence. The research was conducted in the form of interviews during one month in 4 pharmacies, using the MARS-5 questionnaire. In the questionnaire, questions related to patients' adherence to recommended non-pharmacological measures that reduce overall cardiovascular risk were added. 50 patients participated in the research, 22 (44%) males. Of these, 66%of patients were over 65 years old, 30% of patients were 45-65 years of age, and 4% were under the age of 45 years. Most had comorbidity (80%). The most prevalent was dyslipidemia. The largest number of respodents used valsartan in therapy (58%). Analyzing the questionnaire, 18% of patients were 100% adherent for sartans' therapy. Summarizing all the answers from the questionnaire and their representation (by scoring the answers), the average percentage of adherence for sartans therapy was 84,8%. Women were more adherent than men (86.42% compared to 82.6%). Most patients measured their blood pressure regulary, took care of their salt intake, limited their alcohol consumption, were non-smokers, and 50% of patients took care of their body weight. Most patients do not adhere to recommendations on diet and physical activity. The research results indicate that the level of adherence following sartane treatment is high but there is still the need for pharmacist to indentify a low level of adherence and participate in its improvement.

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FZZ-P4 FARMACEUTSKA INTERVENCIJA NAKON AKUTNOG KORONARNOG SINDROMA: UTICAJ NA STEPEN ADHERENCE I SPROVOĐENJE NEFARMAKOLOŠKIH MERA

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Dokazi iz kliničke prakse u Srbiji o uticaju farmaceutskih intervencija na stepen adherence i sprovođenje nefarmakoloških mera nakon akutnog koronarnog sindroma (AKS) i dalje su ograničeni. Cilj ove studije bio je da se proceni uticaj strukturisane farmaceutske intervencije na stepen adherence i sprovođenje nefarmakoloških mera kod pacijenata nakon AKS. Sprovedena je prospektivna randomizovana interventiona studija na Klinici za kardiologiju Univerzitetskog kliničkog centra Niš. Hospitalizovani pacijenti sa AKS praćeni su tokom 180 dana nakon otpusta iz bolnice. Strukturisana farmaceutska intervencija pružana je eksperimentalnoj grupi, dok je kontrolna grupa dobijala standardnu zdravstvenu negu, bez učešća farmaceuta. Strukturisana farmaceutska intervencija započeta je pre otpusta iz bolnice i uključivala je pregled terapije, identifikaciju problema povezanih sa lekovima, individualizovano savetovanje, pisanu i usmenu edukaciju, kao i telefonsko praćenje nakon 30, 90 i 180 dana. Stepen adherence prema terapiji i sprovođenje nefarmakoloških mera procenjivani su korišćenjem validiranih instrumenata, uz saglasnost autora. U finalnu analizu uključeno je 104 pacijenta (eksperimentalna grupa n=46; kontrolna grupa n=58), među kojima je bilo 70 muškaraca (67,3%) i 34 žene (32,7%). Eksperimentalna grupa pokazala je značajno viši stepen adherence tokom celog perioda praćenja u poređenju sa kontrolnom grupom (p<0,001). Značajna poboljšanja zabeležena su i u fizičkoj aktivnosti, navikama u ishrani, kvalitetu sna i stepenu vakcinacije. Zadovoljstvo pacijenata intervencijom bilo je visoko, pri čemu je većina ispitanika prijavila najviši nivo zadovoljstva. Farmaceutska intervencija značajno je poboljšala stepen adherence i sprovođenje nefarmakoloških mera nakon AKS. Rezultati podržavaju uključivanje farmaceuta u svakodnevnu kliničku praksu u okviru interdisciplinarnog tima za zbrinjavanje pacijenata sa AKS.

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FZZ-P4 PHARMACIST-LED INTERVENTION FOLLOWING ACUTE CORONARY SYNDROME: EFFECTS ON MEDICATION ADHERENCE AND IMPLEMENTATION OF NON-PHARMACOLOGICAL MEASURES

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Evidence on the impact of pharmacist-led interventions on medication adherence and implementation of non-pharmacological measures following acute coronary syndrome (ACS) in Serbia remains limited. This study evaluated the impact of a structured pharmacist-led intervention on medication adherence and implementation of non-pharmacological measures following ACS. A prospective randomized interventional study was conducted at the Cardiology Clinic, University Clinical Center Niš. Patients with ACS were followed for 180 days after hospital discharge. The experimental group received a structured pharmacist-led intervention, while the control group received standard care without pharmacist involvement. The intervention was initiated before hospital discharge and included medication review, identification of drug-related problems, individualized counselling, written and verbal education, and telephone follow-up at 30, 90, and 180 days. Medication adherence and implementation of non-pharmacological measures were assessed using validated instruments with permission from their authors. A total of 104 patients were included in the final analysis (experimental group n=46; control group n=58), of whom 70 were male (67.3%) and 34 female (32.7%). The experimental group demonstrated significantly higher medication adherence throughout the follow-up period compared with the control group (p<0.001). Significant improvements were also observed in physical activity, dietary habits, sleep quality, and vaccination uptake. Patient satisfaction was high, with most participants reporting the highest level of satisfaction. The pharmacist-led intervention significantly improved medication adherence and implementation of non-pharmacological measures following ACS. These findings support the integration of pharmacists into routine clinical practice as part of an interdisciplinary team involved in the care of patients with ACS.

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FZZ-P5 ADHERENCA PACIJENATA SA HRONIČNIM BOLESTIMA – REZULTATI ANKETE U APOTEKAMA AU ALBA GRAECA PHARM

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Adherenca, odnosno pridržavanje propisane farmakoterapije, ključni je faktor u uspešnom lečenju hroničnih bolesti. Apoteke se nalaze na jedinstvenom mestu za prepoznavanje i rešavanje problema niskog stepena adherence. U apotekama AU Alba Graeca pharm sprovedena je anketa među pacijentima koji nisu preuzeli lek na recept, s ciljem identifikacije uzroka ovog ponašanja. Anonimnom anketom obuhvaćeno je 45 ispitanika. Prikupljani su podaci o uzrastu, razlozima za nepreuzimanje leka, učestalosti preskakanja doza, razlozima za neredovnu upotrebu i prijavljivanju neželjenih efekata. Dominirale su dve starosne grupe: 41–65 godina (42,2%) i 65+ godina (40,0%). Najčešći razlog za nepreuzimanje leka bila je postojeća zaliha kod kuće (46,7%), a zatim visoko učešće u ceni (24,4%) i osećaj da terapija trenutno nije potrebna (20,0%). Od ispitanika koji su imali zalihu, 40,0% navelo je da lek ne uzima redovno. Najčešći razlozi za preskakanje doza bili su namerno izostavljanje usled dobrog opšteg stanja (46,2%) i zaboravnost (30,8%). Neželjene efekte kao razlog za nepreuzimanje navelo je 8,9% ispitanika, od kojih je većina ukinula lek bez konsultacije sa zdravstvenim radnikom. Rezultati ukazuju na značajan problem loše adherence uzrokovane subjektivnom procenom stanja zdravlja, zaboravnošću i ekonomskim barijerama. Farmaceuti u apoteci imaju ključnu ulogu u prepoznavanju ovih pacijenata i pružanju ciljane edukacije o važnosti redovnog uzimanja terapije, posebno u starijim uzrasnim grupama.

FZZ-P5 PATIENT ADHERENCE TO CHRONIC THERAPY – SURVEY RESULTS FROM AU ALBA GRAECA PHARM PHARMACIES

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Adherence to prescribed pharmacotherapy is a key factor in the successful management of chronic diseases. Pharmacies are uniquely positioned to identify and address low patient adherence. An anonymous survey was conducted at AU Alba Graeca Pharm pharmacies among patients who had not collected their prescribed medication. This survey aimed to identify the underlying reasons for not collecting medicines. The survey included 45 respondents. Data were collected on age, reasons for not collecting medication, frequency of missed doses, reasons for irregular use, and reporting of adverse effects. Two age groups predominated: 41–65 years (42.2%) and 65+ years (40.0%). The most common reason for not collecting a prescription was having an existing supply at home (46.7%), followed by high co-payment costs (24.4%) and the perception that therapy was not currently needed (20.0%). Among respondents who had a supply at home, 40.0% reported not taking the medication regularly. The most frequent reasons for skipping doses were intentional omission due to feeling well (46.2%) and forgetfulness (30.8%). Adverse effects were cited as the reason for non-collection by 8.9% of respondents, the majority of whom had simply discontinued the medication without consulting a healthcare professional. The results indicate a significant problem of non-adherence driven by subjective health assessment, forgetfulness and economic barriers. Pharmacists play a crucial role in identifying these patients and providing targeted education on the importance of regular medication intake, particularly among older age groups.

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FZZ-P6 IDENTIFIKACIJA PROBLEMA SA UPOTREBOM AGONISTA GLP-1 I GLP-1/GIP RECEPTORA KROZ STANDARDIZOVANU FARMACEUTSKU USLUGU „SAVETNIK ZA NOVOUVEDENI LEK“

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Farmaceutska usluga „Savetnik za novouvedeni lek“ usmerena je na identifikaciju potencijalnih i postojećih problema povezanih sa primenom novouvedenog leka i pružanje strukturiranog savetovanja radi unapređenja adherence i ishoda lečenja. Cilj je bio da se identifikuju problemi sa upotrebom lekova kod pacijenata kojima je prvi put propisan agonista GLP-1 ili GLP-1/GIP receptora (semaglutid, liraglutid, tirzepatid). Istraživanje je sprovedeno u periodu od 01.07.2024. do 01.05.2026. godine u apotekama „29 Novembar“ i „Sopharmacy 05“ u Kragujevcu. Podaci su prikupljani tokom sprovođenja farmaceutske usluge u trajanju od tri meseca po pacijentu. Za identifikaciju problema sa upotrebom lekova korišćena je *PCNE* klasifikacija terapijskih problema, verzija 9. U istraživanje je uključeno 14 pacijenata starosti 40–66 godina. Ukupno je identifikovano 97 problema sa upotrebom lekova. Najčešći su bili gastrointestinalni neželjeni efekti (39%), greške u doziranju i primeni (18%), nepravilna titracija doze (13%), interakcije lekova (12%), problemi sa efikasnošću terapije (10%), izdavanjem lekova (5%) i izborom doze (3%). Farmaceut je samostalno rešio 33 problema (34%), dok su 64 problema (66%) zahtevala intervenciju propisivača. Od njih je prihvaćeno 5 (7,8%), odbijeno 31 (48,4%), dok za 28 (43,8%) ishod nije bio poznat. Svi pacijenti su edukovani o pravilnoj primeni i čuvanju pena, rotaciji mesta primene, titraciji doze i modifikaciji životnih navika. Farmaceuti imaju značajnu ulogu u prepoznavanju i rešavanju problema povezanih sa primenom agonista GLP-1 i GLP-1/GIP receptora. Standardizovana farmaceutska usluga doprinosi bezbednijoj i efikasnijoj primeni ovih lekova.

FZZ-P6 IDENTIFICATION OF DRUG-RELATED PROBLEMS IN PATIENTS INITIATING GLP-1 AND GLP-1/GIP RECEPTOR AGONIST THERAPY THROUGH THE STANDARDIZED PHARMACEUTICAL SERVICE “NEW MEDICINE SERVICE”

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New Medicine Service is aimed at identifying drug-related problems (DRPs) associated with newly prescribed medicines and providing structured pharmacist counselling to improve medication adherence and treatment outcomes. The aim of this study was to identify DRPs in patients who were prescribed a GLP-1 or a dual GLP-1/GIP receptor agonist (semaglutide, liraglutide, tirzepatide) for the first time. The study was conducted between July 1, 2024, and May 1, 2026, in the community pharmacies “29 Novembar” and “Sopharmacy 05” in Kragujevac. Data were collected during the provision of the standardized New Medicine Service, delivered to each patient over a three-month period. DRPs were identified using the PCNE Classification Version 9. A total of 14 patients aged 40–66 years were included. Overall, 97 DRPs were identified. The most frequent problems were gastrointestinal adverse drug reactions (39%), dosing and administration errors (18%), inappropriate dose titration (13%), drug interactions (12%), treatment effectiveness issues (10%), dispensing-related problems (5%), and dose selection problems (3%). Pharmacists independently resolved 33 problems (34%), while 64 problems (66%) required intervention by the prescriber. Of these, 5 interventions (7.8%) were accepted, 31 (48.4%) were rejected, and the outcome of 28 interventions (43.8%) was unknown. All patients received counselling on proper pen use and storage, injection-site rotation, dose titration schedules, and lifestyle modifications. Pharmacists play an important role in the identification and resolution of DRPs associated with GLP-1 and GLP-1/GIP receptor agonists. The standardized New Medicine Service contributes to the safer and more effective use of these medicines.

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FZZ-P7 UNAPREĐENJE ISHODA LEČENJA PACIJENATA SA HIPERTENZIJOM KROZ STANDARDIZOVANO SAVETOVANJE U JAVNOJ APOTECI

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Hipertenzija je vodeći javnozdravstveni izazov gde nizak stepen adherence i nepravilna samokontrola krvnog pritiska utiču na neuspeh terapije. Cilj rada bio je procena uticaja standardizovane usluge „Savetnik za hipertenziju" Farmaceutske komore Srbije na promenu zdravstvenog ponašanja pacijenata. Prospektivna pre-posle analiza sprovedena je na uzorku od 100 pacijenata (53,4±8,3 godine; 51% muškaraca) iz Šapca i okoline. Komorbiditeti su uključivali dislipidemiju (42%), dijabetes tip 2 (24%) i respiratorne bolesti (12%). U terapiji su dominirali ACE inhibitori samostalno ili u kombinacijama (64%) i ARB antagonisti (28%). Implementirani su svi koraciji usluge koji su obuhvatili savetovanje o pravilnoj upotrebi terapije, samokontrolu i tehniku merenja krvnog pritiska, kao i nefarmakološke mere. Intervencija farmaceuta je obuhvatila 20-to minutno savetovanje pacijenta, izradu personalizovanog plana primene lekova, edukaciju o samokontroli i tehnici merenja krvnog pritiska, životnim navikama. Kontrolno savetovanje je sprovedeno nakon 4 nedelje. Pre intervencije, zaboravnost je zabeležena kod 48% pacijenata, samoinicijativno propuštanje lekova kod 34%, nepravilna tehnika merenja krvnog pritiska kod 68%, a neadekvatne životne navike kod 68% pacijenata. Nakon intervencije, kod 84% pacijenata ostvaren je pozitivan pomak u namanje jednom aspektu. Zaboravnost je smanjena na 14% (p<0,01), a samoinicijativno propuštanje doze leka na 6% (p<0,01). Udeo pacijenata sa adekvatnim životnim navikama porastao je sa 32% na 66% (p<0,01). Pravilna tehnika merenja porasla je sa 32% na 78% (p<0,001), a vođenje dnevnika sa 18% na 65% (p<0,001). Krvni pritisak je smanjen za prosečno 6,4/3,8 mmHg (p<0,05). Rezultati ukazuju na potencijalnu korist standardizovane farmaceutske usluge u unapređenju stepena adherence, pravilne samokontrole krvnog pritiska i usvajanja nefarmakoloških mera kod pacijenata sa hipertenzijom, čime se podržava aktivnija uloga farmaceuta u kontroli bolesti.

FZZ-P7 IMPROVING TREATMENT OUTCOMES IN PATIENTS WITH HYPERTENSION THROUGH STANDARDIZED COUNSELING IN A COMMUNITY PHARMACY

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Hypertension remains a major public health challenge, with poor medication adherence and inadequate blood pressure self-monitoring contributing to suboptimal treatment outcomes. This study aimed to evaluate the impact of the standardized pharmaceutical service "Hypertension Counselling" developed by the Pharmaceutical Chamber of Serbia. A prospective pre–post analysis was conducted in 100 patients (mean age 53.4 ± 8.3 years; 51% males) from Šabac and the surrounding area. Comorbidities included dyslipidaemia (42%), type 2 diabetes mellitus (24%), and respiratory diseases (12%). The most frequently prescribed antihypertensive therapies were ACE inhibitors (64%) and ARBs (28%). The service included pharmacist-led counselling on medication use, blood pressure self-monitoring, measurement technique, and lifestyle modifications. The intervention consisted of a 20-minute counselling session, development of an individualized medication-use plan, and education on self-monitoring and healthy lifestyle practices, followed by a 4-week follow-up. At baseline, medication forgetfulness was reported in 48% of patients, intentional medication omission in 34%, incorrect blood pressure measurement technique in 68%, and inadequate lifestyle habits in 68%. After the intervention, 84% of patients improved in at least one assessed parameter. Medication forgetfulness decreased to 14% (p<0.01), and intentional medication omission to 6% (p<0.01). The proportion of patients with adequate lifestyle habits increased from 32% to 66% (p<0.01). Correct blood pressure measurement technique improved from 32% to 78% (p<0.001), and regular blood pressure diary keeping from 18% to 65% (p< .001). Mean blood pressure decreased by 6.4/3.8 mmHg (p<0.05). These findings suggest that standardized pharmaceutical services may support improved medication adherence, self-monitoring practices, and lifestyle modifications, reinforcing the role of pharmacists in hypertension management.

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FZZ-P8 NEVIDLJIVI IZAZOVI U LEČENJU DIJABETESA: ISKUSTVA IZ STANDARDIZOVANE FARMACEUTSKE USLUGE

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Standardizovana farmaceutska usluga za osobe sa dijabetesom, razvijena od strane Farmaceutske komore Srbije, omogućava strukturisanu procenu farmakoterapije, samokontrole bolesti, životnih navika i prevencije komplikacija u uslovima javne apoteke. Analiza najčešćih problema pacijenata sa dijabetesom identifikovanih tokom standardizovane farmaceutske usluge i intervencija sprovedenih od strane farmaceuta savetnika za dijabetes. Sprovedena je studija preseka koja je obuhvatila 172 pacijenta sa dijabetesom uključena u standardizovanu farmaceutsku uslugu koju su sprovodili farmaceuti savetnici za dijabetes. Usluga je obuhvatala četiri strukturisana savetovanja realizovana u mesečnim intervalima tokom četiri meseca. Tokom svakog koraka evidentirani su identifikovani problemi i sprovedene intervencije, dok je zadovoljstvo uslugom procenjeno po završetku usluge. Kod 172 pacijenta identifikovano je ukupno 765 problema (u proseku 4,4 po pacijentu) i sprovedeno je 545 intervencija (u proseku 3,2 po pacijentu). Najčešći problemi odnosili su se na neredovnu ili neizbalansiranu ishranu (55,2%), neredovno obavljanje preporučenih preventivnih pregleda (54,7%) i nedovoljnu fizičku aktivnost (51,7%). U prva tri koraka usluge (usmerena na farmakoterapiju, samokontrolu bolesti i životne navike), 315 od 320 intervencija (98,4%) sproveli su farmaceuti samostalno, pri čemu nije bilo potrebe za dodatnim uključivanjem lekara u rešavanje identifikovanih problema. Najveći broj intervencija zabeležen je tokom četvrtog koraka (n=145), kada je kod 112 pacijenata bilo potrebno uputiti pacijenta lekaru radi dalje procene i zbrinjavanja identifikovanih komplikacija ili izostanka preporučenih preventivnih pregleda. Uslugu je maksimalnom ocenom ocenilo 93,0% pacijenata. Standardizovana farmaceutska usluga omogućava identifikaciju i rešavanje brojnih problema pacijenata sa dijabetesom, uz visoko zadovoljstvo pacijenata i pravovremeno uključivanje lekara kada je to potrebno.

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FZZ-P8 HIDDEN CHALLENGES IN DIABETES MANAGEMENT: INSIGHTS FROM A STANDARDIZED PHARMACY SERVICE

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The standardized pharmaceutical service for patients with diabetes, developed by the Pharmaceutical Chamber of Serbia, enables a structured assessment of pharmacotherapy, disease self-management, lifestyle habits, and prevention of complications in community pharmacy settings. The objective was to analyze the most common patient problems identified during a standardized pharmacy service as well as pharmacist-led interventions performed by diabetes advisors. A cross-sectional study was conducted including 172 patients with diabetes enrolled in a standardized pharmaceutical service delivered by pharmacists-diabetes advisors. The service consisted of four structured counseling sessions delivered monthly over a four-month period. Identified problems and pharmacist interventions were documented at each consultation, while patient satisfaction was assessed upon completion of the service. A total of 765 problems (on average 4.4 per patient) and 545 interventions (on average 3.2 per patient) were recorded. The most common problems were related to irregular or unbalanced nutrition (55.2%), failure to attend recommended preventive examinations (54.7%), and insufficient physical activity (51.7%). During the first three consultations, focused on pharmacotherapy, diabetes self-management, and lifestyle habits, pharmacists independently delivered 315 of 320 interventions (98.4%), without requiring physician involvement. The highest number of interventions was recorded during the fourth consultation (n=145), when 112 patients required referral to a physician for further evaluation and management of identified complications or missed preventive examinations. Overall, 93.0% of patients rated the service with the highest possible score. A standardized pharmacy service enables the identification and resolution of a wide range of patient problems in diabetes care, while ensuring high patient satisfaction and timely physician involvement when needed.

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FZZ-P9 DOPRINOS STANDARDIZOVANE FARMACEUTSKE USLUGE U EDUKACIJI PACIJENATA SA ASTMOM I HOBP O PRAVILNOJ PRIMENI INHALACIONE TERAPIJE

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Pravilna tehnika primene inhalacione terapije ključna je za optimalni efekat kod pacijenata sa astmom i HOBP. Cilj rada je evaluacija uticaja standardizovane usluge „Savetnik za astmu i HOBP" Farmaceutske komore Srbije na pravilnu inhalacionu tehniku i kontrolu bolesti. Prospektivna studija obuhvatila je 30 pacijenata (58,4±9,2 godine; 47% muškaraca) sa astmom (n=20) ili HOBP (n=10) uz korišćenje doziranih aerosola (MDIs, n=14) ili inhalera sa suvim prahom (DPIs, n=16). Tokom četvoronedeljnog praćenja, od parametara tehnike evaluirani su: položaj tela, aktiviranje doze, izdah pre primene, odgovarajući udah, zadržavanje daha do 10 sekundi, lagani izdah, pauza između doza, ispiranje usta nakon inhalacije i čišćenje usnika. Inicijalno, najmanje jedna kritična greška identifikovana je kod 75% pacijenata sa astmom i 80% sa HOBP. Najčešće greške bile su neadekvatno zadržavanje daha (67%), izostanak izdaha pre primene (60%) i izostanak ispiranja usta (53%). Nakon edukacije od strane farmaceuta, procenat pacijenata sa potpuno pravilnom tehnikom značajno je porastao sa početnih 23% na 93% (p<0,001), odnosno na 95% kod astme (19/20) i 90% kod HOBP (9/10). Unapređenje tehnike koreliralo je sa boljom kontrolom bolesti, što je potvrđeno poboljšanjem skorova uz standardizovane upitnike (*Asthma Control Test* - ACT i *COPD Assessment Test* - CAT), gde je udeo pacijenata sa kontrolisanim simptomima porastao sa 30% na 70% (p<0,01). Zbog ograničenog broja ispitanika, rezultate ovog istraživanja treba tumačiti sa oprezom i potvrditi u studijama na većem uzorku. Rezultati ukazuju na važnu ulogu farmaceuta u edukaciji pacijenata o pravilnoj primeni inhalacione terapije.

FZZ-P9 THE ROLE OF A STANDARDIZED PHARMACEUTICAL SERVICE IN EDUCATING PATIENTS WITH ASTHMA AND COPD ON THE PROPER USE OF INHALATION THERAPY

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Proper inhaler technique is essential for achieving optimal therapeutic outcomes in asthma and COPD patients. This study evaluated the impact of the standardized pharmaceutical service "Asthma and COPD Counselling" developed by the Pharmaceutical Chamber of Serbia. A prospective study included 30 patients (58.4±9.2 years; 47% men) diagnosed with asthma (n=20) or COPD (n=10), using metered-dose inhalers (MDIs, n=14) or dry powder inhalers (DPIs, n=16). During the four-week follow-up, inhaler technique was assessed using the following parameters: body position, dose actuation, exhalation before inhalation, inhalation maneuver, breath-holding for up to 10 seconds, gentle exhalation, interval between doses, mouth rinsing after inhalation, and mouthpiece cleaning. At baseline, at least one critical inhaler technique error was identified in 75% of patients with asthma and 80% with COPD. The most common errors were inadequate breath-holding (67%), failure to exhale before inhalation (60%), and failure to rinse the mouth after inhalation (53%). Following pharmacist-led education, the proportion of patients demonstrating correct inhaler technique increased significantly from 23% at baseline to 93% (p<0.001), reaching 95% (19/20) among patients with asthma and 90% (9/10) among those with COPD. Improvement in inhaler technique was accompanied by better disease control, as reflected by improved scores on the Asthma Control Test (ACT) and COPD Assessment Test (CAT), with the proportion of patients achieving controlled symptoms increasing from 30% to 70% (p<0.01). Due to the limited sample size, these findings should be interpreted with caution and confirmed in larger studies. The results highlight the important role of pharmacists in educating patients on the inhalation technique.

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FZZ-P10 RACIONALNA PRIMENA ANTIBIOTIKA U PEDIJATRIJSKOJ POPULACIJI – REZULTATI ANKETNOG ISTRAŽIVANJA I MOGUĆNOSTI INTERVENCIJE U APOTECI PRIMARNE ZDRAVSTVENE ZAŠTITE

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Antibiotici su među najčešće korišćenim lekovima u pedijatrijskoj populaciji, a njihova neracionalna primena doprinosi razvoju antimikrobne rezistencije i pojavi neželjenih reakcija. Sprovedeno je anketno istraživanje među roditeljima/starateljima dece na antibiotskoj terapiji u apoteci primarne zdravstvene zaštite. Upitnik je popunilo 55 ispitanika. Deca uzrasta do 5 godina činila su 66% uzorka. Najčešća indikacija za primenu antibiotika bile su infekcije respiratornog trakta (73%). Najviše su propisivani penicilini (67%) i makrolidi (22%). Probiotike uz antibiotsku terapiju koristilo je 98% ispitanika. U 95% slučajeva antibiotici su propisani empirijski, bez laboratorijske potvrde bakterijske infekcije. Više od pet antibiotskih terapija u prethodnoj godini primilo je 22% dece, dok je 11% ispitanika prijavilo neželjene reakcije. Samostalnu primenu antibiotika navelo je 15% roditelja, a 44% je smatralo da je antibiotik ponekad neophodan i bez preporuke lekara. Rezultati pokazuju da se antibiotici u pedijatrijskoj populaciji najčešće propisuju kod respiratornih infekcija, uglavnom empirijski. Deo roditelja naveo je samostalnu primenu antibiotika ili uverenje da je antibiotik neophodan i kada ga lekar nije propisao, što ukazuje na potrebu za kontinuiranom edukacijom. U apoteci primarne zdravstvene zaštite sprovode se intervencije kroz Savetovalište Farmaceutske komore Srbije o pravilnoj primeni antibiotika i Savetovalište o suplementaciji. Savetovanje obuhvata režim doziranja, značaj adherencije i nefarmakoloških mera, prepoznavanje neželjenih reakcija antibiotske terapije. Kao dodatna terapija, pored antipiretika i dekongestiva, preporučuju se probiotici (*Lactobacillus rhamnosus GG*), preparati na bazi *Pelargonium sidoides* i crne zove, preparati u terapiji kašlja. Roditeljima se savetuje praćenje simptoma tokom 48–72 časa kod blagih infekcija, čime se doprinosi racionalnoj upotrebi antibiotika i smanjenju antimikrobne rezistencije.

FZZ-P10 RATIONAL USE OF ANTIBIOTICS IN THE PEDIATRIC POPULATION – RESULTS OF A SURVEY STUDY AND OPPORTUNITIES FOR PHARMACEUTICAL INTERVENTIONS IN PRIMARY HEALTHCARE PHARMACIES

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Antibiotics are among the most frequently used medications in pediatric practice, and their irrational use contributes to antimicrobial resistance and adverse drug reactions. A survey was conducted among parents/legal guardians of children receiving antibiotic therapy at a primary healthcare pharmacy. A total of 55 respondents completed the questionnaire. Children under 5 years of age accounted for 66% of the sample. Respiratory infections were the most common indication for antibiotic use (73%). Penicillins (67%) and macrolides (22%) were the most frequently prescribed antibiotic classes. Probiotics were used with antibiotic therapy by 98% of respondents. In 95% of cases, antibiotics were prescribed empirically, without laboratory confirmation of bacterial infection. More than five antibiotic courses during the previous year were reported in 22% of children, while 11% experienced adverse reactions. Self-administration of antibiotics was reported by 15% of parents, and 44% believed antibiotics were sometimes necessary without a physician's recommendation. The findings indicate that antibiotics are most commonly prescribed for respiratory infections and used empirically. Some parents reported self-medication or believed antibiotics were necessary even when not prescribed, highlighting the need for continuous education. Pharmaceutical interventions are provided through the Counseling Services of the Pharmaceutical Chamber of Serbia: Appropriate Antibiotic Use and Supplementation Counseling Service. Counseling includes education on dosing, adherence, non-pharmacological measures, and adverse reactions. Supportive therapy recommendations include probiotics (*Lactobacillus rhamnosus GG*), preparations based on *Pelargonium sidoides* and elderberry, and cough-relief products. Parents are advised to monitor symptoms for 48–72 hours in mild infections, promoting rational antibiotic use and reducing resistance.

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FZZ-P11 MOŽE LI IOF JEDNOMINUTNI TEST PREDVIDETI NIZAK T-SKOR DOBIJEN ULTRAZVUČNOM OSTEODENZITOMETRIJOM KOD ŽENA?

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Rana identifikacija žena sa povećanim rizikom od osteoporoze u primarnoj zdravstvenoj zaštiti može poboljšati prevenciju osteoporotskih preloma. Cilj ovog istraživanja bio je da proceni validnost jednominutnog upitnika Internacionalne fondacije za osteoporozu (IOF) kao skrining alata za procenu rizika od osteoporoze kod žena u primarnoj zdravstvenoj zaštiti. Sprovedena je studija preseka. Mineralna gustina kostiju procenjena je kvantitativnom ultrazvučnom denzitometrijom pomoću uređaja *SONOST 2000* na petnoj kosti, a rezultati su izraženi kroz T-skor. Ispitanice su svrstane u tri grupe na osnovu T-skora: normalna mineralna gustina kostiju (T ≥ -1,0; grupa 1), moguća osteopenija (-2,5 < T < -1,0; grupa 2) i moguća osteoporoza (T ≤ -2,5; grupa 3). Nakon popunjavanja IOF upitnika, izračunat je skor kao procenat pozitivnih odgovora u odnosu na ukupan broj datih odgovora, a zatim su IOF skorovi poređeni između grupa ispitanica formiranih na osnovu T-skora. Statistička analiza odrađena je pomoću *PASW Statistics* v18, korišćeni su *Kruskal–Wallis* test i *post hoc* test *Mann–Whitney U* test. U istraživanju je učestvovalo 530 žena prosečne starosti 61,84±11,52 godina. Utvrđena je statistički značajna razlika u IOF skoru između grupa 1-3 (p < 0,001). Post hoc analiza pokazala je statistički značajne razlike između ispitanica u grupi 1 i grupi 3 (p < 0,001), ispitanica u grupi 2 i grupi 3 (p < 0,01), dok između ispitanica u grupi 1 i grupi 2 nije utvrđena statistička značajnost (p = 0,079). Rezultati ukazuju da IOF jednominutni upitnik može biti brz, jednostavan i ekonomičan skrining alat za identifikaciju žena sa povećanim rizikom od osteoporoze.

FZZ-P11 CAN THE IOF ONE-MINUTE OSTEOPOROSIS RISK TEST PREDICT A LOW T-SCORE OBTAINED BY QUANTITATIVE ULTRASOUND DENSITOMETRY IN WOMEN?

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Early identification of women at increased risk of osteoporosis may improve the prevention of osteoporotic fractures in primary health care. The aim of this study was to evaluate the validity of the International Osteoporosis Foundation (IOF) One-Minute Osteoporosis Risk Test as a screening tool for osteoporosis risk assessment in primary health care. A cross-sectional study was conducted. Bone mineral density was assessed using quantitative ultrasound densitometry of the calcaneus (SONOST 2000). The results were expressed as T-scores. Participants were classified into three groups: normal bone mineral density (T ≥ −1.0), possible osteopenia (−2.5 < T < −1.0), and possible osteoporosis (T ≤ −2.5). After completing the IOF questionnaire, an IOF score was calculated as the percentage of positive responses relative to the total number of responses. IOF scores were compared among groups using the Kruskal–Wallis test and post hoc Mann–Whitney U tests. Statistical analyses were performed using PASW Statistics 18. The study included 530 women with a mean age of 61.84 ± 11.52 years. A statistically significant difference in IOF scores was observed among the three groups (p < 0.001). Post hoc analysis showed significant differences between groups 1 and 3 (p < 0.001) and between groups 2 and 3 (p < 0.01), whereas no significant difference was found between groups 1 and 2 (p = 0.079). These findings suggest that the IOF One-Minute Osteoporosis Risk Test may be a rapid, simple, and cost-effective screening tool for identifying women at increased risk of osteoporosis.

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FZZ-P12 SAMOPRIJAVLJENI OBRASCI UPOTREBE ANTIHISTAMINIKA I KONTROLA SIMPTOMA ALERGIJE PACIJENATA U JAVNOJ APOTECI – REZULTATI ANKETE U APOTEKAMA AU ALBA GRAECA PHARM

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Određeni antihistaminici druge generacije imaju status izdavanje bez lekarskog recepta (loratadin, cetirizin, levocetirizin). Apoteke imaju značajnu ulogu u praćenju farmakoterapije i edukaciji pacijenata. U cilju boljeg razumevanja profila korisnika antihistaminika i njihovog iskustva sa terapijom, u apotekama AU Alba Graeca Pharm sprovedena je anonimna anketa. Anketa je sprovedena na uzorku od 55 ispitanika. Prikupljani su podaci o uzrastu, vrsti alergije, korišćenim lekovima, izvoru preporuke, trajanju terapije i subjektivnoj proceni efikasnosti antihistaminika. Najveći broj ispitanika bio je uzrasta 19–40 godina (45,5%), a zatim 41–65 godina (34,5%). Alergija na polen, potvrđena ili simptomatska, bila je prisutna kod 78,2% ispitanika. Alergologa je konsultovalo 41,8% ispitanika, dok 12,7% nije posetilo nijednog specijalistu. Najčešće korišćeni antihistaminici bili su cetirizin (23,6%), levocetirizin (18,2%) i desloratadin (16,4%). Terapiju je preporučio lekar specijalista u 47,3% slučajeva, a farmaceut u apoteci u 25,5% slučajeva. Čak 83,6% ispitanika je ove lekove koristilo i ranije. Subjektivno, najveće olakšanje simptoma pacijenti su prijavili za svrab, otok i suzenje očiju (60,0%), kao i sekreciju iz nosa (34,5%). Zapušenost nosa najčešće je samo delimično otklonjena (40,0%). Pored antihistaminika, 32,7% ispitanika koristilo je kortikosteroidni sprej, a 27,3% sprej za otpušavanje nosa. Rezultati ukazuju na dugotrajnu primenu bez praćenja efikasnosti i bezbednosti, uz ograničenu kontrolu nazalne kongestije. Farmaceuti imaju važnu ulogu u preporuci terapije i trebalo bi intenzivirati njihovo učešće u praćenju pacijenata sa alergijskim bolestima.

FZZ-P12 SELF-REPORTED PATTERNS OF ANTIHISTAMINE USE AND ALLERGY SYMPTOM CONTROL OF PATIENTS IN A COMMUNITY PHARMACY – SURVEY RESULTS FROM AU ALBA GRAECA PHARM PHARMACIES

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Certain second-generation antihistamines are available with prescription (loratadine, cetirizine, levocetirizine). Pharmacies play a significant role in monitoring pharmacotherapy and in educating patients. To better understand the profile of antihistamine users and their treatment experiences, an anonymous survey was conducted at AU Alba Graeca Pharm pharmacies. The survey was conducted on a sample of 55 respondents. Data were collected on age, type of allergy, medications used, source of recommendation, duration of therapy, and subjective assessment of antihistamine efficacy. The largest proportion of respondents are aged 19–40 years (45.5%), followed by 41–65 years (34.5%). Pollen allergy was reported by 78.2% of respondents. An allergist was consulted by 41.8% of respondents, while 12.7% had not visited any specialist. The most commonly used antihistamines were cetirizine (23.6%), levocetirizine (18.2%), and desloratadine (16.4%). Specialist physicians recommended therapy in 47.3% of cases and pharmacists in 25.5% of cases. As many as 83.6% of respondents were not using the medication for the first time. Subjectively, the most complete symptom relief was reported for ocular itching, swelling, and tearing (60.0%) and nasal discharge (34.5%). Nasal congestion was most frequently only partially relieved (40.0%). In addition to antihistamines, 32.7% of respondents used a corticosteroid nasal spray and 27.3% a decongestant spray. The results indicate prolonged use of antihistamines without monitoring efficiency and safety, as well as limited control of nasal congestion. Pharmacists play an important role in therapy recommendation, and their involvement in the follow-up of patients with allergies should be further strengthened.

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FZZ-P13 ULOGA DERMOSAVETNIKA U PREPORUCI I REŠAVANJU RAZLIČITIH STANJA KOD PACIJENATA SA SUVOM, OSETLJIVOM KOŽOM I KOŽOM SKLONOJ ATOPIJI

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Suva, osetljiva i atopična koža predstavljaju česta stanja koja značajno utiču na kvalitet života pacijenata. Dermosavetnici imaju važnu ulogu u pružanju stručnih saveta o pravilnoj primeni dermokozmetičkih preparata a u cilju smanjenja simptoma kao što su suvoća, svrab, crvenilo i osećaj zategnutosti kože. Cilj ovog rada je da prikaže značaj edukacije farmaceuta i farmaceutskih tehničara u unapređenju nege i podrške pacijentima sa suvom, osetljivom i atopičnom kožom, što doprinosi postizanju boljih kliničkih ishoda i kvaliteta života. U periodu od januara do novembra 2023. godine u AU Lilly Drogerie, ukupno 168 farmaceuta i farmaceutskih tehničara prošlo je edukacije na temu različitih dermatoloških stanja kože. Pored teorijskog dela, bilo je organizovano prikupljanje slučajeva iz prakse. Prikupljeni podaci predstavljeni su u formi *SOAP* i *Follow-up* izveštaja za svakog pacjenta. Ukupno je prikupljeno 166 slučajeva; od toga 90 slučajeva vezanih za suvu, osetljivu i atopičnu kožu. Dermosavetnici su pružali savete o nezi kože, preporučivali medicinsku kozmetiku, suplementaciju i dodatne mere nege. 53 % pacijenata prvo je potražilo savet u apoteci. Poboljšanje simptoma posle savetovanja zabeleženo je kod 47% pacijenata. U 71% slučajeva, pored saveta o nezi kože, preporučena je i odgovarajuća suplementacija. Procenat poboljšanja simptoma nakon savetovanja (47%) ukazuje da je stručni savet dermosavetnika važan deo podrške pacijentima sa suvom, osetljivom i kožom sklonoj atopiji. Dodatne edukacije iz ove oblasti, kroz teorijski deo i radionice/module, važne su i neophodne u sticanju novih znanja za sve dermosavetnike koji rade u apoteci.

FZZ-P13 THE ROLE OF DERMOCONSULTANTS IN THE RECOMMENDATION AND MANAGEMENT OF VARIOUS CONDITIONS IN PATIENTS WITH DRY, SENSITIVE, AND ATOPY-PRONE SKIN

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Dry, sensitive, and atopy-prone skin are common conditions that can significantly affect patients' quality of life. Dermoconsultants play an important role in providing professional advice on the proper use of dermocosmetic products to reduce symptoms such as dryness, itching, redness, and skin tightness. The aim of this study was to demonstrate the importance of educating pharmacists and pharmacy technicians in improving care and support for patients with dry, sensitive, and atopy-prone skin, thereby contributing to better clinical outcomes and quality of life. Between January and November 2023, a total of 168 pharmacists and pharmacy technicians from AU Lilly Drogerie participated in educational programs focused on various dermatological skin conditions. In addition to the theoretical component, the program included the collection and analysis of real-life cases from pharmacy practice. The collected data were presented in the form of SOAP and Follow-up reports for each patient. A total of 166 cases were collected, including 90 cases related to dry, sensitive, and atopy-prone skin. Dermoconsultants provided advice on skin care, recommended medical dermocosmetics, dietary supplementation, and additional supportive care measures. Fifty-three percent of patients initially sought advice at the pharmacy. Improvement in symptoms following counseling was observed in 47% of patients. In 71% of cases, appropriate dietary supplementation was recommended in addition to skin care advice. The rate of symptom improvement following counseling (47%) indicates that professional recommendations and expert guidance provided by dermoconsultants are an important component of support for patients with dry, sensitive, and atopy-prone skin. Additional education in this field, through theoretical training and workshops/modules, is important and necessary for acquiring new knowledge and competencies among dermoconsultants working in community pharmacies.

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FZZ-P14 ULOGA FARMACEUTA U DERMOSAVETOVALIŠTU U KONTROLI ATOPIJSKOG DERMATITISA PRIMENOM CILJANE DERMOKOZMETIČKE NEGE

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Atopijski dermatitis (AD) je hronična, neinfektivna, recidivirajuća zapaljenska dermatoza, složene etiologije. U svakodnevnoj praksi se često poistovećuje sa ekcemom, iako je AD samo jedno od oboljenja koje ovaj entitet obuhvata. Cilj rada je evaluacija savetodavne uloge farmaceuta kao stručnog konsultanta u okviru dermosavetovališta, sa posebnim osvrtom na prevenciju relapsa AD, kroz pravovremenu preporuku nege i suplementacije. U okviru apoteka *AU Lilly Drogerie*, koje su obuhvaćene savetovalištem realizovano je dvomesečno savetovanje dvadesetjednog pacijenata sa AD o pravilnoj higijeni i nezi kože. Savetovanje je sprovodio tim farmaceuta koji je prethodno prošao obuku kroz više modula edukacija za savetovanje pacijenata sa ovom indikacijom. Dve trećine uzorka činile su žene ,a 38% pacijenti starosti 20-40 godina. Savetovanje je realizovano prema standardizovanim protokolu, uz individualizovan pristup. Period praćenja je bio 20 dana, nakon čega nam je povratne informacije dostavilo 76% pacijenata. Najčešće su preporučivani emolijensi sa hidrantnim i barijerno-obnavljajućim delovanjem, pri čemu su preparati laganije strukture omogućili bolju adherencu kod 80% pacijenata. Rezultati su kod većine pacijenata procenjeni uz pomoć SCORAD indeksa, a kod ostalih su zasnovani na samoproceni. Kod 75% pacijenata zabeležena je potpuna redukcija svraba, a kod 15% delimična. Visoka komplijansa zabeležena je i kod preporučene suplementacije, približno 50% pacijenata nabavilo je preporučen preparat prilikom prve posete, dok je ostalih 15% to učinilo tokom kontrolnog savetovanja. Rezultati našeg projekta ukazuju na potencijalni značaj kontinuiranog farmaceutskog savetovanja u upravljanju hroničnim bolestima. Naročito je značajno kod AD, gde pravilna svakodnevna nega i pridržavanje preporuka imaju presudan uticaj na kontrolu bolesti i prevenciju relapsa.

FZZ-P14 THE ROLE OF THE PHARMACIST IN A PHARMACIST-LED DERMOCONSULTATION SERVICES FOR THE MANAGEMENT OF ATOPIC DERMATITIS THROUGH TARGETED DERMOCOSMETIC CARE

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Atopic dermatitis (AD) is a chronic, non-infectious, relapsing inflammatory dermatosis. Appropriate skincare and patient education are essential for symptom control and relapse prevention. To evaluate the role of pharmacists within a pharmacist-led counseling service for patients with AD, with emphasis on improving adherence to skincare recommendations and nutritional supplementation. A two-month pharmacist-led counseling program was conducted in AU Lilly Drogerie pharmacies and included 21 patients with AD. Patients received education on proper skin hygiene and daily skincare. Counseling was delivered by trained pharmacists following a standardized protocol with an individualized approach. Each patient was followed for 20 days after the initial consultation, and feedback was obtained from 76% of participants. Women accounted for two-thirds of participants, while 38% were aged 20–40 years. The most frequently recommended products were emollients with moisturizing and skin barrier-restoring properties. Lightweight formulations were associated with better adherence to the recommended skincare regimen in 80% of patients. Outcomes were assessed primarily using the SCORAD index, while self-assessment was used when SCORAD evaluation was unavailable. At the 20-day follow-up, complete resolution of pruritus was reported in 75% of patients, while partial improvement was observed in an additional 15%. Good adherence to the recommended nutritional supplementation was observed, with 50% of patients purchasing the recommended product during the initial consultation and a further 15% during follow-up. Continuous pharmacist-led counseling may improve adherence to recommended skincare and nutritional supplementation, contributing to better symptom control and relapse prevention while supporting the role of community pharmacists in the management of AD.

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FZZ-P15 POTREBE DOJILJA ZA INFORMACIJAMA O BEZBEDNOJ PRIMENI LEKOVA TOKOM DOJENJA

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Primena lekova tokom dojenja je sve češća, a farmaceutsko savetovanje može biti ključno za bezbednost odojčeta i racionalnu farmakoterapiju dojilja. Cilj istraživanja bio je da se analiziraju potrebe dojilja za informacijama i farmaceutskom podrškom tokom primene lekova. U studiji preseka, sprovedenoj putem onlajn upitnika učestvovala je 241 dojilja i 137 majki dece uzrasta do godinu dana koje su prethodno dojilje. Podaci su obrađeni primenom SPSS v.20.0, a stavovi ispitanica procenjeni su *Likart*-ovom skalom. Primena lekova tokom dojenja zabeležena je kod trećine ispitanica, dok je terapija hroničnih bolesti bila zastupljena kod 20,9%. Starost, nivo obrazovanja i formalno zdravstveno obrazovanje značajno su uticali na primenu lekova ($p < 0,001$). Skoro trećina ispitanica (28,8%) navela je da bi nastavila dojenje i tokom primene lekova koji mogu izazvati neželjene efekte kod odojčeta, dok je većina iskazala potrebu za dodatnim informacijama o dojenju i primeni lekova (65,9%). Kao izvore stručnih informacija podjednako su prepoznavale lekare (54,2%) i farmaceute (53,8%), dok je više od polovine navelo da samostalno pretražuje informacije (52,3%). Uprkos iskazanom poverenju u farmaceute, najčešći izvori informacija bili su članovi porodice i prijatelji (67,68%), internet forumi (61,11%) i drugi internet izvori (55,56%), dok su specijalizovane baze podataka korišćene retko (Nacionalne smernice za primenu lekova tokom laktacije 2,53%, *e-lactancia* 1,01%). Rezultati ukazuju na značajnu potrebu dojilja za pouzdanim informacijama o bezbednoj primeni lekova tokom dojenja i potvrđuju potrebu za većim uključivanjem farmaceuta u edukaciju i pružanje strukturirane farmaceutske podrške.

Zahvalnica
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FZZ-P15 BREASTFEEDING WOMEN'S NEEDS FOR INFORMATION ON MEDICATION USE AND PHARMACISTS' SUPPORT

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Medication use during breastfeeding is becoming increasingly common, and pharmaceutical counseling may play a key role in ensuring infant safety and promoting rational pharmacotherapy in lactating women. The aim of this study was to analyze breastfeeding women's needs for information and pharmaceutical support during medication use. This cross-sectional study, conducted using an online questionnaire, included 241 breastfeeding women and 137 mothers of children up to one year of age who had previously breastfed. Data were analyzed using SPSS v.20.0, and participants' attitudes were assessed using a Likert scale. Medication use during breastfeeding was reported by one-third of participants, while treatment of chronic diseases accounted for 20.9%. Age, educational level, and formal healthcare education significantly influenced medication use ($p < 0.001$). Nearly one-third of participants (28.8%) reported that they would continue breastfeeding while using medications that may cause adverse effects in the infant, whereas the majority expressed a need for additional information on breastfeeding and medication use (65.9%). Physicians (54.2%) and pharmacists (53.8%) were equally recognized as sources of professional information, while more than half of participants reported independently searching for information (52.3%). Despite their trust in pharmacists, the most common sources of information were family members and friends (67.68%), internet forums (61.11%), and other online resources (55.56%), whereas specialized databases were rarely used (National Guidelines for Medication Use During Lactation, 2.53%; e-lactancia, 1.01%). The findings indicate a substantial need for reliable information on the safe use of medications during breastfeeding and support greater pharmacist involvement in patient education and the provision of structured pharmaceutical support.

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FZZ-P16 STANDARDNA OPERATIVNA PROCEDURA ZA PRUŽANJE INFORMACIJA O LEKOVIMA I MEDICINSKIM SREDSTVIMA U AMBULANTNOJ PRAKSI

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Zdravstveni radnici, a posebno farmaceuti, pružaju informacije o lekovima i medicinskim sredstvima pacijentima i drugim zdravstvenim radnicima. Standardna operativna procedura (SOP) je razvijena sa ciljem da se informacije pružaju na jedinstven i dosledan način u Domu zdravlja „Novi Sad".

Razvoj procedure se bazirao na analizi postojećih radnih procesa, nacionalnih propisa i stručnih smernica. Definisane su aktivnosti, odgovornosti zaposlenih, obrasci za evidenciju, indikatori kvaliteta, te način periodične revizije. Aktivnosti uključuju prijem, evidentiranje, i klasifikaciju upita prema vrsti, hitnosti i složenosti; prikupljanje relevantnih podataka o pacijentu ili zdravstvenom problem; pretragu i kritičku procenu referentnih izvora; kao i formulisanje odgovora prilagođenog potrebama podnosioca. Kao referentni izvori koriste se sažeci karakteristika lekova, uputstva za lekove i medicinska sredstva, vodiči dobre kliničke prakse, stručna literatura, regulatorni dokumenti i baze podataka (npr. PubMed, Cochrane Library). Indikatori kvaliteta su broj upita, vreme odgovora, eventualne primedbe podnosioca, i doslednost evidentiranja. SOP predviđa i edukaciju zaposlenih, praćenje primene kroz interne provere, kao i sprovođenje periodičnih revizija u skladu sa regulatornim i stručnim promenama. Ukoliko se tokom obrade upita posumnja na neželjenu reakciju, neefikasnost leka ili neispravnost medicinskog sredstva, predviđeno je njihovo prijavljivanje odgovornim licima za farmakovigilancu odnosno vigilancu.

Očekuje se da primena procedure doprinese unapređenju kvaliteta pruženih informacija, jačanju sistema (farmako)vigilance i povećanju bezbednosti pacijenata u ambulantnoj praksi.

FZZ-P16 STANDARD OPERATING PROCEDURE FOR PROVIDING INFORMATION ON MEDICINES AND MEDICAL DEVICES IN AMBULATORY PRACTICE

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Healthcare professionals, especially pharmacists, provide information on medicines and medical devices to patients and other healthcare professionals. A Standard Operating Procedure (SOP) was developed with the aim of providing information in a uniform and consistent manner at the Health Center "Novi Sad".

The development of the procedure was based on an analysis of existing work processes, national regulations, and professional guidelines. It defined activities, employee responsibilities, documentation forms, quality indicators, and the method for periodic review. The activities include receiving, recording, and classifying enquires by type, urgency, and complexity; gathering relevant data on the patient or health problem; searching and critically appraising reference sources; and formulating a response tailored to the enquirer's needs. Summaries of product characteristics, package leaflets for medicines and medical devices, good clinical practice guidelines, professional literature, regulatory documents, and databases (e.g., PubMed, Cochrane Library) are used as reference sources. Quality indicators are number of enquiries, response time, potential complaints from the enquirer, and consistency of documentation. The SOP also provides for employee training, monitoring implementation through internal audits, and conducting periodic reviews in accordance with regulatory and professional changes. If an adverse drug reaction, lack of efficacy, or medical device defect is suspected during the processing of an enquiry, reporting to the personnel responsible for pharmacovigilance or vigilance is provided.

The implementation of the procedure is expected to contribute to improving the quality of the provided information, strengthening the (pharmaco)vigilance system, and increasing patient safety in ambulatory practice.

FZZ-P17 STANDARDNA OPERATIVNA PROCEDURA ZA RUKOVANJE LEKOVIMA KOJI SADRŽE PSIHOAKTIVNE KONTROLISANE SUPSTANCE U AMBULANTNOJ PRAKSI

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Lekovi koji sadrže psihoaktivne kontrolisane supstance podležu strogim zakonskim zahtevima. Standardna operativna procedura (SOP) je razvijena u Domu zdravlja "Novi Sad" sa ciljem da se osigura bezbedno i sledljivo rukovanje ovim lekovima u skladu sa važećim zakonskim zahtevima.

Razvoj procedure se bazirao na propisima Republike Srbije i zahtevima Dobre apotekarske prakse. Definisane su aktivnosti koje se odnose na prijem lekova i kontrolu usklađenosti isporuke sa pratećom dokumentacijom, te način reklamacije u slučaju odstupanja; bezbedno skladištenje; izdavanje kroz posebno trebovanje; i vođenje evidencije. Predviđene su periodične provere usklađenosti stvarnog i evidentiranog stanja zaliha, kao i postupanje u slučaju sumnje na gubitak, neovlašćeni pristup ili zloupotrebu, uključujući prijavljivanje odgovornom licu, vanredni popis uz analizu uzroka, dokumentovanje činjenica i sprovođenje korektivnih i preventivnih mera (npr. ograničavanje ovlašćenja, pojačan nadzor nad evidencijom). SOP obuhvata i rashodovanje lekova te njihovu predaju ovlašćenom operateru za trajno zbrinjavanje opasnog otpada; izradu godišnjeg izveštaja za Ministarstvo zdravlja; definisanje odgovornosti zaposlenih i njihovu obuku; periodične revizije nakon izmena propisa; i praćenje primene kroz interne kontrole i definisane indikatore kvaliteta (usklađenost stvarnog i evidentiranog stanja zaliha, udeo rashodovanih lekova, potpunost dokumentacije i evidencije).

Konačno, uvođenje automatizovanih sistema za izdavanje i skladištenje lekova predstavlja potencijalni pravac za dodatno unapređenje bezbednosti i sledljivosti rukovanja lekovima koji sadrže psihoaktivne kontrolisane supstance.

FZZ-P17 STANDARD OPERATING PROCEDURE FOR HANDLING CONTROLLED DRUGS IN AMBULATORY PRACTICE

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Controlled drugs are subject to strict legal requirements. A standard operating procedure (SOP) was developed at the Health Center "Novi Sad" with the aim of ensuring the safe and traceable handling of these medicines in accordance with applicable legal requirements.

The development of the procedure was based on the Republic of Serbia's rules and the Good Pharmacy Practice requirements. Activities have been defined regarding the receipt of medicines and verification of delivery compliance with accompanying documentation, alongside the complaint report in case of discrepancies; safe storage; dispensing via a separate requisition; and record-keeping. Periodic audits of compliance between actual and recorded inventory levels are envisaged, as well as proceedings for suspected loss, unauthorized access, or misuse, including reporting to the responsible person, an extraordinary inventory with root cause analysis, documentation of the circumstances, and implementation of corrective and preventive measures (e.g., access privilege restrictions, enhanced record monitoring). The SOP also covers the disposal of expired or damaged medicines and their transfer to an authorized operator for the permanent management of hazardous waste; the preparation of an annual report for the Ministry of Health; the definition of employee responsibilities and their training; periodic revisions following regulatory changes; and the monitoring of implementation through internal audits and defined quality indicators (actual and recorded inventory level compliance, disposed medicine proportion, documentation and record completeness).

Finally, the introduction of automated dispensing cabinets represents a potential direction for further improving the safety and traceability of handling controlled drugs.

FZZ-P18 PRIMENA *STOPP/START* KRITERIJUMA KOD MULTIMORBIDNIH PACIJENATA SA POLIFARMACIJOM: DA LI UTIČE NA TERAPIJSKO OPTEREĆENJE?

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Kriterijumi *Screening Tool of Older Persons' Prescriptions (STOPP)/Screening Tool to Alert to Right Treatment (START)* široko se koriste za pregled terapije kod starijih pacijenata. Cilj istraživanja bio je ispitati uticaj primene *STOPP/START* verzije 2 (v2) na ukupan broj lekova kod multimorbidnih pacijenata sa polifarmacijom. Sprovedena je opservaciona studija u uslovima javne apoteke. Prikupljeni su demografski, klinički i terapijski podaci za starije pacijente (uzrasta ≥65 godina) sa polifarmacijom, odnosno koji koriste pet ili više lekova. Broj lekova pre i nakon primene *STOPP/START* v2 kriterijuma poređen je korišćenjem *Wilcoxon Signed Rank* testa (SPSS softver, verzija 28). U analizu je uključeno ukupno 358 pacijenata prosečne starosti 72,2 ± 5,8 godina. Medijana broja komorbiditeta iznosila je 4, sa interkvartilnim rasponom [IQR 3–5]. Najčešće indikacije bile su hipertenzija (93%), dijabetes (47,8%), koronarna bolest srca (43,9%), insomnija ili anksioznost (27,9%), dislipidemija (25,1%), aritmija (22,1%), muskuloskeletni bol (15,9%), dispepsija ili gastroezofagealni refluks (14,5%), srčana insuficijencija (12,6%) i hronična opstruktivna bolest pluća (11,5%). Medijana broja lekova po pacijentu smanjena je sa 8 [7–10] na 7 [6–9] nakon primene *STOPP/START* v2 kriterijuma (p<0,001). Ukupan broj lekova smanjen je kod 186 pacijenata (52%), povećan kod 74 (20,7%), dok je ostao nepromenjen kod 98 pacijenata (27,4%). Studija je pokazala značajno smanjenje ukupnog broja lekova kod starijih pacijenata u javnoj apoteci primenom *STOPP/START* v2 kriterijuma. *STOPP/START* v2 alat može omogućiti optimizaciju terapije kod starijih multimorbidnih pacijenata sa polifarmacijom.

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FZZ-P18 USE OF *STOPP/START* TOOL IN MULTIMORBID PATIENTS WITH POLYPHARMACY: DOES IT AFFECT TREATMENT BURDEN?

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Screening Tool of Older Persons' Prescriptions (STOPP)/Screening Tool to Alert to Right Treatment (START) criteria are widely used for medication review in elderly patients. The study aimed to investigate the effect of *STOPP/START* version 2 (v2) application on the total number of medications in multimorbid patients with polypharmacy. An observational study was conducted in the community pharmacy setting. Demographic, clinical and therapy data were collected for elderly patients (aged ≥65) with polypharmacy (≥5 medications). The number of medications before and after *STOPP/START* v2 application were compared using Wilcoxon Signed Rank test (SPSS software ver. 28). A total of 358 patients aged 72.2 ± 5.8 years were included in the analysis. The median number of comorbidites was 4 with interquartile range [IQR 3-5]. The most common indications were hypertension (93%), diabetes (47.8%), coronary heart disease (43.9%), insomnia or anxiety (27.9%), dyslipidemia (25.1%), arrhythmia (22.1%), musculoskeletal pain (15.9%), dyspepsia or gastroesophageal reflux (14.5%), heart failure (12.6%) and chronic obstructive pulmonary disease (11.5%). The median number of medications per patients decreased from 8 [7-10] to 7 [6-9] after the application of *STOPP/START* v2 criteria (p<0.001). The total number of medications decreased in 186 patients (52%), increased in 74 (20.7%), whereas it remained unchanged in 98 patients (27.4%). Our study reported a significant decrease in the total number of medications in eldely community pharmaacy patients using *STOPP/START* v2 criteria. *STOPP/START* v2 tool could enable therapy optimization in elderly multimorbid polypharmacy patients.

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FZZ-P19 ANALIZA KARDIOVASKULARNE TERAPIJE KOD STARIJIH PACIJENATA UPOTREBOM PRISCUS I EU(7)-PIM LISTI

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Kardiovaskularne bolesti su jedan od glavnih uzroka morbiditeta i mortaliteta, pri čemu moždani i srčani udar čine oko 80% kardiovaskularnih smrtnih ishoda, naročito kod starije populacije. Starenje je povezano sa većim brojem hroničnih bolesti, što dovodi do polifarmacije. Identifikacija potencijalno neodgovarajućih lekova u farmakoterapiji starijih pacijenata je važna radi unapređenja bezbednosti terapije i optimizacije primene lekova kod starijih pacijenata, uz primenu različitih alata, poput lista lekova. Cilj rada bio je analiza kardiovaskularne terapije starijih pacijenata, primenom listi za procenu potencijalno neodgovarajućih lekova i upoređivanje dobijenih rezultata. Istraživanje je obuhvatilo pacijente starosti preko 65 godina koji su podizali svoju terapiju u apoteci tokom perioda januar–februar 2023. godine. Za analizu propisane terapije korišćene su lek-orijentisane liste: PRISCUS, EU(7)-PIM i PRISCUS 2.0. Prosečna starost 26 pacijenata koji su učestvovali u istraživanju bila je 77,07 ± 6,83 godina; imali su ukupno 181 recept, odnosno prosečno 6,96 lekova po pacijentu. Identifikovano je 23,2% potencijalno neodgovarajućih lekova, pri čemu je najveći broj identifikovan primenom liste EU(7)-PIM (83,33%). Najčešće propisivani potencijalno neodgovarajući lekovi bili su amjodaron, trimetazidin i digoksin. Polifarmaciji su bili izloženi svi pacijenti, naročito oni sa većim brojem potencijalno neodgovarajućih lekova.

Prilikom odabira alata za analizu terapije pacijenata, poput pomenutih listi, preporučuje se primena više različitih alata zbog njihove heterogenosti i različitih kriterijuma procene. Tim zdravstvenih radnika koji procenjuje optimalnost farmakoterapije treba da uzme u obzir individualne karakteristike svakog pacijenta, naročito prilikom primene ovih i sličnih lista u rutinskom pregledu terapije.

FZZ-P19 ANALYSIS OF CARDIOVASCULAR THERAPY IN ELDERLY PATIENTS USING *PRISCUS* AND *EU-(7)-PIM* LISTS

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Cardiovascular diseases are one of main causes of mortality and morbidity – 80% of CV deaths are caused by heart attack or stroke, conditions which are widespread between elderly. Ageing is associated with multiple morbid conditions which leads to usage of large number of drugs and polypharmacy. Potentially inappropriate medications are those drugs where risk of adverse events outweighs clinical benefit. Identification of these drugs has a key role in increasing safety of prescribed therapy and optimizing number of drugs that elderly patients use.

The aim of research was to analyse cardiovascular therapy in elderly patients using lists for evaluation of potentially inappropriate medications and comparing obtained results.

This study included patients, aged 65 and over, who got their therapy in period from January to February 2023. For the analysis of prescribed medications, drug-oriented lists were used: *PRISCUS, EU(7)-PIM*, *PRISCUS 2.0*.

Median age of 26 patients in the study was 77,07±6,83; with in total of 181 prescribed drug, average of 6,96 per patient. There were 23,2% of potentially inappropriate medications identified, primarily by *EU(7)-PIM* list (83,33%). Most frequently prescribed PIMs were amiodarone, trimetazidin and digoxin. All patients were exposed to polypharmacy, mostly those who had greater number of PIMs.

When choosing certain tools for assessing the appropriateness of therapy, several of them should be used because of their heterogeneity and different approach. Individual characteristics of each patient should also be taken into consideration during therapy assessment by medical staff, especially when using these and similar lists in routine check-ups.

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FZZ-P20 ANTIHOLINERGIČKA SKALA OPTEREĆENJA KOD PACIJENATA STARIJIH OD 65 GODINA NA TERITORIJI OPŠTINE GORNJI MILANOVAC

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Antiholinergičko opterećenje predstavlja klinički relevantan problem kod starijih osoba jer je povezano sa padom kognitivnih i funkcionalnih sposobnosti. Cilj ovog istraživanja bio je procena prevalencije i faktora rizika povezanih sa potencijalnim antiholinergičkim opterećenjem među osobama starijim od 65 godina na teritoriji opštine Gornji Milanovac.

Deskriptivna studija preseka sprovedena je među osobama starijim od 65 godina tokom maja 2023. godine. Podaci o demografskim karakteristikama, dijagnozama i propisanim lekovima na lekarski recept prikupljeni su anonimnom anketom uz prethodno dobijenu saglasnost ispitanika. Antiholinergičko opterećenje procenjeno je primenom skale antiholinergičkog opterećenja za nemačke propisivače prema *Kiesel* i saradnicima, prilagođene lekovima registrovanim u Republici Srbiji.

U studiji je učestvovalo 200 ispitanika prosečne starosti 75,05±7,0 godina, od kojih je 63% bilo ženskog pola. Prosečan antiholinergički skor među ženama iznosio je 2,65, a među muškarcima 2,11 ($p<0,05$). Ukupno 40,5% ispitanika imalo je skor antiholinergičkog opterećenja veći od 3. Nisu utvrđene statistički značajne razlike u antiholinergičkom skoru između starosnih grupa, dok je potvrđena značajna korelacija između broja korišćenih lekova i visine antiholinergičkog skora ($p<0,001$). Skor antiholinergičkog opterećenja veći od 3 registrovan je kod 43,43% ispitanika sa višestrukim komorbiditetima.

Studija ukazuje na visoku prevalenciju potencijalnog antiholinergičkog opterećenja među starijim osobama, posebno kod pacijenata sa polifarmacijom i višestrukim komorbiditetima, naglašavajući značaj pregleda terapije i unapređenja farmaceutske zdravstvene zaštite radi optimizacije terapijskih ishoda i smanjenja rizika od neželjenih efekata lekova.

FZZ-P20 ANTICHOLINERGIC BURDEN SCALE IN PATIENTS AGED 65 YEARS AND OLDER IN THE MUNICIPALITY OF GORNJI MILANOVAC, SERBIA

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Anticholinergic burden is a clinically relevant issue in older adults due to its association with cognitive and functional decline. The aim of this study was to assess the prevalence and risk factors associated with potential anticholinergic burden among individuals aged 65 years and older in the municipality of Gornji Milanovac, Serbia.

A descriptive cross-sectional study was conducted among individuals aged 65 years and older during May 2023. Data on demographic characteristics, diagnoses, and prescribed medications were collected through an anonymous questionnaire following informed consent. Anticholinergic burden was assessed using the Anticholinergic Burden Scale for German Prescribers developed by *Kiesel et al*., adapted to medications registered in the Republic of Serbia.

The study included 200 participants with a mean age of 75.05±7.0 years, of whom 63% were female. The mean anticholinergic burden score was significantly higher in women than in men (2.65 vs. 2.11; $p<0.05$). Overall, 40.5% of participants had an anticholinergic burden score greater than 3. No statistically significant differences in anticholinergic burden scores were observed between age groups. However, a significant positive correlation was found between the number of medications used and the anticholinergic burden score ($p<0.001$). Anticholinergic burden scores greater than 3 were recorded in 43.43% of participants with multiple comorbidities.

A high prevalence of potential anticholinergic burden was observed among older adults, particularly in those with polypharmacy and multiple comorbidities. These findings highlight the importance of medication review and enhanced pharmaceutical care in optimizing therapeutic outcomes and minimizing the risk of adverse drug effects.

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FZZ-P21 KLINIČKI ZNAČAJNE INTERAKCIJE LEKOVA U TERAPIJI KARDIOVASKULARNIH BOLESTI – PRIKAZI SLUČAJEVA

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Interakcije lekova se definišu kao kvalitativne i kvantitativne promene delovanja jednog leka usled prisustva drugog. Zahvaljujući komorbiditetima koji prate kardiovaskularne bolesti, u okviru složene primenjene terapije može se očekivati visoka prevalenca interakcija, zbog čega može doći do narušavanja efikasnosti i bezbednosti terapijeCilj ovog rada bio je pružanje farmaceutske zdravstvene zaštite pacijentima obolelim od kardiovaskularnih bolesti sa komorbiditetima u cilju identifikacije i rešavanja terapijskih problema. U radu je primenjena deskriptivna, kvalitativna, neeksperimentalna studija slučaja, a istraživanje sprovedeno pomoću koncepta i plana farmaceutske zdravstvene zaštite. Identifikacija klinički značajnih interakcija izvršena pomoću baza podataka: „*Drug interaction checker*“ i „Drugs.com®“. Pregled terapije sproveden je kod dva kardiovaskularna pacijenta, koji svoju hroničnu terapiju dobijaju u javnoj apoteci.

Prvi slučaj predstavlja petogodišnje praćenje tridesetogodišnjeg kandidata za transplantaciju srca. Tokom ovog perioda identifikovana je ozbiljna interakcija između klaritromicina i rivaroksabana, za vreme lečenja pneumonije, kao i kontraindikovana primena ivabradina. Obzirom na redovnu primenu amjodarona, prilikom lečenja nekomplikovanog cistitisa kod istog pacijenta detektovane su ozbiljne interakcije sa ciprofloksacinom, a u okviru terapije dislipidemije, i interakcija sa simvastatinom.

U drugom slučaju opisana je korekcija duplirane antihipertenzivne terapije starog, gojaznog pacijenta, isključivanje teofilina kao nepotrebnog leka u terapiji bolesti pluća, dok je zarad lakšeg lečenja anemije sugerisana zamena acenokumarola rivaroksabanom. Kod pacijenta je tokom savetovanja otkriven i nelečen dijabetes, sugerisana konsultacija sa lekarom, uvođenje metformina, dapagliflozina kao i razmatranje upotrebe semaglutida u svrhu gubitka telesne mase i poboljšanja opšteg stanja. Primenom farmaceutske zdravstvene zaštite u oba slučaja, prevenirani su potencijalni uzroci koji su uticali na efikasnost i bezbednost primenjene terapije.

FZZ-P21 CLINICALLY SIGNIFICANT DRUG-DRUG INTERACTIONS IN THE PHARMACOTHERAPY OF CARDIOVASCULAR DISEASES: CASE REPORTS

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Drug–drug interactions (DDIs) are defined as qualitative or quantitative changes in the effects of one drug caused by the presence of another. Patients with cardiovascular diseases often have multiple comorbidities requiring complex pharmacotherapy, increasing the risk of clinically significant DDIs that may compromise treatment efficacy and safety. This study aimed to evaluate the role of pharmaceutical care in identifying and resolving drug therapy problems in patients with cardiovascular diseases and comorbidities. A descriptive, qualitative, non-experimental case study was conducted using the pharmaceutical care process. Clinically significant DDIs were identified with the Drug Interaction Checker and Drugs.com® databases during medication reviews of two patients receiving chronic therapy in a community pharmacy.

The first case involved a 30-year-old heart transplant candidate followed for five years. A major interaction between clarithromycin and rivaroxaban was identified during pneumonia treatment, together with the contraindicated use of ivabradine. Because patient was receiving chronic amiodarone therapy, ciprofloxacin prescribed for uncomplicated cystitis posed additional major interactions, while simvastatin therapy required modification because of its interaction with amiodarone.

The second case involved an elderly, obese patient whose duplicate antihypertensive therapy was corrected and unnecessary theophylline discontinued. To simplify anemia management, replacement of acenocoumarol with rivaroxaban was recommended. Pharmaceutical counseling also revealed previously untreated diabetes mellitus, prompting referral to a physician and recommendations to initiate metformin and dapagliflozin, with consideration of semaglutide for weight reduction and improved overall health.

In both cases, pharmaceutical care prevented potential causes of reduced treatment effectiveness and medication-related safety problems, demonstrating the value of pharmacists in optimizing cardiovascular pharmacotherapy.

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FZZ-P22 FARMACEUTSKA ZDRAVSTVENA ZAŠTITA PACIJENATA SA ANKSIOZNOŠĆU I DEPRESIJOM: PERCEPCIJA FARMACEUTA I PREPREKE U PRAKSI

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Savremena uloga farmaceuta u zbrinjavanju pacijenata sa poremećajima mentalnog zdravlja obuhvata strukturirano savetovanje, podršku adherenci i interprofesionalnu saradnju. Cilj ovog istraživanja bio je da se proceni percepcija farmaceuta o pružanju farmaceutske zdravstvene zaštite pacijentima sa anksioznošću i depresijom. Studija preseka sprovedena je među 143 farmaceuta iz Srbije i regiona između 2022. i 2026. godine. Podaci su prikupljeni korišćenjem strukturisanog upitnika koji je obuhvatao sociodemografske karakteristike i nivo saglasnosti sa 10 tvrdnji na Likert skali. Primenjeni su neparametarski statistički testovi sa nivoom značajnosti $p < 0,05$. Unutrašnja konzistentnost ankete je procenjena korišćenjem *Cronbach's alpha* ($\alpha_{anksioznost} = 0,869$; $\alpha_{depresija} = 0,865$). Učesnike su pretežno činile žene (87,4%), prosečne starosti 37,85 ± 10,34 godina, sa 11,92 ± 10,11 godina radnog iskustva. Većina ispitanika radila je u javnim apotekama (92,3%). Nisu uočene razlike u percepciji zbrinjavanja pacijenata sa anksioznošću i depresijom, što ukazuje na ujednačen pristup ovim poremećajima. Takođe, sociodemografski faktori poput pola, godina, dodatnog stručnog usavršavanja nisu bili značajno povezani sa učestalošću i načinom pružanja farmaceutske zdravstvene zaštite. Najčešće prijavljene aktivnosti bile su savetovanje o pravilnoj upotrebi lekova i upućivanje pacijenata lekaru (85,3%). Nasuprot tome, direktna komunikacija sa lekarima i sistematsko praćenje pacijenata prijavljeni su znatno ređe, pri čemu je više od trećine farmaceuta navelo da ih sprovodi retko ili nikada. Farmaceuti smatraju da dosledno pružaju savete o terapiji za anksioznost i depresiju, a odsustvo sociodemografskog uticaja sugeriše na relativno homogenu farmaceutsku praksu. Ipak, ograničena interprofesionalna komunikacija i praćenje ishoda predstavljaju oblasti za unapređenje, čime bi se uloga farmaceuta ojačala.

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FZZ-P22 PHARMACEUTICAL CARE OF PATIENTS WITH ANXIETY AND DEPRESSION: PHARMACISTS' PERCEPTIONS AND BARRIERS IN PRACTICE

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The evolving role of pharmacists in managing patients with mental health disorders encompasses structured patient counseling, adherence support, and interprofessional collaboration. This study aimed to assess pharmacists' perceptions of providing care to patients with anxiety and depression. A cross-sectional study was conducted among 143 pharmacists from Serbia and the region between 2022 and 2026. Data were collected using a structured questionnaire covering sociodemographic characteristics and the level of agreement with 10 statements on a Likert scale. Non-parametric statistical tests were applied, with a significance level of $p < 0.05$. Internal consistency of the instrument was evaluated using Cronbach's alpha ($\alpha_{anxiety} = 0.869$; $\alpha_{depression} = 0.865$). Participants were predominantly female (87.4%), with a mean age of 37.85 ± 10.34 years and 11.92 ± 10.11 years of experience. Most worked in community pharmacies (92.3%). No differences were observed in perceptions between anxiety and depression care, indicating a uniform approach. Furthermore, sociodemographic factors such as gender, age, and additional professional training were not significantly associated with attitudes. The most frequently reported activities were counseling on proper medication use and referring patients to a physician (85.3%). In contrast, direct communication with physicians and systematic patient follow-up were less frequently reported, with more than one-third of pharmacists indicating that they rarely or never engage in these practices. Pharmacists reported consistent counseling on proper medication use for anxiety and depression, with no sociodemographic influence, suggesting a homogeneous practice. However, limited interprofessional communication and outcome monitoring remain areas for improvement, which could further strengthen the pharmacist's role.

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BF-P1 PROCENA TERAPIJE PRIMENOM STOPP/START KRITERIJUMA, PIM-CHECK ALATA I ACB SKALE KOD STARIJIH PACIJENATA U OPŠTOJ BOLNICI UŽICE

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Neodgovarajuća farmakoterapija je sve češći problem kod starijih pacijenata zbog komorbiditeta i polifarmacije koji su česti u ovoj populaciji. Kreirano je više alata koji procenjuju terapiju kod starijih pacijenata i pružaju podršku za postizanje optimalnih ishoda terapije.

Cilj istraživanja je bio da se proceni učestalost neodgovarajuće terapije, uporede nalazi dobijeni primenom različitih alata i ustanovi stepen njihovog preklapanja i međusobna povezanost.

Istraživanje je imalo retrospektivni, opservacioni i analitički karakter, obuhvatilo je 113 pacijenata starijih od 65 godina. Terapija svakog pacijenta je procenjivana primenom STOPP/START kriterijuma, PIM-Check alata i ACB skale. U analizi je korišćen Excel MSOffice, i sledeći statistički testovi i analize: t-test, Pearsonova korelacija, analiza preklapanja. Pacijenti su dodatno podeljeni u dve grupe na osnovu vrednosti ukupnog ACB skora (≥3 i < 3).

PIM-Check je identifikovao veći broj neodgovarajuće terapije u odnosu na STOPP/START. Poređenjem nalaza PIM-Check i STOPP/START, utvrđnjeno je potpuno poklapanje kod 29 pacijenata (29,66%). Delimično preklapanje se javlja kod 70 pacijenata (61,95%). Između ova dva alata postoji statistički značajna razlika (p=0,001), što ukazuje na činjenicu da su međusobno komplementarni.

Pacijenti sa ACB score ≥3, imali su tendenciju ka većem broju STOPP nalaza, ali razlika nije bila statistički značajna, što je verovatno rezultat manjeg uzorka pacijenata koji je bio predmet istraživanja.

Rezultati pokazuju da je neodgovarajuća terapija potencijalni problem u starijoj populaciji pacijenata, te da kombinovana primena sva tri alata omogućava sveobuhvatnu procenu adekvatnosti terapije. Smatra se da ovakav pristup može doprineti optimizaciji i racionalizaciji farmakoterapije kod starijih pacijenata.

BF-P1 ASSESSMENT OF THERAPY USING STOPP/START CRITERIA, PIM-CHECK TOOL AND ACB SCALE IN ELDERLY PATIENTS AT THE GENERAL HOSPITAL UŽICE

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Inappropriate pharmacotherapy is an increasingly common issue among elderly due to comorbidities and polypharmacy, which are prevalent in this population. Several tools have been developed to assess therapy in elderly and to support the achievement of optimal treatment outcomes.

The aim of this study was to evaluate the prevalence of inappropriate therapy, compare the findings obtained through different assessment tools, and determine the extent of their overlap and mutual correlation.

This retrospective, observational and analytical study included 113 patients, aged 65 years and older. Each patient's therapy was evaluated using the STOPP/START criteria, the PIM-Check tool and the ACB scale. Excel spreadsheets and functions- t-test, Pearson correlation and overlap analysis- were used for data processing. Patients were additionally divided into two groups based on their ACB score (≥3 and <3).

PIM-Check identified a higher number of inappropriate therapies compared to STOPP/START. When comparing PIM-Check and STOPP/START findings, complete overlap was observed in 29 patients (29.66%), while partial overlap was in 70 patients (61.95%). A statistically significant difference was found between the two tools (p=0,001), indicating that they are complementary.

Patients with an ACB score ≥3 tended to have a higher number of STOPP findings, although the difference was not statistically significant, likely due to the relatively small sample size.

The results indicate that inappropriate therapy is a substantial issue and that the combined use of all three tools enables a comprehensive assessment of therapy appropriateness. This approach is considered beneficial for optimizing and rationalizing pharmacotherapy in elderly.

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BF-P2 PREGLED LEKOVA KOD STARIJIH PACIJENATA SA SRČANOM INSUFICIJENCIJOM

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Sa starenjem dolazi do postepenih promena u funkciji vitalnih organa, što posledično može izmeniti farmakokinetiku i farmakodinamiku lekova. Politerapija stvara mogućnost lek-lek interakcija, što dodatno usložnjava farmakoterapiju kod starijih pacijenata.

Cilj rada je bio da se ispita adekvatnost propisane terapije kod starijih pacijenata sa srčanom insuficijencijom.

Ispitivanje je sprovedeno kod 100 pacijenata lečenih u Institutu za lečenje i rehabilitaciju "Niška Banja" starijih od 65 godina i obolelih od srčane insuficijencije. Za procenu adekvatnosti propisanih lekova primenjena je verzija 3 STOPP i START kriterijuma.

Ustanovljeno je da je broj lekova po pacijentu 10,43 ± 2,59. Lek-lek interakcije nisu zastupljene u velikoj meri – jedna je aspirin i klopidogrel, druga - antiagregacioni agensi i antagonist vitamina K, direktni inhibitor trombina ili NOAK i treća – NOAK i P-glikoprotein inhibitor. Utvrđeno je prisustvo manje od 3% STOPP kriterijuma u odnosu na ukupan broj lekova i manje od 9% potencijalnih START kriterijuma. Najviše zastupljen STOPP kriterijum bio je C4, a potencijalni START B8.

Utvrđeno je da ispitanici imaju propisane lekove u skladu sa smernicama za lečenje srčane insuficijencije. Korišćenje alata za adekvatno propisivanje lekova može uticati na poboljšanje propisivanja lekova kod gerijatrijske populacije. S tim u vezi, učešće farmaceuta može doprineti racionalizaciji farmakoterapije.

BF-P2 REVIEW OF DRUGS IN ELDERLY PATIENTS WITH HEART FAILURE

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Pharmacokinetics and pharmacodynamics of drugs change with aging. Polytherapy creates the possibility of drug-drug interactions, which further complicates pharmacotherapy in elderly patients.

The aim of the work was to examine the adequacy of prescribed therapy in elderly patients with heart failure.

The study was conducted in 100 patients treated at the Institute for Treatment and Rehabilitation "Niška Banja" over 65 years of age and suffering from heart failure. Version 3 of the STOPP and START criteria was used to assess the adequacy of prescribed medications.

It was found that the number of drugs per patient is 10.43 ± 2.59. Drug-drug interactions - one is aspirin and clopidogrel, the other - antiplatelet agents and vitamin K antagonist, direct thrombin inhibitor or NOAC and the third - NOAC and P-glycoprotein inhibitor. The presence of less than 3% of STOPP criteria in relation to the total number of drugs and less than 9% of potential START criteria was determined. The most represented STOPP criterion was C4, and the potential START was B8.

It was established that the subjects were prescribed medications in accordance with the guidelines for the treatment of heart failure. The participation of pharmacists can contribute to the rationalization of pharmacotherapy.

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BF-P3 PREDIKTORI NEŽELJENIH EFEKATA PSIHOFARMAKOTERAPIJE KOD HOSPITALIZOVANIH ADOLESCENATA: FARMAKOEPIDEMIOLOŠKA STUDIJA

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Neželjeni efekti psihofarmakoterapije kod adolescenata predstavljaju značajan klinički problem zbog razvojnih specifičnosti, metaboličke vulnerabilnosti i česte primene kombinovane terapije. Cilj rada bio je da se identifikuju faktori rizika za razvoj neželjenih efekata psihofarmakoterapije kod hospitalizovanih adolescenata. Sprovedena je retrospektivna farmakoepidemiološka studija tipa slučaj–kontrola na Odeljenju za adolescente Klinike za psihijatrijske bolesti „Dr Laza Lazarević" u Beogradu. Istraživanjem je obuhvaćeno 175 adolescenata uzrasta 12–18 godina lečenih psihofarmacima. Analizirani su demografski, klinički, farmakoterapijski, biohemijski i fiziološki parametri. Za identifikaciju nezavisnih prediktora primenjene su multivarijantna linearna i logistička regresiona analiza. Prosečan broj primenjenih lekova iznosio je 2,53, a prosečna dužina hospitalizacije 17,47 dana. Neurološki rizik bio je prisutan kod 93,3% pacijenata, metabolički kod 79,8%, hematološki kod 57,3%, a kardiovaskularni kod 25,8%, pri čemu je 87,6% adolescenata imalo najmanje dva istovremena sistemska rizika. Olanzapin (β=0,48; p=0,009), veći broj lekova (β=0,21; p=0,016) i viši indeks telesne mase, BMI (β=0,31; p<0,001) bili su nezavisni prediktori povišene glukoze. Metabolički poremećaji bili su značajno povezani sa primenom olanzapina (odnos rizika, OR=3,2), politerapijom (OR=2,6) i BMI>25 (OR=4,8). Valproat je bio povezan sa porastom ALT i AST, dok je risperidon predstavljao najznačajniji prediktor hiperprolaktinemije (β=210 mIU/L; p<0,001), uz dodatni uticaj ženskog pola. Neželjeni efekti psihofarmakoterapije kod adolescenata rezultat su međusobnog delovanja farmakoloških, metaboličkih i individualnih faktora rizika. Racionalizacija politerapije, redovan laboratorijski monitoring i individualizacija terapije mogu doprineti smanjenju učestalosti neželjenih efekata i unapređenju bezbednosti lečenja.

BF-P3 PREDICTORS OF ADVERSE EFFECTS OF PSYCHOPHARMACOTHERAPY IN HOSPITALIZED ADOLESCENTS: A PHARMACOEPIDEMIOLOGICAL STUDY

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Adverse effects of psychopharmacotherapy in adolescents are a major clinical concern due to developmental vulnerability, metabolic susceptibility, and frequent combination therapy. This study aimed to identify predictors of adverse effects associated with psychopharmacotherapy in hospitalized adolescents. A retrospective case–control pharmacoepidemiological study was conducted at the Adolescent Department of the Clinic for Mental Disorders "Dr Laza Lazarević", Belgrade, Serbia. The study included 175 adolescents aged 12–18 years treated with psychotropic medications during hospitalization. Demographic, clinical, pharmacotherapeutic, biochemical, and physiological variables were analyzed. Independent predictors were identified using multivariate linear and logistic regression analyses. The mean number of prescribed psychotropic drugs was 2.53, and the mean hospital stay was 17.47 days. Neurological risk was identified in 93.3% of patients, metabolic risk in 79.8%, hematological risk in 57.3%, and cardiovascular risk in 25.8%; 87.6% had at least two concomitant systemic risks. Olanzapine (β=0.48, p=0.009), polypharmacy (β=0.21, p=0.016), and higher body mass index, BMI (β=0.31, p<0.001) independently predicted elevated blood glucose. Metabolic disorders were associated with olanzapine (odds ratio, OR=3.2), polypharmacy (OR=2.6), and BMI >25 (OR=4.8). Valproate was associated with elevated ALT and AST levels, whereas risperidone was the strongest predictor of hyperprolactinemia (β=210 mIU/L, p<0.001), with female sex as an additional risk factor. Adverse effects of psychopharmacotherapy in adolescents result from the interaction of pharmacological, metabolic, and individual factors. Rationalizing polypharmacy, routine laboratory monitoring, and individualized treatment may reduce adverse drug reactions and improve the safety of psychopharmacotherapy in adolescents.

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BF-P4 PETOGODIŠNJA ANALIZA POTROŠNJE ANTIPSIHOTIKA U KLINICI ZA PSIHIJATRIJSKE BOLESTI „DR LAZA LAZAREVIĆ“ U PERIODU 2020–2024. GODINE

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Analiza potrošnje lekova predstavlja važan pokazatelj racionalne farmakoterapije i kvaliteta zdravstvene zaštite. Primena WHO ATC/DDD metodologije omogućava standardizovano praćenje upotrebe lekova i poređenje između zdravstvenih ustanova i zemalja. Cilj rada bio je analiza petogodišnje potrošnje antipsihotika u Klinici za psihijatrijske bolesti „Dr Laza Lazarević“ u periodu 2020–2024. godine.

Sprovedena je retrospektivna farmakoepidemiološka analiza bolničke potrošnje antipsihotika za period od 1. januara 2020. do 31. decembra 2024. godine. Potrošnja je analizirana primenom WHO ATC/DDD metodologije i izražena kao broj definisanih dnevnih doza na 100 bolesničkih dana (DDD/100 BD).

Lekovi za nervni sistem činili su 89,7–97,6% ukupne bolničke potrošnje. Najzastupljeniji antipsihotici bili su olanzapin, haloperidol, klozapin i paliperidon. Zabeležen je porast potrošnje risperidona (+105,6%), kvetiapina (+92,7%), aripiprazola (+27,0%) i olanzapina (+9,9%), dok je kariprazin uveden u terapiju 2023. godine. Istovremeno, smanjena je potrošnja klozapina (−22,6%), haloperidola (−8,0%) i flufenazina (−1,9%), dok je potrošnja paliperidona ostala stabilna. Tokom pandemije COVID-19 registrovan je manji broj hospitalizacija uz povećanu potrošnju antiinfektivnih lekova i antikoagulanata.

Dominacija antipsihotika druge generacije u skladu je sa izveštajima Agencije za lekove i medicinska sredstva Srbije (ALIMS), prema kojima olanzapin predstavlja najčešće korišćeni atipični antipsihotik. Slični obrasci zabeleženi su u Nemačkoj i Francuskoj, gde olanzapin, risperidon i aripiprazol dominiraju u potrošnji, uz kontinuirano smanjenje primene tipičnih antipsihotika. Veća zastupljenost haloperidola i klozapina u našoj ustanovi verovatno odražava specifičnosti tercijarnog psihijatrijskog centra koji leči akutne i terapijski rezistentne pacijente.

BF-P4 FIVE-YEAR ANALYSIS OF ANTIPSYCHOTIC DRUG UTILIZATION AT THE CLINIC FOR MENTAL DISORDERS “DR LAZA LAZAREVIĆ”, BELGRADE, SERBIA, 2020–2024

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Drug utilization analysis is an important indicator of rational pharmacotherapy and healthcare quality. The World Health Organization (WHO) Anatomical Therapeutic Chemical/Defined Daily Dose (ATC/DDD) methodology enables standardized monitoring of drug utilization patterns and comparisons among healthcare institutions and countries. The aim of this study was to analyze antipsychotic drug utilization at the Clinic for Psychiatric Disorders during the 2020–2024.

A retrospective pharmacoepidemiological analysis of inpatient antipsychotic utilization was conducted using hospital drug consumption data collected between January 1, 2020, and December 31, 2024. Drug utilization was assessed according to the WHO ATC/DDD methodology and expressed as Defined Daily Doses per 100 bed-days.

Drugs acting on the nervous system accounted for 89.7%–97.6% of total inpatient drug utilization. The most frequently used antipsychotics were olanzapine, haloperidol, clozapine, and paliperidone. Utilization increased for risperidone (+105.6%), quetiapine (+92.7%), aripiprazole (+27.0%), and olanzapine (+9.9%), while cariprazine was introduced into clinical practice in 2023. In contrast, utilization of clozapine (−22.6%), haloperidol (−8.0%), and fluphenazine (−1.9%) declined, whereas paliperidone utilization remained stable. During the COVID-19 pandemic, reduced hospital admissions were accompanied by increased utilization of anti-infective agents and anticoagulants.

The predominance of second-generation antipsychotics is consistent with reports from the Serbian Medicines and Medical Devices Agency (ALIMS) and with utilization patterns reported in the Germany and France, where olanzapine, risperidone, and aripiprazole predominate. The relatively higher utilization of haloperidol and clozapine in our institution likely reflects the role of a tertiary psychiatric referral center treating acute and treatment-resistant patients.

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BF-P5 KVALITET ŽIVOTA I ZADOVOLJSTVO ŽIVOTOM KOD PACIJENATA SA SHIZOFRENIJOM

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Kako bi se postiglo osećanje zadovoljstva životom, neophodno je identifikovati faktore koji dovode do ostvarivanja dobrog kvaliteta života. Procena kvaliteta života kod pacijenata sa shizofrenijom predstavlja značajan pokazatelj uspešnosti terapije i planiranja terapijskih intervencija. Cilj ovog istraživanja je bio utvrđivanje najznačajnijih faktora koji utiču na kvalitet života pacijenata koji boluju od shizofrenije, smeštenih u ustanovi socijalne zaštite. Istraživanje je obuhvatilo sprovođenje kliničke, opservacione studije preseka u Zavodu za smeštaj odraslih lica „Male Pčelice" u Kragujevcu primenom Upitnika o kvalitetu života i zadovoljstvu životom – kratka verzija (*The Quality of Life Enjoyment and Satisfaction Questionnaire – Short Form* (*The Q-LES-Q-SF*)). Sociodemografski i klinički podaci o faktorima koji mogu uticati na kvalitet života ispitivane populacije su ekstrahovani iz medicinske dokumentacije 287 korisnika zavoda. Za identifikaciju faktora koji su uticali na vrednost skora korišćenog upitnika upotrebljena je višestruka linearna regresiona analiza. Prosečna vrednost skora korišćenog upitnika je bila 65,997±13,796, što ukazuje na narušen kvalitet života ispitivane populacije prema skoru upitnika *The Q-LES-Q-SF*. Rezultat poslednjeg koraka sprovedene višestruke linearne regresione analize za *Q-LES-Q-SF* skor je ukazivao da su dužina boravka u instituciji (β = -0,164, p = 0,004) i broj psihijatrijskih neželjenih dejstava antipsihotika (β = -0,314, p = 0,000) bili najznačajni faktori koji su negativno uticali na vrednosti skora *Q-LES-Q-SF*. Dužina boravka u instituciji i psihijatrijska neželjena dejstva antipsihotika bili su najznačajniji faktori povezani sa nižim kvalitetom života ispitanika. Rezultati ukazuju na značaj optimizacije antipsihotične terapije, praćenja bezbednosti lečenja i planiranja multidisciplinarnih intervencija usmerenih na očuvanje i unapređenje kvaliteta života.

BF-P5 KNOWLEDGE, PATIENT SATISFACTION AND QUALITY OF LIFE IN PEOPLE WITH SCHIZOPHRENIA

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In order to achieve life satisfaction, it is necessary to identify the essential factors that lead to a high quality of life. Assessing quality of life in patients with schizophrenia represents a significant indicator of treatment success and guides the strategic planning of therapeutic interventions. The aim of this study was to determine the most significant factors influencing the overall quality of life of these institutionalized schizophrenic patients. The research involved conducting a clinical, observational, cross-sectional study at the Institution for the Accommodation of Adults 'Male Pcelice' in Kragujevac. Well-being was evaluated using *The Quality of Life Enjoyment and Satisfaction Questionnaire – Short Form* (*The Q-LES-Q-SF*). Socio-demographic and clinical data regarding the relevant factors were extracted from the medical records of 287 institution residents. Multiple linear regression analysis was applied to identify the most significant predictive factors influencing the final questionnaire score values. The mean score of the questionnaire was 65.997±13.796, indicating an impaired health-related quality of life within the surveyed population. The final step of the multiple linear regression analysis for the *Q-LES-Q-SF* score indicated that the length of institutional stay (β = -0.164, p = 0.004) and the number of psychiatric adverse effects of antipsychotics (β = -0.314, p = 0.000) were the primary factors that negatively influenced the *Q-LES-Q-SF* score values. Ultimately, prolonged institutionalization and frequent antipsychotic-induced side effects were key drivers of lower quality of life. The results emphasized the critical need for optimizing antipsychotic therapy, monitoring treatment safety, and planning multidisciplinary interventions aimed at preserving well-being.

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BF-P6 PREKOMERNA UPOTREBA ANKSIOLITIKA U REPUBLICI SRBIJI U PERIODU OD 2014. DO 2023. GODINE

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Anksiolitici (benzodiazepini: bromazepam, lorazepam, alprazolam, diazepam i dr.) su depresori centralnog nervnog sistema namenjeni kratkotrajnom lečenju teških anksioznih poremećaja (2–4 nedelje, maksimalno 8–12 nedelja). Dugotrajna upotreba nosi visok rizik od zavisnosti, kognitivnih i motoričkih oštećenja, dok nagli prestanak izaziva apstinencijalni sindrom. Zbog narušavanja psihomotornih sposobnosti, tokom terapije zabranjeno je upravljanje vozilima i mašinama, dok se kod starijih pacijenata preporučuje smanjenje doze za 50%.

U radu je primenjena retrospektivna komparativna analiza javno dostupnih zdravstvenih i epidemioloških baza podataka. Analizirani su promet i potrošnja anksiolitika u Republici Srbiji (2014–2023) primenom ATC/DDD metodologije (definisana dnevna doza-DDD), na osnovu zvaničnih podataka Agencije za lekove i medicinska sredstva (ALIMS).

Prosečna potrošnja anksiolitika u posmatranom periodu iznosila je 109,12 DDD/1000 stanovnika/dan, što je višestruko više u odnosu na podatke Organizacije za ekonomsku saradnju i razvoj (OECD) za posmatrani period. (npr. Danska 6,27; Norveška 14,58; Francuska 45,32; Slovenija 13,10; Hrvatska 85,47; DDD/1000 stanovnika/dan).

Najniža potrošnja u Republici Srbiji zabeležena je 2017. godine nakon uvođenja e-recepta (83,19 DDD/1000 stanovnika/dan). Međutim, registrovan je nagli rast tokom pandemije COVID-19, sa pikom dostignutim u 2022. godini (123,89 DDD/1000 stanovnika/dan, odnosno 21,6 miliona izdatih pakovanja).

Nacionalni vodič u kome se definiše pravilna primena anksiolitika je izdat 2012. godine. Pravilnikom o listi lekova koji se propisuju na teret obaveznog zdravstvenog osiguranja uređuje se propisivanje i izdavanje lekova putem e-recepta. Međutim, kontinuirano visoka potrošnja anksiolitika ukazuje na izostanak dugoročnog efekta postojećih regulatornih mera, što nameće potrebu za daljim istraživanjima uzroka njihove primene i definisanjem mera za unapređenje racionalne upotrebe ovih lekova.

BF-P6 OVERUSE OF ANXIOLYTICS IN THE REPUBLIC OF SERBIA BETWEEN 2014 AND 2023

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Anxiolytics (benzodiazepines: bromazepam, lorazepam, alprazolam, diazepam etc.) are depressors of CNS indicated for short-term treatment of severe anxiety disorders (recommended 2-4 weeks, maximum of 8-12 weeks) . Prolonged use presents significant risks, including addiction, cognitive and psychomotor impairment, and abstinence syndrome. Consequently, 50% lower dosages are required for elderly patients, and operating machinery or driving is contraindicated during therapy.

This study conducted a retrospective comparative analysis using publicly available medical and epidemiological databases. Anxiolytic consumption in the Republic of Serbia was evaluated using the WHO ATC/DDD methodology (DDD – Defined Daily Dosage) based on official data from the Medicines and Medical Agency of Serbia (ALIMS).

Serbia exhibited a remarkably high average consumption rate of 109.12 DDD/1,000 citizens/day, significantly exceeding OECD international benchmarks (e.g., Denmark: 6.27; Norway: 14.58; France: 45.32; Slovenia: 13.10; Croatia: 85.47 DDD/1000 citizens/day). Although consumption reached a lower point in 2017 following the implementation of electronic prescriptions (83.19 DDD/1,000 citizens /day), usage surged during the COVID-19 pandemic, peaking in 2022 at 123.89 DDD/1,000 /day (representing 21.6 million boxes).

A national guide defining the correct use of anxiolytics was issued in 2012. The Rulebook on the List of Medicines Prescribed at the Charge of Mandatory Health Insurance regulates the prescribing and issuing of medicines via e-prescription. However, the continuously high consumption of anxiolytics indicates the lack of long-term effect of existing regulatory measures, which imposes the need for further research into the causes of their use and the definition of measures to promote the rational use of these drugs.

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BF-P7 RANO I ODRŽIVO POBOLJŠANJE KVALITETA ŽIVOTA NAKON ZAPOČINJANJA BIOLOŠKE TERAPIJE KOD PACIJENATA SA INFLAMATORNIM BOLESTIMA CREVA

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Biološka terapija je značajno promenila pristup lečenju inflamatornih bolesti creva (IBD). Cilj istraživanja je bio da se proceni promena u kvalitetu života povezanog sa zdravljem (HRQoL) nakon uvođenja terapije. Prospektivno je praćen HRQoL u monocentričnoj longitudinalnoj opservacionoj kohorti bolesnika sa IBD kod kojih je započeta biološka terapija. Upitnik IBDQ-32 (domeni crevnih simptoma, sistemskih simptoma, emocionalnog funkcionisanja i socijalnog funkcionisanja; ukupni skor 32–224) popunjavan je na početku terapije, nakon 3 i 12 meseci (n=113/110/89). Promene tokom vremena analizirane su primenom linearnih mešovitih modela sa slučajnim odsečkom po bolesniku. Za poređenje vremenskih tačaka korišćena je *Holm* korekcija, a veličina efekta procenjena je pomoću uparenog *Cohen*-ovog d (95% *CI*). Relativni doprinos promena pojedinačnih domena ukupnom poboljšanju IBDQ skora procenjen je multiplom linearnom regresijom sa standardizovanim regresionim koeficijentima (β). Ukupan IBDQ skor povećan je sa 158±34,8 na početku terapije na 178±28,6 nakon 3 meseca (Δ=+21,0; d=0,93; 95% *CI* 0,69-1,17) i 189±27,5 nakon 12 meseci (Δ=+25,5; d=1,00; 95% *CI* 0,73-1,27). Sva četiri domena pokazala su velika i održana poboljšanja (d=0,77-1,01), uz značajan vremenski trend (p<0,01). Promene emocionalnog domena imale su najveću povezanost sa poboljšanjem ukupnog IBDQ skora (standardizovani β=0,37), nakon čega su sledili crevni simptomi (β=0,33). Uvođenje biološke terapije povezano je sa brzim i trajnim poboljšanjem specifičnog kvaliteta života kod bolesnika sa IBD, pri čemu emocionalno funkcionisanje i crevni simptomi predstavljaju ključne doprinose ukupnom poboljšanju kvaliteta života. Ovi nalazi ukazuju na multidimenzionalni značaj biološke terapije, koji prevazilazi samu kontrolu kliničke aktivnosti bolesti.

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BF-P7 EARLY AND SUSTAINED IMPROVEMENT IN QUALITY OF LIFE FOLLOWING BIOLOGIC THERAPY INITIATION IN INFLAMMATORY BOWEL DISEASE PATIENTS

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Biologic therapy has transformed inflammatory bowel disease (IBD) management, yet real-world data on health-related quality of life (HRQoL) trajectories following treatment initiation remain limited. We prospectively evaluated HRQoL in a single-center longitudinal observational cohort of IBD patients initiating biologic therapy. The IBDQ-32 (bowel, systemic, emotional, and social domains; total score range 32-224) was completed at treatment initiation, month 3, and month 12 (n=113/110/89). Longitudinal changes were analyzed using linear mixed-effects models with random patient intercepts and time as a fixed effect. Pairwise comparisons were adjusted using Holm correction, and paired Cohen's d (95% CI) was used to quantify effect size. The relative contribution of domain changes to total IBDQ improvement was assessed using multiple linear regression with standardized regression coefficients (β). Total IBDQ score increased from 158±34.8 at baseline to 178±28.6 at month 3 (Δ=+21.0, d=0.93, 95% CI 0.69-1.17) and 189±27.5 at month 12 (Δ=+25.5, d=1.0, 95% CI 0.73-1.27). All four domains demonstrated large and sustained improvements (d=0.77-1.01), with significant time trends across domains (p<0.01). Domain scores were highly correlated; changes in the emotional domain showed the strongest association with total IBDQ improvement (standardized β=0.37), followed by bowel symptoms (β=0.33). Initiation of biologic therapy was associated with rapid and sustained improvement in disease-specific HRQoL across all IBDQ-32 domains, with emotional well-being and bowel symptoms representing key contributors to overall HRQoL improvement. These findings emphasize the multidimensional benefits of biologic therapy beyond clinical disease control.

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BF-P8 RETROSPEKTIVNA OPSERVACIONA STUDIJA EFIKASNOSTI RISANKIZUMABA I IKSEKIZUMABA KOD PACIJENATA SA PLAK PSORIJAZOM U REALNIM USLOVIMA KLINIČKE PRAKSE

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Risankizumab (anti-IL-23) i iksekizumab (anti-IL-17A) su biološki lekovi za lečenje plak psorijaze dokazane efikasnosti u randomizovanim kliničkim studijama, sa ograničenim podacima iz realne kliničke prakse.

Cilj ove retrospektivne opservacione studije bio je da proceni i uporedi efikasnost navedenih lekova tokom prve godine lečenja plak psorijaze u realnim uslovima kliničke prakse.

Od 41 pacijenta, u studiju je uključeno 35 (risankizumab, n=17; iksekizumab, n=18), dok je šestoro isključeno zbog prethodne biološke terapije (n=3) ili alergijske reakcije (n=3; iksekizumab). U predefinisanim vremenskim intervalima, koji odgovaraju 4., 16. i 52. nedelji lečenja, meren je *Psoriasis Area and Severity Index* (PASI) skor. Izvršeno je poređenje poboljšanja PASI skora (≥75%, ≥90% i 100%). Statistička analiza je sprovedena korišćenjem *Chi-Square* testa, *Fisher*-ovog egzaktnog testa, *t*-testa i *Mann-Whitney U* testa, sa statističkom značajnošću $p<0,05$.

Zabeležena je značajno veća zastupljenost pušača (p=0,034) u grupi tretiranoj iksekizumabom i povišen indeks telesne mase, BMI (p=0,011) u grupi tretiranoj risankizumabom. Efikasnost lekova, iskazana PASI skorom bila je uporediva tokom 52 nedelje lečenja. Iako bez statističkog značaja, poređenje ukazuje na razliku u poboljšanju PASI skora za ≥90% u korist iksekizumaba (11,77% *vs.* 23,53%) u intervalu koji odgovara 4. nedelji lečenja. Istovremeno, zabeležena su tri prekida terapije iksekizumabom zbog pojave alergijske reakcije što nije bio slučaj sa risankizumabom.

Iako nije zabeležena statistički značajna razlika u efikasnosti dva leka, potrebno je nastaviti praćenje u dužem vremenskom periodu i na većem broju pacijenata.

Zahvalnica

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BF-P8 RETROSPECTIVE OBSERVATIONAL STUDY OF THE EFFECTIVENESS OF RISANKIZUMAB AND IXEKIZUMAB IN PATIENTS WITH PLAQUE PSORIASIS IN REAL-WORLD CLINICAL PRACTICE

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Risankizumab (anti-IL-23) and ixekizumab (anti-IL-17A) are biologic therapies for plaque psoriasis of proven efficacy in randomized clinical trials, while real-world evidence remains limited.

This retrospective observational study aimed to evaluate and compare the effectiveness of these therapies during the first year of plaque psoriasis treatment in real-world practice.

Out of 41 screened patients, 35 were included in the study (risankizumab, n=17; ixekizumab, n=18), while 6 were excluded due to prior biologic therapy (n=3) or due to exhibiting an allergic reaction (n=3; ixekizumab). Psoriasis Area and Severity Index (PASI) was measured in predefined time intervals corresponding to the 4th, 16th, and 52nd week of treatment. Comparison of PASI reduction (≥75%, ≥90%, 100%) was performed. Statistical analysis was conducted using the Chi-Square test, Fisher's exact test, t-test, and Mann-Whitney U test, with statistical significance set at $p<0.05$.

Significantly more smokers (p=0.034) were found in the ixekizumab-treated group, and higher body mass index, BMI (p=0.011) was found in the risankizumab-treated group. Both treatments showed comparable PASI outcomes over 52 weeks. Although not statistically significant, the comparison indicated a difference in reduction of PASI by ≥90%, favouring ixekizumab (11.77% vs. 23.53%) in the time interval corresponding to the 4th week. Three ixekizumab-treated patients discontinued due to allergic reactions, while no discontinuations occurred with risankizumab.

Although no statistically significant differences in the effectiveness of risankizumab and ixekizumab were reported, further studies are needed for longer follow-up periods and with larger sample sizes.

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BF-P9 KARDIOTOKSIČNOST ONKOLOŠKE TERAPIJE – ULOGA KLINIČKOG FARMACEUTA

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Kardiotoksičnost predstavlja jedan od najznačajnijih izazova savremene onkologije. Iako je razvoj citostatika, ciljane terapije i imunoterapije značajno unapredio ishode lečenja malignih bolesti, istovremeno dovodi do povećane učestalosti kardiovaskularnih neželjenih efekata koji mogu ograničiti primenu antineoplastične terapije i nepovoljno uticati na kvalitet života i dugoročnu prognozu pacijenata.

Cilj rada je prikaz iskustva kliničkog farmaceuta u identifikaciji, proceni i upravljanju kardiotoksičnošću i klinički značajnim interakcijama lekova kod onkoloških pacijenata.

Analizirani su pojedinačni slučajevi iz dvogodišnje prakse kliničkog farmaceuta u Centru za internističku onkologiju UKC Kragujevac, gde je zatražena farmaceutska konsultacija. Procena uzročno-posledične povezanosti neželjenih reakcija sprovedena je korišćenjem baza FAERS, VigiAccess, UpToDate Lexidrug, literature indeksirane u PubMed/MEDLINE, kao i sažetaka karakteristike lekova odobrenih od strane ALIMS-a.

Najčešće identifikovane komplikacije obuhvatale su disfunkciju leve komore sa smanjenjem ejekcione frakcije (LVEF), produženje QT intervala, proinflamatorne kardiovaskularne događaje, poremećaje koagulacije i interakcije sa oralnim antikoagulansima, arterijsku hipertenziju, vaskularne komplikacije, poremećaje metabolizma lipida i interakcije sa statinima. Uočena je značajna interindividualna varijabilnost u vremenu nastanka i težini ispoljavanja neželjenih reakcija, pri čemu su komorbiditeti, polifarmacija i interakcije lekova predstavljali važne faktore rizika.

Kontinuirano praćenje onkoloških pacijenata i pravovremeno prepoznavanje kardiotoksičnosti predstavljaju ključne preduslove za bezbednu i efikasnu primenu antineoplastične terapije. Klinički farmaceut, kao član multidisciplinarnog tima, značajno doprinosi identifikaciji i proceni rizika, prepoznavanju klinički značajnih interakcija, individualizaciji farmakoterapije i optimizaciji terapijskih ishoda. Jačanje uloge kliničkog farmaceuta u onkologiji predstavlja važan korak ka unapređenju bezbednosti pacijenata i kvaliteta zdravstvene zaštite.

BF-P9 CARDIOTOXICITY OF ONCOLOGY THERAPY – THE ROLE OF THE CLINICAL PHARMACIST

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Cardiotoxicity has become one of the major challenges in contemporary oncology. Although advances in cytotoxic chemotherapy, targeted therapies, and immunotherapy have significantly improved cancer survival, they have also increased the incidence of cardiovascular adverse events that may compromise treatment continuity, quality of life, and long-term patient outcomes.

The aim of the study was to present the clinical pharmacist's experience in identifying, assessing, and managing cardiotoxicity and clinically significant drug interactions in patients receiving anticancer therapy.

Individual patient cases requiring clinical pharmacy consultation during two years at the Center of Medical Oncology, UKC Kragujevac, Serbia, were retrospectively reviewed. Causality assessment of suspected cardiovascular adverse drug reactions was performed using FAERS, VigiAccess, UpToDate Lexidrug, PubMed/MEDLINE, and the summaries of product characteristics approved by the Medicines and Medical Devices Agency of Serbia (ALIMS).

The most frequently identified complications included left ventricular dysfunction with reduced left ventricular ejection fraction (LVEF), QT interval prolongation, inflammatory cardiovascular events, coagulation disorders and interactions involving oral anticoagulants, hypertension, vascular complications, and lipid metabolism disorders associated with statin interactions. Considerable interindividual variability was observed regarding both the onset and severity of cardiotoxicity. Comorbidities, polypharmacy, and drug–drug interactions were recognized as major contributors to cardiovascular risk.

Continuous cardiovascular monitoring is essential throughout anticancer treatment. As a member of the multidisciplinary oncology team, the clinical pharmacist plays an important role in identifying cardiotoxicity, evaluating drug-related risks, optimizing pharmacotherapy, and supporting individualized treatment strategies, thereby improving medication safety and patient outcomes. Strengthening clinical pharmacists' role improves patient safety and healthcare quality.

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BF-P10 ULOGA LABORATORIJSKIH METODA U PROCENI PRISUSTVA I UČESTALOSTI INFEKCIJE IZAZVANE BAKTERIJOM CLOSTRIDIOIDES DIFFICILE

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Clostridioides difficile kao uzročnik bolničke infekcije značajno doprinosi morbiditetu i mortalitetu hospitalizovanih pacijenata. Pouzdana laboratorijska dijagnostika ima ključnu ulogu u razlikovanju aktivne infekcije od asimptomatske kolonizacije, omogućavajući pravovremeno lečenje i kontrolu širenja infekcije u bolničkoj sredini.

Cilj rada bio je da se proceni važnost laboratorijskih metoda u utvrđivanju prisustva i učestalosti infekcije izazvane bakterijom *C. difficile* kod hospitalizovanih pacijenata analizom podataka dobijenih u rutinskom radu mikrobiološke laboratorije. Istraživanje je sprovedeno kao retrospektivna analiza laboratorijske dokumentacije Instituta za javno zdravlje Srbije „Dr Milan Jovanović Batut" u periodu od maja 2024. do decembra 2025. godine. Analizom je obuhvaćeno 1335 uzoraka stolice testirane na glutamat-dehidrogenazu (GDH) *C. difficile* (skrining metoda) i na prisustvo toksina A/B (pokazatelj aktivne infekcije). Studiju su činili uzorci simptomatskih pacijenata, sa ≥3 neformiranih stolica tokom 24 sata. Podaci o recidivima i prethodnoj antibiotskoj terapiji nisu bili dostupni.

Od ukupnog broja analiziranih uzoraka, 698 (52,3%) bilo je GDH pozitivno, dok je od GDH pozitivnih kod 353 (26,4%) potvrđeno prisustvo toksina A/B. Najveća učestalost pozitivnih nalaza zabeležena je kod dugotrajno hospitalizovanih pacijenata i kod osoba starijih od 65 godina. Rezultat se može porediti sa studijom Jovanović i saradnika (2018) sa 28,8% toksin pozitivnih sojeva poreklom od pacijenata hospitalizovanih u bolnicama u Srbiji, dok su rezultati evropskih studija varijabilni, i u literaturi se mogu naći podaci koji variraju od 2,8 do 45,9%.

Kombinovana primena GDH i toksin A/B algoritma testiranja značajna je u razlikovanju kolonizacije od infekcije, započinjanju terapije i izolacije pacijenata. Kontinuiran laboratorijski nadzor i detekcija toksigenih sojeva značajna je u kontroli bolničkih infekcija.

BF-P10 THE ROLE OF LABORATORY METHODS IN ASSESSING THE PRESENCE AND PREVALENCE OF CLOSTRIDIOIDES DIFFICILE INFECTION

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Clostridioides difficile is one of the leading causes of healthcare-associated infections and is associated with substantial morbidity and mortality among hospitalized patients. Accurate laboratory diagnosis is essential for distinguishing active infection from asymptomatic colonization, enabling timely treatment and effective infection control.

This retrospective study evaluated the role of routine laboratory testing in detecting *C. difficile* infection among hospitalized patients. Laboratory records from the Institute of Public Health of Serbia "Dr. Milan Jovanović Batut" were reviewed for the period from May 2024 to December 2025. A total of 1,335 stool samples from symptomatic patients with ≥3 unformed stools within 24 hours were analyzed. All samples were screened for glutamate dehydrogenase (GDH), followed by testing for toxins A/B to identify toxigenic strains. Data on prior antibiotic therapy and recurrent infections were unavailable.

From the total number of analyzed samples, 698 (52.3%) were GDH positive, while the presence of toxin A/B was confirmed in 353 (26.4%) of GDH positive samples. Positive findings were most frequently observed in patients over 65 years of age and in those with prolonged hospitalization. The prevalence of toxin-positive samples was comparable to previously reported data (Jovanović et al, 2018), while published European studies demonstrate considerable variation, ranging from 2.8 to 45.9%.

The combined GDH and toxin A/B testing algorithm is a valuable approach for differentiating colonization from active *C. difficile* infection. Routine laboratory surveillance supports timely diagnosis, appropriate patient management, and effective prevention and control of healthcare-associated *C. difficile* infections.

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BF-P11 STANDARDIZACIJA PRIMENE TRANEKSAMIČNE KISELINE U SPECIJALNOJ BOLNICI „VASO ĆUKOVIĆ" RISAN

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Operacija totalne endoproteze kuka (TEK) često je povezana sa značajnim perioperativnim gubitkom krvi i potrebom za transfuzijom. Traneksamična kiselina (TXA), snažan antifibrinolitik, postala je standardni deo savremenih protokola za smanjenje krvarenja i optimizaciju ishoda lečenja.

Cilj rada bio je analiza kliničke efikasnosti i bezbednosnog profila primene TXA kod pacijenata podvrgnutih primarnoj operaciji totalne endoproteze kuka.

Prva primena ampulirane TXA u Specijalnoj bolnici „Vaso Ćuković" Risan uvedena je 2011. godine. Pre toga su za svaku operaciju TEK u proseku korišćene najmanje dve jedinice krvi. Na osnovu stečenog iskustva razvijen je bolnički protokol koji podrazumeva primenu 1,0 g TXA nakon hirurškog reza i dodatnih 1,0 g tri sata nakon prve doze. Analizirani su podaci iz kliničke prakse o intraoperativnom i postoperativnom gubitku krvi i stopama transfuzije kod pacijenata sa TEK u periodu 2003–2025. Upoređene su dve grupe. Prvu je činilo 1416 pacijenata operisanih od 2003. do 2008. godine bez primene TXA, uz ukupnu potrošnju 5239 jedinica krvi (3,7 jedinica po TEK). Drugu grupu činilo je 2536 pacijenata operisanih od 2021. do 2025. godine uz primenu TXA, sa ukupno 2083 jedinice krvi (0,82 po TEK).

Primena TXA kod TEK značajno smanjuje ukupan gubitak krvi i potrebu za alogenom transfuzijom bez povećanja rizika od duboke venske tromboze ili plućne embolije. Manji gubitak krvi povezan je sa manje postoperativnih hematoma, bržim zarastanjem rane, kraćom hospitalizacijom i nižim troškovima lečenja.

BF-P11 STANDARDIZATION OF TRANEXAMIC ACID USE IN THE SPECIAL HOSPITAL "VASO ĆUKOVIĆ" RISAN

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Total hip arthroplasty (THA) is frequently associated with substantial perioperative blood loss and a consequent need for allogeneic blood transfusion. Tranexamic acid (TXA), a potent antifibrinolytic agent, has become an integral component of contemporary blood management protocols aimed at reducing perioperative bleeding and improving surgical outcomes.

Study objective was to evaluate clinical effectiveness and safety of standardized TXA administration in patients undergoing primary THA.

Intravenous TXA was first introduced at the Special Hospital "Vaso Ćuković" in Risan in 2011. Before its implementation, patients undergoing THA routinely required at least two units of blood per procedure. Based on accumulated clinical experience, a standardized institutional protocol was established consisting of 1.0 g TXA administered immediately after the surgical incision, followed by additional 1.0 g three hours later. Clinical data on perioperative blood loss and transfusion requirements from patients undergoing THA between 2003 and 2025 were retrospectively analyzed. Two cohorts were compared: 1416 patients treated between 2003 and 2008 without TXA and 2536 patients treated between 2021 and 2025 according to the standardized TXA protocol

Patients operated without TXA required a total of 5,239 units of blood (3.7 units per THA). Patients receiving TXA required 2,083 units (0.82 per procedure).

Standardized TXA administration during primary THA significantly reduces blood loss and the need for allogeneic transfusion without increasing the incidence of deep vein thrombosis or pulmonary embolism. Reduced perioperative bleeding is also associated with fewer postoperative hematomas, improved wound healing, shorter hospital stays, and lower overall treatment costs.

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BF-P12 VEŠTAČKA INTELIGENCIJA U SLUŽBI BEZBEDNOSTI PACIJENATA: PILOT EVALUACIJA LLM-OVA ZA ANALIZU INTERAKCIJA LEKOVA

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Interakcije između lekova (DDIs) predstavljaju izazov u farmakoterapiji pacijenata sa hroničnim nezaraznim bolestima, uključujući kardiovaskularna oboljenja i dijabetes, zbog potencijalne polifarmacije i povećanog rizika od klinički relevantnih interakcija. Razvoj efikasnih metoda za ranu identifikaciju DDIs ima ključnu ulogu u unapređenju bezbednosti pacijenata. Primena savremenih digitalnih alata, poput veštačke inteligencije (AI), predstavlja potencijalni pristup za unapređenje identifikacije i interpretacije DDIs. Ovaj pilot-projekat procenjuje mogućnosti velikih jezičkih modela (LLMs) u identifikaciji i proceni DDIs. Četiri savremena LLM-a (ChatGPT, Gemini, Claude i lokalni Qwen) odabrana na osnovu učestalosti korišćenja i opšte dostupnosti, evaluirana su kroz modularni analitički okvir koji integriše sažetke karakteristika leka iz baze ALIMS-a i platformu RxList. Primenjen je dvostruki pristup: pacijentski orijentisani upiti (laički) i farmaceutski strukturirani upit (stručni) zasnovani na JSON podacima o lekovima. Analizirano je šest parova interakcija: glimepirid–ciprofloksacin, glimepirid–varfarin, metformin–ibuprofen, inzulin aspart–prednizon, atorvastatin–klaritromicin i semaglutid–inzulin aspart. Tačnost i pouzdanost odgovora procenjivani su kroz stepen podudaranja identifikacije i kategorizacije težine rizika sa referentnim izvorima. Svi modeli su prepoznali klinički značajne interakcije, uz razlike u proceni njihove težine. Gemini (r=0.91 za stručni upit) i ChatGPT (r=0.86 za oba tipa upita) pokazali su najveći stepen podudarnosti sa procenama RxList-a. Najveći izazov predstavljala je kombinacija atorvastatin–klaritromicin, gde su jedino Qwen i stručni Gemini korektno identifikovali kontraindikaciju. Pacijentski prompti generisali su konzervativnije procene rizika, dok su farmaceutski prompti omogućili preciznije razlikovanje kliničke relevantnosti. Nalazi su preliminarni, ali ukazuju na potencijal velikih jezičkih modela kao pomoćnih alata u identifikaciji i proceni DDIs, uz neophodnost dalje validacije na većim i reprezentativnijim skupovima podataka.

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BF-P12 ARTIFICIAL INTELLIGENCE FOR PATIENT SAFETY: PILOT EVALUATION OF LLMs FOR DRUG-DRUG INTERACTION ANALYSIS

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Drug–drug interactions (DDIs) represent a significant challenge in the pharmacotherapy of patients with chronic non-communicable diseases, including cardiovascular diseases and diabetes, due to polypharmacy and increased risk of clinically relevant interactions. Effective approaches for early DDI identification are essential for improving patient safety. Artificial intelligence (AI)-based tools represent a potential approach for enhancing DDI identification and interpretation. This pilot study evaluated the potential of large language models (LLMs) for DDIs identification and clinical risk assessment. Four LLMs (ChatGPT, Gemini, Claude, and the locally deployed Qwen model), selected based on widespread use and accessibility, were evaluated using a modular framework integrating drug information from the ALIMS database and the RxList platform. A dual-prompting approach was applied, including patient-oriented (layperson) queries and structured pharmacist-oriented (expert) queries based on JSON-formatted drug information. Six DDI pairs were analysed: glimepiride–ciprofloxacin, glimepiride–warfarin, metformin–ibuprofen, insulin aspart–prednisone, atorvastatin–clarithromycin, and semaglutide–insulin aspart. Model performance was assessed by comparing interaction identification and risk severity categorization with reference sources. All models identified clinically relevant interactions, although differences were observed in risk severity assessment. Gemini (r=0.91 for expert queries) and ChatGPT (r=0.86 for both query types) demonstrated the highest agreement with RxList assessments. The atorvastatin–clarithromycin combination represented the most challenging case, with only Qwen and expert Gemini correctly identifying the contraindication. Patient-oriented prompts generated more conservative risk assessments, whereas expert prompts enabled more precise differentiation of clinical relevance. These preliminary findings suggest that LLMs may serve as supportive tools for DDI assessment, although further validation using larger and more representative datasets is required.

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BF-P13 ASSESSMENT OF POTENTIALLY CLINICALLY RELEVANT IMATINIB INTERACTIONS IN PATIENTS WITH CHRONIC MYELOID LEUKEMIA: THE ROLE OF THE CLINICAL PHARMACIST

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Imatinib is a tyrosine kinase inhibitor widely used for chronic myeloid leukemia (CML). As it is predominantly metabolized by CYP3A4 and CYP3A5, concomitant medicines, herbal products, supplements, and foods may affect its efficacy and safety. This retrospective study aimed to identify potentially clinically relevant interactions in patients receiving imatinib and highlight the potential contribution of pharmacist-led medication review. Medical records of 34 patients with CML treated at the PHI University Clinic for Hematology in Skopje, North Macedonia, between April and June 2024 were reviewed by a clinical pharmacist. Potential interactions were assessed using *Stockley's Interactions Checker* and classified by clinical significance and pharmacokinetic or pharmacodynamic mechanism. Twenty-nine patients (85.3%) had at least one potential interaction. Eighteen distinct interactions were identified: seven severe and eleven moderate. The most frequently recorded interacting agents or exposures were paracetamol (76%), St John's wort-based supplements (26%), grapefruit (26%), tamsulosin (12%), atorvastatin (9%), lansoprazole (6%), lercanidipine (6%), alprazolam (6%), and metformin (6%). Severe interactions may require therapeutic modification, avoidance, or intensified monitoring, whereas moderate interactions warrant individualized assessment and follow-up. Frequently documented adverse effects included extremity pain (41%), muscle cramps (35%), nausea and vomiting (29%), and periorbital edema (26%). However, formal causality and temporal relationship assessments were unavailable, therefore these events could not be attributed to the identified interactions. As the review was retrospective, no pharmacist-initiated intervention or associated clinical outcome was evaluated. The high prevalence of potential interactions supports systematic medication reconciliation and pharmacist-led interaction assessment to promote individualized monitoring and safer imatinib therapy.

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MB-P1 USPOSTAVLJANJE POLNO- I STAROSNO-SPECIFIČNIH REFERENTNIH INTERVALA ZA REDUKOVANI GLUTATION U ERITROCITIMA U ZDRAVOJ POPULACIJI

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U rutinskim medicinsko-biohemijskim laboratorijama, poželjno je definisati sopstvene referentne vrednosti, ili verifikovati postojeće na sopstvenoj populaciji. Redukovani glutation (GSH) u eritrocitima nije rutinski parametar i za njega ne postoji opšte-primenjiv referentni interval. Iz tog razloga ispitana je distribucija njegovih vrednosti u zdravoj populaciji, sa ciljem uspostavljanja referentnog intervala. Pri tome su u obzir uzeti i značajni nepromenjivi faktori varijabilnosti – pol i starost. U istraživanje je uključeno 219 retrospektivnih podataka za vrednosti GSH, određenih spektrofotometrijskom hemijskom metodom sa DTNB reagensom u periodu između maja 2025. i jula 2026. godine. Primećeno je da su vrednosti GSH bile značajno više kod žena (4,0 (2,3 – 5,6) µmol/g Hb) u odnosu na muškarce (2,4 (1,3 – 5,0) µmol/g Hb), p=0,002. Referentni intervali su određeni u različitim starosnim kategorijama kod muškaraca i žena. Referentni interval za muškarce mlađe od 30 godina iznosio je 1,0 – 7,9 µmol/g Hb; za muškarce starosti 30-49 godina 0,5 – 7,6 µmol/g Hb; a za muškarce starosti 50 godina i više 0,2 – 8,5 µmol/g Hb. Referentni interval za žene mlađe od 30 godina iznosio je 0,7 – 10,2 µmol/g Hb; za žene starosti 30-49 godina 0,5 – 15,7 µmol/g Hb; a za žene starosti 50 godina i više 0,4 – 19,2 µmol/g Hb. Uspostavljeni polno- i starosno-specifični referentni intervali za GSH pružaju značajno usmerenje praćenju statusa oksidativnog stresa i opšteg zdravstvenog stanja pacijenata, doprinoseći uključivanju ovog parametra u rutinsku laboratorijsku praksu.

MB-P1 ESTABLISHMENT OF SEX- AND AGE-SPECIFIC REFERENCE INTERVALS FOR REDUCED GLUTATHIONE IN ERYTHROCYTES IN A HEALTHY POPULATION

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In routine medical biochemistry laboratories, it is recommended to establish laboratory-specific reference values, or to verify existing reference intervals in the local population. Reduced glutathione (GSH) in erythrocytes is not a routine laboratory parameter, and no universally applicable reference interval has been established. Therefore, the distribution of erythrocyte GSH concentrations was investigated in a healthy population with the aim of establishing reference intervals. The influence of important non-modifiable sources of biological variation, namely sex and age, was also evaluated. A total of 219 GSH measurements, determined using a spectrophotometric chemical method with DTNB reagent between May 2025 and July 2026, were retrospectively included in the study. GSH concentrations were significantly higher in women (4.0 (2.3–5.6) µmol/g Hb) than in men (2.4 (1.3–5.0) µmol/g Hb), p = 0.002. Reference intervals were established for different age and sex groups. The reference interval for men younger than 30 years was 1.0–7.9 µmol/g Hb; for men aged 30–49 years, 0.5–7.6 µmol/g Hb; and for men aged 50 years and older, 0.2–8.5 µmol/g Hb. The corresponding reference intervals for women were 0.7–10.2 µmol/g Hb, 0.5–15.7 µmol/g Hb, and 0.4–19.2 µmol/g Hb, respectively. The established sex- and age-specific reference intervals for erythrocyte GSH provide valuable guidance for assessing oxidative stress status and the overall health of patients, thereby supporting the implementation of this parameter into routine laboratory practice.

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MB-P2 VERIFIKACIJA NEKOLIKO KARAKTERISTIKA SPEKTROFOTOMETRIJSKE METODE SA DTNB REAGENSOM ZA ODREĐIVANJE KONCENTRACIJE REDUKOVANOG GLUTATIONA U HEMOLIZATU ERITROCITA

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Redukovani glutation (GSH) je mali tripeptidni molekul i jedan od glavnih elemenata antioksidativne zaštite organizma. Metoda određivanja je zasnovana na cikličnom enzimskom procesu gdje 5,5'-ditiobis(2-nitrobenzoična kiselina) (DTNB) oksiduje glutation do GSSH uz nastanak 2-nitro-5-tiobenzoične kiseline (TNB) čija se apsorbancija mjeri na 410nm, spektrofotometrijski. Ciljevi ovog rada bili su: ispitivanje uticaja načina pripreme uzorka (hemolizata) na dobijene koncentracije, ispitivanje linearnosti i tačnosti metode, kao i uticaja vremena inkubacije na intenzitet dobijene boje. Pitanje stabilnosti glutationa u zavisnosti od načina pripreme uzorka smo pokušali da rasvijetlimo poređenjem dva načina pripreme (1. sekvencijalno koje podrazumijeva zamrzavanje ispranih eritrocita i pravljenje hemolizata neposredno prije izvođenja analize i 2. zamrzavanje pripremljenog hemolizata). Poređenje je izvedeno na 4 uzorka pripremljenih na dva načina i zaključak je da je adekvatniji prvi način pripreme. Linearnost metode je ispitivana izradom kalibracione krive upotrebom osam standardnih razblaženja GSH (7,8 – 1000 µmol/L) mjerenih u duplikatu. Dobijena jednačina prave y=0,0005x-0,0043 uz r=0,999, potvrđuju adekvatnu linearnost metode. Tačnost metode je ispitivana primjenom recovery testa. Regresiona analiza za opseg dodatih koncentracija od 15,6-1000 µmol/L je pokazala odlično slaganje dodatih i izmjerenih koncentracija. Dobijena je regresiona jednačina y=0,9744x+107,8 (recovery=97,4%, a na osnovu vrijednosti koeficijenta a=107,8 utvrđena je inicijalna koncentracija GSH u pulu hemolizata od 107,8 µmol/L). Recovery vrijednost bliska 100% je prihvatljiva za rutinski rad u laboratoriji i potvrđuje tačnost metode. Intenzitet boje nakon 25 minuta inkubacije je bio stabilan do 35. minuta. Spektrofotometrijska metoda za određivanje koncentracije redukovanog glutationa ima zadovoljavajuću stabilnost, linearnost i tačnost za rutinsku primjenu u biohemijskoj laboratoriji.

MB-P2 VERIFICATION OF A SEVERAL CARACTERISTICS OF A DTNB SPECTROPHOTOMETRIC METHOD FOR DETERMINATION OF REDUCED GLUTATHION IN ERITHROCYTE HEMOLYSATE

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Reduced glutathione (GSH) is a small tripeptide molecule and one of the principal components of the body's antioxidant defense system. The GSH assay is based on an enzymatic cycling method in which 5,5'-dithiobis(2-nitrobenzoic acid) (DTNB) oxidizes glutathione to GSSG, which forms 2-nitro-5-thiobenzoic acid (TNB), which absorbance is measured spectrophotometrically at 410 nm. The aims of this study were to evaluate the effect of hemolysate preparation on the GSH concentrations, the linearity and accuracy of the method, and investigate the incubation time influence on color intensity. The glutathione stability regarding sample preparation was evaluated by comparing two procedures: (1) involving freezing of washed erythrocytes followed by preparation of the hemolysate immediately before analysis (2) preparation of the hemolysate prior to freezing. The comparison was performed using four samples prepared by both procedures, and the results indicated that the first preparation method was more appropriate. Method linearity was evaluated by constructing a calibration curve using eight GSH standard (7.8–1000 **µmol**/L), measured in duplicate. Regression equation, y = 0.0005x – 0.0043, with r = 0.999, confirmed excellent method linearity. Method accuracy was assessed using recovery test. Regression analysis over the range of added GSH concentrations (15.6–1000 **µmol**/L) demonstrated excellent agreement between the added and measured concentrations. Regression equation was y = 0.9744x + 107.8 (recovery = 97.4%), which confirms method accuracy. Color intensity remained stable until the 35th minute. The spectrophotometric method for determining blood GSH demonstrated satisfactory stability, linearity, accuracy, supporting its suitability for routine application in a biochemical laboratory.

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MB-P3 ODREĐIVANJE GLUTATIONA: ANALITIČKI IZAZOVI I KLINIČKI ZNAČAJ

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Glutation (GSH) predstavlja najznačajniji intracelularni antioksidans i regulator redoks homeostaze. Odnos redukovanog i oksidovanog glutationa (GSH/GSSG) predstavlja pouzdan biomarker oksidativnog stresa povezanog sa kardiovaskularnim, metaboličkim, neurodegenerativnim i malignim bolestima. Zbog visoke reaktivnosti i sklonosti oksidaciji, određivanje glutationa predstavlja analitički izazov. Cilj rada bio je pregled metoda za određivanje glutationa, analiza njihovih prednosti i ograničenja, kao i procena kliničkog značaja ovog biomarkera.

Izvršena je uporedna analiza dostupne literature o određivanju GSH i GSSG, sa osvrtom na radove Hamada i saradnika, Tipple i Rogers, kao i kolorimetrijsku metodu Alisika i saradnika. Analizirane su spektrofotometrijske, hromatografske, maseno-spektrometrijske, elektrohemijske i senzorske metode uz razmatranje preanalitičkih zahteva.

Analiza literature pokazala je da visokoefikasna tečna hromatografija i masena spektrometrija predstavljaju metode visoke osetljivosti i specifičnosti, ali njihovu rutinsku primenu ograničavaju visoki troškovi i složena instrumentacija. Kolorimetrijska metoda zasnovana na natrijum-borohidridu i DTNB reagensu omogućava jednostavno, precizno i ekonomično određivanje GSH, GSSG i ukupnog glutationa u eritrocitima. Novija klinička istraživanja potvrđuju da snižene vrednosti GSH i poremećen odnos GSH/GSSG predstavljaju pouzdane pokazatelje oksidativnog stresa kod pacijenata sa sepsom, opioidnom zavisnošću i karcinomom mokraćne bešike.

Standardizacija preanalitičkih procedura i razvoj jednostavnijih analitičkih metoda omogućavaju širu primenu određivanja glutationa u rutinskoj laboratorijskoj dijagnostici, dok razvoj senzorskih i point-of-care tehnologija dodatno unapređuje klinički značaj.

MB-P3 DETERMINATION OF GLUTATHIONE: ANALYTICAL CHALLENGES AND CLINICAL SIGNIFICANCE

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Glutathione (GSH) is the most important intracellular antioxidant and a regulator of redox homeostasis. Reduced to oxidized glutathione ratio (GSH/GSSG) represents a reliable biomarker of oxidative stress associated with cardiometabolic, neurodegenerative, and malignant diseases. Due to its high reactivity and susceptibility to oxidation, glutathione determination represents an analytical challenge. We aimed to review methods for glutathione determination, analyze their advantages and limitations, and assess the clinical significance of this biomarker.

A comparative analysis of the available literature was performed, with particular reference to the studies by Hamad et al., Tipple and Rogers, and the colorimetric method described by Alisik et al. Spectrophotometric, chromatographic, mass spectrometric, electrochemical, and sensor-based methods were analyzed, with consideration of preanalytical requirements.

According to available references, high-performance liquid chromatography and mass spectrometry exhibit high sensitivity and specificity; however, their routine application is limited by high costs and complex instrumentation. The colorimetric method based on sodium borohydride and DTNB reagent enables simple, precise, and cost-effective determination of GSH, GSSG, and total glutathione in erythrocytes. Recent clinical studies confirm that decreased GSH concentrations and an altered GSH/GSSG ratio are reliable indicators of oxidative stress in patients with sepsis, opioid dependence, and urinary bladder cancer.

Standardization of preanalytical procedures and the development of simpler analytical methods may enable broader application of glutathione determination in routine laboratory diagnostics, while the development of sensor-based and point-of-care technologies may further enhance its clinical significance.

MB-P4 EVALUACIJA MATEMATIČKOG MODELA ZA PROCENU KONCENTRACIJE sdLDL-HOLESTEROLA KAO INDIKATORA RIZIKA ZA NASTANAK KARDIOVASKULARNIH BOLESTI

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Kardiovaskularne bolesti predstavljaju vodeći uzrok morbiditeta i mortaliteta u svetu, a ateroskleroza je njihov osnovni patofiziološki mehanizam. Male guste LDL čestice (sdLDL) imaju izražen aterogeni potencijal i prepoznate su kao značajan biomarker kardiovaskularnog rizika. Cilj ovog rada bio je da se ispita značaj matematičkog modela za procenu koncentracije sdLDL-holesterola (E-sdLDL-C) kod pacijenata sa koronarnom arterijskom bolešću i proceni njegova povezanost sa lipidnim i inflamatornim parametrima, stepenom koronarne stenoze i kardiovaskularnim rizikom. Istraživanje je obuhvatilo 361 ispitanika, od kojih je 171 pacijent sa koronarnom arterijskom bolešću i 190 zdravih ispitanika. Koncentracije E-sdLDL-C izračunate su primenom *Sampson*-ove jednačine. Pacijenti su imali značajno više koncentracije E-sdLDL-C u odnosu na kontrolnu grupu [1,27 (1,08–1,50) prema 1,10 (0,86–1,36) mmol/L; p<0,001]. Takođe, kod pacijenata su zabeležene više koncentracije non-HDL-C (p=0,008), triglicerida (p<0,001), odnosa TG/HDL-C (p<0,001), lipoproteina(a) (p<0,001), mokraćne kiseline (p<0,001), fibrinogena (p<0,001) i hs-CRP (p<0,001), uz niže koncentracije HDL-C (p<0,001). E-sdLDL-C je pozitivno korelisao sa mokraćnom kiselinom, fibrinogenom, hs-CRP i lipoproteinom(a), a negativno sa dijametrom LDL i HDL čestica (p<0,05). Više koncentracije E-sdLDL-C bile su povezane sa većim stepenom koronarne stenoze. Logistička regresiona analiza pokazala je da E-sdLDL-C predstavlja nezavisan prediktor koronarne arterijske bolesti (OR=3,316; p=0,001). ROC analizom utvrđena je umerena dijagnostička tačnost E-sdLDL-C (AUC=0,646), dok je kombinovani model pokazao dobru sposobnost razlikovanja ispitanika sa i bez koronarne arterijske bolesti (AUC=0,753).

MB-P4 EVALUATION OF A MATHEMATICAL MODEL FOR ESTIMATING sdLDL-CHOLESTEROL CONCENTRATION AS AN INDICATOR OF CARDIOVASKULAR RISK

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Cardiovascular diseases are the leading cause of morbidity and mortality worldwide, with atherosclerosis representing their principal pathophysiological mechanism. Small dense low-density lipoprotein (sdLDL) particles exhibit pronounced atherogenic potential and have been recognized as significant biomarkers of cardiovascular risk. The aim of this study was to evaluate the significance of a mathematical model for estimating sdLDL cholesterol concentration (E-sdLDL-C) in patients with coronary artery disease and to assess its association with lipid and inflammatory parameters, the severity of coronary stenosis, and cardiovascular risk. The study included 361 participants, comprising 171 patients with coronary artery disease and 190 healthy controls. E-sdLDL-C concentrations were calculated using the Sampson equation. Patients exhibited significantly higher E-sdLDL-C concentrations compared with controls [1.27 (1.08–1.50) vs. 1.10 (0.86–1.36) mmol/L; p<0.001]. In addition, patients had higher concentrations of non-HDL-C (p=0.008), triglycerides (p<0.001), TG/HDL-C ratio (p<0.001), lipoprotein(a) (p<0.001), uric acid (p<0.001), fibrinogen (p<0.001), and hs-CRP (p<0.001), along with lower HDL-C concentrations (p<0.001). E-sdLDL-C showed positive correlations with uric acid, fibrinogen, hs-CRP, and lipoprotein(a), and negative correlations with LDL and HDL particle diameters (p<0.05). Higher E-sdLDL-C concentrations were associated with greater severity of coronary stenosis. Multivariate logistic regression analysis identified E-sdLDL-C as an independent predictor of coronary artery disease (OR = 3.316; p=0.001). ROC analysis demonstrated moderate diagnostic accuracy of E-sdLDL-C (AUC=0.646), whereas a combined model showed good discriminatory performance (AUC=0.753).

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MB-P5 ATEROGENI INDEKS PLAZME KAO PREDIKTOR TEŽINE I ANATOMSKE KOMPLEKSNOSTI KORONARNE BOLESTI PROCENJENE SYNTAX I SKOROM

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Procena težine i anatomske kompleksnosti koronarne arterijske bolesti (KAB) ključna je za donošenje terapijskih odluka i selekciju pacijenata za koronarnu revaskularizaciju. Cilj ovog rada bio je da se ispita povezanost osnovnih lipidnih parametara (ukupnog holesterola (UH), holesterola u lipoproteinima visoke i niske gustine (HDL-H i LDL-H), triglicerida (TG)), non-HDL holesterola (non-HDL-H), aterogenog indeksa plazme (AIP), indeksa TG i glukoze (TyG), Kastelijevog indeksa rizika I (UH/HDL-H) i Kastelijevog indeksa rizika II (LDL-H/HDL-H)), sa anatomskom težinom KAB-a, procenjenom pomoću SYNTAX I skora kod pacijenata sa stabilnom anginom pektoris (SAP).

U istraživanje je uključeno 248 ispitanika sa SAP-om iz KBC „Zvezdara" i KBC „Dr Dragiša Mišović - Dedinje". Na osnovu koronarografije, pacijenti su podeljeni u dve grupe: sa manjom (SYNTAXI≤ 22) i većom anatomskom kompleksnošću (SYNTAX I>22). Parametri osnovnog lipidnog statusa su određeni rutinskim biohemijskim metodama. AIP je izračunat kao logaritamski odnos koncentracija TG i HDL-H, dok je TyG indeks izračunat kao logaritamska funkcija proizvoda koncentracija TG i glukoze.

U grupi SYNTAX I>22 bila je značajno veća zastupljenost muškog pola (p<0,001), češća primena statina i beta-blokatora (p<0,001). Koncentracije HDL-H bile su značajno više u grupi SYNTAXI≤ 22 (p=0,011), dok su AIP i TyG bili značajno viši u grupi SYNTAX I>22 (p=0,001). Ostali parametri nisu pokazali značajne razlike. Multivarijantnom logističkom regresijom, nakon korekcije za demografske faktore i terapiju, jedino je AIP potvrđen kao snažan, nezavisan prediktor SYNTAX I>22. AIP može poslužiti kao koristan, neinvazivni biomarker za procenu anatomske težine KAB-a.

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MB-P5 ATHEROGENIC INDEX OF PLASMA AS A PREDICTOR OF THE SEVERITY AND ANATOMICAL COMPLEXITY OF CORONARY ARTERY DISEASE ASSESSED BY THE SYNTAX I SCORE

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Assessment of the severity and anatomical complexity of coronary artery disease (CAD) is crucial for therapeutic decision-making and selecting patients for coronary revascularization. The aim of this study was to examine the association of basic lipid parameters (total cholesterol (TC), high/low density lipoprotein cholesterol (HDL-C, LDL-C), triglycerides (TG)), non-HDL-C, atherogenic index of plasma (AIP), TG-glucose index (TyG), Castelli risk index I and II (TC/HDL-C; LDL-C/HDL-C) with the anatomical severity of CAD, assessed by the SYNTAX I score in patients with stable angina pectoris (SAP).

The study included 248 subjects with SAP from KBC "Zvezdara" and KBC "Dr Dragiša Mišović - Dedinje". Based on coronary angiography, patients were divided into two groups: lower (SYNTAX I≤22) and higher anatomical complexity (SYNTAX I>22). Lipid status parameters were determined using routine biochemical methods. AIP was calculated as the logarithmic ratio of TG and HDL-C; TyG index was calculated as a logarithmic function of the product of TG and glucose.

In the SYNTAX I>22 group, there was a significantly higher prevalence of the male gender (p<0.001), more frequent use of statins and beta-blockers (p<0.001). HDL-C was significantly higher in the SYNTAX I≤22 group (p=0.011), while AIP and TyG were significantly higher in the SYNTAX I>22 group (p=0.001). Other parameters showed no significant differences. By multivariate logistic regression, after adjusting for demographic factors and therapy, only AIP was confirmed as an independent predictor of SYNTAX I>22. AIP can serve as a useful, non-invasive biomarker for assessing the anatomical severity of CAD.

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MB-P6 SFINGOLIPIDNI PROFIL: IZVOR POTENCIJALNIH BIOMARKERA GESTACIONE GOJAZNOSTI

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Sfingolipidi predstavljaju veliku klasu lipida koji igraju značajnu ulogu u fiziološkoj trudnoći, ali mogu biti povezani i sa kardiometaboličkim komplikacijama trudnoće, pre svega preeklampsijom i gestacijskim dijabetes melitusom. Cilj ovog istraživanja bio je da se ispitaju longitudinalne promene u nivoima sfingolipida kod žena sa preporučenim i prekomernim povećanjem težine tokom trudnoće, kao i da se proceni uticaj prekomernog gestacijskog povećanja težine na sfingolipidni profil. Naša studija je obuhvatila 124 trudnice, 58 sa preporučenim i 66 sa prekomernim povećanjem težine tokom trudnoće. Prevalencija komplikacija bila je veća u grupi sa prekomernim povećanjem težine. Kvantifikacija sfingolipida (ceramid C16:0, ceramid C24:0, sfingozin, sfinganin, sfingozin-1-fosfat, sfinganin-1-fosfat i sfingomijelin) sprovedena je korišćenjem HPLC-MS/MS metode, nakon pripremnog koraka ekstrakcije uzorka. Nivoi ceramida C16:0, ceramida C24:0, sfinganina i sfingomijelina značajno su se povećavali tokom trudnoće (P<0,001), sa najvišim vrednostima u trećem trimestru, kod obe grupe ispitanica. Upoređujući nivoe sfingolipida između dve grupe pacijentkinja, primećeno je da su trudnice sa prekomernim gestacijskim povećanjem težine imale značajno niže koncentracije sfinganina u drugom i trećem trimestru (P<0,05). Pored toga, nivoi sfingozin-1-fosfata i sfinganin-1-fosfata na početku trudnoće bili su niži u ovoj grupi ispitanica, u poređenju sa onima sa preporučenim gestacijskim povećanjem težine (P<0,01). Rezultati ovog istraživanja ukazuju na to da prekomerno povećanje težine tokom trudnoće može biti povezano sa promenama u gestacijskom sfingolipidnom profilu, što potencijalno doprinosi razvoju komplikacija povezanih sa trudnoćom.

MB-P6 THE SPHINGOLIPID PROFILE: A SOURCE OF POTENTIAL BIOMARKERS FOR GESTATIONAL OBESITY

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Sphingolipids represent a large class of lipids that play a significant role in physiological pregnancy, but may also be associated with cardiometabolic pregnancy-related complications, particularly preeclampsia and gestational diabetes mellitus. This research aimed to examine longitudinal changes in sphingolipid levels in women with recommended and excessive weight gain during pregnancy, as well as to assess the impact of excessive gestational weight gain on the sphingolipid profile. Our study included 124 pregnant women, 58 with recommended and 66 with excessive pregnancy weight gain. Prevalence of complications was higher in the group with excessive weight gain. Quantification of sphingolipids (ceramide C16:0, ceramide C24:0, sphingosine, sphinganine, sphingosine-1-phosphate, sphinganine-1-phosphate and sphingomyelin) was carried out using the HPLC-MS/MS, following a preparatory sample extraction step. Levels of ceramide C16:0, ceramide C24:0, sphinganine and sphingomyelin significantly increased across trimesters (P<0.001), with the highest values in the 3rd trimester, in both groups of participants. Comparing the levels of sphingolipids between two groups of patients, it was observed that pregnant women with excessive gestational weight gain had significantly lower concentrations of sphinganine in the second and third trimesters (P<0.05). Additionally, levels of sphingosine-1-phosphate and sphinganine-1-phosphate at the beginning of pregnancy were lower in this study group, compared to those with recommended gestational weight gain (P<0.01). These results imply that excessive weight gain during pregnancy can be associated with changes in gestational sphingolipid profile, potentially contributing to the development of pregnancy-related complications.

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MB-P7 ISPITIVANJE PREDIKTIVNOG I DIJAGNOSTIČKOG ZNAČAJA KOMBINOVANIH METABOLIČKIH BIOMARKERA U MASLD

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Steatotična bolest jetre povezana sa metaboličkom disfunkcijom (MASLD) je među najvažnijim javno-zdravstvenim izazovima u savremenom svetu. Promena nomenklature i dijagnostičkih kriterijuma na osnovu Delphi konsenzusa iz 2023. godine uslovila je potrebu da se ponovo evaluiraju postojeći biomarkeri ove bolesti, posebno oni koji se oslanjaju primarno na metaboličke parametre. U ovoj studiji smo ispitali prediktivni i dijagnostički potencijal predloženih kombinovanih biomarkera hepatične steatoze, koji su izvedeni iz rutinskih hematoloških i biohemijskih analiza.

U studiji je učestvovao 91 pacijent sa MASLD i 48 zdravih osoba. Ispitivani kombinovani biomarkeri uključivali su indeks triglicerida i glukoze (TyG) i indeks udela monocita i HDL-holesterola (Mo/HDL). Za ispitivanje dijagnostičke tačnosti korišćena je analiza površina ispod ROC krivih (AUC), a za ispitivanje prediktivnog potencijala logistička regresiona analiza (odds ratio; OR).

Ispitivani indeksi TyG i Mo/HDL su se značajno razlikovali između pacijenata i zdravih ispitanika (P<0,001 za oba indeksa). Bolju dijagnostičku tačnost pokazao je TyG (AUC=0,801), dok je dijagnostička tačnost Mo/HDL bila zadovoljavajuća (AUC=0,683). Oba indeksa pokazala su značajan prediktivni potencijal za pojavu MASLD (TyG: OR=10,058, P<0,001; Mo/HDL: OR=1,387, P=0,002). Međutim, u multivarijantnom modelu koji je uključivao pol, uzrast i indeks telesne mase ispitanika, samo TyG je zadržao nezavisni dijagnostički potencijal (OR=7,170, P=0,001).

Naše istraživanje ukazalo je na značajne mogućnosti kombinovanih metaboličkih indeksa u predikciji i dijagnostici MASLD. TyG i Mo/HDL indeks izdvajaju se po jednostavnosti primene u kliničko-laboratorijskoj praksi, s obzirom da su zasnovani na lako dostupnim biohemijskim parametrima koji se rutinski određuju.

MB-P7 ASSESSMENT OF THE PREDICTIVE AND DIAGNOSTIC SIGNIFICANCE OF COMBINED METABOLIC BIOMARKERS IN MASLD

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Metabolic dysfunction-associated steatotic liver disease (MASLD) is one of the major public health challenges of the modern era. The change in nomenclature and diagnostic criteria introduced by the 2023 Delphi consensus has highlighted the need to re-evaluate existing biomarkers of this disease, particularly those based on metabolic parameters. In this study, we investigated the predictive and diagnostic potential of proposed combined biomarkers of hepatic steatosis derived from routine hematological and biochemical analyses.

The study involved 91 patients with MASLD and 48 healthy controls. The investigated combined biomarkers were the triglyceride-glucose index (TyG) and the monocyte-to-HDL cholesterol ratio (Mo/HDL). Diagnostic accuracy was assessed using receiver operating characteristic curve analysis and the area under the curve (AUC), while predictive potential was evaluated by logistic regression analysis using odds ratios (OR).

TyG and Mo/HDL differed significantly between patients and healthy controls (P<0.001 for both). TyG showed better diagnostic accuracy (AUC=0.801), whereas the diagnostic accuracy of Mo/HDL was satisfactory (AUC=0.683). Both indices demonstrated significant predictive potential for MASLD occurrence (TyG: OR=10.058, P<0.001; Mo/HDL: OR=1.387, P=0.002). However, in the multivariate model including sex, age, and body mass index, only TyG retained independent diagnostic potential (OR=7.170, P=0.001).

Our findings indicate a significant potential of combined metabolic indices in the prediction and diagnosis of MASLD. TyG and Mo/HDL are particularly notable for their simple application in clinical laboratory practice, as they are based on readily available and routinely measured biochemical parameters.

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MB-P8 INFLAMATORNI STATUS KOD PACIJENATA SA DIJABETIČNIM STOPALOM

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Dijabetesno stopalo predstavlja jednu od najtežih hroničnih komplikacija dijabetes melitusa i povezano je sa izraženim inflamatornim odgovorom koji može doprineti progresiji bolesti i lošijem kliničkom ishodu. Cilj ovog istraživanja bio je da se uporede parametri inflamacije i kardiometaboličkog rizika kod pacijenata sa dijabetes melitusom sa i bez dijabetesnog stopala. Studija je obuhvatila 61 ispitanika lečenih u Institutu za ortopediju „Banjica“, od kojih je 22 imalo dijabetes melitus bez dijabetesnog stopala, dok je 39 ispitanika imalo dijabetesno stopalo. Analizirani su antropometrijski, klinički, biohemijski i inflamatorni parametri.

Pacijenti sa dijabetesnim stopalom imali su duže trajanje dijabetesa u odnosu na kontrolnu grupu. Nisu uočene statistički značajne razlike u koncentracijama glukoze, HbA1c, ukupnog holesterola, uree, kreatinina, aktivnosti AST i ALT. Koncentracija triglicerida (p=0,044) i koncentracija albumina (p=0,024) bile su značajno niže kod pacijenata sa dijabetesnim stopalom. U poređenju sa pacijentima koji su imali samo dijabetes, ispitanici sa dijabetesnim stopalom imali su značajno više vrednosti sedimentacije eritrocita (p=0,012), broja neutrofila (p=0,035) i C-reaktivnog proteina (p=0,002).

Dobijeni rezultati ukazuju na prisustvo izraženog sistemskog inflamatornog odgovora kod pacijenata sa dijabetesnim stopalom, koji se manifestuje povećanim vrednostima tradicionalnih inflamatornih markera i nižim koncentracijama albumina. Ovi rezultati potvrđuju značaj inflamacije u patogenezi i progresiji dijabetesnog stopala i ukazuju na potencijalnu kliničku vrednost praćenja inflamatornih biomarkera u proceni težine bolesti i rizika od komplikacija.

MB-P8 INFLAMMATORY STATUS IN PATIENTS WITH DIABETIC FOOT

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Diabetic foot represents one of the most severe chronic complications of diabetes mellitus and is associated with a pronounced inflammatory response that may contribute to disease progression and adverse clinical outcomes. The aim of this study was to compare inflammatory markers and cardiometabolic risk parameters in patients with diabetes mellitus with and without diabetic foot. The study included 61 participants treated at the Institute for Ortopedic Surgery “Banjica”. Of these, 22 patients had diabetes mellitus without diabetic foot, while 39 patients had diabetic foot. Anthropometric, clinical, biochemical, and inflammatory parameters were analyzed.

Patients withdiabetic foot had a longer duration of diabetes compared with the control group. No statistically significant differences were observed in glucose, HbA1c, total cholesterol, urea, creatinine concentrations, or AST and ALT activities. Triglyceride concentrations (p=0.044) and albumin concentrations (p=0.024) were significantly lower in patients with diabetic foot. Compared with patients with diabetes mellitus alone, individuals with diabetic foot exhibited significantly higher erythrocyte sedimentation rate (p=0.012), neutrophil count (p=0.035), and C-reactive protein levels (p=0.002).

The obtained results indicate the presence of a pronounced systemic inflammatory response in patients with diabetic foot, characterized by elevated levels of conventional inflammatory markers and reduced albumin concentrations. These findings support the important role of inflammation in the pathogenesis and progression of diabetic foot and suggest the potential clinical value of monitoring inflammatory biomarkers for assessing disease severity and the risk of complications.

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MB-P9 HIPOTIREOIDIZAM KAO FAKTOR POGORŠANJA METABOLIČKE KONTROLE KOD PACIJENATA SA DIJABETES MELITUSOM TIP 2

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Hipotireoidizam može dodatno doprineti metaboličkim poremećajima prisutnim kod pacijenata sa dijabetes melitusom tipa 2, utičući na glikoregulaciju, lipidni profil i inflamatorni status. Cilj ovog rada bio je da se ispita uticaj hipotireoidizma na glikoregulaciju, parametre lipidnog profila i inflamacije kod pacijenata sa dijabetes melitusom tipa 2, kao i značaj postizanja ciljnih vrednosti tireostimulišućeg hormona (TSH). U istraživanju je uključeno 80 pacijenata sa dijabetes melitusom tipa 2, od kojih je 46 imalo samo dijabetes, dok je kod 34 pacijenta bio prisutan i hipotireoidizam. Pacijenti sa dijabetesom i hipotireoidizmom imali su značajno više koncentracije glukoze (9,6±3,86 prema 7,6±2,21 mmol/L; p<0,05), HbA1c (9,8±2,01 prema 8,3±1,81%; p<0,05), triglicerida i sedimentacije eritrocita (p<0,05) u poređenju sa pacijentima bez hipotireoidizma. Nisu utvrđene značajne razlike u koncentracijama ukupnog holesterola, LDL-holesterola, HDL-holesterola, C-reaktivnog proteina, fibrinogena i broja leukocita. Korelaciona analiza pokazala je pozitivnu korelaciju između koncentracije glukoze sa ukupnim holesterolom, trigliceridima i HbA1c. Pacijenti sa hipotireoidizmom dodatno su podeljeni prema vrednosti TSH na grupu sa TSH≤2,5 mIU/L i grupu sa TSH>2,5 mIU/L. Iako između grupa nisu uočene značajne razlike u parametrima glikoregulacije, većini parametara lipidnog profila i markerima inflamacije, pacijenti sa TSH>2,5 mIU/L imali su značajno više koncentracije LDL-holesterola (p<0,05). Dobijeni rezultati ukazuju da je hipotireoidizam kod pacijenata sa dijabetes melitusom tipa 2 povezan sa lošijom metaboličkom kontrolom i nepovoljnijim kardiometaboličkim profilom, dok viši TSH može doprineti dodatnom pogoršanju aterogenog lipidnog statusa.

MB-P9 HYPOTHYROIDISM AS A FACTOR CONTRIBUTING TO IMPAIRED METABOLIC CONTROL IN PATIENTS WITH TYPE 2 DIABETES MELLITUS

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Hypothyroidism may further contribute to the metabolic disturbances observed in patients with type 2 diabetes mellitus by affecting glycemic control, lipid metabolism, and inflammatory status. The aim of this study was to investigate the impact of hypothyroidism on glycemic control, lipid profile parameters, and markers of inflammation in patients with type 2 diabetes mellitus, as well as the significance of achieving target thyroid-stimulating hormone (TSH) levels. The study included 80 patients with type 2 diabetes mellitus, of whom 46 had diabetes alone, while 34 had concomitant hypothyroidism. Patients with both diabetes and hypothyroidism exhibited significantly higher glucose concentrations (9.6±3.86 vs. 7.6±2.21 mmol/L; p<0.05), HbA1c levels (9.8±2.01 vs. 8.3±1.81%; p<0.05), triglyceride concentrations, and erythrocyte sedimentation rate (p<0.05) compared with patients without hypothyroidism. No significant differences were observed in total cholesterol, LDL-cholesterol, HDL-cholesterol, C-reactive protein, fibrinogen, or leukocyte count. Correlation analysis demonstrated positive associations between glucose concentrations and total cholesterol, triglycerides, and HbA1c. Patients with hypothyroidism were further stratified according to TSH levels into a group with TSH≤2.5 mIU/L and a group with TSH>2.5 mIU/L. Although no significant differences were found between these groups in glycemic control, most lipid parameters, or inflammatory markers, patients with TSH>2.5 mIU/L had significantly higher LDL-cholesterol concentrations (p<0.05). These findings suggest that hypothyroidism in patients with type 2 diabetes mellitus is associated with poorer metabolic control and a less favorable cardiometabolic profile, while higher TSH levels may contribute to a more atherogenic lipid pattern.

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MB-P10 PROCENA UTICAJA LIPEMIJE UZROKOVANE TOTALNOM PARENTERALNOM ISHRANOM NA ODREĐIVANJE STATUSA ELEKTROLITA U PEDIJATRIJSKOJ LABORATORIJSKOJ DIJAGNOSTICI

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Lipemija seruma predstavlja značajan uzrok preanalitičkih grešaka, kao i bitan izvor analitičkih interferencija u laboratorijskoj dijagnostici. Jedan od glavnih sekundarnih uzroka lipemije je totalna parenteralna ishrana (TPN), tj. primena potrebnih nutrijenata parenteralnim putem u vidu intravenskih rastvora. Lipemija, bilo kog uzroka, uključujući TPN, predstavlja negativnu interferenciju prilikom određivanja koncentracije serumskih elektrolita metodom indirektne potenciometrije.

Cilj ispitivanja bio je procena uticaja lipemije seruma, izazvane TPN, na koncentracije elektrolita dobijene korišćenjem dve različite metode, direktne i indirektne potenciometrije, iz istog uzorka.

Ispitivanje je obuhvatilo 12 ispitanika pedijatrijskog uzrasta. Koncentracije elektrolita određene su metodama direktne i indirektne potenciometrije. Za statističku obradu korišćeni su Shapiro-Wilk i Studentov T-test za poređenje parova i linearna regresiona analiza. Statistička značajnost definisana je kao $p<0,05$.

Utvrđena je statistički značajna razlika između vrednosti Na^+ i Cl^- ($p<0,01$) dobijenih različitim metodama, dok za K^+ razlika nije bila statistički značajna ($p>0,05$). Linearna regresiona analiza je pokazala da su vrednosti koeficijenta korelacije ispod prihvatljive granice (0,99), što ove dve metode čini međusobno neuporedivim.

Lipemija uzrokovana TPN značajno utiče na rezultate određivanja koncentracije Na^+ i Cl^- indirektnom potenciometrijom. Suprotno, direktna potenciometrija nije osetljiva na lipemiju seruma što doprinosi pravilnoj interpretaciji laboratorijskih nalaza kod pacijenta na totalnoj parenteralnoj ishrani, usled izostanka efekta potiskivanja elektrolita.

MB-P10 ASSESSMENT OF THE INFLUENCE OF LIPEMIA CAUSED BY TOTAL PARENTERAL NUTRITION ON THE DETERMINATION OF ELECTROLYTE STATUS IN PEDIATRIC LABORATORY DIAGNOSTICS

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Serum lipemia is a significant cause of preanalytical errors, as well as an important source of analytical interference in laboratory diagnostics. One of the main secondary causes of lipemia is total parenteral nutrition (TPN), i.e. the administration of the necessary nutrients parenterally in the form of intravenous solutions. Lipemia, of any cause, including TPN, represents a negative interference when determining the concentration of serum electrolytes by the method of indirect potentiometry.

The aim of the study was assessment of the effect of TPN-induced serum lipemia on electrolyte concentrations obtained using two different methods, direct and indirect potentiometry, from the same sample.

The study included 12 subjects of pediatric age. Electrolyte concentrations were determined by direct and indirect potentiometry methods. Statistical analysis included the Shapiro-Wilk test, Student's paired T-test and linear regression analysis. Statistical significance is defined as $p<0.05$.

A statistically significant difference was found between the values of Na^+ and Cl^- ($p<0.01$) obtained by different methods, while for K^+ the difference was not statistically significant ($p>0.05$). Linear regression analysis showed that the values of the correlation coefficient were below the acceptable limit (0.99), which makes these two methods mutually incomparable.

Lipemia caused by TPN significantly affects the results of determining the concentration of Na^+ and Cl^- by indirect potentiometry. On the contrary, direct potentiometry is not sensitive to serum lipemia, which contributes to the correct interpretation of laboratory findings in a patient on total parenteral nutrition, due to the absence of an electrolyte suppression effect.

MB-P11 EKSPRESIJA ALERGENA AMB A 1 I IgE REAKTIVNOST EKSTRAKATA POLENA AMBROZIJE IZ RAZLIČITIH ŽIVOTNIH SREDINA

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Polen ambrozije (*Ambrosia artemisiifolia*) predstavlja jedan od najznačajnijih izvora inhalacionih alergena, pri čemu je Amb a 1 prepoznat kao njegov glavni alergen. Uslovi životne sredine mogu značajno uticati na sastav polena, a samim tim i na ekspresiju alergena i njihovo imunološko prepoznavanje. Cilj ovog istraživanja bio je poređenje zastupljenosti alergena Amb a 1 i kapaciteta vezivanja IgE antitela u ekstraktima polena ambrozije prikupljenim iz različitih životnih sredina.

Uzorci polena ambrozije prikupljeni iz urbanih i ruralnih sredina odmašćeni su dietil-etrom i ekstrahovani u fosfatnom puferu (PBS, pH 7,4) tokom 24 časa na 4 °C. Dobijeni ekstrakti su analizirani UV–Vis spektroskopijom, određivanjem ukupnog sadržaja proteina BCA metodom, SDS-PAGE elektroforezom i Western blot metodom korišćenjem zečjeg anti-Amb a 1.2 antitela. IgE reaktivnost određena je korišćenjem seruma pacijenata alergičnih na ambroziju sa potvrđenom senzibilizacijom.

Analizirani ekstrakti pokazali su razlike kako u proteinskom sastavu, tako i u sadržaju alergena. Ekstrakti polena poreklom iz urbanih sredina sadržali su veće količine ekstrahovanih proteina u poređenju sa ruralnim uzorkom. Imunoblot analiza pokazala je izraženiju traku na približno 40 kDa, koja odgovara alergenu Amb a 1, u urbanim ekstraktima. Istovremeno, serumi pacijenata alergičnih na ambroziju pokazali su intenzivnije IgE prepoznavanje urbanih ekstrakata, ukazujući na povećanu imunoreaktivnost. Uočene razlike u vezivanju IgE antitela u skladu su sa razlikama u sadržaju alergena Amb a 1 između analiziranih uzoraka.

Dobijeni rezultati ukazuju na značaj detaljne biohemijske i imunohemijske karakterizacije izvora alergena i mogu doprineti unapređenju standardizacije materijala namenjenih dijagnostici alergija i alergen-specifičnoj imunoterapiji.

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MB-P11 AMB A 1 EXPRESSION AND PATIENT SERUM IgE RECOGNITION IN RAGWEED POLLEN EXTRACTS FROM CONTRASTING ENVIRONMENTS

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Ragweed pollen (*Ambrosia artemisiifolia*) is one of the most important sources of inhalant allergens, with Amb a 1 recognized as its major allergen. Environmental conditions can significantly influence pollen composition and consequently affect allergen expression and immune recognition. The aim of this study was to compare Amb a 1 abundance and IgE-binding capacity in ragweed pollen extracts collected from different environments.

Ragweed pollen samples collected from urban and rural environments were defatted with diethyl ether and extracted in phosphate-buffered saline (PBS, pH 7.4) for 24 h at 4 °C. The obtained extracts were analyzed by UV–Vis spectroscopy, total protein quantification using the BCA assay, SDS-PAGE electrophoresis, and Western blotting with rabbit anti-Amb a 1.2 antibody. IgE reactivity was assessed using sera from ragweed-allergic patients with confirmed sensitization.

The analyzed extracts showed differences in both protein composition and allergen content. Pollen extracts originating from urban environments contained higher amounts of extracted proteins compared with the rural sample. Immunoblot analysis revealed a more intense band at approximately 40 kDa, corresponding to the Amb a 1 allergen, in the urban extracts. In parallel, sera from ragweed-allergic patients exhibited stronger IgE recognition of urban extracts, indicating increased immunoreactivity. The observed differences in IgE binding were consistent with differences in Amb a 1 content among the analyzed samples.

These findings highlight the importance of detailed biochemical and immunochemical characterization of allergen sources and may contribute to improved standardization of materials intended for allergy diagnostics and allergen-specific immunotherapy.

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MB-P12 MEDICINSKA SREDSTVA NASPRAM REKREATIVNIH UREĐAJA: ANALIZA MERENJA SRČANE FREKVENCE I OKSIGENACIJE KRVI

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Sve šira primena nosivih rekreativnih uređaja za praćenje zdravstvenih parametara nameće potrebu za procenom njihove tačnosti u odnosu na uređaje koji imaju sertifikat medicinskog sredstva. Cilj ovog istraživanja bio je da se utvrdi da li postoje statistički značajna odstupanja u merenju srčane frekvence i zasićenosti krvi kiseonikom (SpO_2) između rekreativnih uređaja i referentnog pulsnog oksimetra registrovanog kao medicinsko sredstvo.

Sprovedeno je komparativno istraživanje na 30 dobrovoljaca starijih od 18 godina. Kao referentni uređaj korišćen je pulsni oksimetar MD300C29, dok su ispitivani Garmin Forerunner 55, Samsung Galaxy Fit 3 i Xiaomi Smart Band 9. Srčana frekvenca merena je kod sva tri rekreativna uređaja, a SpO_2 kod Samsung i Xiaomi uređaja. Podaci su obrađeni primenom odgovarajućih statističkih testova, korelacione analize i Bland–Altman metode.

Nije utvrđena statistički značajna razlika u merenju srčane frekvence između rekreativnih uređaja i referentnog pulsnog oksimetra, uz veoma visoke koeficijente korelacije i male srednje apsolutne greške. Nasuprot tome, merenja SpO_2 pokazala su značajna odstupanja u odnosu na referentni uređaj, pri čemu su rekreativni uređaji često prikazivali niže vrednosti zasićenosti kiseonikom.

Rekreativni uređaji mogu se smatrati pouzdanim alatima za praćenje trendova srčane frekvence u uslovima mirovanja, dok rezultate merenja SpO_2 treba tumačiti sa oprezom. Ovi uređaji ne mogu zameniti medicinska sredstva u kliničkoj proceni zdravstvenog stanja.

MB-P12 MEDICAL DEVICES VERSUS CONSUMER WEARABLE DEVICES: ANALYSIS OF HEART RATE AND BLOOD OXYGEN SATURATION MEASUREMENTS

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The widespread use of wearable consumer devices for health monitoring has increased the need to evaluate their accuracy compared with certified medical devices. The aim of this study was to determine whether statistically significant differences exist in heart rate and blood oxygen saturation (SpO_2) measurements obtained using consumer wearable devices compared with a medical-grade pulse oximeter.

A comparative study was conducted on 30 volunteers aged over 18 years. The MD300C29 pulse oximeter was used as the reference medical device, while Garmin Forerunner 55, Samsung Galaxy Fit 3, and Xiaomi Smart Band 9 were evaluated as consumer devices. Heart rate was measured using all three wearable devices, whereas SpO_2 measurements were assessed using Samsung and Xiaomi devices. Data were analyzed using appropriate statistical tests, correlation analysis, and Bland–Altman methodology.

No statistically significant differences were observed between wearable devices and the reference pulse oximeter regarding heart rate measurements. High correlation coefficients and low mean absolute errors indicated good agreement. In contrast, SpO_2 measurements demonstrated significant discrepancies compared with the reference device, with wearable devices frequently reporting lower oxygen saturation values.

Consumer wearable devices may be considered reliable tools for monitoring heart rate trends under resting conditions; however, SpO_2 measurements should be interpreted with caution. These devices cannot replace certified medical devices in clinical decision-making or health assessment.

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T-P1 UNAPREĐENJE PRIORITIZACIJE ŠTETNIH POJEDINAČNIH SUPSTANCI KAO I NJIHOVIH SMEŠA PRIMENOM TOX-PI MODELA

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Indeks toksikološke prioritizacije (*ToxPi*, *Toxicological Prioritization Index*) predstavlja alat za statističko modelovanje koji omogućava integraciju i analizu različitih toksikoloških parametara za potrebe rangiranja i prioritizacije ispitivanih hemijskih supstanci. Korišćenjem različitih izvora podataka i dokaza, kao što su informacije o toksičnosti i izloženosti hemijskim supstancama iz životne sredine, podaci se prevode u jasne i interpretabilne sisteme rangiranja zasnovane na vizualizaciji podataka. Budući da smeše toksičnih supstanci mogu ispoljiti efekte koji se razlikuju od pojedinačnih supstanci, cilj rada je da pruži sveobuhvatan pregled primene *ToxPi* alata u njihovoj prioritizaciji. Na osnovu pregleda dostupne literature, ovaj alat je do sada korišćen u prioritizaciji endokrinih ometača, proceni rizika i rangiranju supstanci iz životne sredine, kao i u grupisanju supstanci prema sličnosti njihovih bioloških profila. Takođe, *ToxPi* se pokazao kao efikasan komplementarni alat tradicionalnim *BMD* (*Benchmark Dose*) grafikonima intervala poverenja, naročito u analizama koje obuhvataju više biomarkera, omogućavajući sveobuhvatniju procenu toksičnog potencijala hemijskih supstanci u složenim skupovima podataka. Zahvaljujući istovremenoj sintezi i vizuelizaciji parametara više varijabli, *ToxPi* značajno ubrzava evaluaciju toksičnog profila pojedinačnih jedinjenja i njihovih smeša, smanjujući problem interpretacije u kompleksnim toksikološkim bazama podataka. Primena ove metodologije na bisfenol A (BPA) i njegove analoge ukazala je da sedam od devet ispitivanih zamenskih bisfenola poseduje veći toksični potencijal od BPA, prema ukupnom skoru toksičnosti. Ovi nalazi potvrđuju da ToxPi prevazilazi ulogu alata za vizualizaciju podataka i predstavlja efikasan pristup za prioritizaciju supstanci koje zahtevaju dalja toksikološka ispitivanja, naročito u slučaju novih ili nedovoljno proučenih jedinjenja prisutnih u životnoj sredini.

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T-P1 ADVANCING CHEMICAL PRIORITIZATION USING THE TOX-PI FRAMEWORK FOR TOXIC SUBSTANCES AND THEIR MIXTURES

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The Toxicological Prioritization Index (ToxPi) represents a statistical modeling framework designed to integrate and analyze diverse toxicological parameters for ranking and prioritization of chemical substances. By synthesizing heterogeneous data streams and weight-of-evidence sources, including information about toxicity and environmental exposure profiles, ToxPi converts complex datasets into transparent and interpretable ranking systems supported by advanced data visualization. Given that chemical mixtures often exhibit toxicological effects distinct from those of individual components, this paper provides a review of ToxPi applications in mixture prioritization. Based on a systematic review of the literature, ToxPi has been widely applied in the prioritization of endocrine-disrupting chemicals, environmental risk assessment, chemical ranking, and grouping of substances based on similarities in biological profiles. Additionally, ToxPi serves as a complementary approach to traditional Benchmark Dose confidence interval plots, particularly in multi-biomarker analyses, enabling a more comprehensive evaluation of toxic potential in complex datasets. By facilitating simultaneous integration and visualization of multivariate parameters, ToxPi enhances the profiling of individual compounds and their mixtures and addresses challenges associated with interpretation of high-dimensional toxicological data. Application of this methodology to bisphenol A (BPA) and its analogues demonstrated that seven of nine replacement bisphenols exhibited higher toxic potential than BPA, based on cumulative toxicity scores. These findings indicate that ToxPi extends beyond a data visualization tool, representing a robust framework for prioritizing substances that require further toxicological investigation, particularly emerging and data-poor environmental contaminants.

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T-P2 TROVANJA BENZODIAZEPINIMA U REPUBLICI SRBIJI: UČESTALOST, UZROCI I ISHODI

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Benzodiazepini predstavljaju jednu od najčešće propisivanih grupa lekova zbog svojih anksiolitičkih, sedativnih i hipnotičkih svojstava. Njihova široka primena povezana je sa rizikom od zloupotrebe i razvoja zavisnosti, što predstavlja značajan javnozdravstveni problem.

Cilj rada bio je analiza učestalosti, uzroka i ishoda trovanja benzodiazepinima u Republici Srbiji u periodu 2021–2024. godine.

Sprovedena je retrospektivna analiza godišnjih izveštaja Nacionalnog centra za kontrolu trovanja Vojnomedicinske akademije. Analizirani su učestalost trovanja, zastupljenost pojedinačnih lekova iz grupe benzodiazepina i smrtni ishodi.

Lekovi su bili druga najčešća grupa uzročnika trovanja u Srbiji, odmah nakon alkohola, pri čemu su benzodiazepini bili najčešći uzročnici trovanja lekovima. Tokom posmatranog perioda registrovano je 535–618 slučajeva godišnje. Najčešće zastupljeni lekovi bili su bromazepam (oko polovine slučajeva) i diazepam (oko jedne petine), zatim lorazepam i alprazolam, dok su ostali benzodiazepini bili zastupljeni u znatno manjem procentu. Udeo hospitalizovanih pacijenata je porastao sa 24,1% na 30,7%, što ukazuje na povećanje težine kliničkih slika. Smrtni ishodi su bili retki (1–2 godišnje), izuzev 2023. godine kada je registrovano šest slučajeva, najčešće uz prisutne komorbiditete i komplikacije.

Iako se benzodiazepini u Srbiji propisuju u velikom obimu (desetine miliona izdatih recepata godišnje), stopa prijavljenih trovanja (535–618 slučajeva godišnje) ostaje niska u odnosu na ukupnu potrošnju, što ukazuje da zloupotreba, a ne terapijska primena, predstavlja glavni faktor rizika. Uprkos učestalosti trovanja, smrtni ishodi sa pojedinačnim benzodiazepinima ostaju retki. Dobijeni rezultati ukazuju na potrebu za racionalnijim propisivanjem, prevencijom zloupotrebe i kontinuiranim praćenjem trendova trovanja.

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T-P2 BENZODIAZEPINE POISONING IN THE REPUBLIC OF SERBIA: FREQUENCY, CAUSES, AND OUTCOMES

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Benzodiazepines are among the most frequently prescribed drugs due to their anxiolytic, sedative, and hypnotic properties. Their widespread use is associated with the risk of abuse and dependence, representing a significant public health concern.

The aim of this study was to analyze the frequency, causes, and outcomes of benzodiazepine poisoning in the Republic of Serbia during the period 2021–2024.

A retrospective analysis of annual reports from the National Poison Control Center of the Military Medical Academy was conducted. The frequency of poisoning, distribution of benzodiazepines, and fatal outcomes were evaluated.

Drugs were the second most common cause of poisoning in Serbia, after alcohol, with benzodiazepines being the leading drug-related agents. During the study period, 535–618 cases were recorded annually. The most frequently involved drugs were bromazepam (about half of cases) and diazepam (about one fifth), followed by lorazepam and alprazolam, while other benzodiazepines were involved in lower proportions. The proportion of hospitalized patients increased from 24.1% to 30.7%, indicating more severe clinical presentations. Fatal outcomes were rare (1–2 per year), except in 2023 when six cases were reported, mostly in patients with comorbidities and complications.

Although benzodiazepines are widely prescribed in Serbia (tens of millions of prescriptions annually), the number of reported poisoning cases (535–618 per year) remains low relative to overall consumption, suggesting that abuse rather than therapeutic use represents the main risk factor. Fatal outcomes involving isolated benzodiazepines remain rare. These findings highlight the need for more rational prescribing, prevention of misuse, and continuous monitoring of poisoning trends.

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T-P3 HEPATOTOKSIČNI EFEKTI BISFENOLA A, S I F I NJIHOVIH SMEŠA: INTEGRATIVNA *IN SILICO* I *IN VIVO* STUDIJA

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Bisfenol A (*BPA*), bisfenol S (*BPS*) i bisfenol F (*BPF*) su endokrini i reproduktivni ometači koji mogu izazvati oštećenje jetre. Cilj studije bio je da se uporedi toksičnost pojedinačnih bisfenola i njihovih smeša integrativnim *in silico* i *in vivo* pristupom. Zajednički geni povezani sa bisfenolima i oštećenjem jetre identifikovani su u Komparativnoj toksikogenomičkoj bazi podataka (*CTD*). Biomarkeri izdvojeni *CytoHubba* alatom određeni su kod ženki *Wistar* pacova subakutno izloženih pojedinačno *BPA* (0,26 μg/kg t.m./dan), *BPS* (0,60 μg/kg t.m./dan) i *BPF* (0,68 μg/kg t.m./dan) i njihovim smešama oralnim putem, u dozama preračunatim na osnovu humane ekspozicije. Nivoi biomarkera u jetri određeni su *ELISA* metodom. *CTD* analizom identifikovana su 192 zajednička gena, među kojima su izdvojeni *IL6, TNF, IL1B, MMP9* i *MCP1*. *In vivo* rezultati pokazali su značajno povećanje *IL1B* u *BPF, BPA+BPS* i *MIX* grupama, pri čemu je nivo *IL1B* u *MIX* grupi bio 1,65 puta viši u odnosu na kontrolu ($p<0,0001$). *TNF* je pokazao najizraženije povećanje u *MIX* grupi (54% u odnosu na kontrolu, $p<0,01$), uz povišene vrednosti u drugim grupama. *IL6* je pokazao suprotan obrazac, sa smanjenjem u *BPA+BPS* i povećanjem u *MIX* grupi ($p<0,05$), dok su *MMP9* i *MCP1* bili promenjeni nakon izlaganja bisfenolima i njihovim smešama, sa najizraženijim efektima u *BPF* i *BPA+BPF* grupama. Ove promene ukazuju na poremećaje inflamacije i remodelovanja jetre. Integrativni pristup pokazao je da bisfenoli i njihove smeše utiču na gene/proteine povezane sa oštećenjem jetre, pri čemu su smeše ispoljile izraženije efekte, naročito ternarna smeša, dok je *BPF* imao najveći potencijal među pojedinačnim bisfenolima.

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T-P3 HEPATOTOXIC EFFECTS OF BISPHENOLS A, S, AND F AND THEIR MIXTURES: AN INTEGRATIVE *IN SILICO* AND *IN VIVO* STUDY

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Bisphenol A (BPA), bisphenol S (BPS), and bisphenol F (BPF) are endocrine and reproductive-disrupting chemicals that may induce liver injury. The aim of this study was to compare the toxicity of individual bisphenols and their mixtures using an integrative *in silico* and *in vivo* approach. Common genes associated with bisphenols and liver injury were identified using the Comparative Toxicogenomics Database (CTD). Biomarkers selected using the CytoHubba algorithm were determined in female Wistar rats subacutely exposed orally to BPA (0.26 μg/kg bw/day), BPS (0.60 μg/kg bw/day), and BPF (0.68 μg/kg bw/day), individually and in mixtures, at doses calculated based on human exposure. Liver biomarker levels were determined by ELISA. CTD analysis identified 192 common genes, including *IL6, TNF, IL1B, MMP9,* and *MCP1*. *In vivo* results showed significantly increased IL1B levels in the BPF, BPA+BPS, and MIX groups, with IL1B in the MIX group being 1.65-fold higher than in controls ($p<0.0001$). TNF showed the most pronounced increase in the MIX group (54% higher than controls, $p<0.01$), with elevated levels in other groups. IL6 showed an opposite pattern, decreasing in the BPA+BPS group and increasing in the MIX group ($p<0.05$). MMP9 and MCP1 were altered after bisphenol exposure, with the most pronounced effects in the BPF and BPA+BPF groups. These changes indicate disturbances in inflammation and liver remodeling. Integrative analysis demonstrated that bisphenols and their mixtures affect liver injury-related genes/proteins, with stronger effects of mixtures, particularly the ternary mixture, while BPF showed the highest potential among individual bisphenols.

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T-P4 PROCENA BEZBEDNOSTI ZA DERMALNU IZLOŽENOST SASTOJCIMA ETARSKOG ULJA CVETA LAVANDE U SAMOSTALNO PRIPREMLJENOM ULJU ZA MASAŽU

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Rastuća popularnost prirodnih kozmetičkih proizvoda povećala je interesovanje za njihovu bezbednost, posebno kada su u pitanju formulacije koje potrošači sami pripremaju. Etarsko ulje cveta lavande je čest sastojak takvih proizvoda. Cilj ove studije bio je procena dermalne izloženosti sastojcima etarskog ulja cveta lavande i ispitivanje njihove bezbednosti prilikom primene ulja za masažu koje se samostalno priprema. Pored toga, procenjena je opasnost samog proizvoda na osnovu koncentracija sastojaka i njihove opasnosti u skladu sa CLP regulativom 1272/2008. Sastojci etarskog ulja lavande određeni su iz osušenih cvetova nakon destilacije vodenom parom. Ulje je kvalitativno i kvantitativno analizirano gasnom hromatografijom i gasnom hromatografijom sa masenom spektrometrijom. Formulacija ulja za masažu pripremljena je razblaživanjem etarskog ulja u arganovom ulju do koncentracije od 1,9%. Dermalna izloženost sastojcima etarskog ulja procenjena je korišćenjem softvera ConsExpo, uz scenarije prilagođene uobičajenim praksama potrošača i informacijama iz onlajn izvora. Identifikovano je šesnaest komponenti ulja, a izloženost je procenjena pojedinačno za svaki sastojak pod istim scenarijom. Ova formulacija i njeni sastojci pokazali su nisku dermalnu izloženost i zanemarljiv rizik. Značajno je da, iako su neki pojedinačni sastojci klasifikovani kao opasni prema CLP-u, kompletna smeša nije klasifikovana kao opasna. Simulirana procena pokazala je da ovi proizvodi verovatno ne predstavljaju značajan rizik pri uobičajenoj upotrebi, što ukazuje na to da sam kvalitet proizvoda nije garancija bezbednosti. Ovi nalazi naglašavaju važnost procene rizika zasnovane na izloženosti za kozmetiku pripremljenu van standardnih proizvodnih praksi.

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T-P4 SAFETY EVALUATION OF DERMAL EXPOSURE TO LAVENDER ESSENTIAL OIL CONSTITUENTS WHEN USED AS PART OF A SELF-PREPARED MASSAGE OIL

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The growing popularity of natural cosmetic products has raised interests in their safety, specifically for self-prepared formulations. Lavender essential oil is a common component of such products. The aim of this study was to assess dermal exposure to lavender essential oil constituents and to evaluate their safety when used as part of a self-prepared massage oil. Moreover, product hazard was assessed based on the constituents concentrations and theirs hazard in accordance with the CLP Regulation 1272/2008. Lavander essential oil constituents were determined from dried lavender flowers after hydrodistillation. Oil was qualitatively and quantitatively analysed using gas chromatography and gas chromatography with mass spectrometry. Massage oil formulation was prepared with essential oil diluted in argan oil to a concentration of 1.9%. Dermal exposure to the essential oil constituents was assessed using *ConsExpo* software. Scenarios were adapted to typical consumer practices and information from online sources. Sixteen components of the oil were identified. Exposure was estimated individually for each identified essential oil constituent under the same exposure scenario. This massage oil formulation and its constituents exhibited low dermal exposure and negligible risk. Notably, while some individual constituents are classified as hazardous under CLP, the complete preparation was not classified as a hazardous mixture.The simulated exposure assessment demonstrated that these home-prepared products are unlikely to pose significant risks under normal use conditions. Furthermore, this indicates that product quality alone is not a guarantee of safety. These findings underline the relevance of exposure-based risk assessment for cosmetic products prepared outside the standard manufacturing practices.

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T-P5 PFOA-INDUKOVANI POREMEĆAJI HEMATOLOŠKE HOMEOSTAZE ZAVISNI OD DOZE I POLA KOD WISTAR PACOVA

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Per- i polifluoroalkil supstance, uključujući perfluorooktansku kiselinu (PFOA), predstavljaju perzistentne zagađivače životne sredine od globalnog značaja. Postoje naznake da izloženost PFOA može doprineti poremećajima hematološke homeostaze, čak i pri niskim nivoima izloženosti. Cilj ovog rada bio je da se ispita uticaj PFOA na hematološke parametre kod mužjaka i ženki Wistar pacova nakon izloženosti niskim dozama koje odražavaju realnu izloženost iz životne sredine. Ukupno 48 pacova (24 po polu) nasumično je raspoređeno u tri tretirane i kontrolne grupe. Izbor doza PFOA koje su korišćene u studiji, zasnivao se na prethodno objavljenim literaturnim podacima i obuhvatio je tri nivoa izloženosti. Grupe M1/F1 bile su izložene dozama koje odgovaraju niskom nivou izloženosti u opštoj populaciji, M2/F2 dozama koje odgovaraju višem nivou izloženosti, dok su M3/F3 grupe tretirane najvišim dozama koje ne dovode do pojave štetnog efekta, a pronađene su u literaturi. Nakon 28 dana životinje su humano žrtvovane, krv je prikupljena kardijačnom punkcijom, a hematološki parametri su analizirani pomoću automatskog hematološkog analizatora. Kod mužjaka je uočeno značajno povećanje broja eozinofila u grupama M2 i M3, praćeno smanjenjem broja eritrocita u M2, kao i smanjenjem broja trombocita u obe grupe sa višom dozom (M2 i M3). Nasuprot tome, ženke su pokazale suprotan odgovor, sa povećanim brojem eritrocita u grupama F2 i F3, uz povišen hematokrit u F2. Rezultati u celini ukazuju na izražene polno-specifične razlike u osetljivosti hematološkog sistema na PFOA, pri čemu su promene doslednije pri višim nivoima izloženosti.

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T-P5 PFOA-INDUCED DOSE- AND SEX-DEPENDENT DISRUPTION OF HEMATOLOGICAL HOMEOSTASIS IN WISTAR RATS

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Per- and polyfluoroalkyl substances, including perfluorooctanoic acid (PFOA), are persistent environmental contaminants of global concern. There is evidence suggesting that PFOA exposure may contribute to disturbances in hematological homeostasis, even at low exposure levels. The aim of this study was to investigate the effects of PFOA on hematological parameters in male and female Wistar rats following exposure to low doses reflecting real-life environmental exposure. A total of 48 rats (24 per sex) were randomly assigned to three treatment groups and a control group. PFOA dose selection was based on previously published literature and included three exposure levels. Groups M1/F1 were exposed to doses corresponding to low levels of exposure in the general population, M2/F2 to doses corresponding to higher exposure levels, while M3/F3 were treated with doses based on the highest no-observed-adverse-effect levels reported in the literature. After 28 days, the animals were humanely euthanized, blood was collected via cardiac puncture, and hematological parameters were analyzed using an automated hematology analyzer. In males, a significant increase in eosinophil counts was observed in the M2 and M3 groups, together with a decrease in erythrocyte counts in M2, as well as reduced platelet counts in both higher-dose groups (M2 and M3). In contrast, females showed an opposite response, with increased erythrocyte counts in F2 and F3 groups, along with elevated hematocrit in F2. Overall, the results indicate pronounced sex-specific differences in hematological sensitivity to PFOA, with more consistent alterations observed at higher exposure levels.

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T-P6 TOKSIČNOST SEMAGLUTIDA: PRIMERI SLUČAJEVA IZ PRAKSE

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Semaglutid je lek iz grupe agonista receptora za glukagonu-sličan peptid-1 (GLP-1) koji se primenjuje u terapiji dijabetesa tipa 2 i gojaznosti. Veliku popularnost stekao je na društvenim mrežama, gde je predstavljan kao efikasno rešenje za brzo mršavljenje. Kao posledica toga, javila se pogrešna primena i zloupotreba ovog leka, dok su pacijenti kojima je zaista potreban ostajali uskraćeni za terapiju usled nestašice.

Cilj ovog rada bio je da se kroz pregled literature i prijavljenih slučajeva iz prakse analizira toksičnost semaglutida usled predoziranja ili neadekvatne primene.

Za pretragu literature korišćena je baza *PubMed*, a prikazi slučajeva preuzeti su sa servisa *ResearchGate*, časopisa *American Journal of Case Reports* i izveštaja *Oklahoma State University Center for Health Sciences*.

U slučajevima gde je došlo do namernog ili slučajnog predoziranja ovim lekom najčešće su se javljali gastrointestinalni simptomi poput mučnine i povraćanja, koji su se postepeno povlačili. Ovi efekti posredovani su usporenim i produženim pražnjenjem želuca, smanjenim motilitetom creva i promenama glukoregulacije. Sa druge strane, u jednom pokušaju suicida usled primene doze četvorostruko veće od propisane javila se hipoglikemija, opšta slabost, duodenalni ulkus i disfunkcija jetre. Nasuprot tome, zabeležen je i slučaj predoziranja starije osobe koja je tokom 7 dana svakodnevno primenjivala dozu leka namenjenu za jednu nedelju, ali nije došlo do ispoljavanja toksičnih efekata.

Prevencija pogrešne primene semaglutida od značaja je za smanjenje rizika od toksičnih efekata, ali i za sprečavanje nestašica koje ugrožavaju pacijente sa stvarnim terapijskim potrebama. Farmaceuti imaju ključnu ulogu u edukaciji pacijenata, te prevenciji zloupotrebe ovog leka.

T-P6 TOXICITY OF SEMAGLUTIDE: CASE REPORTS FROM PRACTICE

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Semaglutide is glucagon-like peptide-1 receptor agonist, used in the management of type 2 diabetes and obesity. It gained widespread popularity on social media, where it was promoted as an easy solution for weight loss. Consequently, this led to the misuse and abuse of the medication, resulting in shortages that deprived patients with genuine therapeutic needs of their treatment.

The aim of this paper was to analyse the toxic effects associated with semaglutide misuse and overdose, through a comprehensive literature review and an evaluation of reported clinical cases.

Literature was searched via PubMed, with case reports retrieved from ResearchGate, *American Journal of Case Reports* and Oklahoma State University Center for Health Sciences.

In documented cases of accidental or intentional overdose, gastrointestinal symptoms, such as nausea and vomiting, were most frequently reported and resolved gradually over time. These effects are mediated by prolonged delay of gastric emptying, reduction in gastrointestinal motility and impaired glucoregulation. However, a suicide attempt utilizing a four-fold higher dose than recommended resulted in hypoglycaemia, generalised weakness, a duodenal ulcer, and liver dysfunction. In contrast, a case of overdose was reported in an elderly patient who administered a weekly dose daily for 7 consecutive days, yet remained completely asymptomatic.

Preventing the misuse and abuse of semaglutide is of great importance, both to mitigate the risk of severe toxicological outcomes and to avert the supply shortages that compromise patients with genuine therapeutic indications. Pharmacists play a pivotal role in patient education and the prevention of medication misuse.

T-P7 SMANJENJE IZLOŽENOSTI SUSPENDOVANIM ČESTICAMA PUTEM ZAGAĐENOG VAZDUHA: EFIKASNOST NE-FARMAKOLOŠKIH MERA

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Svetska zdravstvena organizacija je 2019. godine prepoznala zagađenje vazduha kao jedan od najznačajnijih javno-zdravstvenih izazova današnjice. Suspendovane čestice (particulate matter-PM) su, zbog brojnih štetnih efekata poput rizika za razvoj kardiovaskularnih i respiratornih bolesti, najznačajnija zagađujuća materija u vazduhu. Kako opšta javnost danas posvećuje pažnju zdravstvenim rizicima koje izloženost zagađenom vazduhu i PM česticama nosi, u farmaceutskoj praksi sve su češći upiti o merama zaštite, a najčešće se odnose na efikasnost prečišćavača vazduha, nošenje maski za lice na otvorenom i upotreba proizvoda za nazalnu higijenu. Međutim, Međunarodna farmaceutska federacija ukazuje na to da još uvek ne postoji dovoljno smernica zasnovanih na dokazima koje bi farmaceutima pomogle u savetovanju pacijenata u vezi ove teme. Stoga, cilj ovog istraživanja bio je pregled rezultata studija sprovedenih u periodu 2000-2025. godine, objavljenih na engleskom jeziku u bazama PubMed i Scopus koje su ispitivale efikasnost navedenih mera u smanjenju izloženosti PM česticama, a samim tim i zaštiti od štetnih efekata. Prečišćivači vazduha smanjuju koncentraciju čestica u vazduhu, mada njihova efikasnost opada sa smanjenjem dijametra čestica. Ipak, još uvek nema dovoljno dokaza da njihova upotreba ima benefite po zdravlje. Efikasnost maski za lice zavisi od njihove filtracione sposobnosti, prijanjanja uz lice, a indirektno i od udobnosti za korisnika. Za razliku od hirurških maski, respiratori N95, KN95 i FFP2, mogu filtrirati PM čestice, ali nema dokaza da njihovo nošenje umanjuje zdravstvene rizike. Na kraju, iako unapređenje higijene nosne sluznice doprinosi prevenciji alergija i respiratornih infekcija, trenutno nema dovoljno dokaza da ovaj način zaštite smanjuje izloženost česticama.

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T-P7 PARTICULATE MATTER EXPOSURE REDUCTION: THE EFFECTIVENESS OF NON-PHARMACOLOGICAL MEASURES

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According to the World Health Organization (WHO), air pollution represents major public health concern. Among air pollutants, particulate matter (PM) is recognized as the main air pollutant for both environment and human health. Growing awareness of the health risks linked to PM exposure has led to more frequent inquiries about protective measures in everyday pharmacy practice – implementation of air purifiers, wearing face masks outdoors and improving nasal hygiene. However, the International Pharmaceutical Federation emphasises that there are limited evidence-based guidelines to support pharmacists' advice on such actions. Therefore, our aim was to review findings from studies that examined the effectiveness of abovementioned measures in reducing PM exposure and associated health benefits. Original research articles for the period 2000-2005 searched in PubMed and Scopus were included. In the case of portable air purifiers, literature suggests that they successfully reduce indoor PM levels, but there is still not enough evidence that their usage has health benefits. Their efficiency decreases as the particles' diameter decreases. Effectiveness of face masks depends on filtration efficiency, fit to the face, and, indirectly, on the extent to which mask affects wearer's comfort. Respirators N95, KN95 and FPP2 can filter PM particles (0.3 μm), in contrast to surgical masks, but there is no evidence that wearing them provides health benefits against PM exposure. Finally, while improving nasal hygiene may contribute to the prevention of allergies and respiratory infections, currently, there is insufficient evidence to support its effectiveness in decreasing inhalation of PM.

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T-P8 OD FARMACEUTSKOG ZAGAĐENJA DO EKOFARMAKOVIGILANCE: BIBLIOMETRIJSKA ANALIZA TRENDOVA ISTRAŽIVANJA U OBLASTI TOKSIKOLOGIJE ŽIVOTNE SREDINE

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Lekovi i njihove rezidue se sve više prepoznaju kao zagađivači životne sredine usled njihovog kontinuiranog dospevanja u vodene i kopnene ekosisteme. Rastuća zabrinutost zbog farmaceutskog zagađenja podstakla je razvoj održivih koncepata, uključujući ekofarmakovigilancu, zelenu farmaciju i održivu farmaciju. Cilj ovog rada je analiza trendova publikovanja i istraživačkih tema povezane sa ovim oblastima tokom poslednje decenije.

Bibliometrijska analiza sprovedena je korišćenjem baze PubMed. Publikacije indeksirane u periodu od 2016. do 1. juna 2026. godine pretražene su korišćenjem termina *„pharmaceutical pollution“*, *„ecopharmacovigilance“*, *„green pharmacy“* i *„sustainable pharmacy“*. Analizirani su trendovi publikovanja po godinama, dok je analiza povezanosti termina iz naslova i sažetaka radova o farmaceutskom zagađenju sprovedena pomoću softvera VOSviewer.

Identifikovano je ukupno 235 publikacija o farmaceutskom zagađenju, 45 o ekofarmakovigilanci, 38 o održivoj farmaciji i 27 o zelenoj farmaciji. Broj publikacija o farmaceutskom zagađenju porastao je sa 5 u 2016. na 48 u samo prvoj polovini 2026. godini, dok su ostale oblasti pokazale sporiji, ali kontinuirani rast. Identifikovana su tri tematska klastera: (1) prisustvo i uklanjanje lekova u akvatičnim ekosistemima, uključujući karbamazepin i ibuprofen; (2) izloženost akvatičnih organizama lekovima, posebno fluoksetinu, i njihovi efekti na ponašanje različitih vrsta; i (3) povezanost farmaceutskog zagađenja sa antimikrobnom rezistencijom i javnim zdravljem.

Istraživanja farmaceutskog zagađenja značajno su intenzivirana tokom poslednje decenije i prevazilaze obim istraživanja održivih farmaceutskih koncepata. Ipak, rastući broj publikacija iz oblasti ekofarmakovigilance, zelene i održive farmacije ukazuje na postepeni prelazak sa identifikacije problema ka razvoju preventivnih i održivih strategija za smanjenje uticaja lekova na životnu sredinu.

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T-P8 FROM PHARMACEUTICAL POLLUTION TO ECOPHARMACOVIGILANCE: A BIBLIOMETRIC ANALYSIS OF RESEARCH TRENDS IN ENVIRONMENTAL TOXICOLOGY

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Medicines are increasingly recognized as environmental contaminants due to their continuous release into aquatic and terrestrial ecosystems. Concerns regarding pharmaceutical pollution have stimulated the development of sustainable concepts, including ecopharmacovigilance, green and sustainable pharmacy. This study aimed to analyze publication trends and research hotspots related to these topics over the last decade.

A bibliometric analysis was performed using the PubMed database. Publications indexed between 2016 and the first half of 2026 were retrieved using the terms “pharmaceutical pollution”, “ecopharmacovigilance”, “green pharmacy”, and “sustainable pharmacy”. Publication trends were analyzed, while co-occurrence analysis of terms from titles and abstracts of pharmaceutical pollution publications was conducted using VOSviewer.

A total of 235 publications on pharmaceutical pollution, 45 on ecopharmacovigilance, 38 on sustainable pharmacy, and 27 on green pharmacy were identified. Publications on pharmaceutical pollution increased from 5 in 2016 to 48 in the first half of 2026, whereas the remaining concepts showed lower but increasing outputs. Three thematic clusters were identified. The first focused on the occurrence and removal of pharmaceutical residues in aquatic environments, including carbamazepine and ibuprofen. The second addressed exposure of aquatic organisms to medicines, particularly fluoxetine, and its effects on wildlife. The third linked pharmaceutical pollution with public health and antimicrobial resistance.

Research on pharmaceutical pollution has expanded substantially during the last decade, considerably exceeding activity related to sustainable pharmaceutical concepts. Nevertheless, growing interest in ecopharmacovigilance, green pharmacy, and sustainable pharmacy suggests a shift toward preventive and sustainable strategies to reduce the environmental impact of medicines.

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T-P9 KOMPARATIVNA ANALIZA IMUNOTURBIDIMETRIJSKE I HPLC-PDA METODE ZA DETEKCIJU METADONA U RUTINSKOJ TOKSIKOLOŠKOJ PRAKSI

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Brza i pouzdana detekcija metadona u krvi od ključnog je značaja u kliničko-toksikološkoj praksi. Iako je tečna hromatografija sa *photodiode array* detektorom (HPLC-PDA) referentna tehnika, niske koncentracije analita i interference endogenih supstanci iz složenih bioloških uzoraka mogu maskirati UV apsorpciju, uslovljavajući lažno negativne rezultate. Cilj ovog rada je evaluacija analitičke efikasnosti i primene automatske imunoturbidimetrijske metode u poređenju sa HPLC-PDA tehnikom za rutinsku detekciju metadona.

Retrospektivnom studijom obuhvaćeni su uzorci krvi pacijenata analizirani tokom 2025. godine u Centru za kontrolu trovanja (CKT) Srbije. Poređene su dve metode za detekciju metadona: imunoturbidimetrijski esej na automatskom analizatoru DIRUI CS-T180 i HPLC-PDA tehnika. Priprema uzorka za imunoturbidimetrijsku analizu zahtevala je samo centrifugiranje pune krvi radi dobijanja plazme koja je analizirana. Nasuprot tome, hromatografska analiza (HPLC-PDA) zahtevala je prethodnu pripremu uzorka kroz kompleksan proces tečno-tečne ili čvrstofazne ekstrakcije (SPE) u cilju prečišćavanja analita i eliminacije interferencije koje potiču od komponenata matriksa.

Imunoturbidimetrijska metoda je pokazala visoku reproducibilnost i senzitivnost. Eliminacijom koraka ekstrakcije značajno je skraćeno vreme analitičkog ciklusa i minimalizovana mogućnost greške u preanalitičkoj fazi. Primenom ovog protokola u CKT tokom 2025. godine potvrđeno je prisustvo metadona u 30 uzoraka krvi dobijenih od pacijenata sa sumnjom na predoziranje metadonom. Automatizovani sistem DIRUI CS-T180 efikasna je alternativa za brzu detekciju metadona u krvi. Odsustvo kompleksne pripreme uzorka optimizuje laboratorijski rad smanjujući mogućnost greške i dajući ovoj metodi jasnu prednost u rutinskoj praksi u odnosu na klasične hromatografske tehnike.

T-P9 COMPARATIVE ANALYSIS OF IMMUNOTORBIDIMETRIC AND HPLC-PDA METHODS FOR THE DETECTION OF METHADONE IN ROUTINE TOXICOLOGICAL PRACTICE

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Fast and reliable detection of methadone in blood is of key importance in clinical toxicological practice. Although liquid chromatography with photodiode array detector (HPLC-PDA) is the reference technique, low analyte concentrations and interference of endogenous substances from complex biological matrices can mask UV absorption, causing false negative results. The aim of this work is the evaluation of the analytical efficiency and applicability of the automatic immunoturbidimetric method in comparison with the HPLC-PDA technique for the routine detection of methadone.

The retrospective study included patietns blood samples analyzed in 2025. in Poison Controle Center (PCC) Serbia. The immunoturbidimetric assay on the DIRUI CS-T180 automatic analyzer and the HPLC-PDA technique for methadone determination were compared. Sample preparation for immunoturbidimetric analysis required only centrifugation of whole blood to obtain the plasma that was analyzed. Chromatographic analysis (HPLC-PDA) required previous sample preparation through a liquid-liquid or solid-phase extraction in order to purify analytes and eliminate interferences from matrix. The immunoturbidimetric method showed high reproducibility and sensitivity. Eliminating the extraction step significantly shortened the analytical time and minimized the possibility of error in the pre-analytical phase. By applying this protocol in the PCC during 2025, the presence of methadone was confirmed in 30 blood samples obtained from patients with suspected methadone overdose. The automated system is an effective alternative for the rapid detection of methadone in blood. The absence of complex sample preparation optimizes laboratory work, reducing the possibility of error and giving this method a clear advantage in routine practice over classical chromatographic techniques.

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T-P10 FATALNI PAD SA VISINE U KONTEKSTU IZUZETNO VISOKE KONCENTRACIJE LSD-A: PRIKAZ SLUČAJA

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Dietilamid lizerginske kiseline (LSD) je snažan serotonergički psihodelik čija je upotreba poslednjih godina u porastu usled obnovljenog interesovanja za njegovu terapijsku primenu i veće dostupnosti. Pored promena stanja svesti, euforije i izmenjene percepcije, LSD može izazvati psihomotornu agitaciju, agresivnost i rizično ponašanje, što povećava verovatnoću nastanka traumatskih povreda.

Prikazan je slučaj dvadesetogodišnjeg muškarca koji je pronađen bez znakova života u prizemlju stambene zgrade nakon pada sa visine, usled propadanja kroz staklenu površinu tavanskog otvora. Prema iskazu svedoka, neposredno pre događaja mladić se znojio, nepovezano govorio, imao neuobičajen pogled, bio uznemiren i agresivan, nakon čega je bez odeće napustio stan. Postojali su podaci o ranijoj upotrebi psihoaktivnih supstanci, uključujući LSD.

Biološki uzorci prikupljeni tokom sudskomedicinske obdukcije analizirani su metodom tečne hromatografije sa tandem masenom spektrometrijom (LC-MS/MS). LSD je identifikovan u krvi (0,26 mg/L), urinu (0,02 mg/L) i tečnosti staklastog tela (0,001 mg/L). U krvi i urinu detektovan je i hidroksi-metabolit LSD-a.

Na osnovu obdukcionog nalaza utvrđeno je da je smrt nasilna i da je nastala usled višestrukih traumatskih povreda zadobijenih padom sa visine. U ovom slučaju utvrđena je izuzetno visoka koncentracija LSD-a, koja, prema našem saznanju i dostupnoj literaturi, predstavlja najvišu do sada prijavljenu u postmortalnom slučaju. Ovaj slučaj naglašava značaj interpretacije toksikoloških nalaza u kontekstu obdukcionih nalaza, okolnosti slučaja i klinički ispoljenog agitiranog ponašanja, kako bi se pouzdanije procenila moguća uloga psihoaktivnih supstanci u nastanku smrtnog ishoda.

T-P10 FATAL FALL FROM HEIGHT IN THE CONTEXT OF AN EXTREMELY HIGH LSD CONCENTRATION: A CASE REPORT

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Lysergic acid diethylamide (LSD) is a potent serotonergic psychedelic whose use has increased in recent years due to renewed interest in its therapeutic potential and its greater availability. In addition to altered states of consciousness, euphoria, and perceptual disturbances, LSD may induce psychomotor agitation, aggression, and risk-taking behavior, thereby increasing the likelihood of traumatic injuries.

We present the case of a 20-year-old man who was found dead on the ground floor of a residential building after falling from a height through a glass attic hatch. According to witness statements, immediately prior to the incident, the young man was sweating, speaking incoherently, displaying an unusual stare, and exhibiting agitated and aggressive behavior, after which he left the apartment unclothed. There was a documented history of previous psychoactive substance use, including LSD.

Biological samples collected during the forensic autopsy were analyzed using liquid chromatography–tandem mass spectrometry (LC–MS/MS). LSD was identified in blood (0.26 mg/L), urine (0.02 mg/L), and vitreous humor (0.001 mg/L). A hydroxy metabolite of LSD was also detected in both blood and urine.

Based on the autopsy findings, the death was determined to be violent and caused by multiple traumatic injuries sustained in the fall from height. In this case, an exceptionally high concentration of LSD was detected, which, to the best of our knowledge and according to the available literature, represents the highest postmortem LSD concentration reported to date. This case highlights the importance of interpreting toxicological findings in conjunction with autopsy findings, case circumstances, and the clinically manifested agitated behavior in order to more reliably assess the potential role of psychoactive substances in the fatal outcome.

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T-P11 OSTACI PESTICIDA U ZELENOM LISNATOM POVRĆU

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Kontrola ostataka pesticida u zelenom lisnatom povrću od značaja je za zaštitu zdravlja potrošača i procenu usaglašenosti hrane sa važećim propisima. Cilj rada bio je određivanje vrste i sadržaja ostataka pesticida u uzorcima zelenog lisnatog povrća dostavljenim u okviru službenog inspekcijskog nadzora. Tokom 2025–2026. godine u laboratoriji Gradskog zavoda za javno zdravlje Beograd analizirano je 58 uzoraka (24 zelene salate, 17 blitve i 17 spanaća). Ostaci pesticida određeni su metodama GC-MS/MS i LC-MS/MS. Ocena usaglašenosti izvršena je u skladu sa Pravilnikom o maksimalno dozvoljenim količinama ostataka sredstava za zaštitu bilja u hrani i hrani za životinje („Službeni glasnik RS“, br. 91/22, 26/24) i (Sl. glasnik RS, 13/26), uz primenu merne nesigurnosti i pravila odlučivanja prema smernicama SANTE/11312/2021, čime je obezbeđena pouzdana interpretacija rezultata u odnosu na propisane MDK. Ostaci pesticida detektovani su u 15 (63%) uzoraka zelene salate, 6 (35%) uzoraka blitve i 3 (18%) uzorka spanaća. Dva uzorka zelene salate ocenjena su kao neusaglašena zbog povećanog sadržaja flonikamida (0,96 ± 0,48 mg/kg; MDK 0,07 mg/kg) i teflutrina (0,029 ± 0,014 mg/kg; MDK 0,01 mg/kg), dok je kod jednog uzorka blitve utvrđen povećan sadržaj formetanata (0,04 ± 0,02 mg/kg; MDK 0,01 mg/kg). U ostalim pozitivnim uzorcima ostaci pesticida bili su ispod propisanih MDK. Dobijeni rezultati potvrđuju značaj laboratorijske kontrole u okviru službenog nadzora. Rezultati se odnose isključivo na analiziranu grupu inspekcijskih uzoraka i ne predstavljaju reprezentativan prikaz stanja na tržištu. Kontinuirano praćenje ostataka pesticida ostaje važan element zaštite potrošača i kontrole pravilne primene sredstava za zaštitu bilja.

T-P11 PESTICIDE RESIDUES IN GREEN LEAFY VEGETABLES

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Control of pesticide residues in leafy vegetables is essential for consumer health protection and for assessing food compliance with current regulations. The aim of this study was to determine the type and content of pesticide residues in leafy vegetable samples collected during official inspection. Between 2025–2026, the laboratory of the Institute of Public Health of Belgrade analyzed 58 samples: 24 lettuces, 17 Swiss chards, and 17 spinaches. Residues were determined using GC-MS/MS and LC-MS/MS methods. Compliance assessment was performed according to the Regulation on maximum permitted levels of pesticide residues in food and feed (“Official Gazette RS”, No. 91/22, 26/24) and (“Official Gazette RS”, No. 13/26), applying measurement uncertainty and decision rules in line with SANTE/11312/2021 guidelines, ensuring reliable interpretation of results against prescribed MRLs. Pesticide residues were detected in 15 (63%) lettuce samples, 6 (35%) Swiss chard samples, and 3 (18%) spinach samples. Two lettuce samples were non-compliant due to elevated levels of Flonicamid (0.96 ± 0.48 mg/kg; MRL 0.07 mg/kg) and Tefluthrin (0.029 ± 0.014 mg/kg; MRL 0.01 mg/kg), while one Swiss chard sample showed increased Formetanate (0.04 ± 0.02 mg/kg; MRL 0.01 mg/kg). In other positive samples, residues were below prescribed MRLs. The results confirm the importance of laboratory control within official monitoring, noting that they apply exclusively to the analyzed inspection samples and do not represent a market-wide overview. Continuous monitoring of pesticide residues remains a vital element of consumer protection and proper pesticide use control.

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T-P12 UPRAVLJANJE FARMACEUTSKIM OTPADOM U APOTEKARSKOJ PRAKSI-IZAZOVI PRIMENE REGULATIVE I ZAŠTITA JAVNOG ZDRAVLJA

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Farmaceutski otpad predstavlja značajan javnozdravstveni i ekološki problem zbog prisustva biološki aktivnih supstanci koje mogu dospeti u životnu sredinu i negativno uticati na zdravlje ljudi i ekosisteme. Poseban značaj ima pravilno upravljanje neupotrebljenim i lekovima sa isteklim rokom trajanja, čije neadekvatno odlaganje može doprineti kontaminaciji zemljišta i voda, kao i razvoju antimikrobne rezistencije. Cilj rada bio je da se sagleda primena važeće regulative i identifikuju ključni izazovi u upravljanju farmaceutskim otpadom u apotekarskoj praksi.

Istraživanje je obuhvatilo terensko ispitivanje sprovedeno u 11 apoteka na teritoriji Novog Beograda, analizu stručne literature i regulatornog okvira Republike Srbije. Terensko istraživanje sprovedeno je putem strukturisanih intervjua sa odgovornim farmaceutima, uz uvid u praksu upravljanja farmaceutskim otpadom u apotekama. Prikupljeni su podaci o postupcima skladištenja i odlaganja farmaceutskog otpada, saradnji sa ovlašćenim operaterima i mogućnostima preuzimanja lekova sa isteklim rokom trajanja od građana.

Rezultati su pokazali da sve ispitane apoteke dosledno primenjuju propisane procedure za upravljanje sopstvenim farmaceutskim otpadom i sarađuju sa licenciranim operaterima. Međutim, većina apoteka ne preuzima lekove od građana zbog visokih troškova zbrinjavanja, nedostatka prostora i neadekvatno definisanih mehanizama finansiranja. Takođe je uočena nedovoljna informisanost građana o pravilnom odlaganju neupotrebljenih lekova.

Dobijeni rezultati ukazuju na potrebu unapređenja sistema prikupljanja farmaceutskog otpada i usklađivanja sa postojećom regulativom, jačanja institucionalne podrške i kontinuirane edukacije zdravstvenih radnika i stanovništva radi efikasnije zaštite javnog zdravlja i životne sredine.

T-P12 PHARMACEUTICAL WASTE MANAGEMENT IN PHARMACY PRACTICE-CHALLENGES OF REGULATORY IMPLEMENTATION AND PUBLIC HEALTH PROTECTION

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Pharmaceutical waste represents a significant public health and environmental concern due to the presence of biologically active substances that may enter the environment and adversely affect human health and ecosystems. Proper management of unused and expired medicines is essential, as inappropriate disposal may contribute to soil and water contamination and the development of antimicrobial resistance. This study aimed to evaluate the implementation of the current regulatory framework and identify the key challenges in pharmaceutical waste management in pharmacy practice.

The study included a field survey conducted in 11 community pharmacies in the municipality of New Belgrade, supported by a review of the scientific literature and the regulatory framework of the Republic of Serbia. Data were collected through structured interviews with responsible pharmacists and an assessment of pharmaceutical waste management practices.

The results showed that all surveyed pharmacies complied with the prescribed procedures for managing pharmaceutical waste and cooperated with licensed waste management operators. However, most pharmacies did not accept expired medicines from the public due to high disposal costs, limited storage capacity, and inadequate funding mechanisms. In addition, insufficient public awareness regarding the proper disposal of unused medicines was identified.

The findings emphasize the need to improve pharmaceutical waste collection systems, strengthen implementation of the existing regulatory framework, and enhance institutional support and continuous education of healthcare professionals and the public to better protect public health and the environment.

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T-P13 MIGRACIJA METALA IZ METALNOG POSUĐA I PROCENA NJEGOVE ZDRAVSTVENE ISPRAVNOSTI PRIMENOM ICP-OES METODE

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Metalni materijali koji dolaze u kontakt sa hranom široko se koriste u domaćinstvu i prehrambenoj industriji zbog svojih povoljnih mehaničkih, termičkih i hemijskih svojstava. Pod određenim uslovima upotrebe može doći do migracije metala iz posuđa u hranu, što može predstavljati potencijalni rizik po zdravlje potrošača. Cilj rada bio je da se primenom ICP-OES metode proceni zdravstvena ispravnost metalnog posuđa i pribora za jelo određivanjem migracije metala u uslovima koji simuliraju kontakt sa hranom, kao i da se proceni uticaj vrste materijala, temperature i model-rastvora na intenzitet migracije.

Istraživanje je sprovedeno u laboratorijskim uslovima korišćenjem model-rastvora koji simuliraju kontakt hrane sa metalnim materijalima pri različitim temperaturama i vremenima izlaganja. Koncentracije migriranih metala određivane su metodom ICP-OES, koja omogućava preciznu i pouzdanu kvantifikaciju elemenata u tragovima.

Analizirano je ukupno 368 uzoraka metalnog posuđa i pribora za jelo dostavljenih na ispitivanje u akreditovanu laboratoriju REA-LAB u okviru redovne kontrole materijala namenjenih za kontakt sa hranom. Rezultati su pokazali da je 32 uzorka (8,7%) bilo zdravstveno neispravno zbog povećane migracije pojedinih metala. Kod neispravnih uzoraka najčešće je utvrđena povećana migracija gvožđa (10 uzoraka), hroma (8), nikla (7), bakra (4) i mangana (3). Na intenzitet migracije značajno utiču vrsta materijala, sastav model-rastvora, temperatura i vreme kontakta, pri čemu je najveća migracija zabeležena u kiselim sredinama i pri povišenim temperaturama.

Rezultati ukazuju da većina ispitanih proizvoda ispunjava zahteve važeće regulative u pogledu migracije metala. Kontinuirani monitoring migracije metala i primena savremenih analitičkih metoda predstavljaju značajne mere za unapređenje bezbednosti hrane i zaštitu zdravlja potrošača.

T-P13 THE MIGRATION OF METALS FROM METAL COOKWARE AND ASSESSMENT OF ITS HEALTH SAFETY USING THE ICP-OES METHOD

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Metal food-contact materials are widely used in households and the food industry due to their favorable mechanical, thermal, and chemical properties. Under certain conditions of use, metals may migrate from cookware into food, potentially posing a risk to consumer health. The aim of study was to assess the safety of metallic cookware by determining metal migration under conditions simulating food contact using ICP-OES method, and to evaluate the influence of material type, temperature, and food simulants on the extent of metal migration.

The study was conducted under laboratory conditions using food simulants designed to mimic contact between food and metal materials at different temperatures and exposure times. Concentrations of migrated metals were determined by ICP-OES, a highly sensitive and reliable analytical technique for trace element quantification.

A total of 368 samples of metallic cookware submitted for routine compliance testing to the accredited REA-LAB laboratory as part of official control of food contact materials were analyzed. Thirty-two samples (8.7%) were non-compliant due to excessive migration of specific metals. Elevated migration was most frequently observed for iron (10 samples), chromium (8), nickel (7), copper (4), and manganese (3). Metal migration was significantly influenced by the type of material, the composition of the food simulant, temperature, and contact time, with the highest migration levels detected under acidic conditions and at elevated temperatures.

The findings indicate that most tested products comply with current regulatory requirements for metal migration. Continuous monitoring using sensitive analytical methods are essential for improving food safety and protecting consumer health.

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Poster sesija 2
Poster session 2

SOCIJALNA FARMACIJA I FARMACEUTSKO ZAKONODAVSTVO
SOCIAL PHARMACY AND PHARMACEUTICAL LEGISLATION

ISTORIJA FARMACIJE
HISTORY OF PHARMACY

FARMACEUTSKA HEMIJA I ANALITIKA LEKOVA
PHARMACEUTICAL CHEMISTRY AND DRUG ANALYSIS

FARMAKOLOGIJA I FARMAKOTERAPIJA
PHARMACOLOGY AND PHARMACOTHERAPY

SFZ-P1 POVEZANOST BIOETIČKIH STAVOVA, ETIČKE SAMOPROCENE I STAVOVA FARMACEUTA O RADU SA PACIJENTIMA U JAVNIM APOTEKAMA

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Cilj istraživanja bio je ispitivanje odnosa između bioetičkih stavova, etičke samoprocene i stavova farmaceuta o sopstvenom radu sa pacijentima, utvrđivanje njihovih međusobnih povezanosti i prediktivnih odnosa u populaciji farmaceuta zaposlenih u javnim apotekama, kao i procena u kojoj meri bioetičke i profesionalne dimenzije doprinose ukupnoj etičkoj orijentaciji farmaceuta. U studiji preseka učestvovalo je 377 farmaceuta. Primenjene su tri skale: Skala stavova i uverenja farmaceuta o radu sa pacijentima (SOSUF/PABS), koja procenjuje stavove prema radu usmerenom na pacijenta; Skala bioetičkih stavova (BIOETH), koja procenjuje stavove prema bioetičkim principima; i Skala samoprocene etičkih aspekata (ETHICS), koja procenjuje samopercipiranu etičnost profesionalnog postupanja. Sve skale ocenjivane su na petostepenoj Likertovoj skali, pri čemu viši skorovi ukazuju na pozitivnije stavove i viši nivo samoprocenjene etičnosti. Rezultati su pokazali da je najviša prosečna vrednost zabeležena na ETHICS skali (M = 4,46 ± 0,44), zatim na BIOETH skali (M = 3,72 ± 0,36), dok je najniža vrednost zabeležena na PABS skali (M = 3,37 ± 0,34). Statistički značajna pozitivna korelacija utvrđena je između BIOETH i ETHICS (r = 0,341; p < 0,001), dok PABS nije bio značajno povezan sa ETHICS (r = -0,020; p = 0,700). Regresiona analiza pokazala je da BIOETH predstavlja značajan pozitivan prediktor etičke samoprocene (β = 0,351; p < 0,001). Zaključuje se da bioetički stavovi imaju značajnu ulogu u oblikovanju etičke samoprocene farmaceuta, dok su stavovi o svakodnevnom radu sa pacijentima slabije povezani sa opštom etičkom orijentacijom, što ukazuje na različitu prirodu ovih profesionalnih dimenzija.

Zahvalnica
Autori izražavaju zahvalnost svim farmaceutima koji su učestvovali u istraživanju i svojim izdvojenim vremenom i saradnjom omogućili realizaciju ove studije.

SFZ-P1 ASSOCIATION BETWEEN BIOETHICAL ATTITUDES, ETHICAL SELF-ASSESSMENT, AND PHARMACISTS' ATTITUDES TOWARD PATIENT CARE IN COMMUNITY PHARMACIES

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The aim of the study was to examine the relationships between bioethical attitudes, ethical self-assessment, and pharmacists' attitudes toward their work with patients, to determine their interrelationships and predictive associations among pharmacists employed in community pharmacies, and to assess the extent to which bioethical and professional dimensions contribute to ethical orientation. A total of 377 pharmacists participated in this cross-sectional study. Three instruments were applied: the Pharmacists' Attitudes and Beliefs about Patient Care Scale (SOSUF/PABS), assessing attitudes toward patient-centered care; the Bioethical Attitudes Scale (BIOETH), assessing attitudes toward bioethical principles; and the Ethics Self-Assessment Scale (ETHICS), assessing self-perceived ethicality of professional conduct. All instruments were rated on a five-point Likert scale, with higher scores indicating more positive attitudes and higher ethicality. The highest mean score was recorded on the ETHICS scale (M = 4.46 ± 0.44), followed by the BIOETH scale (M = 3.72 ± 0.36), while the lowest mean score was observed on the PABS scale (M = 3.37 ± 0.34). A statistically significant positive correlation was found between BIOETH and ETHICS (r = 0.341, p < 0.001), whereas PABS was not significantly associated with ETHICS (r = −0.020, p = 0.700). Regression analysis indicated that BIOETH was a significant positive predictor of ethical self-assessment (β = 0.351, p < 0.001). Bioethical attitudes appear to play an important role in shaping pharmacists' ethical self-assessment, whereas attitudes toward everyday work with patients were less closely related to overall ethical orientation, suggesting that these dimensions reflect distinct aspects of professional practice.

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SFZ-P2 LEADERSHIP DEVELOPMENT PROGRAM FOR PHARMACISTS: APPLICATION OF INTERNATIONAL COMPETENCY FRAMEWORKS

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Leadership development in healthcare is recognized as a shared professional responsibility, highlighting the need for an approach to developing leadership competencies within the pharmacy profession.

The objective of the study was to present the development, concept, and applicability of a structured leadership competency program for pharmacists and its role in continuing professional development.

The program was developed by analyzing and adapting two competency frameworks—the NHS Healthcare Leadership Model and the Royal Pharmaceutical Society Leadership Development Framework—to the needs of the pharmacy profession in the Republic of North Macedonia. Both frameworks define leadership as a set of competencies applicable across all levels of healthcare practice. The program is based on the premise that leadership is the responsibility of every pharmacist, regardless of workplace or formal leadership position. It is structured around nine leadership domains, each comprising four progressive levels. The six-week program includes a pre-program self-assessment, a one-day interactive workshop, an online follow-up session, a post-program self-assessment with a leadership development report, and a personalized leadership action plan.

A structured leadership competency program for pharmacists was developed and accredited by the Pharmaceutical Chamber of the Republic of North Macedonia. Its design enables assessment of leadership competencies and monitoring

The program provides a structured model for leadership development that supports pharmacists' growth and may serve as a model for implementation in healthcare systems across the region.

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SFZ-P3 SAMOPROCENA PRISUSTVA SIMPTOMA DEPRESIJE, ANKSIOZNOSTI I STRESA KOD ZAPOSLENIH U JAVNIM APOTEKAMA U SRBIJI

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Rad u javnim apotekama nosi visok nivo odgovornosti i stalnu interakciju sa pacijentima, što može negativno uticati na mentalno zdravlje zdravstvenih profesionalaca. Razumevanje prevalence anksioznosti, depresije i stresa važno je za samo blagostanje zaposlenih, odnosno pacijenata u smislu potencijalnog uticaja na kulturu bezbednosti pacijenata.

Cilj rada bio je ispitati prisustvo simptoma anksioznosti, depresije i stresa kod zaposlenih zdravstvenih profesionalaca u javnim apotekama u Srbiji na osnovu njihove samoprocene, te identifikovati njihovu povezanost sa demografskim i profesionalnim karakteristikama.

U okviru studije preseka, koja je sprovedena tokom maja 2026. godine, obuhvaćeno je 836 farmaceuta i farmaceutskih tehničara zaposlenih u različitim tipovima apoteka u Srbiji. Svi ispitanici su dobrovoljno prihvatili učešće u anonimnom istraživanju. Samoprocena nivoa depresije, stresa i anksioznosti sprovedena je korišćenjem standardizovanog i validiranog DASS21 upitnika. Za analizu podataka korišćen je Pearson-ov χ^2 test.

Prema DASS21 upitniku, depresivnost je bila prisutna kod 4,5%, anksioznost kod 5%, a stres kod 1,9% farmaceuta. Žene su bile značajno češće sa simptomima anksioznosti u odnosu na muškarce (p=0,015). Značano veći rizik od depresivnosti imali su ispitanici sa većim prosečnim brojem recepata (p=0,029) i "prolaznim" pacijentima (p=0,002). Tip apoteke u kojoj rade (p=0,018) i sa kojim pacijentima rade (p<0,001) pokazali su se kao ključni faktori povezani sa nivoom stresa.

Iako je učestalost javljanja simptoma stresa, anksioznosti i depresivnosti niska, faktori poput obima posla i strukture pacijenata značajno utiču na mentalno blagostanje. Neophodne su preventivne strategije za unapređenje rada farmaceuta koje bi doprinele redukciji faktora koji doprinose stresu, depresivnosti i anksioznosti u apotekarskoj praksi.

SFZ-P3 SELF-ASSESSMENT OF SYMPTOMS OF DEPRESSION, ANXIETY AND STRESS AMONG EMPLOYEES IN COMMUNITY PHARMACIES IN SERBIA

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Working in community pharmacies involves high levels of responsibility and constant patient interaction, which can negatively impact mental health of healthcare professionals. Understanding the prevalence of anxiety, depression, and stress is important for the well-being of employees and can potentially impact patient safety culture.

The aim of the study was to examine the presence of symptoms of anxiety, depression and stress among employed health professionals in public pharmacies in Serbia based on their self-assessment, and to identify their relationship with demographic and professional characteristics.

In a cross-sectional study conducted in May 2026, 836 pharmacists and pharmacy technicians employed in various types of pharmacies participated voluntarily in an anonymous survey. Self-assessment of depression, stress, and anxiety levels was conducted using a standardized and validated DASS-21 questionnaire. Pearson's chi-squared test was used for data analysis.

According to the DASS-21 questionnaire, depression was present in 4.5%, anxiety in 5%, and stress in 1.9% of pharmacists. Women were significantly more likely to exhibit symptoms of anxiety compared to men (p=0.015). A significantly higher risk of depression was observed among participants with a higher average number of prescriptions (p=0.029) and "transient" patients (p=0.002). The type of pharmacy (p=0.018) and interactions with different patient groups (p<0.001) were key factors associated with the level of stress.

Although the prevalence of stress, anxiety, and depression symptoms is low, factors such as workload and patient structure significantly affect mental well-being. Preventive strategies are necessary to enhance pharmacists' work practices and reduce factors contributing to stress, depression, and anxiety in pharmacy practice.

SFZ-P4 MOŽE LI RAZVOJ EMOCIONALNE INTELIGENCIJE DA UTIČE NA STRES, SAGOREVANJE NA POSLU I MENTALNO BLAGOSTANJE FARMACEUTA U APOTEKAMA? – PRELIMINARNI REZULTATI STUDIJE PRESEKA

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Istraživanja emocionalne inteligencije (EI) u farmaceutskoj praksi pokazala su da viši nivo EI doprinosi većoj motivaciji, preduzimljivosti, empatičnosti, komunikacionim i liderskim veštinama i rezilijentnosti farmaceuta. Takođe je utvrđeno da programi profesionalnog usavršavanja farmaceuta u Srbiji nedovoljno doprinose razvoju EI. Do sada nije istraživana povezanost EI sa sagorevanjem na poslu i mentalnim blagostanjem farmaceuta zaposlenih u apotekama u Srbiji.

Cilj ove studije preseka bio je da ispita povezanost EI, percipiranog stresa, sagorevanja na poslu i mentalnog blagostanja, kao i moguću medijacionu ulogu pojedinih faktora. Dodatno, istražen je uticaj specijalno osmišljenih i akreditovanih edukativnih programa Farmaceutske komore Srbije na razvoj EI i povezanih ishoda. Korišćeni su validirani upitnici, deskriptivna i korelaciona statistika, kao i medijaciona analiza prema Hayesu. Poziv za učešće upućen je elektronski svim obaveznim članovima FKS, na koji se odazvalo ukupno 239 farmaceuta (90,4% žena), prosečne starosti 40,9±10,3 godina i sa 14,1±9,8 godina radnog iskustva. Utvrđena je statistički značajna korelacija EI sa percipiranim stresom, sagorevanjem na poslu i mentalnim blagostanjem ($p<0,01$). U grupi koja je prošla edukativnu intervenciju (n=59) zabeležen je niži nivo sagorevanja ($p<0,01$) u odnosu na grupu koja nije prošla intervenciju (n=180), dok razlike u ukupnim nivoima EI, stresa i mentalnog blagostanja nisu bile značajne. Značajne razlike uočene su u subdomenima EI (emocionalna svest o sebi i emocionalna ekspresija) i komponentama sagorevanja (emocionalna iscrpljenost i napetost). Medijaciona analiza pokazala je značajnu ulogu stresa i prevencije sagorevanja u odnosu između EI i mentalnog blagostanja ($p<0,001$).

Rezultati ukazuju da ciljane edukacije mogu doprineti razvoju EI i unapređenju mentalnog blagostanja farmaceuta.

Zahvalnica

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SFZ-P4 CAN THE DEVELOPMENT OF EMOTIONAL INTELLIGENCE INFLUENCE STRESS, BURNOUT, AND MENTAL WELL-BEING AMONG COMMUNITY PHARMACISTS? – PRELIMINARY RESULTS OF A CROSS-SECTIONAL STUDY

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Research on emotional intelligence (EI) in pharmaceutical practice has shown that higher EI is associated with greater motivation, initiative, empathy, communication, leadership, and resilience among pharmacists. Professional development programs for pharmacists in Serbia, however, appear to provide limited support for EI development. To date, the relationship between EI, burnout, and well-being among pharmacists working in Serbian pharmacies has not been explored comprehensively.

This cross-sectional study examined the relationships among EI, perceived stress, burnout, and well-being, and the potential mediating role of specific factors. It also investigated the impact of specially designed, accredited educational programs organised by the Pharmaceutical Chamber of Serbia on EI development and related outcomes. Validated questionnaires were used alongside descriptive, correlational, and Hayes' mediation analyses. Invitations to participate were sent electronically to all mandatory Chamber members. A total of 239 pharmacists participated (90.4% female), with a mean age of 40.9±10.3 years and 14.1±9.8 years of work experience. Statistically significant correlations were observed between EI and perceived stress, burnout, and well-being ($p<0.01$). Participants who completed the educational intervention (n=59) demonstrated lower levels of burnout ($p<0.01$) than those in the non-intervention group (n=180), whereas differences in overall EI, stress, and well-being were not significant. Significant differences were found in EI subdomains, self-emotional awareness and emotional expression, and in burnout components, emotional exhaustion and tension. Mediation analysis highlighted the significant role of stress and burnout prevention in the relationship between EI and well-being ($p<0.001$).

These findings suggest that targeted development programs can strengthen EI competencies and improve pharmacists' well-being.

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SFZ-P5 FARMACEUTI U VREMENU IZAZOVA: RAZVOJ KARIJERE I POSLOVNIH VEŠTINA KAO POKRETAČ PROFESIONALNE OTPORNOSTI U SRBIJI

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Razvoj karijere i poslovnih (mekih) veština farmaceuta u Srbiji decenijama je bio nedovoljno zastupljen u osnovnom i kontinuiranom obrazovanju, koje je pretežno bilo usmereno na stručne kompetencije i klinička znanja. Veštine profesionalne komunikacije, samoprezentacije, upravljanja karijerom i pripreme za proces selekcije retko su bile sistematski zastupljene u obrazovanju farmaceuta.

U periodu od juna 2025. do maja 2026. sprovedena je kvalitativna studija sa 50 farmaceuta korišćenjem strukturiranih intervjua. Učesnici su regrutovani metodom „grudve snega". Kriterijumi za uključivanje bili su i. želja za promenom posla i ii. minimum dve godine rada na prethodnoj poziciji. Instrument je obuhvatio demografske podatke, 10 tipičnih pitanja iz procesa selekcije sa Likertovom skalom procene odgovora (1–4), kao i pitanja o prethodnoj pripremi za intervju.

Među ispitanicima, 45 su bile žene, a 5 muškarci, prosečne starosti 37±8,4 godina. Srednja vrednost ocena odgovora bila je 2,8±1,2. Čak 81% ispitanika imalo je poteškoće da prepozna sopstvene snage, dok je 96% preuveličano sagledavalo svoje slabosti. Većina učesnika (79%) nikada nije imala organizovanu pripremu za intervju, niti edukaciju vezanu za izradu profesionalne biografije i profesionalno predstavljanje. Gotovo svi ispitanici (96%) smatrali su ovakav vid edukacije veoma korisnim za profesionalni razvoj i povećanje samopouzdanja. Ispitanici su posebno istakli značaj praktičnih radionica, simulacija intervjua i individualnog *feedback*-a mentora.

Rezultati ukazuju na potrebu integracije razvoja karijere i mekih veština u dodiplomsko i kontinuirano obrazovanje farmaceuta radi jačanja profesionalne otpornosti i adaptacije na savremene izazove farmaceutske prakse.

SFZ-P5 PHARMACISTS IN TIMES OF CHALLENGE: CAREER DEVELOPMENT AND BUSINESS SKILLS AS DRIVERS OF PROFESSIONAL RESILIENCE IN SERBIA

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Career development and business (soft) skills among pharmacists in Serbia have long been insufficiently represented in undergraduate and continuing education, which has primarily focused on professional competencies and clinical knowledge. Skills related to professional communication, self-presentation, career management, and interview preparation have rarely been systematically included in pharmacy education.

A qualitative study was conducted between June 2025 and May 2026 involving 50 pharmacists using structured interviews. Participants were recruited through „snowball sampling". Inclusion criteria included i. willingness to change employment and ii. at least two years of experience in their previous position. The instrument included demographic data, 10 common interview questions assessed using a 4-point Likert scale (1–4), and questions regarding previous interview preparation.

Among participants, 45 were female and 5 male, with a mean age of 37±8.4 years. The mean interview response score was 2.8±1.2. A total of 81% reported difficulties recognising their own strengths, while 96% tended to overestimate their weaknesses. Most participants (79%) had never received organised interview preparation or education related to CV writing and professional self-presentation. Nearly all participants (96%) considered this type of education highly beneficial for professional development and self-confidence. Participants particularly highlighted the value of practical workshops, mock interviews, and individual mentor feedback.

The findings highlight the need to integrate career development and soft skills training into undergraduate and continuing pharmacy education to strengthen professional resilience and adaptability in contemporary pharmacy practice.

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SFZ-P6 FARMACEUTI KAO POKRETAČI PROMENE: RAZVOJ I SERTIFIKACIJA INTERNIH TRENERA MEKIH VEŠTINA KROZ DR.MAX LIDERSKU AKADEMIJU

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Savremena farmaceutska praksa zahteva kontinuirani razvoj liderskih i mekih veština zaposlenih. Razvoj internih trenera predstavlja održiv pristup unapređenju kompetencija, prenosu znanja i podršci organizacionim promenama. Cilj istraživanja bio je prikaz selekcije, razvoja i sertifikacije internih trenera mekih veština u Dr.Max Liderskoj akademiji.

Tokom maja–juna 2025. sproveden je interni konkurs u sistemu sa preko 400 apoteka. Kriterijumi za uključivanje bili su najmanje tri godine iskustva na rukovodećoj poziciji i motivacija za razvoj u oblasti edukacije zaposlenih. Od 60 prijavljenih kandidata izabrano je 13 trenera. Selekcija je sprovedena kompetencijski zasnovanim strukturiranim intervjuom uz ocenu tri procenjivača. Od septembra 2025. do januara 2026. realizovan je program koji je obuhvatio trening trenera i osam modula: liderstvo, komunikaciju, upravljanje konfliktima, koučing i fidbek, upravljanje vremenom, razvoj tima, upravljanje rizicima i promenama te upravljanje učinkom i razvojem zaposlenih. Sertifikacija je sprovedena kroz samostalno izvođenje treninga uz evaluaciju master trenera. Efekti programa procenjivani su primenom Kirkpatrick modela.

Svih 13 polaznika uspešno je završilo program i steklo status sertifikovanih internih trenera. Evaluacija reakcija pokazala je zadovoljstvo programom, sa prosečnim ocenama 4,75 za sadržaj, 4,78 za metodologiju i 4,80 za odnos prema učesnicima (1 = uopšte nisam zadovoljan/na; 5 = u potpunosti sam zadovoljan/na). Prosečan nivo znanja povećan je sa 2,44 na 8,71 od maksimalnih 12 bodova. Indeks uvećanja znanja 1 iznosio je +257% ($p<0,001$), dok je Indeks uvećanja znanja 2 iznosio +45% u odnosu na benchmark znanja ($p<0,02$).

Razvoj i sertifikacija internih trenera predstavljaju održiv model za razvoj mekih veština, liderstva i kontinuiranog učenja u farmaceutskoj praksi.

SFZ-P6 PHARMACISTS AS AGENTS OF CHANGE: DEVELOPMENT AND CERTIFICATION OF INTERNAL SOFT SKILLS TRAINERS THROUGH THE DR.MAX LEADERSHIP ACADEMY

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Contemporary pharmacy practice requires continuous development of leadership and soft skills. Developing internal trainers represents a sustainable approach to enhancing competencies, knowledge transfer and organisational change. The aim of this research was to present the selection, development and certification of internal soft skills trainers within the Dr.Max Leadership Academy.

During May–June 2025, a recruitment process was conducted within a system comprising over 400 pharmacies. Inclusion criteria were a minimum of three years' managerial experience and motivation for employee development. From 60 applicants, 13 trainers were selected. Selection was conducted using a competency-based structured interview, with assessment by three evaluators. From September 2025 to January 2026, a programme comprising train-the-trainer and eight modules: leadership, communication, conflict management, coaching and feedback, time management, team development, risk and change management, and performance and employee development management. Certification was achieved through independent delivery of training sessions evaluated by master trainers. Programme outcomes were assessed using Kirkpatrick evaluation model.

All 13 participants completed the programme and achieved certification as internal trainers. Reaction evaluation demonstrated satisfaction, with mean scores 4.75 for content, 4.78 for methodology and 4.80 for facilitator–participant interaction (1 = not satisfied at all; 5 = completely satisfied). Mean knowledge scores increased from 2.44 to 8.71 out of 12 points. Knowledge Gain Index 1 was +257% ($p<0.001$), while Knowledge Gain Index 2 was +45% compared with the knowledge benchmark ($p<0.02$).

The development and certification of internal trainers represent a sustainable model for advancing soft skills, leadership and learning culture in pharmacy practice.

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SFZ-P7 STAVOVI I ISKUSTVA FARMACEUTA O INTERPROFESIONALNOJ SARADNJI SA LEKARIMA

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Interprofesionalne timove čine zdravstveni profesionalci različitih profesija koji ravnopravno sarađuju, uz aktivno uključivanje pacijenata u donošenje odluka, sa ciljem unapređenja zdravstvenih ishoda.

Cilj rada bio je ispitivanje stavova i iskustava farmaceuta zaposlenih u apotekama na primarnom nivou zdravstvene zaštite o interprofesionalnoj saradnji sa lekarima.

Istraživanje je sprovedeno primenom namenski kreiranog upitnika za prikupljanje podataka o stavovima i iskustvima farmaceuta u kontekstu interprofesionalne saradnje sa lekarima. Upitnik je obuhvatao pitanja o socio-demografskim karakteristikama ispitanika, intraprofesionalnoj saradnji unutar apoteke i interprofesionalnoj saradnji između farmaceuta i lekara. Nakon prikupljanja i tabelarnog prikaza podataka, statistička analiza izvršena je u programu SPSS verzija 27.0.

U istraživanju je učestvovalo 84 farmaceuta. Većina farmaceuta najčešće sarađuje sa lekarima opšte prakse (59,5%), prvenstveno u vezi sa proverom ispravnosti propisane terapije (55,0%), ali ređe od jednom mesečno (42,9%). Komunikaciju sa lekarima 44,0% ispitanika ne smatra jasnom i efikasnom, a saradnju najčešće iniciraju farmaceuti (76,2%). Iako se 40,5% ispitanika u potpunosti slaže da je saradnja sa lekarima ključna za kvalitetnu zdravstvenu zaštitu, samo 6% smatra da ih lekari uključuju u rešavanje problema povezanih sa farmakoterapijom, pritom 70,2% farmaceuta navodi da postoji profesionalna hijerarhija. Većina farmaceuta navodi da tokom studija nije imala priliku da razvija veštine interprofesionalne saradnje (58,3%) i smatra da bi interprofesionalnu saradnju trebalo više razvijati i podsticati tokom studija (78,5%).

Rezultati ukazuju na značaj unapređenja interprofesionalne saradnje, kao i na potrebu za većim uključivanjem interprofesionalnog obrazovanja u studijske programe zdravstvenih profesija, radi razvoja komunikacionih i timskih kompetencija neophodnih za obezbeđenje integrisane zdravstvene zaštite.

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SFZ-P7 PHARMACISTS' ATTITUDES AND EXPERIENCES REGARDING INTERPROFESSIONAL COLLABORATION WITH PHYSICIANS

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Interprofessional teams include healthcare professionals from different disciplines who collaborate as equal partners, with active patients involvement in decision-making to improve health outcomes.

The aim of the study was to examine attitudes and experiences of pharmacists working in primary healthcare regarding interprofessional collaboration with physicians.

A purpose-designed questionnaire was used to assess pharmacists' attitudes and experiences related to interprofessional collaboration with physicians. The questionnaire included items on sociodemographic characteristics, intraprofessional collaboration within pharmacies, and interprofessional collaboration between pharmacists and physicians. Data were analyzed using SPSS version 27.0.

A total of 84 pharmacists participated. Most respondents collaborated primarily with general practitioners (59.5%), mainly to verify prescribed therapy (55.0%), although such collaboration occurred less than once a month for 42.9% of participants. Communication with physicians was not considered clear and effective by 44.0% of respondents, while pharmacists most often initiated collaboration (76.2%). Although 40.5% strongly agreed that collaboration with physicians is essential for high-quality healthcare, only 6.0% believed that physicians include them in resolving pharmacotherapy-related problems. Furthermore, 70.2% reported the existence of a professional hierarchy. Most pharmacists stated that they had not opportunities to develop interprofessional collaboration skills during their studies (58.3%) and believed that such competencies should be promoted more extensively in healthcare education (78.5%).

The findings emphasize the need to strengthen interprofessional collaboration and increase the integration of interprofessional education into healthcare curricula to improve communication, teamwork, and healthcare quality.

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SFZ-P8 ULOGA I ZNAČAJ PARTNERSKOG PRISTUPA U PREVENCIJI RAKA DOJKE ISKUSTVO NA TERITORIJI GRADA SUBOTICE 2013-2026

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Rak dojke predstavlja najčešću malignu bolest kod žena. Promocija zdravlja u oblasti prevencije raka dojke sprovodi se kroz edukativne kampanje, skrining programe ranog otkrivanja, kao i kroz psihosocijalnu podršku obolelim ženama.

Cilj rada je prikaz dobre prakse Apotekarske ustanove Subotica, Zavoda za javno zdravlje Subotica, udruženja građana „Jedna uz drugu" i drugih aktera iz lokalne zajednice. Sprovedena je retrospektivna deskriptivna analiza javnozdravstvenih aktivnosti realizovanih u periodu od marta 2013. do marta 2026. godine na osnovu dokumentacije partnerskih institucija.

Tokom tog perioda, u kontinuitetu su obeležavani Nacionalni dan borbe protiv raka dojke i „Pink oktobar" – međunarodni mesec borbe protiv raka dojke. Organizovano je ukupno 24 konferencije za medije, 24 bazara zdravlja, 15 edukativnih aktivnosti (tribine, okrugli stolovi, paneli, ZOOM sastanci, predavanja i javne edukacije), 7 šetnji u prirodi i jedna tematska izložba umetničkih radova u galerijskom prostoru.

Apotekarska ustanova Subotica bila je partner na konferencijama za medije, kontinuirano je pružala podršku kroz savetovanja u apotekama i promociju zdravih stilova života u akcijama u zajednici. Sve javnozdravstvene aktivnosti bile su medijski propraćene na lokalnim kanalima, kao i na internet stranicama Apoteke, Zavoda i drugih partnera.

Prikazani model saradnje zdravstvenih ustanova, civilnog sektora i lokalne zajednice predstavlja primer dobre prakse u sprovođenju aktivnosti promocije zdravlja i prevencije raka dojke na lokalnom nivou. Za procenu uticaja ovih aktivnosti na svest stanovništva i zdravstvene ishode potrebna su dalja evaluaciona istraživanja.

SFZ-P8 THE ROLE AND IMPORTANCE OF A PARTNERSHIP APPROACH IN THE PREVENTION OF BREAST CANCER: EXPERIENCE IN THE TERRITORY OF THE CITY OF SUBOTICA 2013 – 2026

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Breast cancer is the most common malignant disease among women. Health promotion in the field of breast cancer is carried out through educational campaigns, screening programs for early detection, and psychosocial support for women affected by the disease.

This paper aims to present the partnership between the Subotica Pharmacy Institution, the Institute for Public Health Subotica, the citizens' association "Jedna uz drugu", and other actors from the local community during the period from March 2013 to March 2026.

During this period, the National Day of the Fight against Breast Cancer and "Pink October", the international month dedicated to breast cancer awareness, were continuously commemorated. In total, 24 media conferences, 24 health fairs, 15 educational activities (discussions, round tables, panels, ZOOM meetings, lectures, and public education), 7 nature walks, and one thematic art exhibition were organized.

The Subotica Pharmacy Institution participated in media conferences and continuously provided support through consultations in pharmacies and the promotion of healthy lifestyles within community activities. All public health activities were covered by local media and presented on the websites of participating institutions.

The presented model of collaboration between healthcare institutions, the civil sector, and the local community represents an example of good practice in implementing health promotion and breast cancer prevention activities at the local level. Further evaluation studies are needed to assess the impact of these activities on public awareness and health outcomes.

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SFZ-P9 SAMOPROCENA ZNANJA ZAPOSLENIH U JAVNIM APOTEKAMA U VEZI SA PRAKSOM IZDAVANJA ANTIBIOTIKA

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Antimikrobna rezistencija (AR) je jedan od vodećih problema u današnje vreme, a uloga farmaceuta u lancu izdavanja je izuzetni bitna.

Cilj istraživanja bio je ispitati stručna znanja zaposlenih u apotekama o antibioticima i AR i zakonskim okvirima u vezi sa izdavanjem antibiotika.

Sprovedena je studija preseka primenom namenski kreiranog upitnika kojim su ispitanici samoprocenjivali znanja u vezi sa izdavanjem antibiotika. U istraživanju su učestvovali zdravstveni radnici svih nivoa farmaceutskog obrazovanja zaposleni u gotovo svim apotekama na teritoriji grada Šapca i okoline, podaci su prikupljani od marta do avgusta 2022. godine.

Stopa odgovora iznosila je 57,7%, 229 ispitanika je kompletno popunilo upitnik. U istraživanju su dominirale osobe ženskog pola (87,3%). U pogledu formalnog obrazovanja najviše je bilo farmaceuta (59%). Kada su u pitanju virusne infekcije 95,2% ispitanika znalo je da su antibiotici u tom slučaju neefikasni. Gotovo svi ispitanici su potvrdili iskaze da neodgovarajuća upotreba antibiotika utiče na porast AR i da izdavanje antibiotika bez recepta dovodi do razvoja AR (99,6%, 96,5% sledstveno). Ukupno 90,8% ispitanika je svesno da farmaceuti u skladu sa postojećim zakonskim propisima mogu biti kažnjeni ako izdaju antibiotik bez recepta, a gotovo svi u uzorku su znali (98,3%) da farmaceut ima regulativom zahtevanu obavezu da evidentira izdavanje antibiotika. Svaki deseti ispitanik je znao da u Srbiji postoji lek koji sadrži antibiotik, a koji je registrovan kao lek koji se izdaje bez lekarskog recepta.

Rezultati su pokazali visok nivo samoprocenjenog teorijskog znanja i poznavanje osnovnih regulatornih zahteva kada je u pitanju praksa izdavanje antibiotika.

SFZ-P9 SELF-ASSESSMENT OF KNOWLEDGE AMONG EMPLOYEES IN PUBLIC PHARMACIES REGARDING THE PRACTICE OF DISPENSING ANTIBIOTICS

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Antimicrobial resistance (AR) is one of the leading problems today, and the role of pharmacists in the dispensing of antibiotics is extremely important. The aim of the research was to examine the professional knowledge of pharmacy employees about antibiotics and AR and the legal frameworks related to antibiotics' dispensing.

A cross-sectional study was conducted using a specially designed questionnaire. The study included healthcare workers of all levels of pharmaceutical education employed in almost all pharmacies in the city of Šabac and its surroundings, sampling period March-August, 2022.

The response rate was 57.7%, and 229 respondents completed the questionnaire in full. The study respondents were predominantly women (87.3%), in terms of formal education, most were pharmacists (59%). Regarding viral infections, 95.2% of respondents knew that antibiotics are ineffective. Almost all respondents confirmed the statements that inappropriate use of antibiotics contributes to increased AR and that dispensing antibiotics without a prescription leads to the development of AR (99.6% and 96.5%, respectively). Overall, 90.8% of respondents are aware that pharmacists can be penalized under current legal regulations if they dispense antibiotics without a prescription, and almost everyone in the sample (98.3%) knew that pharmacists are required by regulation to record the dispensing of antibiotics. However, only one in ten respondents knew that in Serbia there is a drug with an antibiotic that is registered as an OTC medicine.

The results showed a high level of self-assessed theoretical knowledge and awareness of basic regulatory requirements when it comes to the practice of dispensing antibiotics.

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SFZ-P10 ORGANIZACIJA RADA KAO FAKTOR OPERATIVNE EFIKASNOSTI U APOTEKARSKOJ USTANOVI SUBOTICA

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Cilj ovog istraživanja je ispitivanje percipiranog nivoa organizacije rada u Apotekarskoj ustanovi Subotica kao i analiza aspekata njenog organizacionog funkcionisanja. Istraživanje je sprovedeno 2024. godine u Apotekarskoj ustanovi Subotica. Primenjen je kvantitativni, neeksperimentalni, deskriptivni i presečni istraživački dizajn, korišćenjem anketne metode prikupljanja podataka. Za prikupljanje podataka koristila se Skala načina organizovanja, koja se sastoji od 12 tvrdnji, procenjivanih na petostepenoj Likertovoj skali. Uzorak je činilo 17 zaposlenih iz Apotekarske ustanove Subotica. Stopa odziva ispitanika bila je 100%, a istraživanjem su obuhvaćeni svi zaposleni iz Apotekarske ustanove Subotica.

Rezultati pokazuju da zaposleni organizaciju rada u celini percipiraju kao dobro uspostavljenu. Najviše ocenjeni aspekti bili su: zadaci se obavljaju u predviđenom roku (M=4,41), posao se obavlja logičnim tokom (M=4,41), svaki korak radnog procesa je neophodan (M=4,41), kao i da su zaposleni koji rade na međusobno povezanim poslovima smešteni blizu jedni drugima (M=4,47). Visoko su ocenjene i jasno definisane funkcije, konkretni ciljevi i precizno definisane odgovornosti. Niže ocene dobijene su za decentralizovano upravljanje (M=3,11), maksimalno korišćenje sposobnosti zaposlenih (M=3,52) i produktivnost sastanaka (M=3,64), što ukazuje na oblasti u kojima je moguće unaprediti organizaciono funkcionisanje.

Nalazi ukazuju da ustanova ima funkcionalnu organizaciju rada, uz potrebu za unapređenjem osnaživanja zaposlenih, decentralizacije odlučivanja i efikasnosti sastanaka. Rezultati mogu biti osnova za unapređenje menadžerskih praksi u apotekarskim ustanovama. Ipak, istraživanje je sprovedeno u samo jednoj ustanovi, na relativno malom uzorku i primenom presečnog istraživačkog dizajna, zbog čega je mogućnost generalizacije nalaza ograničena.

SFZ-P10 ORGANIZATION OF WORK AS A FACTOR OF OPERATIONAL EFFICIENCY IN A PHARMACY INSTITUTION SUBOTICA

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The aim of this study was to examine the perceived level of work organization in a Pharmacy institution Subotica and to identify the most and least developed aspects of its organizational functioning. The study was conducted in 2024 at the Pharmacy Institution Subotica. A quantitative, non-experimental, descriptive, cross-sectional research design was applied using the survey method. Data were collected using the 12-item Work Organization Scale, rated on a five-point Likert scale. The sample comprised all 17 employees of the Pharmacy Institution Subotica, yielding a response rate of 100%.

The results indicate that employees perceive work organization as generally well established. The highest-rated aspects were completing tasks within the scheduled time (M=4.41), performing work in a logical sequence (M=4.41), the necessity of every step in the work process (M=4.41), and the proximity of employees performing interrelated tasks (M=4.47). Clearly defined functions, specific objectives, and well-defined responsibilities also received high ratings. Lower ratings were obtained for decentralized management (M=3.11), the optimal utilization of employees' abilities (M=3.52), and the productivity of meetings (M=3.64), indicating areas with potential for organizational improvement.

The findings suggest that the institution has a functional work organization, while further improvements are needed in employee empowerment, decentralized decision-making, and meeting efficiency. The results may serve as a basis for improving managerial practices in pharmacy institutions. However, the study was conducted in a single institution, on a relatively small sample, and using a cross-sectional research design, which limits the generalizability of the findings.

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SFZ-P11 NIVO ORGANIZACIONE POSVEĆENOSTI ZAPOSLENIH U APOTEKARSKOJ USTANOVI SUBOTICA

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Cilj ovog istraživanja je ispitivanje nivoa i strukture organizacione posvećenosti zaposlenih u apotekarskoj ustanovi. Istraživanje je sprovedeno 2024. godine u Apotekarskoj ustanovi Subotica. Primenjen je kvantitativni istraživački pristup. Za merenje organizacione posvećenosti korišćen je upitnik organizacione posvećenosti (engl. Organizational Commitment Questionnaire – OCQ). Upitnik se sastoji od 15 tvrdnji, koje se procenjuju na petostepenoj Likertovoj skali odgovora. Uzorak je obuhvatio 17 zaposlenih Apotekarske ustanove Subotica. Stopa odziva ispitanika iznosila je 100%, a istraživanjem su obuhvaćeni svi zaposleni Apotekarske ustanove Subotica.

Rezultati ukazuju na visok nivo organizacione posvećenosti zaposlenih. Najviši stepen slaganja zabeležen je kod tvrdnji da je zaposlenima važna budućnost organizacije (M=4,70), da su spremni da ulože dodatni trud za njen uspeh (M=4,41) i da im je drago što rade upravo u toj organizaciji (M=4,41). Visoko su ocenjeni i osećaj ponosa zbog pripadnosti organizaciji (M=4,29), inspirisanost za rad (M=4,23) i percepcija organizacije kao poželjnog mesta za rad (M=4,23), dok su negativno formulisane tvrdnje o niskoj lojalnosti (M=1,41) i žaljenju zbog zaposlenja (M=1,58) imale niske prosečne vrednosti. Rezultate treba tumačiti uz određena ograničenja, budući da je istraživanje sprovedeno u samo jednoj apotekarskoj ustanovi i na relativno malom uzorku zaposlenih, što ograničava mogućnost generalizacije nalaza.

Nalazi ukazuju na to da zaposleni pokazuju izraženu lojalnost, identifikaciju sa organizacionim vrednostima i spremnost da doprinesu uspehu organizacije.

SFZ-P11 LEVEL OF ORGANIZATIONAL COMMITMENT AMONG EMPLOYEES IN A PHARMACY INSTITUTION SUBOTICA

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The aim of this study was to examine the level and structure of organizational commitment among employees in a pharmacy institution. The research was conducted in 2024 at the Pharmacy Institution Subotica using a quantitative approach. Organizational commitment was measured using the 15-item Organizational Commitment Questionnaire (OCQ) rated on a five-point Likert scale. The sample comprised all 17 employees of the Pharmacy Institution Subotica, yielding a response rate of 100%.

The results indicate a high level of organizational commitment among employees. The highest level of agreement was found for the statements that the future of the organization is important to employees (M=4.70), that they are willing to invest additional effort to contribute to the organization's success (M=4.41), and that they are pleased to work for this organization (M=4.41). High mean scores were also recorded for pride in belonging to the organization (M=4.29), inspiration to perform at their best (M=4.23), and the perception of the organization as a desirable place to work (M=4.23). Conversely, negatively worded statements regarding low loyalty to the organization (M=1.41) and regret over the decision to work in the organization (M=1.58) received low mean scores. The findings should be interpreted in light of certain limitations, as the study was conducted in a single pharmacy institution and involved a relatively small sample of employees, which limits the generalizability of the findings.

The findings indicate that employees demonstrate strong loyalty, identification with organizational values, and a willingness to contribute to the organization's success.

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SFZ-P12 POKAZATELJI KVALITETA I USLUGE U APOTEKAMA: UPOREDNI PRIKAZ DOBRIH PRAKSI U SVETU

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Rad istražuje značaj obezbeđivanja kvaliteta u zdravstvenim sistemima, sa fokusom na apotekarsku praksu. Težnja da se poveća obim farmaceutskih usluga nameće i potrebu da se obezbedi i zadovoljavajući kvalitet istih, kako bi se osigurala bezbednost i efikasnost lečenja.

Cilj istraživanja bio je prikaz dobrih praksi u razvoju pokazatelja kvaliteta u različitim zemljama, obim njihove primene, te poređenje pokazatelja sa onima koji se prate u Srbiji i Norveškoj.

Pregledom dostupne literature identifikovani su naučni radovi i istraživanja iz ove oblasti, iz kojih su dalje izdvojeni alati za merenje strukture, procesa i ishoda farmaceutskih usluga.

Rezultati ukazuje na značaj farmaceuta u obezbeđivanju kvaliteta lečenja i bezbednosti pacijenata optimizacijom upotrebe lekova, kao i na ulogu pokazatelja kvaliteta u poboljšanju efikasnosti, transparentnosti i finansijske opravdanosti usluga. Takođe se ističe značaj primene pokazatelja za interno praćenje, eksternu procenu i kao osnov za modele plaćanja po učinku. Posebna pažnja posvećena je izazovima u razvoju i implementaciji pokazatelja kvaliteta, posepno problemu validnosti, izvodljivosti i pouzdanosti merenja. Analizom različitih pristupa razvoju pokazatelja u svetu, rad pruža smernice za unapređenje apotekarske prakse kroz sistematsko praćenje kvaliteta. Uporednom analizom Srbije i Norveške prikazane su sličnosti i razlike u praćenju kvaliteta između ove dve zemlje, sa osvrtom na dobru apotekarsku praksu i dostupne smernice i standarde.

Istraživanje ukazuje na značaj razvoja pokazatelja kvaliteta sa ciljem unapređivanja farmaceutskih usluga. Iako mlada oblast, implementacija ima potencijal za unapređenje bezbednosti pacijenata. Ipak, pokazalo se i da su potrebna opsežnija istraživanja kako bi se proces razvoja pokazatelja mogao standartizovati i validirati.

SFZ-P12 QUALITY INDICATORS AND SERVICES I COMMUNITY PHARMACIES: A COMPARATIVE OVERVIEW OF GOOD PRACTICES WORLDWIDE

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Quality assurance is increasingly important in healthcare systems, and the research focuses particularly on pharmacy practice. As the scope of pharmaceutical services expands, ensuring their quality becomes essential for maintaining treatment safety and effectiveness.

The aim of the research was to present good practices in the development and implementation of pharmacy quality indicators worldwide and compare them with those used in Serbia and Norway.

A literature review was conducted to identify relevant studies on quality indicators in pharmacy practice. Tools used to measure the structure, processes, and outcomes of pharmaceutical services were analyzed.

Pharmacists play a key role in improving treatment quality and patient safety through the optimization of medication use. Quality indicators contribute to greater efficiency, transparency, and cost-effectiveness of pharmaceutical services and are increasingly used for internal quality monitoring, external evaluation, and pay-for-performance models. The review highlights major challenges in developing and implementing quality indicators, particularly regarding their validity, feasibility, and reliability. By examining international approaches, the study identifies strategies for enhancing pharmacy practice through systematic quality assessment. A comparative analysis of Serbia and Norway reveals similarities and differences in quality monitoring systems, with particular emphasis on good pharmacy practice guidelines and standards.

The development of quality indicators is an important tool for improving pharmaceutical services and strengthening patient safety. Although this field is still evolving, its potential is considerable. Further research is needed to support the standardization and validation of quality indicator development and implementation.

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SFZ-P13 FARMACEUTSKO SAVETOVANJE RODITELJA DECE SA HRONIČNIM NEZARAZNIM BOLESTIMA: IMPLIKACIJE ZA BEZBEDNU I EFIKASNU PRIMENU TERAPIJE

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Hronične nezarazne bolesti u dečjem uzrastu predstavljaju značajan klinički i javnozdravstveni izazov zbog potrebe za dugotrajnim lečenjem, kontinuiranim praćenjem i aktivnim učešćem roditelja u primeni terapije. Farmaceut, kao lako dostupan zdravstveni radnik, može značajno doprineti unapređenju bezbednosti terapije, adherencije i zdravstvene pismenosti porodice.

Cilj istraživanja bio je da se ispitaju stavovi roditelja u vezi sa ulogom farmaceuta u savetovanju roditelja dece sa hroničnim nezaraznim bolestima i identifikuju ključne prepreke za unapređenje savetodavne prakse.

Studija preseka sprovedena je tokom septembra 2025. godine. U istraživanju je učestvovalo 52 farmaceuta i farmaceutska tehničara zaposlenih u apotekama u Srbiji. Podaci su prikupljeni anonimnim *online* upitnikom koji je sadržao 21 pitanje o učestalosti i sadržaju savetovanja, samoproceni znanja i kompetentnosti, organizacionim barijerama i stavovima o dodatnoj edukaciji farmaceuta/farmaceutskih tehničara.

Većina ispitanika prepoznala je savetodavnu ulogu farmaceuta kao veoma značajnu, ali se savetovanje roditelja najčešće odvijalo povremeno (57,7%) i kratko, u trajanju od 2 do 5 minuta (55,8%). Najčešće teme savetovanja bile su alergije i astma. Iako je 69,2% ispitanika navelo da poseduje osnovno znanje o pedijatrijskim hroničnim bolestima, većina je istakla potrebu za dodatnim stručnim usavršavanjem. Glavne prepreke u savetovanju roditelja bile su nedostatak vremena, privatnosti i saradnje sa lekarima.

Farmaceuti predstavljaju važan, ali nedovoljno iskorišćen resurs u podršci roditeljima dece sa hroničnim nezaraznim bolestima. Jačanje ove uloge zahteva dodatnu edukaciju, standardizaciju savetovanja i bolju interdisciplinarnu saradnju.

Zahvalnica

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SFZ-P13 PHARMACIST COUNSELLING FOR PARENTS OF CHILDREN WITH CHRONIC NON-COMMUNICABLE DISEASES: IMPLICATIONS FOR SAFE AND EFFECTIVE THERAPY USE

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Chronic non-communicable diseases in childhood represent a major clinical and public health challenge due to the need for long-term treatment, continuous monitoring, and active parental involvement in therapy management. As highly accessible healthcare professionals, pharmacists may contribute to improving medication safety, adherence, and family health literacy.

This study aimed to examine the attitudes of parents regarding the role of pharmacists in counselling parents of children with chronic non-communicable diseases and to identify key barriers to improving counselling practice.

The cross-sectional study was conducted in September 2025. In the research participated 52 pharmacists and pharmaceutical technicians employed in pharmacies in Serbia. Data were collected using an anonymous online questionnaire comprising 21 items on counselling frequency and content, self-perceived knowledge and competence, organizational barriers, and attitudes toward additional professional education pharmacists/pharmaceutical technicians.

Most respondents recognized the pharmacist's counselling role as highly important; however, counselling was most often provided only occasionally (57.7%) and within 2-5 minutes (55.8%). Allergies and asthma were the most frequent counselling topics. Although 69.2% of participants reported having basic knowledge of chronic pediatric diseases, most expressed a need for further professional training. The main barriers were lack of time, limited privacy, and insufficient collaboration with physicians.

Pharmacists are an important yet underutilized resource in supporting parents of children with chronic non-communicable diseases. Strengthening this role requires additional education, standardized counselling practices, and improved interdisciplinary collaboration.

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SFZ-P14 STAVOVI GRAĐANA O MOGUĆNOSTIMA I OGRANIČENJIMA U SPROVOĐENJU JAVNO-ZDRAVSTVENIH USLUGA U JAVNIM APOTEKAMA

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Kroz preventivne preglede organizovane u domovima zdravlja, prevencija postaje deo redovne brige o zdravlju na nivou cele populacije. Farmaceuti kao zdravstveni radnici koji su u svakodnevnom kontaktu sa velikim brojem pacijenata imaju mogućnost da kroz sprovođenje javno-zdravstvenih usluga značajno doprinesu zdravlju zajednice.

Cilj istraživanja bio je da se ispitaju stavovi opšte populacije u vezi sa uvođenjem javno-zdravstvenih usluga u javnim apotekama.

Ispitivanje je sprovedeno pomoću anonimnog *online* upitnika u kom su ispitanici imali mogućnost da odgovore na 28 zatvorenih pitanja, kroz koje su dobijene informacije o socio-demografskim karakteristikama ispitanika, njihovim životnim navikama i stavovima u vezi sa uvođenjem javno-zdravstvenih usluga u apotekama. Prospektivna studija preseka sprovedena u periodu februar-april 2026. godine.

U istraživanju je učestvovalo 215 ispitanika. Da je apoteka adekvatno mesto za sprovođenje javno-zdravstvenih usluga smatra 81% ispitanika, a da su farmaceuti praktičari javnog zdravlja smatra 86% ispitanika. Usluge kojima je dat prioritet od strane ispitanika su prevencija i kontrola dijabetesa i savetovanje o kontraceptivnim merama. U sprovođenju ovih usluga, pacijenti su prepoznali kao glavne barijere nepostojanje novčane nadoknade namenjene farmaceutima za uslugu koju sprovode (53,49%) i nedostatak vremena farmaceuta (51,62%). Iako su prepoznali potrebu da farmaceuti budu plaćani za sprovođenje ovih usluga, skoro svi ispitanici su istakli da farmaceuti treba da budu plaćeni od strane države ili poslodavca, a ne od strane pacijenta.

Ispitanici su pokazali pozitivan stav prema farmaceutima kao praktičarima javnog zdravlja i apoteci kao mestu gde bi se pomenute usluge odvijale, ali nisu pokazali spremnost da pruže novčanu nadoknadu za eventualno pruženu uslugu.

Zahvalnica

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SFZ-P14 CITIZENS' ATTITUDES TOWARDS THE OPPORTUNITIES AND LIMITATIONS IN IMPLEMENTING PUBLIC HEALTH SERVICES IN COMMUNITY PHARMACIES

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Through preventive check-ups organized in primary health centers, prevention becomes a regular method of healthcare at population level. As healthcare professionals in daily contact with a large number of patients, pharmacists have the possibility to significantly contribute to community health by implementing specific public health services.

The research aim was to examine attitudes of the general population regarding introduction of public health services in community pharmacies.

The study was conducted using anonymous online questionnaire, with 28 closed-ended questions regarding socio-demographic characteristics, lifestyle habits, and attitudes toward introducing public health services in pharmacies. This prospective cross-sectional study was conducted between February and April 2026.

There were 215 respondents. In total 81% of respondents believe that pharmacy is an adequate place for delivering public health services, 86% believe that pharmacists are public health practitioners. The services prioritized by respondents were prevention and control of diabetes, and counseling on contraceptive measures. In the implementation of these services, patients identified the lack of financial compensation for pharmacists, for services provided (53.49%) and the lack of pharmacists' time (51.62%) as the main barriers. Although they recognized the need for pharmacists to be compensated for providing these services, the majority of respondents pointed out that this compensation should be paid by the state or the employer, rather than by the patient.

Respondents demonstrated a positive attitude toward pharmacists as public health practitioners and pharmacies as venues for these services; however, they did not show a willingness to provide financial compensation for any services rendered.

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SFZ-P15 UTICAJ JEZIČKIH BARIJERA NA RAZUMEVANJE I PRIMENU TERAPIJE KOD RUSINSKE NACIONALNE MANJINE

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Pravilna primena terapije predstavlja značajan faktor uspešnog i bezbednog lečenja pacijenata. Jezičke barijere mogu značajno otežati razumevanje uputstava i uticati na adekvatnu primenu terapije, posebno u populacijama nacionalnih manjina.

Cilj istraživanja bio je ispitivanje uticaja jezičkih barijera na razumevanje informacija o pravilnoj primeni terapije kod pripadnika rusinske nacionalne manjine u Vojvodini.

Za potrebe istraživanja sprovedena je opservaciona studija primenom namenski kreiranog onlajn upitnika. Ispitanici su odabrani namenskim uzorkovanjem iz populacije pripadnika rusinske nacionalne manjine u Vojvodini, a link ka upitniku dostavljen je elektronskom poštom korišćenjem kontakt baze dostupne preko Nacionalnog saveta rusinske nacionalne manjine.

U istraživanju je učestvovalo 113 ispitanika (84 ženskog i 29 muškog pola), starosti preko 30 godina. Skoro svi ispitanici (97%) govore rusinski jezik kod kuće, dok ga sa lekarom/farmaceutom koristi samo 27%. Informacije o terapiji najčešće se dobijaju usmeno od zdravstvenih radnika (87%). Čak 65% ispitanika navodi nesigurnost u vezi sa pravilnom primenom propisane terapije usled mogućeg nerazumevanja preporuka, dok je 39% ispitanika izjavilo da je terapiju primenjivalo drugačije od preporučene. Kao najčešće prepreke u komunikaciji izdvajaju se nedostatak vremena zdravstvenih radnika za objašnjenje (60%), nerazumevanje medicinske terminologije i brzina izlaganja (52%).

Rezultati ukazuju da jezičke barijere ne predstavljaju samo komunikacioni izazov već mogu direktno uticati na pravilnu primenu terapije i bezbednost pacijenata. Ovo naglašava potrebu za unapređenjem komunikacije u zdravstvu, jačanjem zdravstvene pismenosti i razvojem pristupa za jasnije razumevanje stručnih informacija radi poboljšanja adherencije i bezbednosti farmakoterapije, posebno među nacionalnim manjinama.

SFZ-P15 IMPACT OF LANGUAGE BARRIERS ON THE UNDERSTANDING AND PROPER USE OF THERAPY AMONG THE RUTHENIAN NATIONAL MINORITY

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Proper use of therapy represents an important factor in achieving successful and safe patient treatment. Language barriers can significantly hinder understanding of instructions and affect appropriate therapy use, particularly among national minority populations.

The study aimed to examine the impact of language barriers on understanding information related to the correct use of therapy among members of the Ruthenian national minority in Vojvodina.

An observational study was conducted using a purpose-designed online questionnaire. Participants were selected through purposive sampling from the Ruthenian national minority population in Vojvodina, and the questionnaire link was distributed via email using a contact database of the National Council of the Ruthenian National Minority.

The study included 113 respondents (84 female and 29 male), aged over 30 years. Almost all respondents (97%) speak Ruthenian at home, while only 27% use it with their physician/pharmacist. Information about therapy is most commonly obtained verbally from healthcare professionals (87%). Uncertainty regarding correct therapy use due to possible misunderstanding of recommendations was reported by 65% of respondents, while 39% stated that they had used therapy differently from recommended. The most common communication barriers were insufficient time for explanations (60%), misunderstanding of medical terminology, and rapid speech (52%).

The results indicate that language barriers may directly affect proper therapy use and patient safety, rather than representing only a communication challenge. This highlights the need to improve communication in healthcare, strengthen health literacy, and develop approaches for clearer understanding of professional information to improve adherence and pharmacotherapy safety, particularly among national minorities.

SFZ-P16 ANALIZA UTICAJA DIGITALNOG MARKETINGA NA PERCEPCIJU KORISNIKA O KOZMETIČKIM PROIZVODIMA

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Kozmetički proizvodi pored toga što doprinose ličnom zadovoljstvu i samopouzdanju, utiču i na očuvanje zdravlja. Digitalni marketing je osnova savremenih poslovnih strategija i ima važnu ulogu u promociji kozmetičkih proizvoda. Razumevanje marketinških strategija i digitalnog oglašavanja je od velikog značaja za uspešnost kozmetičkih brendova.

Cilj studije bio je da se ispitaju navike korisnika, izvori informisanja o kozmetičkim proizvodima i poverenje u njih.

Istraživanje je sprovedeno 2025. godine pomoću namenski kreiranog upitnika, nakon prikupljanja podataka urađena je statistička analiza u programu SPSS 27.0.

Učestvovalo je 430 ispitanika, većina ženskog pola (74,2%) i starosti između 18 i 35 godina (43,7%). Najčešći razlog upotrebe je nega i čišćenje lica/tela (62,7%). Kao najpouzdaniji izvor informacija ispitanici su najčešće navodili stručnjake (47%), Instagram je najkorišćenija društvena mreža (32,1%), dok 35,6% smatra da reklame u određenoj meri utiču na izbor prilikom kupovine kozmetičkog proizvoda. Većina ispitanika (73%) navela je da je kozmetički proizvod, koji smatra najboljim za svoje potrebe, kupila na preporuku stručnjaka, dok je 32,1% nekada kupilo kozmetički proizvod na osnovu preporuke na društvenoj mreži. Kao najvažniji kriterijum pri izboru proizvoda istaknut je sastav (19,1%). Uočene su razlike u navikama i stavovima korisnika u odnosu na pol, starosnu dob i razloge upotrebe kozmetičkih proizvoda, pri čemu su žene pokazale veću učestalost kupovine i češće korišćenje društvenih mreža kao izvora informisanja.

Iako digitalni marketing ima uticaj na informisanje i ponašanje korisnika prilikom izbora kozmetičkih proizvoda, ipak je neophodno integrisati stručne preporuke u kreiranju strategije promocije kozmetičkih proizvoda.

Zahvalnica

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SFZ-P16 ANALYSIS OF THE IMPACT OF DIGITAL MARKETING ON CONSUMERS' PERCEPTION OF COSMETIC PRODUCTS

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Cosmetic products, in addition to contributing to personal satisfaction and self-confidence, also play an important role in maintaining health. Digital marketing represents the foundation of modern business strategies and plays a significant role in the promotion of cosmetic products. Understanding marketing strategies and digital advertising is essential for the success of cosmetic brands.

The objective of research was to examine consumers' habits, sources of information about cosmetic products, and their trust in these sources.

The study was conducted in 2025 using a specifically designed questionnaire. Following data

A total of 430 respondents participated in the study, the majority of whom were female (74.2%) and aged between 18 and 35 years (43.7%). The most common reason for cosmetic product use was facial and body care and cleansing (62.7%). Respondents most frequently identified healthcare professionals and experts as the most reliable source of information (47%). Instagram was the most commonly used social media platform (32.1%), while 35.6% of respondents believed that advertisements influenced their purchasing decisions to some extent. Most respondents (73%) reported purchasing the cosmetic product they considered most suitable for their needs based on expert recommendations, whereas 32.1% had purchased a cosmetic product at least once based on recommendations found on social media. Product composition was identified as the most important criterion when choosing a cosmetic product (19.1%). Differences in consumer habits and attitudes were observed according to gender, age, and reasons for cosmetic product use, with women demonstrating more frequent purchasing behavior and greater reliance on social media as a source of information.

Although digital marketing influences consumer information-seeking behavior and purchasing decisions regarding cosmetic products, the integration of professional recommendations into cosmetic product promotion strategies remains essential.

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SFZ-P17 ZNANJE I STAVOVI MLADIH O UPOTREBI KONVENCIONALNIH I ELEKTRONSKIH CIGARETA: IMPLIKACIJE ZA ZDRAVSTVENU EDUKACIJU I PREVENTIVNE PROGRAME

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Pušenje predstavlja jedan od glavnih javnozdravstvenih izazova savremenog društva i značajan faktor rizika za nastanak brojnih hroničnih nezaraznih bolesti. Posebnu zabrinutost izaziva sve veća upotreba elektronskih cigareta među mladima, koja se često promoviše kao manje štetna alternativa konvencionalnim cigaretama. Takvi trendovi ukazuju na potrebu za kontinuiranim preventivnim merama i zdravstvenim obrazovanjem, kao i za procenom znanja i stavova mladih o rizicima povezanim sa upotrebom ovih proizvoda.

Cilj ove studije bio je da se procene znanje i stavovi mladih u vezi sa upotrebom konvencionalnih i elektronskih cigareta.

Sprovedena je opservaciona studija korišćenjem originalnog upitnika, koji je distribuiran putem Google platforme.

U studiji je učestvovalo ukupno 139 ispitanika (123 ženskog i 16 muškog pola), starosti između 19 i 25 godina. Svi ispitanici bili su upoznati sa e-cigaretama, pri čemu je 67% navelo društvene mreže i prijatelje kao glavne izvore informisanja i 33% univerzitet/školu. Većina ispitanika (93%) smatra da e-cigarete nisu manje štetne od konvencionalnih, dok 84% veruje da mogu izazvati zavisnost. Istovremeno, 23% ispitanika smatra da upotreba e-cigareta smanjuje pasivno pušenje, 17% veruje da su korisne za prestanak pušenja, a 24% nije sigurno u vezi sa njihovom ulogom u odvikavanju od pušenja.

Rezultati ukazuju na postojanje određenih zabluda i nedoumica u vezi sa upotrebom elektronskih cigareta među mladima, što naglašava potrebu za kontinuiranom edukacijom i sprovođenjem preventivnih programa usmerenih na unapređenje znanja i formiranje pravilnih stavova o njihovim zdravstvenim rizicima.

SFZ-P17 KNOWLEDGE AND ATTITUDES OF YOUNG ADULTS REGARDING CONVENTIONAL AND ELECTRONIC CIGARETTE USE: IMPLICATIONS FOR HEALTH EDUCATION AND PREVENTIVE PROGRAMS

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Smoking remains one of the major public health challenges of modern society and significant risk factor for the development of numerous chronic non-communicable diseases. Particular concern is increasing use of electronic cigarettes among young adults, which is often promoted as a less harmful alternative to conventional cigarettes. Such trends highlight the need for continuous preventive measures and health education, as well as for assessing young people's knowledge and attitudes regarding the risks associated with use of these products.

The aim of this study was to evaluate the knowledge and attitudes regarding conventional and electronic cigarette use among young adults.

A cross-sectional observational study was conducted using an original questionnaire distributed via the Google platform.

A total of 139 participants (123 females and 16 males), aged 19 to 25 years, participated in the study. All participants were familiar with e-cigarettes, with 67% reporting social media and friends as their main sources of information and 33% the university/school. The majority of participants (93%) considered that e-cigarettes are not less harmful than conventional cigarettes, while 84% believed that they can cause addiction. At the same time, 23% considered that use of e-cigarettes reduces passive smoking, 17% belived them useful for smoking cessation, and 24% were uncertain about their role in quiting smoking.

The findings indicate the presence of certain misconceptions and uncertainties regarding electronic cigarette use among young adults, emphasizing the need for continuous education and implementation of preventive programs aimed at improving knowledge and shaping appropriate attitudes toward their health risks.

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SFZ-P18 ZDRAVSTVENA ZAŠTITA U BUDUĆNOSTI – VEŠTAČKA INTELIGENCIJA

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Veštačka inteligencija (*Artificial Intelligence* – AI) transformiše zdravstvo unapređujući dijagnostiku, lečenje i organizaciju rada, ali otvara i etička, pravna i socijalna pitanja.

Cilj istraživanja bio je ispitati stavove građana Srbije prema primeni AI u zdravstvu i razlike prema sociodemografskim karakteristikama.

Studija preseka sprovedena je tokom avgusta i septembra 2025. godine putem anonimnog *online* upitnika visoke pouzdanost (*Cronbach* α = 0,96) sa sociodemografskim podacima i skalama poverenja, preferencija i zabrinutosti u vezi sa AI.

Uzorak je obuhvatio 522 ispitanika, 82,8% ženskog pola, uzrasta 16–80 godina, prosečne starosti 44,7 godina (44,7±13,7), dominantno sa završenim fakultetom, 45,4%. Pozitivno mišljenje o upotrebi AI u medicini imalo je 57,4% ispitanika. Potpuno i prilično poverenja da AI može unaprediti zdravstvenu zaštitu ima 29,6% ispitanika. Utvrđene su statistički značajne razlike prema opštem stavu i poverenju o AI u odnosu na obrazovanje ($p < 0,001$); ispitanici sa višim stepenom obrazovanja imali su pozitivnije mišljenje o AI. Polne razlike bile su značajne u izboru posete zdravstvenih ustanova koje koriste softvere AI ($p < 0,001$) i zabrinutosti da bi upotreba AI mogla da dovede do većih troškova zdravstvene zaštite ($p=0,001$); muškarci su pokazali veću preferenciju i manju zabrinutost. Većina ispitanika (70,5%) preferirala je objašnjivu AI.

Stavovi prema AI razlikovali su se prema obrazovanju i polu. Muškarci su znatno češće izražavali sklonost upotrebi AI i pokazali su manje zabrinutosti zbog njene upotrebe, dok su ispitanici sa završenim fakultetom izražavali pozitivnije stavove, više poverenja i veće preferencije za korišćenje AI, što potvrđuje da obrazovanje igra važnu ulogu u prihvatanju novih tehnologija.

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SFZ-P18 HEALTHCARE IN THE FUTURE – ARTIFICIAL INTELLIGENCE

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Artificial intelligence (AI) is increasingly transforming healthcare by improving diagnostics, treatment, and organisation, but raises ethical, legal, and social issues.

The aim of research was to examine attitudes of Serbian citizens toward the use of AI in healthcare and differences according to sociodemographic characteristics.

The cross-sectional study was conducted during August-September 2025 using anonymous online questionnaire with high reliability (Cronbach's α = 0.96) containing socio-demographic data and scales of AI-related trust, preferences and concerns.

There were 522 respondents, 82.8% females, aged 16–80 years, with an average age of 44.7 years (44.7±13.7), mostly with university degree (45.4%). Overall, 57.4% of respondents had positive opinion about use of AI in medicine; 29.6% were completely or fairly confident that AI can improve healthcare. Statistically significant differences were found in general attitude and confidence about AI in relation to education ($p < 0.001$); more educated respondents had more positive opinion about AI. Gender differences were significant in the choice of visiting healthcare facilities that use AI software ($p < 0.001$) and in concerns that the use of AI could lead to higher healthcare costs ($p = 0.001$); men showed greater preference and less concern. Most respondents (70.5%) preferred explainable AI.

Attitudes towards AI differed by education and gender. Men were significantly more likely to express willingness to use AI and showed less concern, while respondents with a university degree expressed more positive attitudes, greater trust and stronger preference for using AI, confirming that education plays an important role in acceptance of new technologies.

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SFZ-P19 ČUVANJE I ODLAGANJE ANTIBIOTIKA U DOMAĆINSTVIMA: NAVIKE GRAĐANA SRBIJE

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Antibiotici su jedno od najvećih dostignuća savremene medicine, ali im je efikasnost sve više ugrožena neracionalnom upotrebom. Ostaci antibiotika u domaćinstvima predstavljaju zanemaren aspekt antimikrobne rezistencije. Za javnozdravstvene intervencije je važno razumevanje navika čuvanja i nepravilnog odlaganja neiskorišćenih antibiotika.

Cilj istraživanja bio je da se ispitaju stavovi i prakse građana Srbije u vezi sa čuvanjem i odlaganjem antibiotika i razumevanje njihove povezanosti sa antimikrobnom rezistencijom.

Sprovedena je opservaciona studija preseka među građanima Srbije. Podaci su prikupljeni anonimnim onlajn upitnikom. Za prikaz podataka je korišćena deskriptivna statistika, a povezanost varijabli ispitivana je hi-kvadrat testom. U studiji je učestvovalo 367 ispitanika.

Polovina ispitanika (49,6%) čuva neiskorišćene antibiotike kod kuće. Posedovanje antibiotika u domaćinstvu bilo je značajno povezano sa zaposlenjem (p=0,043) i regionom (p=0,032), uz veću učestalost u južnoj i istočnoj Srbiji i Beogradu (53,1% i 50,0%) u odnosu na Vojvodinu i Šumadiju i zapadnu Srbiju (34,8% i 23,8%). Među ovim ispitanicima, 9,3% ih odlaže adekvatno. Iako 93,4% navodi spremnost da neiskorišćene antibiotike vrati u apoteku, 37,9% ne poznaje proceduru, dok 23,1% navodi nedovoljnu informisanost. Ipak, na nivou celokupnog uzorka, 78,7% ispitanika prepoznaje opasnost prisustva antibiotika u životnoj sredini, dok 61,6% smatra da neadekvatno odlaganje može doprineti razvoju antimikrobne rezistencije, ali ovo znanje nije bilo značajno povezano sa praksom čuvanja antibiotika u domaćinstvu.

Prisustvo neiskorišćenih antibiotika i njihovo nepravilno odlaganje ukazuju na rizične obrasce ponašanja u kontekstu antimikrobne rezistencije, što naglašava potrebu za jačanjem zdravstvene pismenosti, uloge farmaceuta u edukaciji i preuzimanju lekova, kao i za unapređenjem dostupnosti sistema za njihovo vraćanje.

Zahvalnica

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SFZ-P19 STORAGE AND DISPOSAL OF ANTIBIOTICS FROM HOUSEHOLDS IN SERBIA

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Antibiotics are one of the greatest achievements of modern medicine, but their effectiveness is increasingly threatened by irrational use. Antibiotic residues in households represent a neglected aspect of antimicrobial resistance. Understanding storage habits and improper disposal of unused antibiotics is important for public health interventions.

The aim of the study was to examine attitudes and practices of Serbian citizens regarding storage and disposal of antibiotics and their perceived association with antimicrobial resistance.

An observational, cross-sectional study was conducted among Serbian citizens. Data were collected using an anonymous online questionnaire. Descriptive statistics were used, and associations between variables were tested using a chi-square test. The study included 367 respondents.

Half of the respondents (49.6%) keep unused antibiotics at home. Household possession of antibiotics was significantly associated with employment (p=0.043) and region (p=0.032), with higher frequency in southern and eastern Serbia and Belgrade (53.1% and 50.0%) compared with Vojvodina, Šumadija and western Serbia (34.8% and 23.8%). Among these respondents, 9.3% dispose of them adequately. Although 93.4% report being willing to return unused antibiotics to the pharmacy, 37.9% are unaware of the procedure, and 23.1% report insufficient information. Nevertheless, across the entire sample, 78.7% of respondents recognised the risk of antibiotics in the environment, while 61.6% knew that inadequate disposal could contribute to antimicrobial resistance; however, this knowledge was not significantly associated with household storage of antibiotics.

Unused antibiotics and improper disposal indicate risky behavioral patterns in antimicrobial resistance, highlighting the need to strengthen health literacy, pharmacists' educational role, and medicine take-back systems.).

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SFZ-P20 ZNANJE BEZ PRAKSE: FARMACEUTSKI OTPAD I BUDUĆI ZDRAVSTVENI TEHNIČARI

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Farmaceutski proizvodi značajno doprinose očuvanju zdravlja ljudi, ali kao farmaceutski otpad postaju značajan faktor zagađenja životne sredine. Pravilno upravljanje farmaceutskim otpadom iz domaćinstava u velikoj meri zavisi od spremnosti i znanja zdravstvenih radnika da informišu i usmere građane o njegovom bezbednom odlaganju. Cilj ovog rada bio je procena znanja i stavova budućih medicinskih i farmaceutskih tehničara o ovom problemu.

Istraživanje je sprovedeno među učenicima završnog razreda srednje Medicinsko - farmaceutske škole „Sv. Petka" u Smederevu. Kao istraživački instrument korišćen je anonimni anketni upitnik u papirnoj formi koji je sadržao 14 pitanja. Podaci su obrađeni metodama deskriptivne statistike.

Čak 94,5% ispitanika navodi da poznaje pojam farmaceutskog otpada, dok 98,9% prepoznaje njegov uticaj na zagađenje životne sredine, a 96,7% rizik od zloupotrebe nepravilno odloženih lekova. Uprkos visokoj svesti, 53,8% ispitanika tečne lekove odlaže u kanalizaciju ili sudoperu, a 50,5% čvrste lekove i kapsule u komunalni otpad. Takođe, 81,3% ispitanika nije dobilo informacije o pravilnom odlaganju prilikom preuzimanja lekova u apoteci, dok 56% nije upoznato sa zakonskom obavezom njihovog vraćanja. Ipak, 71,4% ispitanika pokazuje interesovanje za dodatnu edukaciju.

Iako ispitanici pokazuju visok nivo opšte svesti o farmaceutskom otpadu, uočava se značajan nedostatak praktičnog znanja i poznavanja zakonske regulative. S obzirom na to da je reč o budućim zdravstvenim radnicima, rezultati jasno ukazuju na potrebu za sistematskim uvođenjem ove teme u nastavne programe farmaceutskih i medicinskih škola, radi unapređenja odgovornog ponašanja u praksi.

SFZ-P20 KNOWLEDGE WITHOUT PRACTICE: PHARMACEUTICAL WASTE AND FUTURE HEALTHCARE TECHNICIANS

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Pharmaceutical products significantly contribute to healthcare but become environmental pollutants when discarded improperly. Safe management of household pharmaceutical waste largely depends on healthcare professionals' readiness to guide the public. The aim of this study was to assess the knowledge and attitudes of future medical and pharmaceutical technicians regarding this issue.

The research was conducted among final year students at the Secondary Medical and Pharmaceutical School "Sv. Petka" in Smederevo. An anonymous, paper-based questionnaire with 14 questions was used, and data were processed using descriptive statistics.

High general awareness was observed: 94.5% of respondents understand the concept of pharmaceutical waste, 98.9% recognize its environmental impact, and 96.7% note the risk of medication misuse. However, practical habits remain poor: 53.8% dispose of liquid medications into the sewage system, and 50.5% throw solid medicines into municipal waste. Furthermore, 81.3% did not receive disposal information at pharmacies, and 56% are unaware of legal obligations to return unused medications. However, 71.4% of respondents show interest in additional education.

Although respondents show a high level of general awareness regarding pharmaceutical waste, a significant lack of practical knowledge and familiarity with legal regulations is observed. Given that these are future healthcare professionals, the results clearly indicate the need for a systematic introduction of this topic into the curricula of pharmaceutical and medical schools, in order to enhance responsible behavior in practice.

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SFZ-P21 PROCENA RAZUMEVANJA UPUTSTVA ZA LEK NA PRIMERU LEKA ZA HITNA STANJA

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Uputstvo za lek (PIL) predstavlja sastavni deo dozvole za lek i osnovni pisani izvor informacija o leku. Nerazumevanje tih informacija može dovesti do nepravilne primene leka, smanjene efikasnosti lečenja ili povećanog rizika od neželjenih ishoda. Cilj rada je bio da se proceni razumevanje informacija o leku koje se nalaze u PIL-u. Kao model korišćen je PIL leka registrovanog u Srbiji za urgentna stanja, koji se primenjuje kod anafilaktičkog šoka i koji je označen kao lek ABCD (sadrži epinefrin). Istraživanje je sprovedeno na prigodnom uzorku, a podaci su prikupljani *online* pomoću namenskog upitnika koji je sadržao pitanja o socio-demografskim karakteristikama i životnim navikama ispitanika, i 28 pitanja koja su se odnosila na prepoznavanje anafilaktičkog šoka i njegovih simptoma, namenu i način primene leka, postupanje u posebnim situacijama, doziranje leka, kao i izgled i ispravnost auto-injektora koja su postavljana nakon čitanja određenih delova PIL-a. U istraživanju je učestvovalo 146 ispitanika, prosečne starosti 31,3 godine, 82,2% žena. Prosečan broj tačnih odgovora bio je 20,7 od 28 (medijana 23). Najveći procenat tačnih odgovora zabeležen je kod pitanja o osnovnim pojmovima i prepoznavanju anafilaktičkog šoka, i kod pravilne primene leka (89,7%). Poteškoće su uočene kod praktičnih aspekata primene - najniži procenat tačnih odgovora imala su pitanja kada je potrebno nositi lek sa sobom (34,9%) i kako proveriti ispravnost auto-injektora (3,4%). Rezultati ukazuju da razumevanje informacija o leku predstavlja preduslov za pravilnu i bezbednu primenu terapije, posebno kod hitnih stanja, i da informacije namenjene pacijentima treba da budu jasne, pregledne i prilagođene različitim nivoima zdravstvene pismenosti.

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SFZ-P21 ASSESSMENT OF UNDERSTANDING OF THE PATIENT INFORMATION LEAFLET USING A RESCUE MEDICATION AS AN EXAMPLE

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Patient information leaflet (PIL) is an integral part of a medicine's marketing authorization and its primary written information source. A lack of understanding of this information can lead to incorrect use, reduced treatment efficacy, or increased adverse outcome risk. The aim was to assess PIL information understanding. The model used was PIL of a medicine authorized in Serbia for urgent use in anaphylactic shock cases, labeled as medicine ABCD (containing epinephrine). Research was conducted on a convenience sample, with data collected online via a questionnaire covering respondents' socio-demographic characteristics and lifestyle habits, as well as 28 questions on anaphylactic shock recognition and its symptoms, the medicine's purpose and administration, actions in special situations, dosing, and the auto-injector appearance and functionality, asked after reading specific PIL sections. The study included 146 respondents, with an average age of 31.3 years, 82.2% of whom were women. The average number of correct answers was 20.7 out of 28 (median 23). The highest percentage of correct answers concerned fundamental terms and anaphylactic shock recognition, and correct medicine administration (89.7%). Difficulties were observed regarding practical aspects of use - the lowest percentage of correct answers was found for questions on when the medicine needs to be carried (34.9%) and how to check the auto-injector functionality (3.4%). The results indicate that understanding of medicine information is a prerequisite for correct and safe therapy, particularly in urgent conditions, and that information intended for patients should be clear, well-organized, and adapted to different health literacy levels.

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SFZ-P22 ANALIZA ODOBRENIH PROMOTIVNIH MATERIJALA ZA LEKOVE ZA HUMANU UPOTREBU U REPUBLICI SRBIJI U PERIODU OD 2011. DO 2025. GODINE

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Oglašavanje lekova u Republici Srbiji je visoko regulisano, svaki promotivni materijal, namenjen opštoj ili stručnoj javnosti mora biti odobren od strane Agencije za lekove i medicinska sredstva Srbije. Cilj rada je da se analizira promotivni materijal koji je odobren u periodu 2011-2025. Javno dostupna baza odobrenih promotivnih materijala je korišćena kao izvor podataka, a podaci su analizirani pomoću programa Microsoft Office Excel i Joinpoint Regression Software. Rezultati analize trenda su izraženi kroz Annual Percent Change (APC), sa granicom za statistički značajne rezultate od p<0,05.

Ukupan broj odobrenih materijala u petnaestogodišnjem periodu je bio 6170, od čega je većina bila namenjena stručnoj javnosti (~60%). U posmatranom periodu, ukupan broj promotivnih materijala je rastao godišnje za APC =3,13 (p<0,05), gde ih je prosečno odobreno 411 godišnje (raspon: 249 – 540). Zabeležen je trend rasta odobravanja promotivnih materijala namenjenih opštoj javnosti za APC=19,91 (2011 – 2018, p<0,05), dok se trend pada od APC=-1,93 beleži za period 2018-2025 (p>0,05). Kod odobravanja materijala za stručnu javnost beleži se trend rasta od APC =0,32 (p>0,05). Najzastupljeniji tipovi promotivnih materijala bili su brošura, liflet, TV spot, prospekt, vizuali i internet oglasi. Digitalni formati čine značajan i rastući udeo, što ukazuje na postepenu digitalizaciju promocije lekova.

Odobreni promotivni materijal za humane lekove u Srbiji oslanja se na kombinaciju štampanih materijala i sve brojnije digitalne formate, uz blagu većinu onih koji su odobreni za stručnu javnost. Ovi rezultati predstavljaju osnovu za dalje praćenje promotivnih praksi, sa potencijalno značajnim implikacijama za zaštitu pacijenata i racionalnu upotrebu lekova.

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SFZ-P22 ANALYSIS OF APPROVED PROMOTIONAL MATERIALS FOR MEDICINAL PRODUCTS FOR HUMAN USE IN THE REPUBLIC OF SERBIA FROM 2011 TO 2025

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Medicinal products (medicines) advertising in Serbia is highly regulated; every promotional material (PM), intended for the general public or healthcare professionals (HCP), must be approved by the Medicines and Medical Devices Agency of Serbia. The aim was to analyse the PM approved in the period 2011-2025. The publicly available database of approved PMs was used as the data source, and the data were analysed using Microsoft Office Excel and Joinpoint Regression Software. The results of the trend analysis are expressed as Annual Percent Change (APC), with the threshold for statistically significant results set at p<0.05.

The total number of approved materials over the fifteen-year period was 6,170, the majority intended for HCPs (~60%). Overall, the number of PMs increased annually by APC =3.13 (p<0.05), with an average of 411 approvals per year (range 249-540). Promotional materials intended for the general public showed an increasing trend of APC=19.91 (2011-2018, p<0.05), followed by a non-significant decline of APC=-1.93 (2018-2025, p>0.05). Materials intended for HCPs showed an increasing trend of APC=0.32 (p>0.05). The most frequent types of PMs were brochures, leaflets, TV spots, prospectuses, visuals, and internet advertisements. Digital formats hold a significant and growing share, indicating a gradual digitalisation of medicine promotion.

Approved PM for human medicines in Serbia relies on a combination of printed and increasingly numerous digital formats, with a slight majority approved for HCPs. These results provide a basis for further monitoring of promotional practices, with potentially significant implications for patient protection and the rational use of medicines.

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SFZ-P23 PROMENA REFERENTNE ZEMLJE – ANALIZA UTICAJA NA MAKSIMALNU VELEPRODAJNU CENU LEKOVA U REPUBLICI SRBIJI

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Maksimalnu veleprodajnu cenu (MVC) lekova u Srbiji reguliše odgovarajući Pravilnik, koji se oslanja na eksterno (ERP) i interno referentno određivanje cena. Tokom 2023. godine Grčka je zamenila Hrvatsku u ERP „korpi". Cilj rada je bio analiza uticaja zamene referentne zemlje na MVC. U redovnoj reviziji cena, nadležna ministarstva su u maju 2024. godine objavila predložene revidirane cene lekova (PRP). One su iskorišćene za kreiranje skupa podataka koji obuhvata maksimalne odobrene cene pre revizije (CAP), PRP, razlog promene cene, status leka (referentni, generički, biosimilar) i ATC grupu. Analiza je sprovedena u programu *Microsoft Excel* na 4.321 ceni (dozvola za stavljanje leka u promet, MA). Prosečna CAP iznosila je 40.342,1 din, a prosečna PRP 36.177,7 din, odnosno sniženje od 10% (medijana PRP 1.389,4 din). Prosečan pad na nivou MA iznosio je 7,4% (uključujući kursnu razliku i nepromenjene cene), pri čemu je ATC grupa L imala najveći prosečan pad cena (11,6%). Posmatrajući isključivo uticaj ERP-a, prosečan pad iznosio je 16,2% (17,4% za referentne lekove, 15,5% za generičke i 12,4% za biosimilare). Među referentnim lekovima, najčešći razlog pada bio je kursna razlika (55,1%), dok je ERP doveo do pada kod 44,1% CAP-ova, gde je Grčka uzrokovala pad u 25,3% slučajeva, a zatim Slovenija i Italija. S obzirom na grčka pravila o određivanju cena (upotreba najnižih cena u Evrozoni), rezultati su potvrdili očekivani uticaj uvođenja Grčke kao referentne zemlje, ali se ovaj uticaj nije pokazao kao jedini, te se u budućnosti, nakon pregovora između nosilaca MA i nadležnih organa, može očekivati i niži uticaj.

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SFZ-P23 REFERENCE COUNTRY CHANGE – IMPACT ANALYSIS ON THE MAXIMUM WHOLESALE MEDICINE PRICE IN THE REPUBLIC OF SERBIA

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The maximum wholesale price (MWP) of medicines in Serbia is regulated by the relevant Rulebook, based on external (ERP) and internal reference pricing. During 2023, Greece replaced Croatia in the ERP basket. The study aimed to analyze the impact of the reference country change on MWP. In the regular price revision, competent ministries announced proposed revised medicine prices (PRP) in May 2024. These were used to compile a dataset including maximum approved prices before revision (CAP), PRP, reason for price change, medicine status (reference, generic, biosimilar), and ATC group. Analysis was performed in Microsoft Excel on 4,321 prices (marketing authorization, MA). The average CAP was RSD 40,342.1 and the average PRP RSD 36,177.7, i.e., a 10% decrease (median PRP RSD 1,389.4). The average decrease at the MA level was 7.4% (including exchange rate differences and unchanged prices), with ATC group L showing the highest average decrease (11.6%). Considering only ERP impact, the average decrease was 16.2% (17.4% for reference medicines, 15.5% for generics, and 12.4% for biosimilars). Among reference medicines, the most common reason was the exchange rate (55.1%), while ERP caused a decrease in 44.1% of CAPs, of which Greece accounted for 25.3%, followed by Slovenia and Italy. Given the Greek pricing rules (based on the lowest Eurozone prices), the results confirmed the expected impact of introducing Greece as a reference country, but this was not the only one, so in the future, following negotiations between MA holders and the competent authorities, an even lower impact can be expected.

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SFZ-P24 COMPARATIVE ANALYSIS OF ISO 14155:2020 AND ISO 14155:2026: EVOLUTION OF CLINICAL INVESTIGATION REQUIREMENTS

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ISO 14155 provides the internationally recognized framework for the design, conduct, recording, and reporting of clinical investigations involving medical devices. The publication of ISO 14155:2026 introduced more detailed and practice-oriented requirements for clinical investigations.

The aim of the study was to identify and evaluate the key changes introduced in ISO 14155:2026 compared with ISO 14155:2020 and assess their impact on the planning, conduct, and oversight of medical device clinical investigations.

A comparative documentation analysis was performed using the full texts of ISO 14155:2020 and ISO 14155:2026 as primary sources. Relevant regulatory documents and scientific publications related to medical device clinical investigations and the implementation of Regulation (EU) 2017/745 were reviewed to support interpretation of the revised requirements. The standards were systematically compared across risk management, study governance, clinical investigation planning, safety reporting, statistical considerations, and terminology.

The analysis identified several key revisions in ISO 14155:2026. The updated standard introduces a more structured risk-management framework, distinguishing device-related risks from those associated with non-routine clinical procedures. Governance requirements have been strengthened through the formal inclusion of Clinical Events Committees and expanded responsibilities for Data Monitoring Committees. Greater emphasis is placed on aligning study objectives, endpoints, populations, and statistical justification within the Clinical Investigation Plan. Additional updates include enhanced safety reporting guidance and clearer terminology definitions.

ISO 14155:2026 represents a substantial advancement in clinical investigation requirements, strengthening risk-based decision-making, oversight mechanisms, and methodological rigor, thereby supporting the generation of more reliable clinical evidence for medical devices.

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SFZ-P25 PROCESS OPTIMIZATION AND ERROR REDUCTION IN PHARMACEUTICAL DISTRIBUTION

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Pharmaceutical wholesale operations require high levels of accuracy, efficiency, and regulatory compliance to ensure patient safety and supply chain reliability. This paper presents the application of the Six Sigma methodology in pharmaceutical wholesale operations as a systematic approach for process optimization and error reduction. Using the DMAIC framework (Define, Measure, Analyze, Improve, Control), operational data from 204,516 pharmaceutical orders processed between January and December 2023 were analyzed to identify critical sources of process variability and order-picking errors. The dataset included 135,698 commercial orders and 68,818 public healthcare (fond) orders.

Order preparation performance was evaluated through quantitative analysis of picking errors, order volumes, employee experience, workload fluctuations, seasonal variations, and workflow conditions. Pareto analysis demonstrated that more than 80% of errors originated from three major categories: incorrect product selection, extra products, and missing products in orders. Additional statistical analyses identified associations between error frequency, operational workload, picker experience, and periods of increased demand. Root Cause Analysis (RCA) identified insufficiently structured training programs, inconsistent knowledge transfer, lack of standardized onboarding practices, and limited awareness of the impact of picking errors on pharmaceutical quality and patient safety as the primary contributing factors.

Improvement measures included revised Standard Operating Procedures (SOPs), structured training, mentorship, continuous performance monitoring, feedback mechanisms, and employee recognition. Following implementation, the error rate decreased, customer satisfaction improved, and operational efficiency increased. The findings demonstrate that Six Sigma is an effective methodology for reducing operational errors while strengthening quality, regulatory compliance and continuous improvement in pharmaceutical wholesale distribution.

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SFZ-P26 STRATEGIJE ZA OSNAŽIVANJE PARTNERSTVA IZMEĐU VISOKOŠKOLSKIH USTANOVA I FARMACEUTSKE INDUSTRIJE

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U oblasti farmacije saradnja visokoškolskih ustanova i privrede postaje sve važnija jer omogućava integraciju teorijskog znanja sa praktičnim iskustvom.

Cilj istraživanja bio je ispitati trenutni nivo, najčešći način i predloge za unapređenje saradnje visokoškolskih ustanova i privrede u oblasti farmacije. Istraživanje je sprovedeno u novembru 2025. godine među zaposlenima u farmaceutskoj industriji putem namenski kreiranog anonimnog *online* upitnika prema usaglašenom stavu istraživača koji je sadržao 19 pitanja. Statistička analiza urađena je u programu SPSS 27.0.

Učestvovalo je 222 ispitanika, većina ženskog pola (67,1%), starosti između 25 i 34 godine (44,8%). Preko 10 godina iskustva u poslu imalo je 46,4% ispitanika, a kompanije u kojima pretežno rade su predstavništva farmaceutskih kompanija (43,5%), u privatnom vlasništvu (91,9%) sa preko 250 zaposlenih (92%). Saradnju sa visokoškolskom ustanovom navelo je da ima 56,3% ispitanika, a najčešći vidovi saradnje su ostvareni kroz studentsku stručnu praksu (29,2%) i kasnije zapošljavanje studenata (21,4%). Najveći izazovi prilikom saradnje su prema odgovorima ispitanika neusklađeni ciljevi obrazovanja i potreba industrije (30,18%). U programe obrazovanja treba uključiti privredu navodi 45% ispitanika, kroz razvoj praktičnih veština kao ključan segment u kome privreda može imati uticaj (30%). Kako bi se na što bolji način ostvarila saradnja najpotrebnije je razgovarati sa rukovodstvom (41,9%) i nastavnim kadrom (35,1%) na visokoškolskim ustanovama. Kroz različite oblike saradnje (praksa, projekti, predavanja, mentorstvo, edukacije) spremno je da sarađuje 41% ispitanika.

Potrebno je unapređenje saradnje visokoškolskih ustanova i privrede kroz povećan obim stručnog osposobljavanja, usklađivanje nastavnih planova prema potrebama privrede i samom unapređenju komunikacije i prevazilaženju postojećih barijera.

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SFZ-P26 STRATEGIES FOR STRENGTHENING PARTNERSHIPS BETWEEN HIGHER EDUCATION INSTITUTIONS AND THE PHARMACEUTICAL INDUSTRY

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Collaboration between higher education institutions and the pharmaceutical industry has become increasingly important, as it enables the integration of theoretical knowledge with practical experience.

The aim of this study was to assess the current level, the most common forms, and potential improvements of collaboration between higher education institutions and the pharmaceutical industry. The study was conducted in November 2025 among employees in the pharmaceutical industry using a purpose-designed anonymous online questionnaire developed by the research team, consisting of 19 questions. Data were analyzed using SPSS version 27.0. A total of 222 respondents participated, the majority of whom were female (67.1%) and aged 25–34 years (44.8%). Nearly half (46.4%) had more than 10 years of professional experience. Most respondents worked in pharmaceutical company representative offices (43.5%), in privately owned companies (91.9%) with more than 250 employees (92.0%). Collaboration with higher education institutions was reported by 56.3% of respondents, most commonly through student internships (29.2%) and subsequent employment of students (21.4%). The main challenge identified was the mismatch between educational objectives and industry needs (30.18%). Almost half of the respondents (45.0%) believed that industry should be more actively involved in educational programs, particularly in developing students' practical skills (30.0%). To strengthen collaboration, respondents emphasized the importance of communication with institutional leadership (41.9%) and academic staff (35.1%). Furthermore, 41.0% expressed willingness to contribute through internships, projects, lectures, mentoring, and educational activities. Strengthening collaboration requires expanding practical training opportunities, aligning curricula with industry needs, improving communication, and overcoming existing barriers.

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SFZ-P27 FARMAKOEKONOMIJA U NASTAVNIM PROGRAMIMA FARMACEUTSKIH FAKULTETA U BOSNI I HERCEGOVINI

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Farmakoekonomija ima značajnu ulogu u zdravstvenim sistemima, jer doprinosi efikasnoj raspodjeli resursa i donošenju odluka zasnovanih na dokazima. Kako potreba za ovim kompetencijama kontinuirano raste, važno je procijeniti na koji način su znanja iz farmakoekonomije integrirana u obrazovni sistem i obrazovanje budućih farmaceuta. Ovaj rad ima za cilj da pruži pregled zastupljenosti edukacije iz farmakoekonomije u nastavnim programima farmaceutskih fakulteta u Bosni i Hercegovini.

Sprovedena je deskriptivna studija presjeka koja je obuhvatila svih 12 programa farmacije (5 javnih i 7 privatnih). Prikupljeni su i analizirani podaci o zastupljenosti predmeta farmakoekonomija, njegovom statusu (obavezni ili izborni predmet), te jeziku na kojem se nastava izvodi. Razlike između zastupljenosti analizirane su pomoću χ^2 testa i Fisherovog egzaktog testa, uz nivo statističke značajnosti $p < 0,05$.

Predmet farmakoekonomija zastupljen je u 58,33% studijskih programa farmacije u Bosni i Hercegovini. Ovaj udio je veći na javnim fakultetima (80%) u poređenju sa privatnim fakultetima (42,86%), međutim ova razlika nije statistički značajna ($p = 0,186$). Predmet je u 85,7% slučajeva ponuđen kao izborni. Samo jedna visokoškolska ustanova (8,33%), privatni univerzitet na kojem se nastava izvodi na engleskom jeziku, ima farmakoekonomiju kao obavezni predmet.

Rezultati pokazuju da su znanja iz farmakoekonomije nedovoljno integrirana u nastavne programe farmaceutskih fakulteta u Bosni i Hercegovini, uz ograničenu zastupljenost i pretežno status predmeta kao izbornog. U skladu s međunarodnim preporukama, uvođenje ovog predmeta kao obaveznog na svim fakultetima moglo bi bolje osposobiti buduće farmaceute za aktivniju ulogu u kreiranju zdravstvenih politika, kao i u donošenju odluka zasnovanih na dokazima i ekonomskim pokazateljima.

SFZ-P27 PHARMACOECONOMICS EDUCATION IN PHARMACY FACULTIES: CURRENT STATUS IN BOSNIA AND HERZEGOVINA

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Pharmacoeconomics plays a crucial role in modern healthcare systems by supporting efficient resource allocation and evidence-based decision-making. As the demand for these competencies continues to grow, it is essential to evaluate how this discipline is integrated into the education of future pharmacists. This study aims to provide an overview of pharmacoeconomics education across integrated undergraduate pharmacy programmes in Bosnia and Herzegovina.

A descriptive cross-sectional analysis was conducted, including all 12 integrated undergraduate pharmacy study programmes in Bosnia and Herzegovina (5 public and 7 private). Data regarding pharmacoeconomics course availability, course status (mandatory vs. elective), and language of instruction were analyzed. Differences between public and private institutions were assessed using the χ^2 test and Fisher's exact test, with a significance level set at $p < 0.05$.

A pharmacoeconomics course was included in 58.33% of pharmacy study programmes in Bosnia and Herzegovina. The proportion was higher in public faculties (80%) compared to private ones (42.86%); however, the difference was not statistically significant ($p = 0.186$). Notably, the course was offered as an elective in 85.7% of cases. Only one institution (8.33%), a private university offering the course in English, included pharmacoeconomics as a mandatory course.

The findings indicate that pharmacoeconomics education in Bosnia and Herzegovina is insufficiently integrated into pharmacy curricula, with limited availability and predominantly elective status. In line with international recommendations, making this course mandatory across all faculties could better equip future pharmacists to play a more effective role in health policy, and in evidence-based and economically informed decision-making.

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SFZ-P28 CONTENT VALIDATION OF A COMMUNITY PHARMACY QUESTIONNAIRE FOR PHARMACEUTICAL CARE OF PATIENTS WITH TYPE 2 DIABETES MELLITUS

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Patients with type 2 diabetes mellitus (T2DM) require continuous monitoring, appropriate pharmacotherapy, lifestyle modification and their engagement in self-management. Community pharmacists can contribute to T2DM management through assessment of pharmacotherapy, adherence, treatment safety, lifestyle, glycemic control and patient self-management.

The aim of this study was to develop and assess the content validity of a structured questionnaire for use by community pharmacists in the pharmaceutical care of patients with T2DM.

A 35-item questionnaire was developed covering key aspects of patient assessment, diabetes management and pharmaceutical care. Content validity was evaluated by five pharmacists: two clinical pharmacists, two community pharmacists and one specialist in pharmacoinformatics. Items were rated for relevance on a four-point scale from 1 (not relevant) to 4 (highly relevant), with ratings of 3 or 4 considered content-valid. An I-CVI ≥0.78 was considered acceptable, while an S-CVI/Ave ≥0.90 indicated excellent scale-level content validity. I-CVI, S-CVI/Ave and universal agreement (S-CVI/UA) were calculated.

Thirty-one of 35 items (88.6%) achieved an I-CVI of 1.00, while four items (11.4%) had an I-CVI of 0.80. No item had an I-CVI below 0.80. The S-CVI/Ave was 0.977 and S-CVI/UA was 0.886, demonstrating high overall expert agreement.

The questionnaire demonstrated excellent content validity and may provide a structured framework for community pharmacists to assess patients with T2DM and identify needs related to pharmacotherapy, adherence, treatment safety, lifestyle, glycemic control and self-management. Further pilot testing is warranted to evaluate reliability, feasibility and applicability in routine community pharmacy practice.

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IF-P1 ZDRAVSTVENA PISMENOST NEKADA I SADA: PEDESET GODINA KONCEPTUALNOG RAZVOJA

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Zdravstvena pismenost prvi put je pomenuta u kontekstu zdravstvenog vaspitanja i socijalne politike, kroz delo Skota Simonda (1974), ističući da pismenost učenika u oblasti zdravlja ne sme biti zanemarena. Uprkos slučajnoj upotrebi termina, zdravstvena pismenost je prepoznata kao važna determinanta zdravlja, a njena definicija i koncept značajno su se menjali tokom decenija. Cilj ovog rada je da prikaže razvoj konceptualizacije zdravstvene pismenosti kako bi se bolje razumele rasprave koje oblikuju ovu oblast. Zdravstvena pismenost je prvobitno posmatrana kao individualna karakteristika, naglašavajući primenu veština čitanja, pisanja i računanja u kontekstu zdravlja. *Nutbeam*-ov okvir funkcionalne, interaktivne i kritičke zdravstvene pismenosti (2000) pomerio je fokus sa osnovnih veština ka širem spektru kognitivnih i socijalnih kompetencija koje pojedincu omogućavaju aktivno učešće u donošenju odluka o zdravlju. Zdravstvena pismenost je tako prerasla iz koncepta koji se posmatrao kao klinički faktor rizika povezan sa lošijim zdravstvenim ishodima u javnozdravstveni resurs koji omogućava uspešnu promociju zdravlja. Nadovezujući se na ove ideje, *Sørensen* i saradnici (2012) predložili su integrisani konceptualni model koji je objedinio različite definicije i uspostavio okvir zasnovan na sposobnostima pristupa, razumevanja, procene i primene zdravstvenih informacija. Važnost ovih sposobnosti potvrđuju *Malloy-Weir* i saradnici (2016), kroz analizu 250 definicija iz baze MEDLINE, ali ističu zabrinutost da većina interpretacija zanemaruje druge zdravstvene i kontekstualne odrednice. Time se ističe da zdravstvena pismenost mora biti posmatrana kao zajednička odgovornost pojedinaca, organizacija i zdravstvenih sistema. Iako ključni principi zdravstvene pismenosti ostaju isti, proširenje njenog koncepta je predstavilo nove izazove u definisanju, proceni i implementaciji u oblasti istraživanja, politike i prakse.

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IF-P1 HEALTH LITERACY THEN AND NOW: FIFTY YEARS OF CONCEPTUAL EVOLUTION

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Health literacy was first mentioned in the context of health education and social policy by Simonds (1974), who emphasized students' health literacy shouldn't be neglected. Despite accidental use, health literacy has been recognized as an important health determinant, and its definition and conceptualization have changed considerably over the decades. This paper aims to outline health literacy conceptualizations development to better understand the debates shaping the field. Initially, health literacy was viewed as an individual characteristic, emphasizing the application of reading, writing, and numeracy skills in a health context. Nutbeam's framework of functional, interactive, and critical health literacy (2000) shifted the focus from basic skills toward a broader range of cognitive and social competencies enabling individuals to actively participate in health decision-making. Health literacy thus evolved from being viewed as a clinical risk factor associated with poor health outcomes to a public health resource enabling successful health promotion. Building on this, Sørensen and colleagues (2012) proposed an integrated conceptual model that consolidated various definitions and established a framework based on the abilities to access, understand, appraise, and apply health information. By analyzing 250 definitions in MEDLINE, Malloy-Weir and colleagues (2016) confirmed the importance of these abilities. They also highlight concerns that most interpretations neglect health and contextual determinants. This underscores that health literacy is as a shared responsibility among individuals, organizations, and health systems. Although the core principles remain the same, the broadening of its concept has introduced new challenges for its definition, assessment, and implementation in research, policy, and practice.

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IF-P2 VELIKI LONDNOSNI SMOG IZ 1952. GODINE I RAZVOJ KONCEPTA ODRŽIVOSTI: ULOGA ZDRAVLJA KAO POKRETAČA PROMENA

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Održivi razvoj predstavlja koncept koji podrazumeva zadovoljavanje potreba sadašnjih generacija bez ugrožavanja mogućnosti budućih generacija da zadovolje sopstvene potrebe, uz ravnotežu između ekonomskog i društvenog razvoja i zaštite životne sredine.

Cilj ovog rada bio je da prikaže značaj Londonskog smoga u razvoju koncepta održivog razvoja i politika zaštite životne sredine.

Primenom dokumentacione analize sekundarnih izvora dostupnih na engleskom jeziku analizirani su istorijski i savremeni izvori o razvoju koncepta, sa posebnim osvrtom na Londonski smog i regulatorne promene koje su usledile nakon njega.

Analiza literature ukazala je da je ubrzana industrijalizacija dovela do povećanja emisija zagađujućih materija i zanemarivanja posledica po zdravlje ljudi i životnu sredinu. Akutna izloženost visokim koncentracijama zagađujućih materija tokom Londonskog smoga iz 1952. godine bila je povezana sa 4.000–12.000 prevremenih smrtnih slučajeva i porastom respiratornih i kardiovaskularnih oboljenja. Longhurst i saradnici navode da je ovaj događaj predstavljao ključni podsticaj za donošenje *Clean Air Act*-a (1956), jednog od prvih regulatornih okvira za kontrolu emisija i upravljanje kvalitetom vazduha. Dalji razvoj politika zaštite životne sredine ojačao je međunarodnu svest, što je kasnije formalizovano kroz Stokholmsku konferenciju (1972) i *Brundtland* izveštaj (1987), kojim je prvi put definisan koncept održivog razvoja.

Londonski smog predstavljao je važnu prekretnicu u razumevanju posledica industrijskog zagađenja i razvoju politika zaštite životne sredine, koje su postavile temelje savremenog koncepta održivog razvoja. Ovaj događaj ukazao je da zaštita životne sredine predstavlja istovremeno i zaštitu zdravlja stanovništva, naglašavajući značaj zdravstvenih radnika u prepoznavanju i prevenciji rizika povezanih sa faktorima životne sredine i promociji održivih rešenja.

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IF-P2 THE GREAT LONDON SMOG OF 1952 AND THE DEVELOPMENT OF SUSTAINABILITY: HEALTH AS A DRIVER OF CHANGE

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Sustainable development represents a concept that involves meeting needs of present generations without compromising ability of future generations to meet their own needs, while maintaining balance between economic and social development and environmental protection.

The aim of this study was to present significance of London Smog in development of sustainable development concept and environmental protection policies.

Using documentary analysis of secondary sources available in English, historical and contemporary sources on development of concept were analyzed, with particular focus on London Smog and regulatory changes that followed.

Literature analysis indicated that accelerated industrialization led to increased emissions of pollutants and neglect of consequences for human health and environment. Acute exposure to high concentrations of pollutants during London Smog in 1952 was associated with 4,000–12,000 premature deaths and increased respiratory and cardiovascular diseases. Longhurst et al. state that this event represented key stimulus for adoption of Clean Air Act (1956), one of first regulatory frameworks for emission control and air quality management. Further development of environmental protection policies strengthened international awareness, later formalized through Stockholm Conference (1972) and Brundtland Report (1987), which first defined sustainable development concept.

London Smog represented important turning point in understanding consequences of industrial pollution and development of environmental protection policies, establishing foundations of modern sustainable development concept. This event demonstrated that environmental protection is also protection of population health, emphasizing importance of health professionals in identifying and preventing risks related to environmental factors and promoting sustainable solutions.

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IF-P3 RAZVOJ KONCEPTA DIGITALNIH DETERMINANTI ZDRAVLJA

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Istorija razvoja koncepta digitalnih determinanti zdravlja može se pratiti od početka 21. veka, kao odgovor na intenzivnu digitalnu transformaciju, primenu digitalnih zdravstvenih tehnologija (DZT) i promene u načinu pružanja zdravstvene zaštite. Cilj je bio predstavljanje razvoja koncepta digitalnih determinanti zdravlja (DDZ), kroz analizu promene pojmovnog određenja. Primenom dokumentacione analize podataka sekundarih izvora na engleskom jeziku, praćeni su relevantni međunarodni dokumenti zdravstvene politike koji su definisali, oblikovali ove faktore i njihov odnos sa socijalnim determinantama zdravlja. Milenijumski razvojni ciljevi Ujedinjenih nacija (2000) prepoznali su ulogu tehnologije u unapređenju kvaliteta zdravstvenih usluga, 2005. godine Svetska zdravstvena organizacija (SZO) pozvala je na razvoj strategija digitalnog zdravlja. Tokom druge decenije 21. veka istraživači ukazuju na to da internet, digitalna pismenost i digitalna povezanost predstavljaju važne determinante zdravlja. Prvi struktuirani koncept DDZ pojavljuje se 2020. godine, dok je 2024. razvijen prvi sveobuhvatni međunarodni okvir SZO. On proširuje koncept socijalnih determinanti zdravlja u digitalno okruženje, definiše DDZ kao skup tehnoloških, društvenih i strukturnih faktora koji oblikuju sposobnost pojedinca da pristupi, koristi i ostvari korist od DZT. Obuhvata individualni, zajednički i strukturni nivo. Koncept naglašava interakciju između pojedinaca, zajednice i zdravstvenog sistema, dok DDZ utiču na kvalitet odnosa kroz povezanost sa inovacijama, obrazovanjem i zdravstvenom jednakošću. Digitalna zdravstvena pismenost u ovom kontekstu se ne posmatra isključivo kao individualna sposobnost, već kao rezultat interakcije DDZ na makro, mezo i mikro nivou. Razvoj koncepta pomerio je fokus sa individualnog na društveni kontekst. Buduća istraživanja treba usmeriti ka razumevanju uticaja DDZ na različite populacione grupe i smanjenju digitalnih nejednakosti.

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IF-P3 DEVELOPMENT OF THE CONCEPT OF DIGITAL DETERMINANTS OF HEALTH

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History of the concept of digital determinants of health (DDoH) dates back to the early 21st century as a response to intensive digital transformation, implementation of digital health technologies (DHTs), and changes in healthcare delivery. Aim of this paper was to present the development of DDoH through analysis of changes in its conceptual definition. Document analysis of secondary sources in English was used, reviewing international health policy documents that defined and shaped these factors and their relationship with social determinants of health. United Nations Millennium Development Goals (2000) recognized role of technology in improving healthcare quality, while in 2005 the World Health Organization (WHO) called for development of digital health strategies. During the second decade of the 21st century, researchers increasingly identified internet, digital literacy, and digital connectivity as key determinants of health. First structured concept of DDoH appeared in 2020, and in 2024 WHO developed the first comprehensive international framework. It extends social determinants of health into the digital environment and defines DDoH as technological, social, and structural factors influencing individuals' ability to access and use DHTs. Framework includes individual, community, and structural levels, emphasizing interaction between individuals, communities, and health systems. DDoH affect these relationships through links with innovation, education, and health equity. Digital health literacy is not only an individual skill but also a result of DDoH interactions across macro, meso, and micro levels. This shift moves focus from individual to a broader social context. Future research should address DDoH across population groups and reduce digital inequalities.

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IF-P4 ISTORIJSKI RAZVOJ I SASTAV OFICINALNIH VIŠEKOMPONENTNIH BILJNIH ČAJEVA U FARMAKOPEJAMA I MAGISTRALNIM FORMULAMA KORIŠĆENIM NA TERITORIJI SRBIJE (1881–2024)

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Biljni čajevi imaju dugu tradiciju u srpskoj farmaciji i priznati su kao oficinalni preparati u srpskim i jugoslovenskim farmakopejama i magistralnim formulama još od objavljivanja prvog izdanja Srpske farmakopeje iz 1881. godine.

Cilj ovog istraživanja bio je da se ispita istorijski razvoj oficinalnih višekomponentnih biljnih čajeva u farmakopejama i magistralnim formulama korišćenim u farmaceutskoj praksi u Srbiji.

Analizirano je ukupno 13 srpskih i jugoslovenskih farmakopeja i magistralnih formula objavljenih u periodu od 1881. do 2024. godine, uključujući Srpske farmakopeje (1881 i 1926), Jugoslovenske farmakopeje (1933, 1951, 1972, 1984 i 2000) i Magistralne formule (1957, 1958, 1966, 1979, 2008 i 2024), kako bi se identifikovali oficinalni višekomponentni biljni čajevi.

Identifikovane su 62 monografije višekomponentnih biljnih čajeva, uključujući ponovljene monografije u različitim izdanjima, koje obuhvataju 72 različite biljne droge. Najčešći su bili prsni, gorki, laksativni, sedativni, diuretski i biljni čaj protiv grčeva. Najčešće korišćene biljne droge bile su *Menthae piperitae folium* (n=22), *Liquiritiae radix* (n=16), *Matricariae flos* (n=15), *Malvae flos* (n=11), *Althaeae folium* (n=11) i *Althaeae radix* (n=11). Najjednostavnije formulacije sadržale su tri biljne droge, dok je najsloženiji bio *Species pectorales* (*Ph. Serb. I*) sa deset komponenti. Kontinuitet primene pojedinih biljnih droga tokom više od jednog veka uočen je za *Althaeae radix*, *Althaeae folium*, *Liquiritiae radix*, *Matricariae flos*, *Menthae piperitae folium* i *Valerianae radix*.

Ova studija ukazuje na istorijski razvoj oficinalnih višekomponentnih biljnih čajeva u okviru farmakopejske i magistralne farmaceutske prakse u Srbiji.

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IF-P4 HISTORICAL DEVELOPMENT AND COMPOSITION OF OFFICIAL MULTICOMPONENT HERBAL TEAS IN PHARMACOPOEIAS AND MAGISTRAL FORMULARIES USED ON THE TERRITORY OF SERBIA (1881–2024)

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Herbal teas have a long tradition in Serbian pharmacy and have been recognised as official preparations in Serbian and Yugoslav pharmacopoeias and magistral formularies since the publication of *Pharmacopoeia Serbica editio prima* in 1881.

The objective of this study was to examine the historical development of official multicomponent herbal teas in pharmacopoeias and magistral formularies used in pharmaceutical practice in Serbia.

A total of 13 Serbian and Yugoslav pharmacopoeias and magistral formularies published between 1881 and 2024, including the Serbian Pharmacopoeias (1881 and 1926), the Yugoslav Pharmacopoeias (1933, 1951, 1972, 1984, and 2000) and the Magistral Formularies (1957, 1958, 1966, 1979, 2008, and 2024), were analysed to identify official multicomponent herbal teas.

Sixty-two monographs of multicomponent herbal teas, including repeated entries in multiple editions, comprising 72 different herbal drugs, were identified. The most common were pectoral, bitter, laxative, sedative, diuretic and antispasmodic herbal teas. The most frequently used herbal drugs were *Menthae piperitae folium* (n=22), *Liquiritiae radix* (n=16), *Matricariae flos* (n=15), *Malvae flos* (n=11), *Althaeae folium* (n=11) and *Althaeae radix* (n=11). The simplest formulations contained three herbal drugs, while the most complex was *Species pectorales* (*Ph. Serb. I*), which contained ten components. Continuity in the use of several herbal drugs was observed throughout the study period, notably *Althaeae radix*, *Althaeae folium*, *Liquiritiae radix*, *Matricariae flos*, *Menthae piperitae folium*, and *Valerianae radix*, which were repeatedly recorded over more than a century.

This study highlights the long-term historical evolution of official multicomponent herbal teas within pharmacopoeial and magistral pharmaceutical practice in Serbia.

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IF-P5 BETA-BLOKATORI: OD OTKRIĆA DO SAVREMENE TERAPIJSKE PRIMENE

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Blokatori adrenergičkih beta receptora (β-blokatori) predstavljaju jednu od najznačajnijih inovacija farmakoterapije 20. veka. Cilj rada bio je da se analiziraju ključne etape njihovog razvoja i utvrdi kako su promene farmakoloških svojstava usmeravale širenje terapijske primene. Sprovedena je bibliografska narativna analiza literature pretraživanjem baze PubMed/MEDLINE i zvaničnog arhiva Nobelove nagrade za period 1958–2025. Korišćeni su termini „beta-blockers", „history", „propranolol", „cardioselectivity", „vasodilating beta-blockers" i „clinical use". Uključeni su istorijski radovi, pregledni članci i dokumenti koji opisuju nastanak, generacijski razvoj i kliničku primenu ove grupe lekova. Analizom su izdvojene četiri prelomne etape: razvoj dihloroizoproterenola 1958. godine kao eksperimentalnog antagoniste; sinteza pronetalola 1962. i propranolola 1964. godine, čime je započela klinička primena; uvođenje β1-selektivnih lekova od kraja 1960-ih; i razvoj vazodilatatornih beta-blokatora sa dodatnom α1-blokadom ili vazodilatacijom posredovanom azot-monoksidom. Razvoj propranolola, zasnovan na receptorskom konceptu, predstavljao je primer racionalnog projektovanja leka, a doprinos Džejmsa V. Bleka nagrađen je Nobelovom nagradom 1988. godine. Evolucija od neselektivne blokade ka relativnoj β1-selektivnosti i dodatnim vazodilatatornim mehanizmima poboljšala je podnošljivost i omogućila precizniji izbor leka prema karakteristikama pacijenta. Terapijska primena proširena je od angine pektoris i arterijske hipertenzije na infarkt miokarda, aritmije, hroničnu srčanu insuficijenciju, glaukom, tremor i migrenu. Istorijski razvoj beta-blokatora pokazuje kako je racionalno projektovanje lekova zasnovano na receptorskom konceptu oblikovalo savremenu farmakoterapiju i zadržalo klinički značaj tokom više od šest decenija.

IF-P5 BETA-BLOCKERS: FROM DISCOVERY TO MODERN THERAPEUTIC APPLICATIONS

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Beta-adrenergic receptor blockers (β-blockers) represent one of the most important innovations in twentieth-century pharmacotherapy. The aim of this study was to analyse the key stages of their development and determine how changes in pharmacological properties guided the expansion of therapeutic use. A bibliographic narrative analysis was conducted by searching PubMed/MEDLINE and the official Nobel Prize archive for the period 1958–2025. The terms "beta-blockers", "history", "propranolol", "cardioselectivity", "vasodilating beta-blockers", and "clinical use" were used. Historical papers, review articles, and documents describing the discovery, generational development, and clinical use of this drug class were included. Four turning points were identified: the development of dichloroisoproterenol in 1958 as an experimental antagonist; the synthesis of pronethalol in 1962 and propranolol in 1964, which initiated clinical use; the introduction of β1-selective agents from the late 1960s; and the development of vasodilating beta-blockers with additional α1-blockade or nitric-oxide-mediated vasodilation. The development of propranolol, based on the receptor concept, represented an example of rational drug design, and James W. Black's contribution was recognised by the 1988 Nobel Prize. The evolution from non-selective blockade to relative β1-selectivity and additional vasodilating mechanisms improved tolerability and enabled more precise drug selection according to patient characteristics. Therapeutic use expanded from angina pectoris and arterial hypertension to myocardial infarction, arrhythmias, chronic heart failure, glaucoma, tremor, and migraine. The historical development of beta-blockers demonstrates how receptor-based rational drug design shaped modern pharmacotherapy and retained clinical relevance for more than six decades.

IF-P6 ISTORIJSKI PREGLED TERAPIJE EPILEPSIJE U SREDNJOVEKOVNOJ SRBIJI

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Lečenje epilepsije u srednjovekovnoj Srbiji sprovodili su lekari-empirici, najčešće monasi, u bolnicama pri manastirima Hilandar, Studenica, Dečani, Svetih Arhangela, Presvete Bogorodice Evergetide, Prohora Pčinjskog, Manasija, Ravanica.

Cilj rada bio je da se utvrde institucionalni okviri i osnovni terapijski pristupi opisani u izvorima koji se odnose na period od kraja XII do kraja XV veka. Sprovedena je istorijsko-dokumentarna analiza objavljene transkripcije i Hilandarskog medicinskog kodeksa i odabranih istoriografskih radova o lečenju epilepsije u srpskim manastirskim bolnicama. Podaci su razvrstani u tri kategorije: organizacija zbrinjavanja, korišćena lekovita sredstva i odnos empirijskih i religijskih shvatanja bolesti.

Analiza je pokazala da su manastirske bolnice predstavljale organizovan okvir za zbrinjavanje obolelih, a istorijski podaci o dečanskoj bolnici beleže prijem osoba sa „sveštenom bolešću", tadašnjim nazivom za epilepsiju. Hilandarski medicinski kodeks sadrži farmakološke spise sa preparatima biljnog, životinjskog i mineralnog porekla. Njihova primena zasnivala se na tadašnjim humoralnim i empirijskim shvatanjima, dok termin „sveštena bolest" i manastirsko okruženje lečenja ukazuju na istovremeno prisustvo religijskog tumačenja. U srednjovekovnoj farmaciji upotrebljavano je oko 300 lekovitih biljaka, među njima su se po terapijskom značaju izdvajale žalfija, ljiljan, ruža, morač, nana, grčko seme, čubar, rutvica, vratič. Žalfija je bila izuzetno cenjena, pa se u narodu nazivala „svetom travom", dok se koren božura smatrao zaštitnim sredstvom od epileptičnih napada, naročito ako je prikupljen tokom pomračenja Meseca. Kantarion je imao značaj kao antiepileptik i psihostimulans, dok su velebilje i bunika korišćeni u terapiji epilepsije uprkos svojim toksičnim svojstvima.

IF-P6 HISTORICAL OVERVIEW OF EPILEPSY THERAPY IN MEDIEVAL SERBIA

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The treatment of epilepsy in medieval Serbia was conducted by empirical physicians, most commonly monks, in hospitals within the monasteries of Hilandar, Studenica, Dečani, the Holy Archangels, the Most Holy Mother of God Evergetis, Prohor Pčinjski, Manasija, and Ravanica.

The aim of this study was to determine the institutional framework and main therapeutic approaches described in sources relating to the period from the late 12th to the late 15th century. A historical-documentary analysis was performed using the published transcription of the Hilandar Medical Codex and selected historiographical works on epilepsy treatment in Serbian monastic hospitals. The data were classified into three categories: organization of care, medicinal remedies, and the relationship between empirical and religious concepts of the disease.

The analysis showed that monastic hospitals provided an organized framework for patient care, while records from the Dečani hospital document the admission of patients with the "sacred disease," the historical term for epilepsy.

The Hilandar Medical Codex contains pharmacological texts describing remedies of plant, animal, and mineral origin, based on contemporary humoral and empirical concepts, while the term "sacred disease" and the monastic setting reflect the simultaneous presence of religious interpretations.

Around 300 medicinal plants were used in medieval pharmacy, with sage, lily, rose, fennel, mint, fenugreek, savory, rue, and tansy being among the most important. Sage was known as the "holy herb," peony root was considered protective against epileptic seizures, St. John's wort was valued as an antiepileptic and psychostimulant, while belladonna and henbane were used despite their toxicity.

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FHAL-P1 RAZVOJ I VALIDACIJA IR SPEKTROSKOPSKE METODE ZA ODREĐIVANJE SADRŽAJA ETANOLA

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Etanol predstavlja značajnu komponentu brojnih farmaceutskih, kozmetičkih i dezinfekcionih preparata, zbog čega je neophodno razviti pouzdanu analitičku metodu za kontrolu njegovog sadržaja. Cilj ovog rada bio je razvoj i validacija IR spektroskopske metode za određivanje sadržaja etanola. Prednost IR spektroskopske metode je njena jednostavnost i brzina izvođenja, bez prethodne pripreme uzoraka. Identifikacija etanola zasniva se na praćenju karakterističnih apsorpcionih traka u oblasti 2800–3000 cm^{-1}. Kvantitativna analiza se zasniva na merenju visine apsorpcionog maksimuma koji odgovara specifičnim C-H valencionim vibracijama u navedenoj oblasti. Validacija optimizovane metode obuhvatila je ispitivanje linearnosti, tačnosti, preciznosti i limita kvantifikacije. Linearnost je ispitivana u koncentracionom opsegu etanola od 10% do 100% (R^2=0.999). Tačnost metode procenjena je izračunavanjem *Recovery* vrednosti, pri čemu su dobijeni rezultati bili u opsegu od 98,11% do 101,96%, što zadovoljava unapred definisane kriterijume prihvatljivosti. Preciznost metode je ispitivana kao ponovljivost (*intra-assay precision*) i potvrđena je vrednošću relativne standardne devijacije (RSD) od 0,63%, dok je limit kvantifikacije (LOQ) iznosio 7%. Validirana metoda je primenjena za određivanje sadržaja etanola u komercijalnom uzorku 70% etanola, kao i u uzorku parfema nepoznatog sadržaja etanola. Utvrđeno je da ne postoji značajno odstupanje od deklarisanog sadržaja etanola u komercijalnom 70% rastvoru, dok je u uzorku parfema određena koncentracija etanola od 83%. Dobijeni rezultati pokazuju da je razvijena IR spektroskopska metoda jednostavna, brza, tačna i precizna, te pogodna za rutinsko određivanje sadržaja etanola u preparatima koji ga sadrže.

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FHAL-P1 DEVELOPMENT AND VALIDATION OF AN IR SPECTROSCOPIC METHOD FOR ETHANOL DETERMINATION

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Ethanol is an important component of numerous pharmaceutical, cosmetic, and disinfectant products, making the development of a reliable analytical method for its content determination essential. The aim of this study was the development and validation of an IR spectroscopic method for the determination of ethanol. The main advantages of IR spectroscopy are its simplicity and rapid analysis, without prior sample preparation. Ethanol identification is based on monitoring characteristic absorption bands in the 2800–3000 cm^{-1} region. Quantitative analysis is based on measuring the height of the absorption maximum corresponding to specific C–H stretching vibrations in specified region. Validation of the optimized method included the assessment of linearity, accuracy, precision, and limit of quantification. Linearity was evaluated over a concentration range of 10–100% (R^2 = 0.999). Method accuracy was assessed by recovery studies, yielding values ranging from 98.11% to 101.96%, which met the predefined acceptance criteria. Precision was evaluated as repeatability and confirmed by a RSD value of 0.63%, while the limit of quantification was determined to be 7%. The validated method was applied for the determination of ethanol content in a commercial 70% ethanol sample and in a perfume with an unknown ethanol content. No significant deviation from the declared ethanol content was observed in the commercial ethanol solution, whereas the ethanol concentration in the perfume was determined to be 83%. The obtained results demonstrate that the developed IR spectroscopic method is simple, rapid, accurate, and precise, making it suitable for the routine determination of ethanol content.

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FHAL-P2 UBRZANJE ANALIZA U KONTROLI KVALITETA: TRANSFER KLASIČNE UV/VIS SPEKTROFOTOMETRIJSKE METODE ZA ODREĐIVANJE AKTIVNOSTI LIZOZIMA NA ČITAČ MIKROTITAR PLOČA

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U savremenoj farmaceutskoj kontroli kvaliteta, ubrzavanje analitičkih procedura predstavlja ključni prioritet. Fokus ovog rada je na optimizaciji trajanja analiza kroz transfer klasičnih UV/VIS spektrofotometrijskih metoda na čitač mikrotitar ploča. Kao model za ovo istraživanje poslužila je metoda određivanja enzimske aktivnosti lizozima, opisana u važećoj monografiji Japanske farmakopeje.

Osnovni mehanizam ispitivanja zasniva se na spektrofotometrijskom mjerenju brzine smanjenja apsorbancije bakterijske suspenzije *Micrococcus luteus* na približno 450 nm. Ovo smanjenje je rezultat enzimske hidrolize ćelijskog zida i direktno je proporcionalno aktivnosti lizozima u uzorku, odnosno na referentnom standardu.

Prilagođena metoda je verfikovana i u potpunosti preneta sa standardnog spektrofotometra sa kivetama na format čitača mikrotitar ploča. Kao glavna prednost primene čitača mikrotitar ploča, ostvarena je značajna ušteda vremena analize, prvenstveno zbog mogućnosti uporednog i paralelnog analiziranja velikog broja uzoraka, što klasičnim pristupom nije izvodivo. Tehnički izazovi koji su se pojavili tokom prenosa metode uspješno su riješeni optimizacijom kritičnih eksperimentalnih parametara, uključujući koncentraciju i volumen uzorka i reagensa, redoslijed dodavanja reagensa, te vrijeme reakcije, pri čemu je osigurana ekvivalentnost rezultata. Optimizovana metoda je uspješno primijenjena na tri komercijalno dostupna proizvoda: Lysobact pastile, Lysobact Junior oromukozni sprej i Lysoderm krem.

Verifikacija ovog modela pokazuje da prelazak na čitače mikrotitar ploča omogućava visok protok uzoraka uz održavanje potrebne tačnosti i preciznosti. Ovaj rad pruža praktične smjernice za prilagođavanje klasičnih UV/VIS spektrofotometrijskih metoda modernim tehnologijama, poboljšavajući efikasnost u kontroli kvaliteta lijekova.

FHAL-P2 ACCELERATION OF ANALYSIS IN QUALITY CONTROL: TRANSFER OF THE CLASSIC UV/VIS SPECTROPHOTOMETRIC METHOD FOR DETERMINATION OF LYSOZYME ACTIVITY TO A MICROTITER PLATE READER

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In modern pharmaceutical quality control, accelerating analytical procedures while maintaining high accuracy is a key priority. This study focuses on optimizing analysis times by transferring classical UV/VIS spectrophotometric methods to a microplate reader platform. The model method chosen for this research was the determination of lysozyme enzymatic activity, conducted in accordance with the current Japanese Pharmacopoeia monograph.

The underlying assay mechanism is based on spectrophotometrical measurement of the rate of absorbance decrease of a *Micrococcus luteus* bacterial suspension at approximately 450 nm. This decrease is a result of enzymatic hydrolysis of the cell wall and is directly proportional to the sample's activity relative to an official reference standard.

The adapted method was verified and fully transferred from a standard cuvette-based spectrophotometer to a microplate reader format. This transfer enables simultaneous analysis of a large number of samples, resulting in significant time savings and higher throughput. Technical challenges encountered during the transition were successfully resolved by optimizing critical experimental parameters, including sample and reagent concentrations, volumes, reagent addition order, and reaction times, thereby ensuring strict result equivalence. The optimized method was successfully applied to three commercial products: Lysobact lozenges, Lysobact Junior oromucosal spray, and Lysoderm cream.

Ultimately, verification of this model demonstrates that transferring to microplate readers enables high sample throughput while maintaining required accuracy and precision. This paper provides practical guidance for adapting classic UV/VIS spectrophotometric methods to modern technologies, improving efficiency in drug quality control.

FHAL-P3 HEMOINFORMATIČKA STUDIJA HDAC3 I HDAC6 INHIBITORA

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Histon deacetilaze (HDAC) predstavljaju ključne epigenetičke regulatore koji kontrolišu ekspresiju gena, proliferaciju i diferencijaciju ćelija, a njihova poremećena aktivnost usko je povezana sa nastankom i progresijom brojnih vrsta karcinoma. Među članovima HDAC porodice, HDAC3 i HDAC6 izdvajaju se kao posebno značajne terapijske mete zbog svojih specifičnih bioloških funkcija i uloge u različitim oboljenjima. U ovom radu primenjen je integrisani računarski pristup koji kombinuje mašinsko učenje (ML) u programskom jeziku Python, molekulsko dokovanje korišćenjem GOLD 2022.3.0 paketa i kvantnohemijske proračune u programskom paketu Gaussian 09 kako bi se identifikovale strukturne karakteristike odgovorne za inhibitornu aktivnost prema HDAC3 i HDAC6. U ovom istraživanju ispitivana su jedinjenja koja su deo ChEMBL baze podataka. Razvijeni ML modeli pokazali su izuzetne prediktivne performanse, pri čemu su vrednosti tačnosti, preciznosti, osetljivosti i F1-mere bile gotovo jednake 1,0 za HDAC3 i približno 0,98 za HDAC6, što ukazuje na njihovu visoku robusnost i pouzdanost. Utvrđeno je da se vrednosti metrika ne menjaju značajno za proces unakrsne-validacije, kao ni sa promenom hiperparametra (do 0.05). Analiza značaja deskriptora, potkrepljena rezultatima molekulskog dokovanja i kvantnohemijskih simulacija, otkrila je različite odnose između strukture i aktivnosti za ove dve izoforme. Manji supstituenti sa izraženim elektronski privlačnim efektom u blizini regiona za vezivanje Zn^{2+} jona doprinose većoj inhibitornoj aktivnosti prema HDAC3, dok glomaznije i hidrofobnije grupe favorizuju vezivanje za HDAC6, pružajući vredne smernice za razvoj izoformno selektivnih inhibitora. Dobijeni rezultati potvrđuju da integracija savremenih računarskih metoda predstavlja efikasan pristup za racionalni dizajn novih selektivnih HDAC inhibitora i razvoj budućih epigenetičkih terapija.

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FHAL-P3 CHEMOINFORMATICS STUDY OF HDAC3 AND HDAC6 INHIBITORS

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Histone deacetylases (HDACs) are essential epigenetic regulators that modulate gene expression, cell proliferation, and differentiation, and their dysregulation has been implicated in the development and progression of numerous cancers. Among the HDAC family, HDAC3 and HDAC6 have emerged as particularly attractive therapeutic targets owing to their distinct biological functions and disease relevance. In this study, an integrated computational framework combining machine learning (ML) within Python language, molecular docking using GOLD 2022.3.0 package, and quantum chemical calculations utilized by Gaussian 09 was employed to identify the structural determinants governing inhibitory activity toward HDAC3 and HDAC6. In this research, the molecules which are part of ChEMBL database were examined. The developed ML models demonstrated excellent predictive performance, achieving accuracy, precision, recall, and F1-score values approaching 1.0 for HDAC3 and approximately 0.98 for HDAC6, indicating high robustness and predictive reliability. It was found that metrics' values do not change significantly for cross-validation and when values of hyperparameters were changes (less then 0.05). Feature importance analysis, supported by molecular docking and quantum chemical simulations, revealed distinct structure–activity relationships between the two isoforms. Smaller electron-withdrawing substituents located near the Zn^{2+}-binding region were found to enhance HDAC3 inhibition, whereas bulkier hydrophobic groups favored HDAC6 binding, providing valuable insights into isoform-selective inhibition. These findings demonstrate the potential of integrated computational approaches to guide the rational design of selective HDAC inhibitors for future epigenetic therapies.

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FHAL-P4 INTEGRISANI RAČUNARSKI PRISTUP DIZAJNU INHIBITORA ERK2 I DUALNIH INHIBITORA ERK2/HDAC

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Ras–Raf–MEK–ERK/MAPK signalni put, kao centralni regulator ključnih ćelijskih procesa uključenih u proliferaciju, diferencijaciju i preživljavanje, često je disregulisan u kanceru i predstavlja važnu terapijsku metu. Međutim, inhibitori ovog puta često su ograničeni stečenom rezistencijom, smanjenom selektivnošću i neželjenim efektima. Kako bi se ovi problemi prevazišli, razvijen je sveobuhvatan računarski pristup koji integriše ligand- i strukturno-bazirani dizajn lekova za identifikaciju i optimizaciju ERK2 (Ekstracelularno signal - regulisana kinaza 2) i dualnih ERK2/HDAC (Histon deacetilaze) inhibitora, sa ciljem poboljšanja selektivnosti i prevazilaženja rezistencije. Skup strukturno srodnih ERK2 inhibitora analiziran je molekulskim dokingom, 3D-QSAR i ML-QSAR (3D i mašinsko-učenje zasnovani kvantitativni odnosi struktura–aktivnost) pristupima radi identifikacije ključnih strukturnih determinanti inhibitorne aktivnosti. Dobijeni uvidi primenjeni su u fragment-dizajn strategiji za generisanje derivata pirimidin-2-piridona i pirazolil-pirola. Kroz konsenzusnu evaluaciju zasnovanu na dokingu, QSAR predikcijama i ADMET profilisanju, jedinjenje LCA155 izdvojilo se kao najperspektivniji pirimidin-2-piridon (pKi = 9.22), dok je LCB167 identifikovan kao vodeći pirazolil-pirol (pKi = 8.87). Molekulska dinamika dodatno su potvrdila stabilnost ERK2 inhibitora u dinamičkom, solventno realističnom okruženju. Za višeciljni pristup, HDAC farmakoforni elementi inkorporirani su u dizajn, čime su dobijeni dualni ERK2/HDAC kandidati za modulaciju signalnih puteva povezanih sa kancerom. Jedinjenja D1, D5 i D6 pokazala su povoljne predviđene ERK2 aktivnosti (pKi = 8.62, 8.08, 8.55) i odgovarajuće vezivanje u HDAC6, HDAC3 i HDAC4. Sveukupno, pristup predstavlja robusnu platformu za racionalni dizajn ERK2 i ERK2/HDAC inhibitora sa potencijalom primene u antikancer terapiji i prekliničkom razvoju lekova.

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FHAL-P4 INTEGRATED COMPUTATIONAL APPROACH FOR ERK2 AND DUAL ERK2/HDAC INHIBITORS DESIGN

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The Ras–Raf–MEK–ERK/MAPK signaling pathway, a central regulator of key cellular processes including proliferation, differentiation, and survival, is frequently dysregulated in cancer and represents an important therapeutic target. However, inhibitors often suffer from acquired resistance, limited selectivity, and adverse effects. To address these challenges, a comprehensive computational approach integrating ligand- and structure-based drug design was developed for the identification and optimization of ERK2 (Extracellular signal-regulated kinase 2) and multi-target ERK2/HDAC (Histone deacetylases) inhibitors, with emphasis on improving selectivity and overcoming resistance mechanisms. A dataset of structurally related ERK2 inhibitors was analyzed using molecular docking, 3D-QSAR, and ML-QSAR (3D- and machine learning quantitative structure-activity relationship) approaches to identify key structural determinants of ERK2 inhibitory activity. These insights were applied in a fragment-based design strategy to generate pyrimidine-2-pyridone and pyrazolyl-pyrrole derivatives. Through consensus evaluation involving docking, QSAR prediction, and ADMET profiling, compound LCA155 emerged as the most promising pyrimidine-2-pyridone derivative (pKi = 9.22), while LCB167 was identified as the best pyrazolyl-pyrrole derivative (pKi = 8.87). Molecular dynamics simulations further supported the stability of the selected ERK2 inhibitor in a solvent-aware environment. For multitargeting, HDAC pharmacophoric features were incorporated, yielding dual ERK2/HDAC candidates for modulation of cancer-related signaling networks. Compounds D1, D5, and D6 showed favorable predicted ERK2 activities (pKi = 8.62, 8.08, and 8.55) and appropriate binding modes within HDAC6, HDAC3, and HDAC4. Overall, this approach provides a robust computational platform for the rational design of ERK2 and ERK2/HDAC inhibitors with potential applications in anticancer therapy and preclinical drug development.

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FHAL-P5 *IN SILICO* EVALUACIJA BIORASPOLOŽIVOSTI, FARMAKOKINETIKE I TOKSIKOLOŠKIH OSOBINA ODABRANIH DUALNIH INHIBITORA ACETILHOLINESTERAZE I MONOAMINO OKSIDAZE-B ZA LEČENJE ALCHAJMEROVE BOLESTI

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Alchajmerova bolest (AB) je neurodegenerativni poremećaj kompleksne patologije. Acetilholinesteraza (AChE) i monoamino oksidaza-B (MAO-B) predstavljaju ključna mesta delovanja za regulisanje nivoa neurotransmitera, a dizajnirani su dualni inhibitori (supstance 1–46) kao eksperimentalni kandidati za terapiju AB.

Parametri sličnosti sa lekovima procenjeni su korišćenjem *pkCSM*, *SwissADME veb alata* i *MoloVol softvera (v1.2.0)*. *SwissADME* je predvideo gastrointestinalnu apsorpciju i penetraciju kroz krvno-moždanu barijeru, dok je *pkCSM* evaluirao specifično vezivanje za P-glikoprotein i inhibiciju CYP450 enzima. Toksikološki profili jedinjenja (1–46) procenjeni su pomoću *DataWarrior softvera (v06.05.04)*, klasifikujući jedinjenja u kategorije mutagenih, kancerogenih, reproduktivno toksičnih i agensi koji izazivaju iritaciju.

Većina jedinjenja pokazuje usklađenost sa pravilom Lipinskog (izuzev 12 i 35), što ukazuje na povoljnu apsorpciju i permeabilnost. Sva jedinjenja pokazala su TPSA<140 Å², što ukazuje na dobru intestinalnu apsorpciju, dok su jedinjenja 1, 3–6, 8, 11–16, 18, 19, 27, 30, 31, 34, 36–38 i 44–46 imala TPSA<60 Å², što sugeriše penetraciju kroz krvno-moždanu barijeru. Za većinu jedinjenja predviđeno je da su supstrati P-glikoproteina. Metaboličko profilisanje ukazalo je na inhibiciju CYP1A2, 2C19, 2C9, 2D6 i 3A4. Toksiološka analiza je identifikovala mutagenost (jedinjenja 4, 5, 19, 20 i 27), kancerogenost (jedinjenja 4, 5, 8, 18 i 19), reproduktivnu toksičnost (jedinjenja 15, 16 i 19–23) i iritantne efekte (jedinjenja 7, 11, 17 i 20).

Dobijeni rezultati ukazuju na dalju *in vitro* i *in vivo* evaluaciju jedinjenja 1, 3, 6, 13, 14, 30, 31, 34, 36–38 i 44–46 kao dualnih AChE/MAO-B inhibitora i potencijalno novih lekova za terapiju AB.

Zahvalnica

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FHAL-P5 *IN SILICO* EVALUATION OF BIOAVAILABILITY, PHARMACOKINETICS AND TOXICOLOGICAL PROPERTIES OF SELECTED DUAL INHIBITORS OF ACETYLCHOLINESTERASE AND MONOAMINO OXIDASE-B FOR THE TREATMENT OF ALZHEIMER'S DISEASE

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Alzheimer's disease (AD) is a neurodegenerative disorder with a complex pathology. Acetylcholinesterase (AChE) and monoamine oxidase-B (MAO-B) are key targets regulating neurotransmitter levels, and dual inhibitors (compounds 1–46) were designed as experimental candidates for AD therapy.

Drug-likeness parameters were estimated using *pkCSM*, *SwissADME web tools*, and *MoloVol software (v1.2.0)*. *SwissADME* predicted gastrointestinal absorption and blood–brain barrier penetration, whereas *pkCSM* evaluated P-glycoprotein recognition and CYP450 inhibition. Toxicological profiles of compounds (1–46) were assessed with *DataWarrior software (v06.05.04)*, which predicted structural alerts as mutagenic, carcinogenic, reproductive, or irritant.

Most compounds complied with *Lipinski's rule* (excluding 12 and 35) indicating favorable absorption and permeability. All compounds showed TPSA<140 Å², indicating good intestinal absorption, while compounds 1, 3–6, 8, 11-16, 18, 19, 27, 30, 31, 34, 36-38, and 44–46 displayed TPSA<60 Å², suggesting blood–brain barrier penetration. The majority of compounds were predicted P-glycoprotein substrates. Metabolic profiling predicted inhibition of CYP1A2, 2C19, 2C9, 2D6, and 3A4. Toxicological analysis predicted mutagenicity (compounds 4, 5, 19, 20 and 27), carcinogenicity (compounds 4, 5, 8, 18 and 19), reproductive toxicity (compounds 15, 16 and 19–23), and irritant effects (compounds 7, 11, 17 and 20).

Computational findings support further *in vitro* and *in vivo* evaluation of compounds 1, 3, 6, 13, 14, 30, 31, 34, 36–38, and 44–46 as dual AChE/MAO B inhibitors and potential new drug candidates for AD treatment.

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FHAL-P6 *IN SILICO* PROCENA I ANALIZA BIORASPOLOŽIVOSTI, FARMAKOKINETIKE I TOKSIKOLOŠKIH OSOBINA ODABRANIH DERIVATA PIPERAZINA

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Piperazin je fleksibilan heterociklični skelet, široko primenjivan u dizajnu lekova zbog svoje sposobnosti interakcije sa različitim biološkim ciljevima. Ovo *in silico* istraživanje evaluira bioraspoloživost, farmakokinetička i toksikološka svojstva njegovih derivata (1–27), gde su jedinjenja 1–4 komercijalno dostupni lekovi.

Parametri sličnosti sa lekovima izračunati su korišćenjem *SwissADME* veb-alata i *MoloVol* softvera (v1.2.0). *SwissADME* je predvideo gastrointestinalnu apsorpciju, permeabilnost kroz krvno-moždanu barijeru, specifično vezivanje za P-glikoprotein i inhibiciju *CYP450* izoenzima. Toksikološki profili procenjeni su pomoću *DataWarrior* softvera (v06.05.04), klasifikujući jedinjenja u kategorije mutagenih, kancerogenih, reproduktivno toksičnih i iritantnih agenasa.

Prema pravilu Lipinskog, predviđeno je da sva jedinjenja osim 17 i 19 imaju povoljnu apsorpciju i permeabilnost. Sva jedinjenja (osim 9) pokazala su *TPSA* < 140 Å², što ukazuje na dobru intestinalnu apsorpciju, dok su jedinjenja 2, 4–6, 11–13, 16–18, 23–25 i 27 imala *TPSA* < 60 Å², što sugeriše penetraciju kroz krvno-moždanu barijeru. Za većinu jedinjenja (1–4, 7–9, 14, 16, 17, 19–25) predviđeno je da su supstrati P-glikoproteina. Metaboličko profilisanje ukazuje na inhibiciju *CYP450* izoenzima, uključujući 1A2, 2C19, 2C9, 2D6 i 3A4. Nijedno jedinjenje nije pokazalo mutageni rizik. Kancerogenost je uočena kod jedinjenja 5 i 13. Reproduktivnu toksičnost ispoljavaju jedinjenja 6, 12 i 14. Iritantni efekti su prisutni kod jedinjenja 11–15.

Nakon pažljive analize svih činjenica, preporučuje se sprovođenje daljih *in vitro* i *in vivo* studija radi evaluacije jedinjenja kao potencijalnih novih antiparazitskih (7, 8, 10), antimikrobnih (11), neuroaktivnih (16), antiinflamatornih (18, 20–24), antituberkuloznih (25, 26) i antitumorskih (27) agenasa.

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FHAL-P6 *IN SILICO* ESTIMATION AND ANALYSIS OF BIOAVAILABILITY, PHARMACOKINETICS AND TOXICOLOGICAL PROPERTIES OF SELECTED PIPERAZINE DERIVATIVES

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Piperazine is a flexible heterocyclic scaffold widely employed in drug design due to its ability to interact with diverse biological targets. This study computationally assesses the bioavailability, pharmacokinetic, and toxicological properties of its derivatives (1-27), with compounds 1-4 being commercially available drugs.

Drug-likeness parameters were calculated using the *SwissADME* web tool and *MoloVol* software (v1.2.0). The *SwissADME* web tool predicted gastrointestinal absorption, blood–brain barrier permeability, P-glycoprotein recognition, and *CYP450* inhibition. Toxicological profiles were assessed with *DataWarrior* software (v06.05.04), classifying compounds as mutagenic, carcinogenic, reproductive toxins and irritants.

Based on *Lipinski's rule*, all compounds except 17 and 19 are predicted to have favourable absorption and permeability. All compounds (except 9) exhibited *TPSA* < 140 Å², indicating good intestinal absorption, while compounds 2, 4–6, 11–13, 16–18, 23–25, and 27 displayed *TPSA* < 60 Å², suggesting blood–brain barrier penetration. Most compounds (1–4, 7–9, 14, 16, 17, 19–25) were predicted to be P-glycoprotein substrates. Metabolic profiling indicated inhibition of multiple *CYP450* isoenzymes, including 1A2, 2C19, 2C9, 2D6, and 3A4. None of the compounds exhibited mutagenic risk. Carcinogenicity was observed for compounds 5 and 13. Reproductive toxicity was detected for compounds 6, 12, and 14. Irritant effects were present for compounds 11–15.

After careful consideration of all findings, further *in vitro* and *in vivo* studies are recommended to evaluate the compounds as potential new antiparasitic (7, 8, 10), antimicrobial (11), neuroactive (16), anti inflammatory (18, 20–24), antitubercular (25, 26), and antitumor (27) agents.

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FHAL-P7 KARAKTERIZACIJA RP/HILIC BIMODALNOG HROMATOGRAFSKOG SISTEMA RAZVOJEM MEŠOVITOG QSRR MODELA

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Bimodalni RP/HILIC hromatografski sistem može da se primenjuje za istovremeno ispitivanje analita koji se veoma razlikuju po polarnosti. Međutim, slabo poznavanje obrazaca kompleksnog retencionog ponašanja molekula u hromatografiji višestrukih režima često je ograničavajući faktor za njenu širu praktičnu primenu. Razvojem mešovitih modela kvanitativnog odnosa strukture i retencionog ponašanja (QSRR) može se značajno doprineti njenom boljem razumevanju.

Retenciono ponašanje 36 molekula farmaceutskih supstanci različite polarnosti (log P -1,87 do 3,88) i sposobnosti jonizacije praćeno je na *Acclaim Mixed-Mode HILIC-1* koloni pri temperaturi od 30 °C i brzini protoka mobilne faze 1,00 mL/min, pri čemu je sastav mobilne faze variran prema planu eksperimenata centralnog kompozicionog dizajna i podrazumevao je variranje udela acetonitrila (ACN, 52 – 92 %, v/v), pH vrednosti (3,78 - 5,72) i koncentracije pufera vodenog dela mobilne faze (C, 20 – 50 mM) u slučaju analize jonizovanih molekula, dok je retenciono ponašanje neutralnih molekula ispitano samo u zavisnosti od promene udela ACN. Mešoviti QSRR model je razvijen u *RapidMiner* softveru primenom algoritma gradijentno pojačanih stabala odlučivanja. Model je obuhvatio vrednosti retencionih faktora, eksperimentalnih parametara i molekulskih deskriptora koji su izračunati *PaDel* softverom. Validnost modela je potvrđena desetostrukom unakrsnom validacijom (Q^2_{CV} = 0,912 ± 0,085, RMSEE = 0,106 ± 0,035) i eksternom validacijom (R^2 = 0,911, RMSEP = 0,117). Modelom su istaknuti faktori koji odražavaju ulogu mase i elektronegativnosti atomskih centara u molekulima i elektrotopološke strukture (mindsssC, ACN, ATSC2e, ATSC4m, pH, C, PubchemFP366, minHBd, AATSC3e, ATSC3m) ukazujući tako na dominantan uticaj polarnih interakcija i prisustva jonskih i vodoničnih veza na retenciju.

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FHAL-P7 CARACTERISATION OF A RP/HILIC BIMODAL CHROMATOGRAPHY SYSTEM BY DEVELOPING A MIXED QSRR MODEL

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Bimodal RP/HILIC chromatography has the ability of simultaneous analysis of molecules with diverse polarities. However, poor knowledge of complex retention behaviour patterns in multimodal chromatography limits its wider practical application. Developing mixed quantitative structure-retention relationship (QSRR) models can significantly improve its better understanding.

The retention behaviour of 36 drug molecules of diverse polarity (log P -1.87 to 3.88) and ionisation, was monitored on *Acclaim Mixed-Mode HILIC-1* column heated at 30 °C using mobile phase flow rate of 1.00 mL/min while the mobile phase composition was varied according to the experimental plan of central composite design and included variation in the acetonitrile ratio (ACN, 52 – 92 %, v/v), pH value (3.78 - 5.72) and the buffer concentration (C, 20 – 50 mM) in case of the analyses of ionised molecules, while the retention of neutral molecules was tested only within the variation in ACN ratio. A mixed QSRR model was developed using *RapidMiner* software and the gradient boosted trees algorithm. The model took into account experimental parameters, molecular descriptors calculated by *PaDel* software and retention factor values. The model was evaluated by 10-fold cross-validation (Q^2_{CV} = 0.912 ± 0.085, RMSEE = 0.106 ± 0.035) and external validation (R^2 = 0.911, RMSEP = 0.117). The model pointed out the factors that reflect the importance of mass and electronegativity of molecular atomic centres and electrotopological structure (mindsssC, ACN, ATSC2e, ATSC4m, pH, C, PubchemFP366, minHBd, AATSC3e, ATSC3m), thus implying dominant influence of polar interactions and the presence of ionic and hydrogen bonds on retention.

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FHAL-P8 PROAKTIVAN PRISTUP OPTIMIZACIJI ODGOVORA U MASENOJ SPEKTROMETRIJI ZA DETEKCIJU I KVANTIFIKACIJU NEČISTOĆA

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Osetljiva analiza nečistoća primenom tečne hromatografije sa masenom spektrometrijom (LC-MS) od suštinskog je značaja za bezbednost farmaceutskih proizvoda, ali je optimizacija parametara jonskog izvora često dugotrajna. Modeli kvantitativnog odnosa strukture i osobina (QSPR) su prepoznati kao korisni alati za unapređenje razvoja LC-MS metoda. U ovom istraživanju procenjene su performanse predviđanja QSPR modela za strukturno slična jedinjenja na primeru ftalatnih estara (PAEs). PAEs su odabrani zbog njihove široke rasprostranjenosti u životnoj sredini u tragovima, mogućnosti otpuštanja iz pakovnog materijala i poznatih svojstava endokrinih ometača, zbog čega je značajno njihovo praćenje. U prvom koraku generisan je ansambl konformera, a njihove 3D strukture optimizovane su primenom MMFF94 polja sila. Zatim su izračunati 2D i Bolcmanovim faktorima ponderisani 3D deskriptori, koji su korišćeni kao ulazne promenljive zajedno sa parametrima jonskog izvora variranim prema centralnom kompozicionom dizajnu. Razdvajanje odabranih PAEs izvedeno je korišćenjem prethodno definisanih uslova gradijentnog eluiranja. Kao odgovori su korišćene logaritamski transformisane površine hromatografskih pikova. Ispitana su tri algoritma: veštačke neuronske mreže (ANN), regresija mašinama sa potpornim vektorima (SVR) i regresija slučajnim šumama (RFR). RFR je pokazao bolje performanse u odnosu na ostale modele, sa RMSE vrednošću na test setu od 3,0356, u poređenju sa 3,2144 za ANN i 4,5237 za SVR. Za razliku od drugih modela, RFR omogućava identifikaciju značajnih ulaznih promenljivih, čime olakšava razumevanje odnosa između odgovora i molekulske strukture. Razvijeni model omogućava optimizaciju odgovora za srodne supstance i stoga se može integrisati u racionalizovan radni tok razvoja LC-MS metoda koji štedi vreme i resurse.

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FHAL-P8 FORWARD-THINKING APPROACH IN MASS SPECTROMETRY RESPONSE OPTIMIZATION FOR DETECTION AND QUANTIFICATION OF IMPURITIES

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Sensitive liquid chromatography-mass spectrometry (LC-MS) technique is often essential for impurity analysis in order to ensure the safety of drug products, though optimizing ion source parameters is often time-consuming. Quantitative structure – property relationship (QSPR) models are recognized as valuable tools for facilitating LC–MS method development. This study evaluated the predictive performance of QSPR models for structurally similar compounds, using phthalic acid esters (PAEs) as an example. PAEs were chosen due to their widespread occurrence in the environment at trace levels, their potential to leach from packaging materials, and their known endocrine-disrupting effects, highlighting the importance of their monitoring. As a first step, conformer ensemble was generated, and their 3D structures were optimized using the MMFF94 force field. Subsequently, 2D and Boltzmann-weighted 3D descriptors were calculated and used as inputs, along with the ion source parameters varied according to the central composite design. The separation of selected PAEs was performed using previously established gradient elution LC conditions. Logarithmically-transformed chromatographic peak areas were used as responses. Three algorithms were tested: artificial neural networks (ANN), support vector machine regression (SVR), and random forest regression (RFR). RFR outperformed the other models, with a test RMSE value of 3.0356, compared to 3.2144 for ANN and 4.5237 for SVR. Unlike other models, RFR enables the identification of important input variables, thus facilitating understanding of the relationship between the response and molecular structure. The developed model enables response optimization for related substances and can be integrated into a time- and resource-efficient workflow for LC-MS method development.

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FHAL-P9 HEMOMETRIJSKO ISPITIVANJE RETENCIONIH KARAKTERISTIKA RISPERIDONA I NJEGOVIH NEČISTOĆA

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Hemometrijska analiza je obuhvatala ispitivanje kvantitativnog odnosa strukture i retencije (QSRR) antipsihotika risperidona, njegovih nečistoća A, B, C, D, E, K, L, M i korelacionu analizu. Cilj rada je bio da se formira model koji može da predvidi retenciono ponašanje drugih strukturno sličnih jedinjenja koja nisu oficinalna u monografiji Evropske farmakopeje (EP12.2-01/2011:1559) kako bi se ubrzao postupak ispitivanja novih nečistoća/metabolita koje mogu da budu od toksikološkog značaja.

Za QSRR modelovanje i izračunavanje molekulskih parametara korišćen je *ChemMaster software 1.3. basic* program primenom metode parcijalnih najmanjih kvadrata (PLS). Retenciono ponašanje analizirano je u hromatografskim uslovima propisanim za ispitivanje srodnih supstanci u monografiji risperidone (EP12.2-01/2011:1559). QSRR modelom je uspostavljena korelacija između izračunatih molekulskih parametara ispitivanog seta jedinjenja i vrednosti relativnog retencionog vremena (RRT) u RP-HPLC sistemu. RRT vrednosti su izračunate na osnovu preuzetih retencionih vremena iz oficinalne metode.

PLS-QSRR model sa dve značajne komponente, regresionim parametrom za trening i test set (R^2=0,969, R^2=0,807), niskom srednjom kvadratnom greškom procene za trening i test set (RMSE=0,034,RMSE=0,100) je odabran za dalja ispitivanja. Ispitivana je vrsta i intezitet korelacije molekulskih deskriptora sa retencijom ispitivanih jedinjena. Utvrđeno je da su skoro svi fizičko-hemijski molekulski deksriptori u modelu sa značajnom pozitivnom korelacijom (r>0,76): molekulska masa, tačna molekulska masa, molekulska masa teških atoma, *hydrogen bond acceptors* (HBA), od kojih LogP (r=0,8520) sa najznačajnijom.

QSRR modelom je uspešno predviđeno retenciono ponašanje dodatnih nečistoća H, I, F, J i risperidon-N-oksida u hromatografskim uslovima za srodne supstance (EP12.2-01/2011:1559) koje nisu korišćene za formiranje modela, čime je potvrđen značajan doprinos ovog modela.

FHAL-P9 CHEMOMETRIC EVALUATION OF THE RETENTION BEHAVIOR OF RISPERIDONE AND ITS RELATED COMPOUNDS

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Chemometric evaluation of the Quantitative Structure–Retention Relationship (QSRR) of antipsychotic drug risperidone and its impurities A, B, C, D, E, K, L, and M, has been performed, together with correlation analysis. The aim of the study was to develop a model capable of predicting the retention behavior of structurally related compounds not included in the European Pharmacopoeia monograph (EP12.2-01/2011:1559), thereby facilitating rapid evaluation of new impurities/metabolites of potential toxicological concern.

QSRR modeling and molecular descriptor calculations were performed using ChemMaster Software 1.3 Basic and the Partial Least Squares (PLS) method. The developed model established a relationship between the calculated molecular descriptors and relative retention time (RRT) obtained under the chromatographic conditions prescribed by the official Ph. Eur. method.

Among the evaluated models, the PLS-QSRR model with two significant components showed the best predictive performance and was selected for further analysis. The model achieved R^2 values of 0.969 and 0.807 and RMSE values of 0.034 and 0.100 for the training and test sets, respectively. Correlation analysis revealed strong positive relationships between RRT and most physicochemical descriptors (r>0.76), including molecular weight, exact molecular weight, heavy atom molecular weight, and *Hydrogen bond acceptors* (HBA). LogP exhibited the strongest positive correlation with RRT (r=0.852).

The QSRR model successfully predicted retention behavior of additional impurities H, I, F, J and risperidone-N-oxide under the chromatographic conditions specified for related substances (EP12.2-01/2011:1559). Since these compounds were not used for model development, the results confirmed its applicability for retention behavior prediction of structurally related compounds.

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FHAL-P10 MODDE® AS A TOOL FOR AQbD-DRIVEN ROBUSTNESS ASSESSMENT OF A STABILITY-INDICATING HPLC METHOD FOR THE DETERMINATION OF MELOXICAM AND ITS RELATED SUBSTANCES

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Robustness assessment is an essential part of analytical method validation, particularly for stability-indicating methods intended for the determination of active pharmaceutical ingredients in the presence of their related substances in finished pharmaceutical products. This study aimed to apply MODDE® software for the systematic evaluation of robustness of a stability-indicating HPLC method developed for determination of meloxicam and its related substances in injection solution.

A design of experiments (DoE) approach was employed using a full factorial 2^3 experimental design. Three critical chromatographic parameters were investigated: column temperature (45 ± 2 °C), buffer pH (6.0 ± 0.2), and mobile phase flow rate (1.0 ± 0.2 mL/min). The selected responses included the resolution between impurities C and A (critical pair) and the number of theoretical plates for impurity B and meloxicam.

Experimental data processed using MODDE® generated highly predictive models ($R^2 > 0.8$; $Q^2 > 0.5$) with satisfactory model validity and reproducibility. The analysis revealed that buffer pH had the most pronounced influence on the resolution of the critical pair, whereas mobile phase flow rate mainly affected the number of theoretical plates for impurity B and meloxicam. Visualization of the sweet spot plot successfully defined a robust experimental design space in which all predefined acceptance criteria were simultaneously fulfilled.

The application of MODDE® provided a structured and scientifically justified approach to robustness evaluation, supporting the implementation of Analytical Quality by Design (AQbD) principles in pharmaceutical method development and validation.

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FHAL-P11 EFFECT OF SILICA EXCIPIENT CONCENTRATION ON THE STABILITY OF A HIGHLY UNSTABLE ANGIOTENSIN-CONVERTING ENZYME INHIBITOR IN TABLET FORMULATIONS

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The development of solid oral dosage forms containing highly unstable active pharmaceutical ingredients (APIs) is challenging due to their sensitivity to temperature and humidity. Optimizing excipient concentration is an important strategy for improving formulation stability.

This study evaluated the effect of silicon dioxide concentration on the stability of an angiotensin-converting enzyme (ACE) inhibitor. Two experimental tablet formulations containing 5% and 9% silicon dioxide were prepared by direct compression using a rotary tablet press and evaluated under two long-term stability protocols. Binary mixtures of the API and silicon dioxide at corresponding ratios were also prepared and analysed.

The results demonstrated a clear concentration-dependent stabilizing effect of silicon dioxide. Under both stability protocols, the formulation containing 9% silicon dioxide showed improved stability compared with the formulation containing 5% silicon dioxide. The higher silicon dioxide concentration resulted in higher assay values (e.g., 91.6% vs. 91.2%) at the corresponding stability time points. Furthermore, the formulation containing 9% silicon dioxide exhibited lower total degradation products (6.0% after 30 months) than the formulation containing 5% silicon dioxide (6.3% after 24 months), despite the longer storage period. Similar trends were observed in the binary mixtures, confirming the stabilizing effect of the higher silicon dioxide concentration.

The improved stability at the higher silicon dioxide concentration is consistent with its moisture-adsorbing properties and potential interactions with polar functional groups of the API. Although degradation was not completely prevented, increasing the silicon dioxide concentration reduced degradation and improved the stability profile of formulations containing highly unstable ACE inhibitors.

FHAL-P12 REGULATORNI PRISTUP PROCENI NEČISTOĆA SINTETSKIH PEPTIDA: POREĐENJE FDA I EMA SMERNICA

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FDA i EMA se razlikuju u regulatornom pristupu za sintetske peptide, posebno u definisanju njihove veličine, proceni imunogenosti i zahtevima za generičke lekove. Cilj rada bio je da se uporede aktuelni regulatorni okviri FDA i EMA za sintetske peptide. FDA definiše peptide kao polimere sastavljene od 40 ili manje aminokiselina, dok EMA ne navodi broj aminokiselina i posmatra sintetske peptide kao strukture koje se nalaze na granici između malih molekula (četiri ili manje aminokiselina) i velikih proteina. Ova razlika utiče na pristup razvoju, evaluaciji i kontroli kvaliteta peptidnih lekova.

Nivoi nečistoća predstavljaju jedan od najvažnijih kritičnih atributa kvaliteta (CQA), jer mogu značajno uticati na bezbednost i efikasnost leka, naročito kroz imunogenost. FDA pristup zasnovan je na dokazivanju ekvivalentnosti aktivne supstance sa referentnim biološkim lekom. Za nove nečistoće ili nečistoće prisutne u opsegu od 0,10% do 0,50% potrebna je detaljna karakterizacija i procena, uključujući *in silico* analize i *in vitro* T-ćelijske testove. Nečistoće iznad limita od 0,5% su neprihvatljive za generičke proizvode bez odgovarajućeg obrazloženja.

EMA primenjuje sveobuhvatniji, procesno orijentisan pristup, dodatno naglašen smernicom iz 2026. godine. Fokus je na kontroli proizvodnog procesa, posebno sinteze na čvrstoj fazi, kao i na detaljnoj karakterizaciji i proceni nečistoća nastalih usled racemizacije, delecija ili umetanja sekvenci, acetilovanja, agregacije, izbora kontra-jona, rezidualnih rastvarača i degradacionih procesa. Pri tome se oslanja na farmakopejske limite od 0,1%, 0,5% i 1,0%. Razumevanje regulatornih razlika između FDA i EMA može doprineti uspešnijem razvoju, registraciji i upravljanju životnim ciklusom lekova zasnovanih na sintetskim peptidima.

FHAL-P12 REGULATORY APPROACH IN THE ASSESSMENT OF SYNTHETIC PEPTIDES: COMPARISON OF FDA AND EMA GUIDELINES

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The FDA and EMA differ significantly in their regulatory approaches to synthetic peptides, particularly in defining their size, assessing immunogenicity, and establishing requirements for generic medicines. The aim of this study was to compare the current FDA and EMA regulatory frameworks for synthetic peptides. The FDA defines peptides as polymers composed of 40 or fewer amino acids, whereas the EMA does not specify a numerical threshold and considers synthetic peptides as structures positioned at the boundary between small molecules (four or fewer amino acids) and large proteins. This distinction influences the development, evaluation, and quality control strategies applied to peptide-based medicines.

Impurity levels represent one of the most critical quality attributes (CQAs), as they may significantly affect drug safety and efficacy, particularly through immunogenicity. The FDA approach is based on demonstrating equivalence of the active substance to the reference biological product. For new impurities or impurities present at levels between 0.10% and 0.50%, detailed characterization and assessment are required, including in silico analyses and in vitro T-cell assays. Impurities exceeding the 0.5% limit are considered unacceptable for generic products without appropriate justification.

In contrast, the EMA applies a more comprehensive, process-oriented approach, further emphasized in its 2026 guideline. Particular attention is given to control of the manufacturing process, especially solid-phase peptide synthesis, and to detailed characterization and assessment of impurities arising from racemization, sequence deletions or insertions, acetylation, aggregation, counter-ion selection, residual solvents, and degradation pathways. Pharmacopoeial limits of 0.1%, 0.5%, and 1.0% are applied. Understanding the regulatory differences between the FDA and EMA may support the successful development, registration, and lifecycle management of synthetic peptide medicines.

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FHAL-P13 PRIMENA MONOGRAFIJA ZA GOTOVE LEKOVE EVROPSKE FARMAKOPEJE: REGULATORNI ZAHTEVI I IZAZOVI U UPRAVLJANJU VARIJACIJAMA

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U okviru Evropske farmakopeje (Ph. Eur.) se sve češće uvode monografije za gotove lekove (*Medicinal Product Monographs*, MPM), čime se standardizuje kontrola kvaliteta gotovog leka. Nedavno objavljene preporuke Evropske agencije za lekove (EMA/CHMP/QWP/505156/2023 - Rev.1, 13. april 2026) pružaju smernice za primenu ovih monografija u regulatornim postupcima.

Cilj ovog rada bio je da se razmotre regulatorni zahtevi za primenu MPM, način dokazivanja usklađenosti sa monografijama Ph. Eur. i najčešće nedoumice u vezi sa prijavom varijacija.

Metodologija je obuhvatila analizu preporuka Evropske agencije za lekove koje se odnose na implementaciju MPM, sa posebnim osvrtom na zahteve za nove i već odobrene lekove, primenu alternativnih validiranih analitičkih metoda i postupanje u slučajevima kada proizvođač primenjuje strožije interne specifikacije od onih propisanih monografijama. Analiza je prikazana kroz pristup zasnovan na dijagramu odluke (engl. *Decision Tree*).

Rezultati ukazuju da je primena MPM obavezna u postupcima izdavanja dozvole za lek kada odgovarajuća monografija postoji u Ph. Eur. Istovremeno, prihvatljiva je primena alternativnih validiranih analitičkih metoda uz dokazanu ekvivalentnost. Kod lekova koji već imaju dozvolu za promet, dodatne regulatorne aktivnosti uglavnom nisu potrebne ukoliko su odobrene specifikacije usklađene sa MPM ili strožije od njih. Najčešće nedoumice odnose se na klasifikaciju i prijavu varijacija u slučajevima primene strožijih internih specifikacija ili alternativnih metoda ispitivanja.

Može se zaključiti da mplementacija MPM doprinosi harmonizaciji standarda u kontroli kvaliteta gotovog leka. Međutim, rezultati ukazuju na potrebu za jasnijim smernicama u oblasti upravljanja varijacijama kako bi se obezbedila dosledna regulatorna praksa i efikasnija komunikacija između nosilaca dozvole i regulatornih tela.

FHAL-P13 IMPLEMENTATION OF EUROPEAN PHARMACOPOEIA MEDICINAL PRODUCT MONOGRAPHS: REGULATORY REQUIREMENTS AND CHALLENGES IN VARIATION MANAGEMENT

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The European Pharmacopoeia (Ph. Eur.) has expanded the number of Medicinal Product Monographs (MPMs), thereby standardizing quality control of finished products. Recently published recommendations from the European Medicines Agency (EMA/CHMP/QWP/505156/2023-Rev.1) provide guidance on the implementation of these monographs within regulatory procedures.

The aim of this study was to review the regulatory requirements for MPMs implementation, approaches to demonstrating compliance with Ph. Eur. monographs, and the most common challenges related to variation submissions.

The analysis was based on a review of EMA recommendations, with particular focus on requirements for new and already authorized medicinal products, the use of validated alternative analytical methods, and situations in which manufacturers apply internal specifications more stringent than those specified in the monographs. The findings were evaluated using a decision-tree approach.

The results indicated that the implementation of MPMs is mandatory during marketing authorization procedures when relevant Ph. Eur. monograph is available. Validated alternative analytical methods are acceptable provided that equivalence is adequately demonstrated. For authorized medicinal products, no additional regulatory action is generally required if the approved shelf-life specifications comply with or are more stringent than those described in the MPM. The most common uncertainties relate to the classification and submission of variations when manufacturers apply stricter internal specifications or alternative analytical methods.

Implementation of MPMs contributes significantly to harmonization of standards in quality control of medicinal products. However, further clarification of regulatory expectations regarding variation management would support consistent regulatory practice and more effective communication between marketing authorization holders and regulatory authorities.

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FHAL-P14 SINTEZA I PROCENA AFINITETA I FIZIČKO-HEMIJSKIH SVOJSTAVA ZAŠTIĆENIH INHIBITORA HISTON DEACETILAZA

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Histon deacetilaze (*HDAC*) su familija enzima koji deacetiluju lizinske ostatke histona, ali i nekih nehistonskih proteina. Histon deacetilaza 6 (*HDAC6*) je izoforma koja se dovodi u vezu sa brojnim protumorskim efektima i predstavlja jedno od ciljnih mesta ciljane terapije tumora. Cilj ovog rada bili su sinteza *HDAC* inhibitora (NR2 i NR3) sa zaštićenom cink-vezujućom grupom (*ZBG*), kao i predviđanje afiniteta zaštićenih i nezaštićenih analoga ka *HDAC6*, uz predviđanje fizičko-hemijskih parametara. Jedinjenja sa supstituisanim piperazinskim heterociklusom kao *CAP* grupom, alkil linkerom i zaštićenom hidroksamskom kiselinom kao *ZBG* su sintetisana, uz potvrdu strukture putem masene spektrometrije i *NMR* spektroskopije. Sintetisana jedinjenja i njihovi nezaštićeni analozi su podvrgnuti molekulskom dokingu koristeći *GOLD software 2022.3.0* na izoformi *HDAC6* (*PDB: 5EDU)*, dok su fizičko-hemijski parametri predviđeni pomoću *ADMET_Predictor_13.0* softvera. Jedinjenja NR2 i NR3 su uspešno sintetisana uz prinose od 33% odnosno 43%. Vizuelizacijom vezivnih poza je utvrđeno da sintetisana jedinjenja ne uspevaju da se usidre u aktivni džep *HDAC6*. Sa druge strane, nezaštićeni analozi sintetisanih jedinjenja uspevaju da se usidre u aktivni džep i koordinišu jon cinka, uz afinitet koji je približan afinitetu kokristalnog liganda trihostatina A. S obzirom da je fenolna grupa jedinjenja NR3 prevedena u metil-etar u jedinjenju NR2, uočene su očekivane varijacije u predviđenim parametrima lipofilnosti, permeabilnosti, rastvorljivosti. Sintetisani su zaštićeni inhibitori histon deacetilaza NR2 i NR3, koji će se koristiti u nastavku sintetskih postupaka, kao i u fizičko-hemijskim ispitivanjima.

FHAL-P14 SYNTHESIS AND ESTIMATION OF AFFINITY AND PHYSICO-CHEMICAL PROPERTIES OF PROTECTED HISTONE DEACETYLASE INHIBITORS

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Histone deacetylases (HDACs) are a family of enzymes that deacetylate lysine residues of histones, as well as some non-histone proteins. Histone deacetylase 6 (HDAC6) is an isoform associated with numerous protumorigenic effects and represents one of the targets of targeted cancer therapy. The aim of this work was the synthesis of HDAC inhibitors (NR2 and NR3) with a protected zinc-binding group (ZBG) and also the prediction of the affinity of protected and unprotected analogues towards HDAC6 as well as their physicochemical parameters. Compounds with a substituted piperazine ring as the CAP group, an alkyl linker and a protected hydroxamic acid as the ZBG were synthesized, with their structures confirmed by mass spectrometry and NMR spectroscopy. The synthesized compounds and their unprotected analogues, were subjected to molecular docking using GOLD software 2022.3.0 on the HDAC6 (PDB: 5EDU), while physico-chemical parameters were predicted using ADMET_Predictor_13.0 software. Compounds NR2 and NR3 were successfully synthesized with yields of 33% and 43%, respectively. Visualization of the binding poses revealed that the synthesized compounds were unable to dock inside the active site of HDAC6. The unprotected analogues of the synthesized compounds were able to dock within the active site and coordinate the zinc ion, with affinities comparable to that of the co-crystallized ligand, Trichostatin A. Since a phenol of NR3 is methylated in NR2, expected variations in predicted lypophilicity, permeability and solubility were observed. Protected histone deacetylase inhibitors NR2 and NR3 were synthesized, and will be used in further synthesis as well as in physico-chemical studies.

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FHAL-P15 KOMPLEKSI IVERMEKTINA SA β-CIKLODEKSTRINOM I HIDROKSIPROPIL- β-CIKLODEKSTRINOM

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Ivermektin je antiparazitski lek širokog spektra dejstva sa ograničenom rastvorljivošću u vodenim rastvorima, što utiče na njegovu bioraspoloživost u humanoj i veterinarskoj medicini. Formiranje kompleksa sa ciklodekstrinima predstavlja jedan od pristupa za poboljšalje njegove rastvorljivosti.

Cilj ovog rada je bio priprema i fizičko-hemijska karakterizacija kompleksa ivermektina sa β-ciklodekstrinom (β-CD) i njegovim derivatom, hidroksipropil-β-ciklodekstrinom (HP-β-CD) u cilju poboljšanja njegove rastvorljivosti i bioraspoloživosti.

Kompleksi su pripremljeni u molskom odnosu 1:1 i identifikovani primenom UV-Vis spektrofotometrije, tankoslojne hromatografije (TLC), masene spektrometrije (MS-MS), diferencijalne skenirajuće kalorimetrije (DSC), spektroskopijom nuklearne magnetne rezonance (NMR) i infracrvenom spektrofotometrijom (IC), dok je rastvorljivost ispitivana u fosfatnim puferima pH 4,5, 6,8 i 7,2 i 0,1 M HCl.

Rezultati dobijeni UV-Vis, MS-MS, DSC metodom ukazali su na formiranje kompleksa ivermektina sa β-CD i HP-β-CD. UV-Vis metodom potvrđena je i njihova bolja rastvorljivost u odnosu na čist ivermektin. Stabilnost kompleksa tokom 48h potvrđena je TLC metodom. Na NMR spektrima uočena su pomeranja pojedinih signala kompleksa ivermektina sa β-CD i HP- β-CD u odnosu na signale čistog ivermektina, što ukazuje da je došlo do formiranja kompleksa. Takođe, na IC spektrima uočava se pomeranje karakterističnih signala kompleksa ivermektina u odnosu na čist ivermektin, ali pored pomeranja uočava se i smanjenje intenziteta signala, što ukazuje na interakcije ostvarene između alkoholnih grupa ciklodekstrina i alkoholnih i karbonilnih grupa ivermektina.

Kompleksi su pokazali bolju rastvorljivost i stabilnost u širem opsegu pH vrednosti, što daje osnovu za razvoj farmaceutskih oblika sa poboljšanom biološkom raspoloživosti.

FHAL-P15 IVERMECTIN COMPLEXES WITH β-CYCLODEXTRIN AND HYDROXYPROPYL-β-CYCLODEXTRIN

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Ivermectin is a broad-spectrum antiparasitic drug with limited aqueous solubility, which may affect its bioavailability in human and veterinary medicine. Complexation with cyclodextrins represents one approach to improving its solubility.

The aim of this study was to prepare and physicochemically characterize ivermectin complexes with β-cyclodextrin (β-CD) and its derivative, hydroxypropyl-β-cyclodextrin (HP-β-CD), with the aim of improving its solubility and bioavailability.

The complexes were prepared at a 1:1 molar ratio and characterized using UV-Vis spectrophotometry, thin-layer chromatography (TLC), tandem mass spectrometry (MS/MS), differential scanning calorimetry (DSC), nuclear magnetic resonance (NMR) spectroscopy, and infrared (IR) spectroscopy. Solubility was evaluated in phosphate buffers at pH 4.5, 6.8, and 7.2, as well as in 0.1 M HCl.

The results obtained by UV-Vis, MS/MS, and DSC indicated the formation of ivermectin complexes with both β-CD and HP-β-CD. UV-Vis analysis also confirmed improved solubility compared with pure ivermectin. TLC analysis confirmed the stability of the complexes over 48 h. NMR spectra showed shifts of individual signals of the complexes compared with pure ivermectin, indicating complex formation. IR spectra also revealed shifts and decreased intensities of characteristic signals, suggesting interactions between the hydroxyl groups of cyclodextrins and the hydroxyl and carbonyl groups of ivermectin.

The complexes demonstrated stability over a broader pH range and improved solubility, providing a basis for the development of novel dosage forms with enhanced bioavailability.

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FHAL-P16 ANALIZA RETENCIONOG PONAŠANJA NOVOSINTETISANIH INHIBITORA HISTON DEACETILAZA I *RHO*-VEZANIH PROTEIN KINAZA PRIMENOM HROMATOGRAFIJE NA TANKOM SLOJU

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Retencioni parametri dobijeni metodom hromatografije na tankom sloju mogu imati višestruki značaj.

Cilj ovog istraživanja je bio da se analizira retenciono ponašanje 18 novosintetisanih inhibitora histon deacetilaza (*HDAC*) i *Rho*-vezanih protein kinaza (*ROCK*) primenom reverzno-fazne hromatografije na tankom sloju (*RP-TLC*), a zatim ispita značaj dobijenih hromatografskih parametara u određivanju lipofilnosti i utvrđivanju veze između strukture i retencionog ponašanja (*QSRR*) odabranih jedinjenja.

Oktil-silikagel (R*P-8*) je korišćen kao stacionarna faza, dok su različiti udeli acetona i vode (pH2,5) primenjeni kao mobilna faza (φ acetona 60–90 vol%). Za izračunavanje molekulskih deskriptora korišćeni su *ChemDraw Ultra 7.0, Chem3D Ultra 7.0, Marvin Sketch, SwissADME* i *Dragon* softveri. Q*SRR* modeli su formirani u *SIMCA P+12.0* programu primenom metode parcijalnih najmanjih kvadrata (*PLS*).

Uočen je umeren stepen korelacije između eksperimentalno dobijenih retencionih parametara (R_M^0 i m) i $logD_{2,5}$ vrednosti izračunatih u *MarvinSketch* programu primenom *Viswanadhan–Ghose* metode (R=0,785 između R_M^0 i $logD_{2.5}$; R= 0,786 између m i $logD_{2,5}$). Statistički najpouzdanijim QSRR modelom (Q^2=0,797>0,5; R^2p_{red}=0,682>0,5; R^2=0,810; RMSEE=0,621; RMSEP=0,383; $r_m'^2$=0,598; $r_{maverage}^2$ =0,522; Δ r_m^2=0,151) izdvojeni su lipofilnost jedinjenja, račvanje i masa molekula, i jonizacioni potencijal kao najznačajnije osobine ispitivanih jedinjenja koje imaju uticaj na retenciono ponašanje i zavisnu promenljivu R_M^0.

Odabrani hromatografski sistem i dobijeni retencioni parametri mogu se koristiti za brzu procenu lipofilnosti i *QSRR* analizu strukturno srodnih analoga. Formirani *QSRR* model može se primeniti za pouzdano predviđanje retencionog ponašanja i optimizaciju lipofilnosti novih *HDAC i ROCK* inhibitora kao inovativnih agenasa u terapiji različitih malignih oboljenja.

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FHAL-P16 ANALYSIS OF RETENTION BEHAVIOR OF NEWLY SYNTHESIZED HISTONE DEACETYLASES AND RHO ASSOCIATED PROTEIN KINASES INHIBITORS USING THIN LAYER CHROMATOGRAPHY

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Retention parameters obtained by thin-layer chromatography have multiple applications.

The aim of this study was to analyze the retention behavior of 18 newly synthesized inhibitors of histone deacetylases (HDAC) and *Rho*-associated protein kinases (ROCK) using reversed-phase thin-layer chromatography (RP-TLC), and to evaluate the significance of the chromatographic parameters obtained in determining lipophilicity and establishing a quantitative structure–retention relationship (QSRR) model.

Octyl-silica gel (RP-8) was used as the stationary phase, while different ratios of acetone and water (pH 2.5) were applied as the mobile phase (acetone fraction 60–90 vol%). Molecular descriptors were calculated using ChemDraw Ultra 7.0, Chem3D Ultra 7.0, MarvinSketch, SwissADME and Dragon software. QSRR models were constructed in SIMCA P+12.0 employing the partial least squares (PLS) method.

A moderate correlation was observed between experimentally obtained retention parameters (R_M^0 and m) and logD2.5 values calculated in MarvinSketch using the Viswanadhan–Ghose method (R=0.785 between R_M^0 and logD2.5; R=0.786 between m and logD2.5). The statistically most reliable QSRR model (Q^2=0.797>0.5; R^2_{pred}=0.682>0.5; R^2=0.810; RMSEE=0.621; RMSEP=0.383; $r_m'^2$=0.598; $r_{maverage}$2=0.522; Δr_m2=0.151) identified lipophilicity, branching and molecular mass, as well as ionization potential, as the most significant features influencing retention behavior in the examined chromatographic system.

The selected chromatographic system and the retention parameters obtained can be applied for rapid lipophilicity assessment and QSRR analysis of structurally related analogs. The developed QSRR model may be used for reliable prediction of retention behavior and optimization of lipophilicity of new HDAC and ROCK inhibitors as innovative agents in the therapy of various malignant diseases.

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FHAL-P17 RADIOOBELEŽAVANJE HALKONA JODOM-131 I ISPITIVANJE *IN VITRO* STABILNOSTI

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Halkoni predstavljaju jedinjenja iz grupe flavonoida koja ispoljavaju širok spektar bioloških aktivnosti. Uvođenjem radioizotopa joda-131 (^{131}I) u njihovu strukturu reakcijom elektrofilne aromatične supstitucije, mogu se dobiti radioobeležena jedinjenja sa potencijalom za razvoj radiofarmaceutika.

Cilj ovog istraživanja bio je sinteza serija derivata halkona, njihovo radioobeležavanje ^{131}I i procena prinosa radioobeležavanja, kao i *in vitro* stabilnost dobijenih radioobeleženih jedinjenja u različitim fiziološkim uslovima.

Serija od šest derivata halkona sintetisana je *Claisen–Schmidtovom* kondenzacijom. Reakcijom elektrofilne aromatične supstitucije izvršeno je radioobeležavanje jedinjenja upotrebom natrijum-jodida ([^{131}I]NaI), uz upotrebu hloramin-T kao oksidacionog agensa. *In vitro* stabilnost [^{131}I]halkona ispitivana je na sobnoj temperaturi, u 4% rastvoru humanog serumskog albumina (HSA) i u fiziološkom rastvoru (FR). Prinos radioobeležavanja, kao i *in vitro* stabilnost dobijenih radioobeleženih jedinjenja, procenjivane su u različitim vremenskim intervalima primenom metode tankoslojne hromatografije (TLC) na silika gel (SG) trakama uz hloroform-metanol (9:1, v/v) kao mobilnom fazom, uz detekciju radioaktivnosti pomoću radio-TLC skenera.

Svih šest sintetisanih halkona uspešno je obeleženo [^{131}I]NaI, sa prinosom radioobeležavanja od 87% do 97%. Radioobeleženi halkoni su *in vitro* stabilni do 48 časova u reakcionom rastvoru, FR i rastvoru HSA.

Visok prinos radioobeležavanja, kao i *in vitro* stabilnost sintetisanih derivata halkona u fiziološkim uslovima u toku dužeg vremenskog perioda, ukazuju na njihov potencijal kao kandidata za primenu u nuklearnoj medicini.

FHAL-P17 RADIOLABELING OF CHALCONES WITH IODINE-131 AND IN VITRO STABILITY EVALUATION

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Chalcones are compounds belonging to the flavonoid group that exhibit a broad spectrum of biological activities. By introducing the radioisotope iodine-131 (^{131}I) into their structure through an electrophilic aromatic substitution reaction, radiolabeled compounds with potential for radiopharmaceutical development can be obtained.

The aim of this study was to synthesize a series of chalcone derivatives, radiolabel them with ^{131}I, and evaluate the radiolabeling yield as well as the in vitro stability of the resulting radiolabeled compounds under different physiological conditions

Six chalcone derivatives were synthesized by Claisen–Schmidt condensation and radiolabeled with sodium iodide ([^{131}I]NaI) via electrophilic aromatic substitution using chloramine-T as the oxidizing agent. *In vitro* stability of [^{131}I]chalcones was evaluated at room temperature, in 4% human serum albumin (HSA), and in physiological saline (PS). Radiolabeling yield and *in vitro* stability were assessed at different time points by thin-layer chromatography (TLC) on silica gel (SG) strips using chloroform–methanol (9:1, v/v) as the mobile phase and a radio-TLC scanner for radioactivity detection.

All six synthesized chalcones were successfully radiolabeled with [^{131}I]NaI, achieving radiolabeling yields ranging from 87% to 97%. The radiolabeled chalcones remained in vitro stable for up to 48 h in the reaction mixture, PS, and HSA solution. The high radiolabeling yields and the in vitro stability of the synthesized chalcone derivatives under physiological conditions over an extended period indicate their potential as candidates for applications in nuclear medicine.

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FHAL-P18 RAZVOJ I VALIDACIJA NOVE BRZE HPLC METODE ZA ODREĐIVANJE SADRŽAJA IVERMEKTINA U 3D ŠTAMPANIM TABLETAMA

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Ivermektin je antiparazitik širokog spektra sa primenom u humanoj i veterinarskoj medicini. Novija istraživanja ukazuju na mogućnost primene u terapiji virusnih infekcija i malignih oboljenja. Farmakopejske HPLC metode za određivanje sadržaja ivermektina u tabletama su zasnovane na primeni C18 kolona dužine 25 cm, sa vremenom analize do 60 min i ograničenom selektivnošću. Cilj rada je bio razvoj brze HPLC metode za određivanje sadržaja ivermektina.

Analiza je izvedena na reverzno-faznoj koloni Phenomenex Luna Hexyl-Phenyl (150 ´ 4,6 mm; 5 mm), primenom mobilne faze 0,1% orto-fosforne kiseline i acetonitrila (40:60; V/V), sa protokom 1,0 mL/min i UV detekcijom na 240 nm. Metoda je validirana u skladu sa ICH smernicama. Sadržaj ivermektina je određen u 3D štampanim tabletama (3 mg/tableti) metodom kalibracione krive i metodom standarda.

Metoda je pokazala zadovoljavajuću selektivnost ($Rt_{ivermektin}$ = 4,038 min; bez interferirajućih pikova na placebo hromatogramu). Linearnost je potvrđena u opsegu 0,0015 – 0,0045 mg/mL (r = 0,9996). RSD vrednosti ponovljivosti su bile manje od 2%, a ispunjeni su i zahtevi za srednju preciznost. *Recovery* vrednosti (tačnost) su bile 99,17 – 101,67% (zahtev 98 – 102%). Robusnost je potvrđena promenama udela acetonitrila i temperature kolone. Sadržaj ivermektina je određen metodom standarda (101,15%, RSD = 1,78%) i metodom kalibracione krive (99,53%, RSD = 1,70%) bez statistički značajne razlike (t-test, p > 0,05), u skladu sa farmakopejskim zahtevima (95 – 105%).

Razvijena i validirana *HPLC* metoda sa vremenom analize od 5 min je brža od važećih farmakopejskih metoda, ekonomičnija i pogodna za rutinsku kontrolu kvaliteta ivermektina u tabletama.

FHAL-P18 DEVELOPMENT AND VALIDATION OF A NOVEL RAPID HPLC ASSAY FOR IVERMECTIN IN 3D PRINTED TABLETS

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Ivermectin is a broad-spectrum antiparasitic agent used in human and veterinary medicine. Recent research indicates its potential application in the treatment of viral infections and malignant diseases. Pharmacopoeial HPLC methods for ivermectin assay in tablets are based on C18 columns of 25 cm length, with analysis times up to 60 min and limited selectivity. The aim was to develop a rapid HPLC method for ivermectin analysis in 3D-printed tablets.

The analysis was performed using a reversed-phase Phenomenex Luna Hexyl-Phenyl column (150 ´ 4.6 mm; 5 mm), mobile phase consisted of 0.1% ortho-phosphoric acid and acetonitrile (40:60; V/V), flow rate 1.0 mL/min and UV detection at 240nm. The method was validated per ICH guidelines. Ivermectin content was determined in 3D-printed tablets (3 mg/tablet) using the calibration curve and standard methods.

The method demonstrated satisfactory selectivity ($Rt_{ivermectin}$ = 4.038 min; no interfering peaks in the placebo chromatogram). Linearity was confirmed over 0.0015 – 0.0045 mg/ml (r = 0.9996). Repeatability (RSD) was below 2% and intermediate precision requirements were met. Recovery values (accuracy) were 99.17 – 101.67% (requirement: 98 – 102%). Robustness was confirmed under variations in acetonitrile content and column temperature. Ivermectin content was determined by the standard method (101.15%, RSD = 1.78%) and calibration curve method (99.53%, RSD = 1.70%), with no statistically significant difference (t-test, p > 0.05), complying with pharmacopoeial requirements (95 – 105%).

The developed and validated HPLC method with analysis time of 5 min is faster than current pharmacopoeial methods, cost-effective, and suitable for routine quality control of ivermectin in tablets.

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FHAL-P19 PROCJENA STABILNOSTI TIMOKINONA U SISTEMIMA ĆELIJSKIH KULTURA: UTJECAJ TEMPERATURE, IZLOŽENOSTI SVJETLOSTI I MEDIJUMA ZA ĆELIJSKU KULTURU

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Timokinon (TQ) posjeduje značajan *in vitro* terapeutski potencijal, ali njegova hemijska nestabilnost ograničava reproduktivnost eksperimentalnih rezultata. Ova studija istražuje kinetiku termičke i fotolitičke degradacije TQ-a u biološkim matricama radi uspostavljanja pouzdanih protokola rukovanja i skladištenja.

Rastvori TQ-a (10, 50 i 100 μM) analizirani su validiranom HPLC-UV metodom na sistemu Agilent 1260 Infinity (Agilent Technologies, SAD) i koloni Zorbax C18 (4,6x150 mm, 5 μm). Fotostabilnost je ispitivana u komori Suntest CPS+ (Atlas, SAD) prema ICH Q1B smjernicama (1.2×10^6 lux·h na 35°C tokom 9 h). Termička stabilnost praćena je 168 h na 5°C, sobnoj temperaturi, 25°C/60% RH i 40°C/75% RH u serum-slobodnim i kompletnim medijumima (10% fetalnog goveđeg seruma, Elabscience, Kina) RPMI 1640 i DMEM.

Fotolitički stres uzrokovao je brzu degradaciju, uz svega 0,01% preostalog TQ-a nakon 9 h. Termička degradacija pratila je koncentracijski zavisnu kinetiku pseudo-prvog reda. Na ambijentalnim uslovima potpuna degradacija nastupa za 24–96 h. Skladištenje na 5°C usporava proces, ali postotak ostatka nakon 7 dana pada ispod 42%. Sastav matrice značajno utječe na stabilnost; DMEM i prisustvo seruma pružaju djelimičnu zaštitu, dok RPMI daje manje konzistentne profile.

TQ pokazuje visoku nestabilnost u medijumima za kulturu ćelija. Svjetlost, propisana ICH smjernicama, izaziva brzu, gotovo potpunu degradaciju, zahtijevajući trenutnu zaštitu od svjetlosti od same pripreme uzoraka. Iako čuvanje na 5°C poboljšava kratkoročnu stabilnost, dugoročno dolazi do velikog gubitka analita. Stabilnost zavisi od matrice, uz veću postojanost u DMEM-u i medijumima sa serumom. Zaštita od svjetlosti i minimalno vrijeme skladištenja obavezni su za *in vitro* reproduktivnost.

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FHAL-P19 STABILITY ASSESSMENT OF THYMOQUINONE IN CELL CULTURE SYSTEMS: EFFECTS OF TEMPERATURE, LIGHT EXPOSURE, AND CELL GROWTH MEDIA

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Thymoquinone (TQ) has significant *in vitro* therapeutic potential, but its chemical instability limits experimental reproducibility. This study investigates TQ thermal and photolytic degradation kinetics in various biological matrices to establish robust handling protocols.

TQ solutions (10, 50, and 100 μM) were analyzed using a validated HPLC-UV method employing an Agilent 1260 Infinity HPLC system (Agilent Technologies, USA) with a Zorbax C18 column (4.6x150mm, 5 um). Photostability was assessed in a Suntest CPS+ chamber (Atlas, USA) per ICH Q1B guidelines (1.2×10^6 lux·h at 35°C for 9 h). Thermal stability was tracked for 168 h at 5°C, ambient, 25°C /60% RH, and 40°C /75% RH in serum-free and complete (10% fetal bovine serum, Elabscience, China) RPMI 1640 and DMEM.

Photolytic stress caused extensive degradation, with 0.01% TQ remaining after 9h. Thermal degradation showed concentration-dependent, pseudo-first-order kinetics. Ambient exposure led to complete degradation within 24-96 h. Refrigerated storage (5°C) reduced degradation but recovery fell below 42% after 7 days. Matrix composition significantly influenced stability; DMEM and serum presence provided a partial protective effect, while RPMI formulations yielded less consistent recovery profiles.

TQ exhibits high thermal and photolytic instability in cell media. ICH-compliant light triggers near-complete degradation, demanding immediate light protection during sample preparation. Although storage at 5°C improves short-term stability, substantial loss occurs over time. TQ stability is highly matrix-dependent, showing enhanced persistence in DMEM and serum-supplemented media. Strict light protection and minimized storage times are mandatory for reliable *in vitro* screening.

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FHAL-P20 PROFILISANJE NEČISTOĆA KROZ STUDIJE FORSIRANE DEGRADACIJE AMLODIPIN BESILATA, INDAPAMIDA I PERINDOPRIL ERBUMINA U FORMULACIJI LEKA

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Farmaceutske nečistoće, posebno one koje potiču od razgradnje lekova, predstavljaju rizik za kvalitet leka i potencijalni toksikološki riziki, čak i u tragovima. Metode za ispitivanje nečistoća su uglavnom zasnovane na primeni (U)HPLC i HRMS za razdvajanje i identifikaciju nečistoća. Ovaj rad opisuje istraživanje osnovne stabilnosti lekova amlodipin besilata, indapamida i perindopril erbumina kroz studije forsirane degradacije, naglašavajući njegovu vitalnu ulogu u bezbednosti pacijenata i kvalitetu proizvoda. Studije forsirane degradacije su sprovedene pod strožijim uslovima u poređenju sa formalnim studijama stabilnosti i koriste se za karakterizaciju svih mogućih degradanata lekova i definisanje puteva razgradnje lekova. Pojedinačni aktivni farmaceutski sastojci odvojeno, a takođe i u smeši prema njihovim masenim odnosima u specifičnoj formulaciji tableta leka, korišćeni su kako bi se procenila moguća pojava interakcija lekova tokom razgradnje. Svi rastvori lekova su pripremljeni korišćenjem smeše acetonitrila i vode (50:50, v/v) i primenjeni su sledeći uslovi stresa: 1 M HCl za kiselu hidrolizu, 0,01 M NaOH za baznu hidrolizu, 3% H_2O_2 za oksidativni stres i rastvarač u kombinaciji sa visokom temperaturom (65 °C) za pH-neutralnu hidrolizu i studiju termodegradacije. Za identifikaciju strukture degradanata iz svakog uzorka stresa nakon vremena izlaganja od 3 sata, korišćen je Waters Xevo TQD maseni spektrometar. Rezultati su pokazali da se najznačajnija degradacija dešava pod uticajem kiselina i baza što je rezultiralo stvaranjem većeg broja degradanata kod sva tri analita, dok specifične interakcije koje potiču od ispitivane formulacije lekova nisu primećene.

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FHAL-P20 IMPURITY PROFILING THROUGH FORCED DEGRADATION STUDIES OF AMLODIPINE BESYLATE, INDAPAMIDE AND PERINDOPRIL ERBUMINE IN A DRUG FORMULATION

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Pharmaceutical impurities, originating especially from drug degradation pose quality-related issues and potential toxicological risks, even at trace levels. ICH guidelines mandate stringent regulatory identification and control thresholds for such impurities. Existing profiling uses HPLC, UHPLC, and HRMS for separating and identifying unidentified impurities. This work outlines the degradation profiles of amlodipine besylate, indapamide and perindopril erbumine through forced degradation studies using MS. These studies were performed under more severe conditions than the formal stability studies with the aim of obtaining all possible degradants for characterization and definition of drug degradation pathways. Individual active pharmaceutical ingredients separately and also in a mixture according to their mass ratios in a specific drug tablet formulation were used in order to evaluate the possible occurrence of drug interactions during degradation process. All drug solutions were prepared using acetonitrile and water mixture (50:50, v/v) and the following stress conditions were applied: 1 M HCl for acid hydrolysis, 0.01 M NaOH for base hydrolysis, 3% H_2O_2 for oxidative stress and, solvent in combination with high temperature (65°C) for pH-neutral hydrolysis and thermodegradation study. A Waters Xevo TQD mass spectrometer was used for structure identification of drug degradants resulting from each stress sample after the exposure time of 3 hours. The results showed that acid and base were the most influential stress conditions leading to the formation of more degradants among all three analytes while no specific formulation-related interactions were noticed.

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FFT-P1 KAKO DIJABETES TIPA 2 UTIČE NA TRANSKRIPTOM PREFRONTALNOG KORTEKSA: SAZNANJA IZ MODELA DIJABETESA TIPA 2 KOD STARIJIH ŽENKI PACOVA

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Žene srednjih godina nalaze se na prekretnici kada je reč o zdravlju mozga i riziku od neurodegenerativnih oboljenja, a ovu ranjivost dodatno mogu pogoršati česta metabolička stanja kao što je dijabetes tipa 2 (T2D). Alchajmerova bolest je češća u ovoj populaciji nego kod muškaraca, a pojedini podaci ukazuju i na veću učestalost kognitivnog propadanja kod žena nego kod muškaraca sa T2D. Uprkos tome, postoje ograničeni dokazi o molekularnim mehanizmima u mozgu kod žena, i u kliničkim i u prekliničkim istraživanjima, uključujući transkriptomsko profilisanje prefrontalnog korteksa (pfc), regije mozga uključene u kognitivne funkcije. Zbog toga smo modelovali T2D kod ženki pacova i sproveli analizu transkriptomike u pfc.

Starije ženke Sprague-Dawley pacova hranjene visokomasnom dijetom i tretirane niskom dozom streptozotocina predstavljale su T2D grupu, dok je kontrolna grupa (CTRL) dobijala standardnu dijetu i odgovarajući rastvarač. Sekvenciranje ukupne RNK je sprovedeno na tkivu pfc iz eksperimentalnih grupa, uz naknadnu kontrolu kvaliteta, normalizaciju i analizu diferencijalno eksprimiranih gena (DEG), kao i analizu molekularnih puteva u KEGG bazi podataka u internet alatu GeneCodis 4.

U pfc, prvih deset molekularnih puteva na osnovu DEGs u T2D grupi u poređenju sa CTRL odnosilo se na bazalne transkripcione faktore, sekreciju pankreasa, aldosteronom regulisanu reapsorpciju natrijuma, apsorpciju minerala, sekreciju insulina, degradaciju lizina, sintezu tiroidnih hormona, varenje i apsorpciju ugljenih hidrata, metabolizam glicerofosfolipida i reapsorpciju bikarbonata u proksimalnim tubulima.

Ovi podaci upućuju da žene ne bi trebalo zanemarivati u ovakvim istraživanjima, jer naši rezultati sugerišu T2D-indukovane promene na nivou hormona, elektrolita i metabolizma na nivou pfc.

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FFT-P1 HOW DOES DIABETES TYPE 2 AFFECT PREFRONTAL CORTEX TRANSCRIPTOME: INSIGHTS FROM DIABETES TYPE 2 MODEL IN AGING FEMALE RATS

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Middle-aged women are at a crossroads in terms of their brain health and risk of neurodegenerative disorders, and this vulnerability may be further exacerbated by common metabolic conditions such as diabetes type 2 (T2D). Alzheimer's disease is more prevalent in this population compared with men, and some data also suggest higher prevalence of cognitive decline in females versus males with T2D. Nevertheless, there is limited evidence on the underlying brain molecular mechanisms in females in both clinical and preclinical research, including transcriptomic profiling of the prefrontal cortex (pfc), as brain region involved in cognitive functions. Therefore, we modeled T2D in female rats and performed transcriptomic analysis of the pfc.

Middle-aged female Sprague-Dawley rats fed by high-fat diet and treated with low-dose streptozotocin were selected as T2D group, while control group (CTRL) received control diet and was treated by solvent. Bulk RNA sequencing was performed on pfc tissue from the respective experimental groups, followed by quality control, normalization, and differential expression analysis. Pathway enrichment analysis based on KEGG database was then conducted in GeneCodis 4 web tool.

In pfc, the top 10 significantly enriched pathways in T2D females vs CTRL females were to basal transcription factors, pancreatic secretion, aldosterone-regulated sodium reabsorption, mineral absorption, insulin secretion, lysine degradation, thyroid hormone synthesis, carbohydrate digestion and absorption, glycerophospholipid metabolism, and proximal tubule bicarbonate reclamation.

These findings suggest that females should not be neglected in research, as our insights implicate hormone-related, electrolyte, and metabolic mechanisms in T2D-associated pfc changes.

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FFT-P2 ^{161}Tb-OBELEŽENI BISFOSFONATI KAO POTENCIJALNI AGENSI ZA CILJANU RADIONUKLINDU TERAPIJU

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Terapija bisfosfonatima obeleženim β⁻-emitujućim radionuklidima se pokazala kao efikasna u palijativnom zbrinjavanju i kontroli koštanih metastaza. Cilj ove studije je bila priprema ^{161}Tb obeleženih bisfosfonata sa visokim prinosom, stabilnih u toku određenog vremena, i odgovarajuće biodistribucije.

Etidronat i zoledronat su obeleženi ^{161}Tb na sobnoj temperaturi (pH 7), dok je DOTA konjugovani bisfosfonat BPAMD obeležen ^{161}Tb na 95 °C, 30 minuta. Studije stabilnosti su sprovedene u fiziološkim uslovima. Test vezivanja za hidroksiapatit je *in vitro* metoda procene afiniteta ispitivanih kompleksa prema mineralnoj komponenti kosti. Studije biodistribucije sprovedene su na zdravim Wistar pacovima nakon intravenske primene, a radioaktivnost po organima izmerena je gama brojačem i izražena kao procenat radioaktivnosti po organu (%ID).

Radiohemijska čistoća određena ITLC metodom je bila preko 98% za sve komplekse. Bisfosfonati su pokazali odličnu stabilnost u fiziološkom rastvoru (>95%) i humanom serumu (>94%) tokom 48 časova. Test vezivanja za hidroksiapatit pokazao je izražen afinitet prema kostima (>98%). Biodistribucijom je utvrđeno brzo i izraženo nakupljanje u kostima, pri čemu je više od 60% injektovane aktivnosti izmereno u kostima dva sata nakon aplikacije. Nakupljanje u mekim tkivima je bilo minimalno sa brzom eliminacijom, što ukazuje na povoljan farmakokinetički profil i dugotrajnu retenciju u kostima.

Svi bisfosfonati pokazali su značajnu *in vitro* stabilnost, visok afinitet i zadržavanje u kostima, kao i minimalnu akumulaciju u ostalim organima. Dalja ispitivanja ^{161}Tb-obeleženih bisfosfonata na tumorskim modelima i poređenje sa ^{177}Lu obeleženim bisfosfonatima su neophodna kako bi se utvrdio njihov potencijal za ciljanu radionuklidnu terapiju.

Zahvalnica

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FFT-P2 ^{161}Tb-LABELED BISPHOSPHONATES AS POTENTIAL AGENTS FOR BONE-TARGETED RADIOTHERAPY

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Radiopharmaceutical therapy using bone-targeting agents labeled with β⁻-emitting radionuclides has proven effective for pain palliation and disease management. This study aimed to develop ^{161}Tb-labeled bisphosphonates with high radiolabeling yield, in vitro stability, and appropriate biodistribution.

Etidronate and zoledronate were radiolabeled with ^{161}Tb at room temperature (pH 7), whereas the DOTA- conjugated bisphosphonate BPAMD was labeled with ^{161}Tb under mild heating conditions (95 °C, 30 min). Stability studies were performed under physiological conditions. In vitro hydroxyapatite binding assays were conducted to evaluate mineral affinity. Biodistribution studies were conducted in healthy Wistar rats following intravenous administration, and radioactivity in excised organs was measured by gamma counting and expressed as percentage of the injected dose (%ID).

All radiocomplexes were obtained with radiochemical yields exceeding 98%, as confirmed by ITLC method. The compounds exhibited excellent stability in saline (>95%) and human serum (>94%) over 48 h. Hydroxyapatite binding studies demonstrated strong mineral affinity with high binding (>98%). Biodistribution studies revealed rapid and pronounced skeletal uptake, with more than 60% of the injected activity localized in bone within 2 hours post-injection. Uptake in soft-tissues and non-target organs was low and declined rapidly, indicating favorable pharmacokinetics and prolonged bone retention.

All bisphosphonates showed excellent in vitro stability and strong bone affinity with high skeletal uptake and low non-target accumulation. These results support further evaluation of ^{161}Tb-labeled diphosphonates in tumor-bearing models and comparative studies with established ^{177}Lu analogs, positioning them as strong candidates for bone-targeted radionuclide therapy.

Acknowledgement

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FFT-P3 ANALIZA UČESTALOSTI FARMAKOGENETIČKI RELEVANTNE VARIJANTE CYP4F2*3 (C.1297G>A, rs2108622) U POPULACIJI SRBIJE

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Derivati kumarina (kumarini) široko se koriste u lečenju i prevenciji tromboza, ali zbog izraženih interindividualnih razlika u terapijskom odgovoru, njihova primena kod pojedinih pacijenata predstavlja veliki izazov. Najveći doprinos toj varijabilnosti potiče od varijacija u genima značajnim za farmakodinamiku (VKORC1 i *CYP4F2*) i farmakokinetiku (*CYP2C9*) kumarina. Doprinos ovih faktora može značajno varirati između različitih etničkih grupa, što opravdava sprovođenje populaciono-specifičnih studija. U populaciji Srbije još uvek nema podataka o značaju varijante *CYP4F2* c.1297G>A, mada je iz literature poznato da je prisustvo alela c.1297A povezano sa potrebama za visokim dozama kumarina tokom lečenja. Cilj ovog rada je bio da se dobiju preliminarni podaci o zastupljenosti varijante *CYP4F2* c.1297G>A u opštoj populaciji Srbije i proceni njen potencijalni značaj za sprovođenje farmakogenetičkih studija u Srbiji. Analize su sprovedene na genomskoj DNK izolovanoj iz limfocita periferne krvi 50 ispitanika (29 žena i 21 muškarac), prosečne starosti 55 ± 4,5 godina. Genotipizacija je izvršena primenom *TaqMan* testa. Identifikovano je 20 nosilaca alela c.1297A (14 heterozigota i 6 homozigota), što odgovara učestalosti nosilaca od 40%. Učestalost alela c.1297A iznosila je 26%, što je u skladu sa prosečnom frekvencom u evropskim populacijama (27%). Utvrđena učestalost ovog alela je niža nego u Severnoj Americi i centralnoj i južnoj Aziji (40%), viša nego u istočnoj Aziji (23%), kao i značajno viša nego u podsaharskoj Africi (9%) i kod afrokaripskog stanovništva (7%). Dobijeni rezultati odnosno učestalost alela c.1297A ukaziju na potencijalni značaj ove varijante za farmakogenetičke studije, kao i na značaj u razvoju personalizovane terapije kumarinima.

FFT-P3 FREQUENCY ANALYSIS OF THE PHARMACOGENETICALLY RELEVANT VARIANT CYP4F2*3 (C.1297G>A, rs2108622) IN THE SERBIAN POPULATION

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Coumarin derivatives (coumarins) are widely used for the treatment and prevention of thrombotic disorders; however, their clinical use remains challenging due to substantial interindividual variability in therapeutic response. This variability is largely attributable to genetic variation in genes involved in the pharmacodynamics (*VKORC1* and *CYP4F2*) and pharmacokinetics (*CYP2C9*) of coumarins. The contribution of these factors differs among ethnic groups which justifies conducting population-specific studies. In Serbia, no data are currently available regarding the relevance of the *CYP4F2* c.1297G>A variant. However, based on the literature, the c.1297A allele has been associated with increased coumarin dose requirements. The aim of this study was to obtain preliminary data on the frequency of the *CYP4F2* c.1297G>A variant in the general Serbian population and to evaluate its potential relevance for pharmacogenetic research. Genomic DNA was isolated from peripheral blood lymphocytes of 50 unrelated individuals (29 females and 21 males; mean age 55 ± 4.5 years). Genotyping was performed using a TaqMan allelic discrimination assay. Twenty carriers of the c.1297A allele were identified (14 heterozygotes and 6 homozygotes), corresponding to a carrier frequency of 40%. The allele frequency was 26%, consistent with the average reported in European populations (27%). This frequency was lower than that observed in North America and Central and South Asia (40%), higher than in East Asia (23%), and markedly higher than in sub-Saharan Africa (9%) and Afro-Caribbean populations (7%). These findings support the inclusion of the c.1297G>A variant in pharmacogenetic studies and suggest its potential value in optimizing personalized coumarin therapy.

FFT-P4 POVEZANOST GENSKIH POLIMORFIZAMA TRANSPORTERA LEKOVA SA KONTROLOM UKUPNOG I LDL-HOLESTEROLA KOD PACIJENATA NA TERAPIJI ROSUVASTATINOM I ATORVASTATINOM

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Varijabilnost terapijskog odgovora na statine ograničava postizanje optimalne kontrole lipidnog statusa pri standardnom doziranju. Ispitivanje genskih polimorfizama transportera može pomoći u individualizaciji terapije rosuvastatinom i atorvastatinom kod pacijenata sa dislipidemijom.

Cilj rada bio je ispitivanje distribucije genskih polimorfizama za transportere lekova ABCG2 421C>A i SLCO1B1 521T>C i njihovog uticaja na kontrolu ukupnog holesterola (TC, engl. *total cholesterol*) i LDL-holesterola (LDL-C, engl. *low-density lipoprotein cholesterol*) kod pacijenata na rosuvastatinu i atorvastatinu.

U studiju su uključena 103 pacijenta na terapiji rosuvastatinom i 96 pacijenata na terapiji atorvastatinom. Primenjena je logistička regresiona analiza za ispitivanje povezanosti genskih polimorfizama i kontrole TC (kontrolisan≤5,2 mmol/L) i LDL-C (kontrolisan<2,6 mmol/L). Nezavisne varijable su bile ispitivani genski polimorfizmi, pol, starost i srednje/visoko intenzivan režim odgovarajućeg statina.

Kod pacijenata na terapiji rosuvastatinom, univarijantna analiza pokazala je da su nosioci A alela ABCG2 421C>A genskog polimorfizma (OR=0,307; 95%CI 0,095–0,990; p=0,048) i stariji pacijenti (OR=0,934; 95%CI 0,895–0,974; p=0,002) imali bolju kontrolu TC. U multivarijantnoj analizi značaj ABCG2 polimorfizma je nestao, dok je starost ostala nezavisno povezana sa kontrolom TC. Kod pacijenata na atorvastatinu, ABCG2 polimorfizam bio je jedini značajan prediktor kontrole TC (OR=0,103; 95%CI 0,013–0,827; p=0,032). Nije utvrđena značajna povezanost ispitivanih polimorfizama sa statusom kontrole LDL-C.

Genski polimorfizam ABCG2 421C>A povezan je sa boljom kontrolom TC kod pacijenata na terapiji statinima. Određivanje koncentracije statina u plazmi, uz farmakogenetičke podatke, omogućilo bi dalja istraživanja optimizacije terapije dislipidemije.

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FFT-P4 ASSOCIATION OF DRUG TRANSPORTER GENE POLYMORPHISMS WITH TOTAL AND LDL CHOLESTEROL CONTROL IN PATIENTS RECEIVING ROSUVASTATIN AND ATORVASTATIN THERAPY

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Variability in response to statin therapy limits the achievement of optimal lipid control with standard dosing. Investigation of drug transporter gene polymorphisms may support the individualization of rosuvastatin and atorvastatin therapy in patients with dyslipidemia.

This study aimed to evaluate the distribution of the drug transporter gene polymorphisms ABCG2 421C>A and SLCO1B1 521T>C, and their association with total cholesterol (TC) and low-density lipoprotein cholesterol (LDL-C) control in patients receiving rosuvastatin or atorvastatin.

The study included 103 patients receiving rosuvastatin and 96 patients receiving atorvastatin. Logistic regression analysis was performed to assess the association between gene polymorphisms and TC control (≤5.2 mmol/L) and LDL-C control (<2.6 mmol/L). Independent variables included the investigated polymorphisms, sex, age, and moderate-/high-intensity statin regimen.

Among rosuvastatin-treated patients, A-allele carriers of the ABCG2 421C>A polymorphism (OR=0.307; 95% CI 0.095–0.990; p=0.048) and older age (OR=0.934; 95% CI 0.895–0.974; p=0.002) were associated with better TC control in univariable analysis. In multivariable analysis, only age remained independently associated with TC control. In atorvastatin-treated patients, the ABCG2 421C>A polymorphism was the only significant predictor of TC control (OR=0.103; 95% CI 0.013–0.827; p=0.032). No significant associations were observed between the investigated polymorphisms and LDL-C control.

The ABCG2 421C>A polymorphism was associated with improved TC control in statin-treated patients. Measurement of plasma statin concentrations, combined with pharmacogenetic data, could support further research on optimizing dyslipidemia treatment.

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FFT-P5 EFIKASNOST FARMAKOTERAPIJE NIKOTINSKE ZAVISNOSTI: NARATIVNA ANALIZA SAVREMENIH DOKAZA

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Zavisnost od nikotina je hronično recidivirajuće oboljenje, a farmakoterapija povećava verovatnoću dugotrajne apstinencije. Cilj rada bio je poređenje mehanizama delovanja i efikasnosti savremenih farmakoterapijskih opcija za prestanak pušenja. Sprovedena je ciljana narativna analiza literature pretraživanjem baza PubMed/MEDLINE i Cochrane Library i dokumenata Svetske zdravstvene organizacije, objavljenih od januara 2018. do jula 2026. godine. Korišćeni su termini *„nicotine dependence"*, *„smoking cessation"*, *„nicotine replacement therapy"*, *„bupropion"*, *„varenicline"* i *„cytisine"*. Prednost je data smernicama, sistematskim pregledima i metaanalizama koje su procenjivale apstinenciju nakon najmanje šest meseci. Analizirane opcije bile su nikotinska supstituciona terapija (NST), parcijalni agonisti α4β2 nikotinskih acetilholinskih receptora vareniklin i citizin, i bupropion, inhibitor ponovnog preuzimanja noradrenalina i dopamina. U odnosu na placebo ili odsustvo farmakoterapije, dugotrajna apstinencija bila je verovatnija uz NST (relativni rizik [RR] 1,55; 95% interval poverenja [IP] 1,49–1,61), bupropion (RR 1,60; 95% IP 1,49–1,72), vareniklin (RR 2,32; 95% IP 2,15–2,51) i citizin (RR 2,61; 95% IP 1,50–4,67). Kombinovana NST, flaster uz kratkodelujući oblik, bila je efikasnija od monoterapije (RR 1,25; 95% IP 1,15–1,36). Vareniklin je bio efikasniji od bupropiona i pojedinačnih oblika NST, dok nije utvrđena jasna razlika u odnosu na kombinovanu NST. Rezultati potvrđuju efikasnost svih analiziranih lekova, uz izraženije efekte vareniklina i citizina u odnosu na kontrolu. Izbor terapije treba individualizovati prema kontraindikacijama, podnošljivosti, prethodnim pokušajima i dostupnosti leka, uz istovremenu bihejvioralnu podršku.

FFT-P5 EFFICACY OF PHARMACOTHERAPY FOR NICOTINE DEPENDENCE: A NARRATIVE ANALYSIS OF CONTEMPORARY EVIDENCE

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Nicotine dependence is a chronic relapsing disorder, and pharmacotherapy increases the likelihood of long-term abstinence. The aim was to compare the mechanisms of action and efficacy of contemporary pharmacological options for smoking cessation. A targeted narrative review was conducted by searching PubMed/MEDLINE, the Cochrane Library, and World Health Organization documents published from January 2018 to July 2026. Search terms were "nicotine dependence", "smoking cessation", "nicotine replacement therapy", "bupropion", "varenicline", and "cytisine". Priority was given to guidelines, systematic reviews, and meta-analyses evaluating abstinence at six months or longer. The analysed options were nicotine replacement therapy (NRT), the α4β2 nicotinic acetylcholine receptor partial agonists varenicline and cytisine, and bupropion, an inhibitor of neuronal norepinephrine and dopamine reuptake. Compared with placebo or no pharmacotherapy, long-term abstinence was more likely with NRT (risk ratio [RR] 1.55; 95% confidence interval [CI] 1.49–1.61), bupropion (RR 1.60; 95% CI 1.49–1.72), varenicline (RR 2.32; 95% CI 2.15–2.51), and cytisine (RR 2.61; 95% CI 1.50–4.67). Combination NRT, a patch plus a short-acting formulation, was more effective than monotherapy (RR 1.25; 95% CI 1.15–1.36). Varenicline was more effective than bupropion and single-form NRT, while no clear difference was found compared with combination NRT. The findings confirm the efficacy of all analysed medications, with larger effects for varenicline and cytisine versus control. Treatment should be individualized according to contraindications, tolerability, previous quit attempts, and medicine availability, with concurrent behavioural support.

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FFT-P6 FARMAKOTERAPIJA NEUROPATSKOG BOLA: EFIKASNOST LEKOVA PRVE LINIJE

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Neuropatski bol često zahteva dugotrajno lečenje, ali odgovor na farmakoterapiju je ograničen i individualno varijabilan. Cilj rada bio je da se uporede efikasnost i mesto lekova prve linije u terapiji neuropatskog bola kod odraslih. Sprovedena je ciljana narativna analiza literature pretraživanjem baza PubMed/MEDLINE i Cochrane Library za period od januara 2015. do jula 2026. godine. Korišćeni su termini *„neuropathic pain"*, *„pharmacotherapy"*, *„tricyclic antidepressants"*, *„serotonin-norepinephrine reuptake inhibitors"*, *„gabapentin"*, *„pregabalin"* i *„head-to-head trial"*. Uključene su smernice, sistematski pregledi i metaanalize koje su procenjivale smanjenje intenziteta bola kod odraslih; trigeminalna neuralgija i išijas nisu analizirani zbog posebnih terapijskih algoritama. Najdoslednije preporuke za prvu liniju odnose se na triciklične antidepresive, inhibitore ponovnog preuzimanja serotonina i noradrenalina, gabapentin i pregabalin. U metaanalizi 229 studija, NNT vrednost (*Number Needed to Treat* - broj pacijenata koje je potrebno lečiti) da bi jedan ostvario najmanje 50% smanjenje bola iznosio je 3,6 za triciklične antidepresive, 6,4 za inhibitore ponovnog preuzimanja serotonina i noradrenalina, 6,3 za gabapentin i 7,7 za pregabalin. Međutim, metaanaliza 10 direktnih komparativnih studija sa 920 ispitanika nije pokazala klinički značajnu razliku između tricikličnih antidepresiva i gabapentina ili pregabalina (razlika srednjih vrednosti 0,10; 95% interval poverenja −0,13 do 0,32). Gabapentin i pregabalin vezuju se za α2δ podjedinicu voltažno zavisnih kalcijumskih kanala, a ne inhibiraju natrijumske kanale. Rezultati pokazuju da nijedna grupa nije univerzalno najefikasnija. Izbor leka treba individualizovati prema komorbiditetima, uzrastu, bubrežnoj funkciji, profilu neželjenih dejstava i prethodnom odgovoru na terapiju.

FFT-P6 PHARMACOTHERAPY OF NEUROPATHIC PAIN: EFFICACY OF FIRST-LINE DRUGS

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Neuropathic pain often requires long-term treatment, but response to pharmacotherapy is limited and individually variable. The aim was to compare the efficacy and therapeutic position of first-line medicines for neuropathic pain in adults. A targeted narrative literature review was conducted by searching PubMed/MEDLINE and the Cochrane Library for publications from January 2015 to July 2026. Search terms were "neuropathic pain", "pharmacotherapy", "tricyclic antidepressants", "serotonin-norepinephrine reuptake inhibitors", "gabapentin", "pregabalin", and "head-to-head trial". Guidelines, systematic reviews, and meta-analyses evaluating pain-intensity reduction in adults were included; trigeminal neuralgia and sciatica were excluded because they require separate treatment algorithms. The most consistent first-line recommendations concern tricyclic antidepressants, serotonin and norepinephrine reuptake inhibitors, gabapentin, and pregabalin. In a meta-analysis of 229 studies, the number needed to treat (NNT) for one patient to achieve at least 50% pain reduction was 3.6 for tricyclic antidepressants, 6.4 for serotonin and norepinephrine reuptake inhibitors, 6.3 for gabapentin, and 7.7 for pregabalin. However, a meta-analysis of 10 direct-comparison studies involving 920 participants found no clinically relevant difference between tricyclic antidepressants and gabapentin or pregabalin (mean difference 0.10; 95% confidence interval −0.13 to 0.32). Gabapentin and pregabalin bind to the α2δ subunit of voltage-gated calcium channels and do not inhibit sodium channels. The findings indicate that no drug class is universally the most effective. Treatment selection should be individualized according to comorbidities, age, renal function, adverse-effect profile, and previous treatment response.

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Poster sesija 3
Poster session 3

FARMACEUTSKA TEHNOLOGIJA I KOZMETOLOGIJA
PHARMACEUTICAL TECHNOLOGY AND COSMETOLOGY

LEKOVITE BILJKE I FITOTERAPIJA
MEDICINAL PLANTS AND PHYTOTHERAPY

DIJETETIKA
DIETETICS

FTIK-P1 NAPREDNA ANALIZA PODATAKA U IDENTIFIKACIJI VEZA IZMEĐU KARAKTERISTIKA FORMULACIJE I BIOFARMACEUTSKIH PERFORMANSI PRAŠKA ZA INHALACIJU SA CIPROFLOKSACINOM

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Napredna analiza podataka predstavlja koristan pristup za prepoznavanje obrazaca u složenim skupovima formulacionih i biofarmaceutskih podataka. Cilj ovog rada bio je da se identifikuju ključne veze između karakteristika formulacije i biofarmaceutskih performansi praška za inhalaciju sa ciprofloksacinom. Strukturirani skup podataka obuhvatio je 71 formulaciju, uključujući osobine lekovite supstance, karakteristike formulacije, farmakokinetičke (FK) parametre, pokazatelje pulmonalne isporuke i indikatore bezbednosti (publikovani rezultati). Primenjeni su analiza glavnih komponenti, klasterovanje metodom K-sredina, korelaciona analiza i modelovanje odabranih odnosa između karakteristika i performansi formulacija. Identifikovane su tri šire FK grupe, koje odgovaraju niskoj, srednjoj i visokoj sistemskoj raspoloživosti leka, čime je omogućena karakterizacija formulacija na osnovu celokupnog FK profila, umesto pojedinačnih parametara. Korelaciona analiza je identifikovala veličinu čestica, aerodinamičke karakteristike i profil oslobađanja lekovite supstance kao ključne faktore performansi. Parametri veličine čestica D50 i D90 pokazali su najjaču obrnutu korelaciju sa FK parametrima, ukazujući da su manje čestice povezane sa većom sistemskom raspoloživošću. Procenat leka oslobođen nakon 60 minuta *in vitro* pokazao je najizraženiju korelaciju sa FK parametrima, pri čemu je sporije oslobađanje bilo povezano sa produženim zadržavanjem *in vivo* i većom sistemskom raspoloživošću. Analiza aerodinamičkih karakteristika ukazala je na to da veća respirabilna frakcija i manji aerodinamički prečnik pogoduju depoziciji leka u distalnim delovima pluća, iako se lokalno zadržavanje leka nije moglo objasniti isključivo karakteristikama aerosola. Analiza ćelijske vijabilnosti omogućila je procenu IC50 vrednosti i ukazala na razlike u bezbednosnom profilu između formulacija. Dobijeni rezultati potvrđuju značaj integrisane analize podataka i prepoznavanja obrazaca kao alata za racionalan razvoj praška za inhalaciju sa ciprofloksacinom.

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FTIK-P1 ADVANCED DATA ANALYSIS IN IDENTIFYING RELATIONSHIPS BETWEEN FORMULATION CHARACTERISTICS AND BIOPHARMACEUTICAL PERFORMANCE OF CIPROFLOXACIN DRY POWDER FOR INHALATION

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Advanced data analysis provides valuable tools for identifying patterns in complex formulation and biopharmaceutical datasets. The aim of this study was to identify key relationships between formulation characteristics and biopharmaceutical performance of ciprofloxacin dry powder for inhalation. The structured dataset comprised 71 formulations, and included drug properties, formulation attributes, pharmacokinetic (PK) endpoints, pulmonary delivery indicators and safety metrics (published data). Principal component analysis, K-means clustering, correlation analysis, and modeling of selected relationships between formulation characteristics and formulation performance were applied. Three broad PK groups were identified, corresponding to low, intermediate, and high drug exposure, enabling formulation characterization on the basis of the overall PK signature rather than individual metrics. Correlation analysis identified particle size, aerodynamic properties and dissolution behavior as key determinants of formulation performance. Particle-size variables D50 and D90 showed the strongest inverse correlation with exposure-related PK metrics, indicating that smaller particles were linked to greater systemic exposure. The percentage of drug released at 60 min *in vitro* showed the strongest correlation with PK outcomes, suggesting that slower drug release led to prolonged *in vivo* residence and higher systemic exposure. Aerodynamic descriptors indicated that higher fine particle fraction and smaller aerodynamic diameter favored distal lung deposition, although local pulmonary residence could not be explained by aerosol properties alone. Cell-viability analysis enabled estimation of IC50 values, revealing formulation-dependent safety differences. The obtained findings support the value of integrated data analysis and pattern recognition as tools for guiding rational development of ciprofloxacin dry powder for inhalation.

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FTIK-P2 FIZIOLOŠKI ZASNOVANO MODELOVANJE APSORPCIJE LEVODOPE: ZNAČAJ GASTROINTESTINALNE DISFUNKCIJE KOD PACIJENATA SA PARKINSONOVOM BOLEŠĆU

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Parkinsonova bolest (PB) je progresivni neurodegenerativni poremećaj praćen motornim i nemotornim simptomima, uključujući gastrointestinalnu (GI) disfunkciju. GI simptomi poput disfagije, gastropareze, usporene pokretljivosti creva i konstipacije javljaju se kod čak 81% pacijenata i mogu značajno uticati na apsorpciju oralno primenjenih lekova. Cilj ove studije bio je da se proceni uticaj GI promena povezanih sa PB na oralnu apsorpciju levodope primenom fiziološki zasnovanog biofarmaceutskog modelovanja.

Levodopa-specifičan model razvijen je pomoću GastroPlus® softvera i validiran na osnovu objavljenih podataka iz kliničkih studija. Analiza osetljivosti sprovedena je radi procene uticaja promena pH vrednosti želuca, vremena zadržavanja leka u želucu, tranzita kroz tanko i debelo crevo, kao i smanjene zapremine tečnosti uzete sa lekom usled disfagije, na oralnu apsorpciju leka. Ispitivani opsezi vrednosti za svaki parametar definisani su na osnovu literaturnih podataka o GI disfunkciji kod pacijenata sa PB. Analiza osetljivosti pokazala je da su vremena zadržavanja u želucu i tranzita kroz tanko crevo najznačajniji faktori koji određuju apsorpciju levodope. Iako su oba parametra značajno uticala na vrednosti C_{max} i t_{max}, vreme zadržavanja u želucu imalo je najveći uticaj, dovodeći do smanjenja C_{max} za približno 72% i produženja t_{max} 3,7 puta. Nasuprot tome, promene pH vrednosti želuca, vremena tranzita kroz debelo crevo i zapremine istovremeno uzete tečnosti pokazale su zanemarljiv uticaj na apsorpciju levodope.

Dobijeni rezultati ukazuju na to da je apsorpcija levodope kod pacijenata sa PB pretežno uslovljena izmenjenim GI tranzitom, podržavajući primenu modelovanja koje uzima u obzir karakteristike bolesti radi boljeg predviđanja varijabilnosti terapijskog odgovora i pouzdanije optimizacije doziranja oralno primenjenih lekova.

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FTIK-P2 PHYSIOLOGICALLY BASED MODELING OF LEVODOPA ABSORPTION: THE ROLE OF GASTROINTESTINAL DYSFUNCTION IN PARKINSON'S DISEASE PATIENTS

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Parkinson's disease (PD) is a progressive neurodegenerative disorder associated with both motor and non-motor symptoms, including gastrointestinal (GI) dysfunction. GI symptoms such as dysphagia, gastroparesis, impaired gut motility, and constipation affect up to 81% of patients and may significantly influence the absorption of orally administered drugs. The aim of this study was to evaluate the impact of PD-related GI changes on levodopa oral absorption using physiologically based biopharmaceutics modelling.

The Levodopa-specific model was designed in GastroPlus® software and successfully validated against published clinical data. Sensitivity analysis was performed to evaluate the influence of changes in gastric pH, gastric residence time, small intestinal and colonic transit times, and dysphagia-related reductions in the volume of fluid taken with the drug on oral drug absorption. The ranges investigated for each parameter were quantified using published data describing GI dysfunction in PD patients. Sensitivity analysis identified gastric residence time and small intestinal transit time as primary determinants of levodopa absorption. While both parameters markedly affected C_{max} and t_{max}, gastric residence time had the greatest overall impact, reducing C_{max} by approximately 72%, and prolonging t_{max} by 3.7-fold. In contrast, changes in gastric pH, colonic transit time, and concomitantly taken fluid volume showed negligible impact on levodopa absorption.

These findings suggest that levodopa absorption in PD patients is driven mainly by altered GI transit, supporting the use of disease-informed modelling to better anticipate variability in therapeutic response and guide more reliable dosing optimization for oral drugs.

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FTIK-P3 ICH M13A I PROCENA BIOLOŠKE EKVIVALENTNOSTI U USLOVIMA POVIŠENOG GASTRIČNOG pH: PRIMER GENERIČKIH FORMULACIJA DABIGATRANA

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Smernica ICH M13A uvodi dodatne zahteve za studije biološke ekvivalentnosti (BE) lekova koji sadrže aktivne supstance sa pH-zavisnom rastvorljivošću, kod kojih može biti potrebna dodatna BE studija uz istovremenu primenu lekova koji povećavaju gastrični pH. Dabigatran je prva aktivna supstanca za koju je ovaj pristup primenjen u razvoju generičkih lekova. Cilj rada bio je pregled studija BE dabigatrana za četiri generička leka nakon peroralne primene. Izvršen je pregled javno dostupnih rezultata studija BE uz poređenje parametara brzine i stepena resorpcije (C_{max} i AUC_t) u dve studije, kako kod generičkog, tako i za referentni lek. Analizom dokumentacije utvrđeno je da su za svaki generički lek sprovedene dve studije: u uslovima gladovanja i uz primenu inhibitora protonske pumpe (IPP). U studiji povišenog pH želuca, ispitanici su uzimali pantoprazol 40 mg dva puta na dan tokom četiri uzastopna dana pred svaki period studije. U studijama sa IPP, kod generičkih formulacija zabeleženo je smanjenje C_{max} za 26,7–48,8% i AUC_t za 28,2–37,3% u odnosu na uslove gladovanja. Kod referentnog leka odgovarajuće smanjenje iznosilo je 27,7–49,0% za C_{max} i 28,1–40,6% za AUC_t. Sve četiri generičke formulacije ispunile su kriterijume BE u odnosu na referentni lek u oba ispitivana uslova. Rezultati ukazuju da razlike u formulaciji ne dovode do značajnih razlika u biološkoj raspoloživosti dabigatrana ni pri povišenom gastričnom pH. Sličan obim smanjenja resorpcije nakon primene IPP kod generičkih i referentne formulacije potvrđuje značaj dodatnih ispitivanja predviđenih smernicom ICH M13A za lekove koji sadrže aktivne supstance sa pH-zavisnom rastvorljivošću.

FTIK-P3 ICH M13A AND BIOEQUIVALENCE ASSESSMENT UNDER ELEVATED GASTRIC pH CONDITIONS: THE CASE OF GENERIC DABIGATRAN FORMULATIONS

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ICH M13A guideline introduces additional requirements for bioequivalence (BE) studies of drug products containing active substances with pH-dependent solubility, for which additional study under increased gastric pH conditions achieved by co-administration of pH-modifying agents may be required. Dabigatran is the first active substance for which this approach has been applied in the generic medicines development. The aim of this work was to review dabigatran BE studies for four generic products. Publicly available BE study results were reviewed, with comparison of absorption rate and extent parameters (C_{max} and AUC_t) under two study conditions. Analysis of the available documentation showed that two studies were conducted for each generic product: under fasting conditions and with concomitant administration of a proton pump inhibitor (PPI). In the elevated gastric pH study, subjects received pantoprazole 40 mg twice daily for four consecutive days prior to each study period. Under PPI conditions, generic formulations demonstrated reductions in C_{max} (26.7–48.8%) and AUC_t (28.2–37.3%) compared with fasting conditions. For the reference product, corresponding reductions were 27.7–49.0% for C_{max} and 28.1–40.6% for AUC_t. All four generic formulations met BE criteria relative to the reference product under both investigated conditions. These findings indicate that formulation differences do not result in meaningful differences in dabigatran bioavailability, even under conditions of increased gastric pH. Comparable magnitude of absorption reduction following PPI administration between generic and reference formulations supports the relevance of additional studies recommended by the ICH M13A for drug products containing active substances with pH-dependent solubility.

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FTIK-P4 *BCS BIOWAIVER* KONCEPT U PRAKSI AGENCIJE ZA LEKOVE I MEDICINSKA SREDSTVA SRBIJE: REGULATORNA ISKUSTVA I ULOGA EKSCIPIJENASA

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Ekscipijensi su važne komponente lekova koje imaju značajnu ulogu u formulaciji. Tokom životnog ciklusa leka, promene u formulaciji koje uključuju ekscipijense mogu biti česte. Razlike u formulaciji mogu dovesti do promene bioraspoloživosti, što treba razmotriti u dosijeima za lek. Smernica ICH M9 definiše regulatorni okvir za izostavljanje studija bioekvivalencije (BE) na osnovu Biofarmaceutskog sistema klasifikacije (BCS) za čvrste farmaceutske oblike za oralnu primenu. Ova smernica ističe specifičan rizik povezan sa ekscipijensima prilikom primene „*BCS biowaiver*" koncepta.

Sprovedena je retrospektivna analiza zahteva za procenu dosijea za lek u ALIMS-u koji se odnose na primenu „*BCS biowaiver*" koncepta, u periodu od 2023. do 2025. godine, kao i analiza ključnih regulatornih parametara za odobrenje ovog koncepta. Godišnji procenat podnetih zahteva za „*BCS biowaiver*" izračunat je na osnovu ukupnog broja zahteva za tablete i kapsule kod kojih je postojao zahtev za sprovođenje studije bioekvivalencije.

Rezultati pokazuju stalan godišnji rast broja podnetih zahteva za primenu „*BCS biowaiver*" koncepta, i to: 3,66%, 5,05% i 5,13%. Ključni parametri za odobrenje koncepta bili su: aktivna supstanca BCS klase I (83,33% zahteva) ili klase III (16,67%), kvalitativni i kvantitativni sastav ekscipijenasa u formulaciji i njihov uticaj na brzinu oslobađanja i permeabilnost aktivnih supstanci, kao i sličnost ekscipijenasa sa referentnim lekom. Ovo je očekivano, jer smernica postavlja stroge zahteve u pogledu ekscipijense za supstance BCS klase III.

Interesovanje za „*BCS biowaiver*" je u stalnom porastu. Radi kvalitetnije procene dosijea, rizik povezan sa ekscipijensima kod „*BCS biowaiver-a*" za klasu I i III aktivnih supstanci treba na odgovarajući način razmotriti i obrazložiti.

FTIK-P4 BCS BIOWAIVER CONCEPT IN MEDICINES AND MEDICAL DEVICES AGENCY OF SERBIA PRACTICE: REGULATORY IMPLICATIONS AND EXCIPIENTS ROLE

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Excipients are important components of medicines with a significant role in formulation. During the medicine lifecycle, formulation changes that include excipients could be common. Formulation differences could lead to bioavailability changes, which should be addressed in marketing authorisation (MA) dossiers. ICH M9 guidance outlines a regulatory frame for waiving bioequivalence studies based on the Biopharmaceutics Classification System (BCS) for oral solid dosage forms. This guidance highlights specific risk associated with excipients in application of BCS-based biowaiver.

A retrospective analysis of MA dossiers submitted to ALIMS between 2023 and 2025 that applied the BCS-based biowaiver was performed, alongside an assessment of the key regulatory parameters associated with the approval of this approach. The annual percentage of submitted BCS-based biowaiver requests was calculated based on the total number of requests for tablets and capsules with requirement for implementation of a bioequivalence study.

Results show constant annual growth in the number of submitted BCS-based biowaiver requests, i.e. 3.66%, 5.05% and 5.13% respectively. The key parameters for request approval were active substance of BCS class I (83.33% requests), BCS class III (16.67%), qualitative and quantitative composition of excipients in formulation and their influence on dissolution and permeability of active substances, similarity of excipients with the reference medicine. This is expected as the guideline sets strict requirements regarding excipients for substances with low permeability.

Interest for BCS-based biowaiver is constantly evolving. To facilitate more efficient evaluation of MA dossiers, risks associated with excipients in BCS Class I and III biowaivers should be adequately assessed and scientifically justified.

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FTIK-P5 KONZERVANSI U KAPIMA ZA OČI: SAVREMENI TRENDOVI I REGULATORNI ZAHTEVI

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Prisustvo konzervansa u višedoznim kapima za oči je ključno za sprečavanje mikrobiološke kontaminacije ili proliferacije mikroorganizama tokom skladištenja i upotrebe proizvoda.

Cilj rada je pregled osnovnih kriterijuma pri odabiru konzervansa u kapima za oči, prikaz trenutno dozvoljenih konzervanasa i njihovih koncentracija, kao i regulatornih zahteva za oftalmološke proizvode koji sadrže konzervanse. Urađena je analiza aktuelnih regulatornih zahteva (EMA i FDA smernice, farmakopeje) i najnovijih literaturnih podataka iz ove oblasti.

Ključni regulatorni zahtevi uključuju dokazivanje: adekvatne antimikrobne efikasnosti izabranog konzervansa, odsustva toksičnih ili iritirajućih efekata na površini oka, stabilnosti konzervansa tokom roka upotrebe leka i nepostojanja interakcija sa aktivnim i pomoćnim supstancama i sa primarnim pakovanjem. Koncentracija konzervansa mora biti bezbedna za pacijenta, ali istovremeno ispunjavati zahteve za antimikrobnu efikasnost.

Strategija pri izboru konzervansa u kapima za oči je u novije vreme promenjena, jer su neki postali zastareli (npr. tiomersal) ili zbog otkrivanja njihovih ozbiljnih neželjenih reakcija, naročito pri dugotrajnoj upotrebi (npr. benzalkonijum-hlorid). Alternativni konzervansi, poput polikvaternijuma-1, stabilizovanog oksihlornog kompleksa ili oksidativnog sistema zasnovanog na neorganskim jonima, pokazuju bolju podnošljivost, posebno u dugotrajnoj terapiji, ali zahtevaju detaljno dokumentovano dokazivanje stabilnosti i efikasnosti.

Iako inovativna pakovanja omogućavaju razvoj višedoznih formulacija bez konzervansa, njihova trenutna tehnološka i ekonomska ograničenja sugerišu da će kapi za oči sa konzervansom ostati glavni oslonac u oftalmološkoj terapiji u doglednoj budućnosti. Usklađenost sa važećom regulativom je od presudnog značaja za obezbeđivanje kontrolisanog i konzistentnog kvaliteta ovih proizvoda, naročito imajući u vidu da mikrobiološka kontaminacija predstavlja rizik od ozbiljnih infekcija oka koje mogu uzrokovati trajna oštećenja ili gubitak vida.

FTIK-P5 PRESERVATIVES IN EYE DROPS: CONTEMPORARY TRENDS AND REGULATORY REQUIREMENTS

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The presence of preservatives in multidose eye drops is crucial for preventing microbial contamination or proliferation of microorganisms during storage and use.

The aim of this paper is to review criteria for selecting preservatives in eye drops, currently permitted preservatives and their concentrations, and regulatory requirements for ophthalmic products containing preservatives. An analysis of current regulatory requirements (EMA and FDA guidelines, pharmacopoeias) and the latest literature data in this field was conducted.

Key regulatory requirements include demonstrating the antimicrobial efficacy of the preservative, the absence of toxic or irritating effects on the ocular surface, stability throughout the shelf life, and the absence of interactions with active substances, excipients, and primary packaging. Preservative concentration must be safe while still providing adequate antimicrobial efficacy.

The strategy for selecting preservatives in eye drops has recently changed because some agents have become obsolete (e.g., thiomersal) or serious adverse reactions have been identified, particularly during long-term use (e.g., benzalkonium chloride). Alternative preservatives, such as polyquaternium-1, stabilized oxychloro complex, and inorganic ion-based oxidative systems, offer better tolerability, especially in chronic therapy, but require comprehensive, well-documented evidence of stability and efficacy.

Although innovative packaging enables development of preservative-free multidose formulations, current technological and economic constraints suggest that preserved eye drops will remain a mainstay of ophthalmic therapy for the foreseeable future. Compliance with current regulations is essential to ensure consistent, controlled product quality, especially given that microbial contamination poses a risk of serious eye infections that can lead to permanent damage or loss of vision.

FTIK-P6 ISPITIVANJE UTICAJA PROCESNIH PARAMETARA NA KARAKTERISTIKE KOMPAKATA DOBIJENIH POSTUPKOM ZELENE GRANULACIJE U UREĐAJU TIPA FLUIDIZIRAJUĆEG SISTEMA

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Zelena granulacija u uređaju tipa fluidizirajućeg sistema predstavlja novu, ekološki prihvatljiviju alternativu vlažnoj granulaciji, budući da ne zahteva fazu sušenja usled upotrebe male količine vode (do 5%). Cilj ovog rada bio je ispitivanje uticaja udela vode i procesnih parametara na karakteristike granulata i kompakata dobijenih ovom metodom.

Granulati i kompakti su pripremljeni u skladu sa 2^4 punim faktorijalnim dizajnom, pri čemu su ispitivani sledeći faktori: udeo i protok vode, pritisak vazduha za raspršivanje i opterećenje pri kompresiji. Kao odgovori praćeni su: neto rad kompresije, pritisak pri odvajanju i izbacivanju, zatezna čvrstina, elastični oporavak i raspadljivost kompakata. Granulati su okarakterisani u pogledu raspodele veličine čestica i protočnosti.

Veći udeo vode (5%) doprineo je formiranju nešto krupnijih granula, boljih protočnih svojstava. Svi ispitivani kompakti su pokazali dobra mehanička svojstva, sa vrednostima zatezne čvrstine iznad 1,5 MPa, bez obzira na primenjeni pritisak kompresije. Opterećenje pri kompresiji i protok vode su pokazali statistički značajan uticaj na zateznu čvrstinu, pri čemu su veće opterećenje pri kompresiji i sporiji protok vode doprineli formiranju jačih međučestičnih veza. Ispitivani faktori i njihove interakcije su pokazali značajan uticaj na pritiske pri odvajanju i izbacivanju kompakata. Međutim, bez obzira na uticaj ispitivanih faktora, svi kompakti su pokazali izuzetno niske vrednosti ovih parametara (< 0,7 MPa). Opterećenje pri kompresiji i udeo vode su pokazali statistički značajan uticaj na neto rad kompresije, elastični oporavak, kao i na raspadljivost kompakata.

Dobijeni rezultati ukazuju na značajan potencijal nove, ekološki prihvatljivije metode granulacije za proizvodnju tableta dobrih mehaničkih karakteristika, uz istovremeno brzu dezintegraciju.

Zahvalnica

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FTIK-P6 INVESTIGATION OF THE INFLUENCE OF PROCESS PARAMETERS ON THE PROPERTIES OF COMPACTS PREPARED BY GREEN FLUIDIZED BED GRANULATION

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Green fluidized bed granulation is a new, environmentally friendly alternative to wet granulation, as drying is not required due to the use of a small amount of water (up to 5%). The goal of this study was to investigate the influence of water content and process parameters on the properties of granulates and compacts obtained by this method.

Granulates and compacts were prepared according to a 2^4 full factorial design, with the following factors investigated: water content and feed rate, spray air pressure, and compression load. The response variables were: network of compression, detachment and ejection stresses, tensile strength, elastic recovery, and disintegration time of the compacts. Granulates were characterized by particle size distribution and flowability.

Higher water content (5%) led to the formation of somewhat larger granules with better flow properties. All compacts showed good mechanical properties, with tensile strength greater than 1.5 MPa, regardless of the compression pressure applied. Compression load and water feed rate significantly influenced tensile strength, with higher compression load and slower water feed rate resulting in stronger interparticulate bonding. The investigated factors and their interactions significantly affected detachment and ejection stresses. However, despite the influence of these factors, all compacts exhibited rather low values for these parameters (< 0.7 MPa). Compression load and water content significantly influenced net work of compression, elastic recovery, and disintegration time.

The results obtained indicate the significant potential of this novel, environmentally friendly granulation method for producing tablets with good mechanical properties and rapid disintegration.

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FTIK-P7 DEVELOPMENT OF A NIR MODEL FOR MOISTURE PREDICTION AND END POINT DETERMINATION DURING FLUID BED DRYING

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NIR spectroscopy can be used as a rapid and non-destructive method for moisture content determination. The objective of this study was to develop and evaluate a quantitative NIR model for moisture content prediction and drying end-point determination during manufacturing of a pharmaceutical product.

Laboratory-scale trials were performed using a high-shear mixer granulator to produce the wet granulates, which were subsequently dried in a fluid-bed dryer. A total of 42 samples collected during the drying process were used for model calibration. NIR spectra (*X variables*) were acquired using NIR probe, while moisture content determined by the loss on drying as a reference method (*Y variables*) was used as the response variable. PLS regression was applied for calibration model development following spectral preprocessing with first-derivative transformation. The developed model demonstrated high explanatory and predictive performance ($Q^2cum = 0.946$), strong linearity between predicted and measured moisture values ($R^2 = 0.9747$) and low RMSEE and RMSEcv values. Variable importance analysis identified the 1400-1550 nm spectral region associated with the O-H absorption bands of water, as the most influential for moisture quantification. The analysis of the model's predictability was approached by introducing an independent validation data of 6 samples. The model demonstrated high predictive ability with high linearity ($R^2 = 0.9738$) and low RMSEP value.

The developed model provides accurate moisture content prediction and reliable drying end-point determination, enabling fast and efficient at-line moisture content analysis. Its implementation to an in-line PAT application requires optimization of probe positioning and continuous spectral acquisition strategies under dynamic process conditions.

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FTIK-P8 OPTIMIZATION OF ROLLER COMPACTION: IMPACT OF PROCESS PARAMETERS ON GRANULE SIZE AND TABLET DISINTEGRATION

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Roller compaction is a dry granulation process used in the pharmaceutical industry to improve powder flowability, content uniformity, and tabletability. The aim of this study was to optimize the roller compaction (RC) by evaluating the influence of potential critical process parameters (CPPs) on particle size distribution (PSD) and tablet disintegration, identified as critical quality attributes (CQAs). Based on prior knowledge and risk assessment, feed screw speed, roller speed, hydraulic pressure, and roller gap were systematically varied to evaluate their impact on the selected CQAs.

Two granulate batches containing BCS Class III antidiabetic API and standard excipients were produced by RC. To assess roller compaction parameters, granulates were compressed under identical conditions. Results showed that adequate ribbons were obtained at a feed screw-to-roller speed ratio of approximately 1:1, ensuring stable ribbon formation and consistent roller gap control. PSD was influenced by all investigated parameters, with hydraulic pressure identified as the primary CPP. Increasing hydraulic pressure from 1-1.5 kN/cm² to 2-3 kN/cm² increased D50 values from 0.143 to 0.166 mm and D90 values from 0.307 to 0.413 mm, indicating increased granule size. Tablet disintegration was directly proportional to hydraulic pressure and inversely proportional to roller gap. Tablets produced at higher hydraulic pressure exhibited disintegration ranging between 1min 1s to 2min 30s, compared with 40-55s at lower pressures.

Hydraulic pressure was identified as the primary CPP affecting PSD and tablet disintegration. A feed screw-to-roller speed ratio close to 1:1, lower hydraulic pressure and an appropriate roller gap, ensured consistent quality and compliance with CQAs.

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FTIK-P9 HALOJZIT-HITOZAN NANOKOMPOZITI KAO NOSAČI ACEKLOFENAKA: UTICAJ POSTUPAKA MODIFIKACIJE NA FUNKCIONALNE I BIOFARMACEUTSKE KARAKTERISTIKE

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Halojzit (Hal) je mineral grupe filosilikata cevaste strukture, sa povoljnim fizičkohemijskim svojstvima, zbog kojih se razmatra kao potencijalni nosač lekovitih supstanci. Zahvaljujući pozitivno naelektrisanom lumenu i negativno naelektrisanoj spoljašnjoj površini, Hal se može modifikovati različitim postupcima, čime se proširuje mogućnost njegove biomedicinske primene. Međutim, primenu Hal kao nosača lekovitih supstanci ograničava nizak kapacitet za inkapsulaciju (DL%) i brzo oslobađanje lekovite supstance. Kako bi se prevazišli ovi nedostaci, Hal se tretira kiselinom radi povećanja lumena nanocevi, dok se površinska funkcionalizacija vrši polimerima radi postizanja produženog oslobađanja lekovite supstance. Cilj ovog rada bio je da se ispita uticaj oba postupka modifikacije na funkcionalne i biofarmaceutske karakteristike Hal–hitozan nanokompozita kao nosača za aceklofenak (Ace). Za pripremu kiselinom modifikovanog Hal (eHal) upotrebljena je 1 M sirćetna kiselina, dok je za modifikaciju spoljašnje površine upotrebljen hitozan male molekulske mase (LChi). Karakterizacija pripremljenih nanokompozita obuhvatila je određivanje sadržaja Ace, FT-IR, DSC/TG analizu i ispitivanje brzine oslobađanja Ace. Sadržaj inkapsuliranog Ace bio je veći kod Ace-eHal-LChi kompozita (15,1 ± 0,3%) u poređenju sa Ace-Hal-LChi kompozitom (8,6 ± 0,2%). Rezultati FT-IR i DSC/TG analize potvrdili su da postupci modifikacije nisu uticali na fizičko stanje inkapsuliranog Ace. Iz eHal-LChi-Ace kompozita oslobodilo se 54,1% Ace u toku 5 h i 79,2% u toku 12 h, što je bilo sporije u odnosu na Hal-LChi-Ace kompozit (66,4% u toku 5 h i 92,6% u toku 12 h). Dobijeni rezultati potvrdili su da su primenjeni postupci modifikacije Hal uticali na povećanje kapaciteta inkapsulacije i postizanje produženog oslobađanje Ace iz pripremljenih nanokompozita.

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FTIK-P9 HALLOYSITE-CHITOSAN NANOCOMPOSITES AS ACECLOFENAC CARRIERS: INFLUENCE OF MODIFICATION PROCEDURES ON FUNCTIONAL AND BIOPHARMACEUTICAL CHARACTERISTICS

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Halloysite (Hal) is a phyllosilicate mineral with a tubular structure and favourable physicochemical properties, making it a potential drug carrier. Due to its positively charged lumen and negatively charged outer surface, Hal can be modified by various methods, expanding its potential for biomedical applications. However, the use of Hal as a drug carrier is limited by its low drug loading capacity (DL%) and rapid drug release. To address these limitations, Hal is treated with acid to enlarge the nanotube lumen, while polymer surface functionalisation is employed to achieve prolonged drug release. The aim of this study was to investigate the influence of both modification procedures on the functional and biopharmaceutical characteristics of Hal-chitosan nanocomposite as carrier for aceclofenac (Ace). For preparation of acid-etched Hal (eHal), 1 M acetic acid was used, while low molecular weight chitosan (LChi) was employed to modify the outer surface. Characterization of prepared nanocomposites included determination of Ace content, FT-IR, DSC/TG, and testing of Ace release rate. The content of encapsulated Ace was higher in the Ace-eHal-LChi (15.1 ± 0.3%) than in Ace-Hal-LChi (8.6 ± 0.2%) composite. FT-IR and DSC/TG confirmed that the modification procedures did not affect physical state of encapsulated Ace. From eHal-LChi-Ace composite, 54.1% of Ace was released in 5 hours and 79.2% in 12 hours, indicating a slower release compared to Hal-LChi-Ace composite (66.4% in 5 hours and 92.6% in 12 hours). These results confirmed that the applied Hal modification procedures increased DL% and enabled a prolonged Ace release from prepared nanocomposites.

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FTIK-P10 OD FORMULACIJE DO PACIJENTA: IZAZOVI U RAZVOJU KLINIČKI PRIMENJIVIH LIPIDNIH NANOČESTICA

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Lipidne nanočestice (engl. *Lipid Nanoparticles* – LNPs) jedna su od retkih nanotehnoloških platformi koje su uspešno prešle put od laboratorije do pacijenta, o čemu svedoči njihova primena u mRNK vakcinama protiv COVID-19 i u lečenju naslednih bolesti jetre. Cilj ovog rada bio je da se, kroz pregled i kritičku analizu novije literature (period 2020–2026), sagleda nesklad između fizičkohemijskih i računarskih pokazatelja koji se rutinski koriste za procenu LNP formulacija i bioloških ishoda koji određuju njihovu terapijsku efikasnost. Analizirana je literatura iz šest oblasti razvoja LNP: proizvodnje mikrofluidnim postupkom, liofilizacije, transdermalne isporuke mikroiglama, optimizacije formulacija primenom mašinskog učenja, izlaska iz endozoma (engl. *endosomal escape*) i formiranja proteinske korone. Analiza je pokazala da proizvodni procesi koji se pokažu kao pouzdani na laboratorijskom/pilot nivou neretko gube reproduktivnost pri prenosu na proizvodni/industrijski nivo, dok modeli za računarsku optimizaciju zavise od podataka opterećenih potrebom za uspešnim formulacijama. Efikasnost izlaska iz endozoma izrazito je niska – prema objavljenim podacima svega 1–2% internalizovane siRNK dospeva u citosol, a nijedna poređena formulacija nije prešla 10% efikasnosti napuštanja endozoma, uprkos razlikama u fizičkohemijskim svojstvima. Za karakterizaciju proteinske korone, od koje zavisi biodistribucija LNP, gotovo isključivo se koristi plazma zdravih ispitanika, iako se ciljna populacija pacijenata razlikuje prema patofiziološkom stanju, što značajno utiče na distribuciju nanočestica u organizmu. Na osnovu sprovedene analize zaključuje se da dalji napredak u razvoju LNP ne zavisi isključivo od novih tehnologija, već od sistematskog preispitivanja neproverenih pretpostavki i uvođenja funkcionalne, biološki relevantne validacije kao standarda u proceni LNP formulacija.

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FTIK-P10 FROM FORMULATION TO PATIENT: CHALLENGES IN THE DEVELOPMENT OF CLINICALLY APPLICABLE LIPID NANOPARTICLES

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Lipid nanoparticles (LNPs) are among the few nanotechnology platforms that have successfully transitioned from the laboratory to the clinic, as demonstrated by their use in mRNA vaccines against COVID-19 and in treatments for hereditary liver diseases. This review aimed to critically examine the literature from 2020–2026 to assess the discrepancy between the physicochemical and computational parameters routinely used to evaluate LNP formulations and the biological outcomes that ultimately determine their therapeutic efficacy. The analysis covered six key areas of LNP development: microfluidic production, lyophilization, transdermal microneedle delivery, formulation optimization via machine learning, endosomal escape, and protein corona formation. The findings indicate that manufacturing processes that are reliable at the laboratory or pilot scale frequently lose reproducibility when translated to production or industrial scale, while computational optimization models depend on datasets that are inherently biased toward successful formulations. Endosomal escape efficiency remains strikingly low – according to published data, only 1–2% of internalized siRNA reaches the cytosol, and none of the compared formulations exceeded 10% escape efficiency, despite differences in their physicochemical properties. The protein corona, which governs LNP biodistribution, is almost exclusively characterized using plasma from healthy volunteers, even though the target patient population differs in pathophysiological status – a factor that substantially influences nanoparticle distribution *in vivo*. Based on this analysis, further progress in LNP development appears to depend not only on novel technologies, but more critically on the systematic re-evaluation of unverified assumptions and the establishment of functional, biologically relevant validation as a standard for assessing LNP formulations.

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FTIK-P11 NEURONSKO TEMATSKO MODELOVANJE LITERATURE O LIPIDNIM NANOČESTICAMA IDENTIFIKUJE STABILNE ISTRAŽIVAČKE PRAVCE

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Ekspanzija istraživanja lipidnih nanočestica (LNPs) nakon 2020. godine, podstaknuta uspehom mRNA vakcina, dovela je do obimne literature u kojoj zajednički rečnik prikriva različite istraživačke pravce. Neuronski tematski modeli, poput BERTopic-a, prepoznati su u naučnoj zajednici i kod agencija za finansiranje kao alati za identifikaciju novih istraživačkih pravaca koji prevazilaze pretragu zasnovanu na ključnim rečima. Prema našim saznanjima, još uvek nisu primenjeni u ovoj oblasti. Domenski prilagođen BERTopic model primenjen je na 1320 originalnih istraživačkih radova preuzetih iz PubMed PMC Open Access podskupa (2020–2025; kargo: mRNA, siRNA, saRNA, circRNA). Godišnji broj objavljenih radova desetostruko je porastao u periodu 2020–2025. Ključne fraze iz naslova i apstrakata, korišćene za HDBSCAN klasterovanje, odabrane su primenom IDF ponderisanja (*inverse document frequency*) i maksimalne marginalne relevantnosti (MMR; 15 po dokumentu) kako bi se neutralisao zajednički rečnik platforme. Nakon optimizacije kroz 27 konfiguracija, odabrani model validiran je metodom ponovnog uzorkovanja, čime je potvrđeno da su identifikovane teme reproducibilne strukture, a ne artefakti izbora parametara. Identifikovano je 12 stabilnih istraživačkih pravaca, koji obuhvataju 57% korpusa. Porast udela šuma na 30% u 2025. godini ukazuje da diverzifikacija oblasti prevazilazi trenutni obim modela. Do 2025. godine, tema „imunoterapija kancera mRNA-LNP" porasla je sa 4% na 13% godišnjeg broja radova, potiskujući temu vakcina protiv COVID-19, koja je dostigla maksimum od 26% u 2022. godini i pala na 6%. Pored dominantnih pravaca, identifikovane su i koherentne niše, uključujući isporuku u mišićno-skeletne strukture i biofizičku karakterizaciju mRNA-LNP. Radi sveobuhvatnijeg mapiranja LNP istraživačkog polja, planirano je proširenje korpusa na širi skup literature.

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FTIK-P11 NEURAL TOPIC MODELLING OF LIPID NANOPARTICLE LITERATURE REVEALS STABLE RESEARCH STREAMS

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The post-2020 expansion of lipid nanoparticle (LNP) research, driven by the success of mRNA vaccines, has produced a dense literature in which shared vocabulary obscures distinct research directions. Neural topic modeling, such as BERTopic, has been recognized by researchers and funding agencies as a tool for identifying emerging research streams beyond keyword-based searches and, to our knowledge, has not yet been applied to the LNP domain. Therefore, we applied a domain-adapted BERTopic model to 1320 original research articles retrieved from PubMed's PMC Open Access subset (2020–2025; cargo: mRNA, siRNA, saRNA, circRNA). The annual number of published works increased tenfold between 2020 and 2025. Title–abstract keyphrases were selected using inverse document frequency (IDF) weighting and maximal marginal relevance (MMR; 15 per article) to suppress shared platform vocabulary, serving as enriched representations for HDBSCAN clustering. After optimization across 27 configurations, the selected model was validated by bootstrap resampling, confirming that the identified topics are reproducible structures rather than artifacts of parameter choice. Twelve stable research streams were identified, together accounting for 57% of the corpus; noise proportions rising to 30% in 2025 indicate that field diversification is outpacing the model's current scope. By 2025, the topic"mRNA-LNP cancer immunotherapy" increased from 4% to 13% of annual output, displacing COVID-19 vaccine immunology, which peaked at 26% in 2022 and declined to 6%. Beyond dominant streams, the pipeline identified coherent niches, including musculoskeletal nucleic acid delivery and biophysical characterization of mRNA-LNPs. Expanding the dataset will enable deeper mapping of the LNP research landscape.

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FTIK-P12 MAGNETIC NANOPARTICLES – FORMULATION AND CHARACTERIZATION

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Magnetic nanoparticles (MNPs), particularly magnetite (Fe_3O_4) nanoparticles, have attracted significant interest in nanomedicine due to their unique magnetic properties, biocompatibility, and potential applications in targeted drug delivery, cancer diagnosis and therapy, hyperthermia, and magnetic resonance imaging (MRI). Their effectiveness in biomedical applications depends on physicochemical characteristics such as particle size, morphology, size distribution, surface chemistry, and colloidal stability. Therefore, selecting an appropriate synthesis method is a critical step in the development of magnetic nanomaterials.

The aim of this work is to provide an overview of commonly used synthesis methods for magnetic nanoparticles and to discuss the influence of synthesis conditions on their physicochemical properties. Among the available techniques, co-precipitation and microemulsion are widely employed due to their versatility and reproducibility. Co-precipitation is a simple, rapid, and cost-effective method suitable for large-scale production; however, particle agglomeration, broad size distribution, and limited control over morphology may affect nanoparticle quality and reproducibility. In contrast, the microemulsion method enables better control of particle size, shape, and homogeneity, but requires more complex experimental conditions, the use of surfactants, and may be less suitable for scale-up.

Physicochemical characterization of magnetic nanoparticles is commonly performed using techniques such as Transmission Electron Microscopy (TEM), Dynamic Light Scattering (DLS), and Fourier-Transform Infrared Spectroscopy (FTIR), which provide information on particle morphology, size distribution, and surface chemistry. Understanding the relationship between synthesis methods and nanoparticle properties is essential for the rational design and optimization of magnetic nanomaterials for future biomedical applications.

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FTIK-P13 OPTIMIZACIJA MIKROČESTICA NA BAZI POLIELEKTROLITNIH KOMPLEKSA HITOZANA I KSANTAN GUME SA IBUPROFENOM I ESCINOM: OD FIZIČKO-HEMIJSKE KARAKTERIZACIJE DO *IN VIVO* EVALUACIJE

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Polielektrolitni kompleksi (PEK) hitozana i ksantan gume su perspektivni nosači za peroralnu primenu aktivnih supstanci različitih biofarmaceutskih svojstava. Cilj ovog istraživanja bila je optimizacija mikročestica na bazi PEK-ova hitozana i ksantan gume sa ibuprofenom i escinom, i procena njihovog uticaja na farmakokinetički i farmakodinamski odgovor nakon peroralne primene kod pacova i miševa. Ispitivan je uticaj vrste sredstva za podešavanje pH, pH vrednosti, masenog odnosa polimera, postupka inkorporiranja aktivnih supstanci i načina sušenja, na formiranje i svojstva PEK-ova. Praćenjem provodljivosti, transmitance i reoloških svojstava potvrđeno je formiranje PEK-ova različite jačine međumolekulskih interakcija. FT-IR, DSC i PXRD analize pokazale su da su interakcije između polimera nekovalentne, da je escin u mikročesticama prisutan u amorfnom obliku, a kod ibuprofena je uočeno delimično smanjenje kristaliničnosti. Formulacije pripremljene sa sirćetnom kiselinom pri pH ≈ 4,6 i ksantan gumom u višku imale su najbolji odnos prinosa i efikasnosti inkorporiranja aktivnih supstanci (>50%), uz kontrolisano oslobađanje tokom 10–12 h. Mikroinkapsulirani escin pokazao je pH-zavisno oslobađanje (manje od 20% u simuliranoj želudačnoj sredini i znatno više pri višim pH). Nakon peroralne primene formulacija pacovima zabeleženo je višestruko povećanje maksimalne koncentracije obe aktivne supstance u serumu u odnosu na neinkapsuliranu aktivnu supstancu, dok je kod escina potvrđeno i povećanje biološke raspoloživosti. Farmakodinamska ispitivanja na pacovima i miševima pokazala su da mikroinkapsulacija modifikuje antiinflamatorni i antinociceptivni odgovor, a najizraženije poboljšanje uočeno je kod formulacija sa escinom. Rezultati pokazuju da izbor formulacionih parametara utiče na svojstva PEK-ova i mikročestica, a posledično i na farmakokinetički i farmakodinamski profil mikroinkapsuliranih aktivnih supstanci.

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FTIK-P13 OPTIMIZATION OF CHITOSAN/XANTHAN GUM POLYELECTROLYTE COMPLEX-BASED MICROPARTICLES LOADED WITH IBUPROFEN AND ESCIN: FROM PHYSICOCHEMICAL CHARACTERIZATION TO *IN VIVO* EVALUATION

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Chitosan/xanthan gum polyelectrolyte complexes (PECs) are promising carriers for the oral delivery of drugs with different biopharmaceutical properties. This study aimed to optimize chitosan/xanthan gum PEC-based microparticles containing ibuprofen and escin and to evaluate their effects on pharmacokinetic and pharmacodynamic responses after oral administration in rats and mice. The effects of pH-adjusting agent, pH value, polymer mass ratio, drug incorporation method, and drying technique on PEC formation and properties were investigated. Conductivity, transmittance, and rheological measurements confirmed the formation of PECs with varying strengths of intermolecular interactions. FT-IR, DSC, and PXRD analyses showed that polymer interactions were non-covalent, escin was present in an amorphous form within the microparticles, and ibuprofen exhibited partial loss of crystallinity. Formulations prepared with acetic acid at pH ≈ 4.6 and an excess of xanthan gum achieved the most favorable balance between preparation yield and drug entrapment efficiency (>50%), while providing controlled release over 10–12 h. Microencapsulated escin exhibited pH-dependent release (less than 20% under simulated gastric conditions and substantially more at higher pH values). After oral administration of selected formulations to rats, a several-fold increase in maximum serum concentration was observed for both drugs compared with their non-encapsulated forms, and escin-loaded microparticles also led to improved bioavailability. Pharmacodynamic studies in rats and mice demonstrated that microencapsulation altered anti-inflammatory and antinociceptive responses, with the most pronounced improvement observed for escin-loaded formulations. The results indicate that formulation parameters affect the properties of PECs and microparticles and, consequently, influence the pharmacokinetic and pharmacodynamic profiles of microencapsulated drugs.

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FTIK-P14 NATURAL BIOPOLYMERIC SHELL MATERIALS FOR MICROENCAPSULATION OF CANNABINOIDS: ADVANTAGES, LIMITATIONS, AND FUTURE PERSPECTIVES

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Despite the growing interest in cannabinoids as therapeutic agents, their incorporation into pharmaceutical formulations remains challenging due to their hydrophobic nature, susceptibility to oxidation and photodegradation, and limited bioavailability. Microencapsulation has emerged as promising technology to enhance cannabinoid stability, protect bioactive compounds from environmental degradation, and improve delivery.

The aim of this review was to critically evaluate current evidence on natural biopolymeric shell materials used for cannabinoid microencapsulation, with emphasis on their physicochemical properties, encapsulation performance, advantages, limitations, and potential pharmaceutical applications. A narrative literature review was conducted using the PubMed, Scopus, and Web-of-Science, covering 38 research and review articles published between 2015 and 2025.

The available evidence demonstrates that diverse natural biopolymers, including polysaccharides, proteins and natural gums, have been investigated as shell materials for cannabinoid microencapsulation. Protein-based shell materials generally exhibit favorable emulsifying properties and high encapsulation performance, whereas polysaccharides provide excellent biocompatibility and support controlled-release. Composite protein–polysaccharide systems gained increasing interest due to their complementary properties, resulting in improved structural stability, encapsulation performance, and protection of cannabinoids against degradation. The reviewed literature indicates that formulation composition, polymer interactions, and processing conditions are critical for microencapsulation efficiency and product performance.

Overall, current evidence suggests that natural biopolymers represent safe, biodegradable, and sustainable shell materials with significant potential for cannabinoid delivery. Although chitosan, alginate, whey protein, and zein demonstrate promising encapsulation and controlled-release properties, no single biopolymer can currently be considered universally superior. Further investigations are required to optimize cannabinoid-loaded microcapsules and support their successful industrial translation.

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FTIK-P15 GMP COMPLIANCE AND QUALITY ASSURANCE IN THE MEDICAL CANNABIS INDUSTRY: CHALLENGES AND OPPORTUNITIES IN NORTH MACEDONIA

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The medical cannabis industry (MCI) has become one of the fastest-growing pharmaceutical sectors in N. Macedonia, creating opportunities for the production and export of cannabis-derived medicinal products (CDMPs). Ensuring compliance with GMP requirements is essential to guarantee product quality, patient safety, and international market access. This study aimed to evaluate the current status of GMP-compliance and quality assurance practices in the MCI in N. Macedonia and to identify major challenges and opportunities for its sustainable development. This research was performed based on the analysis of 13 scientific publications published during the last six years, relevant EU-GMP guidelines, national legislations, and regulatory documents governing MCI. Current industry practices were evaluated through comparison of published regulatory requirements, Pharmaceutical-Quality Management System (Ph-QMS) principles, analytical testing recommendations, process validation strategies, documentation practices, and manufacturing requirements applicable to CDMPs. The analysis demonstrated that, although N. Macedonia has established an appropriate legal framework for medical cannabis cultivation and processing, implementation and maintenance of full GMP-compliance remains challenging due to the need for substantial investments in Ph-QMS, facility qualification, process and analytical method validation, personnel training, and standardization of cannabinoid profiles. Comprehensive quality control testing, including cannabinoid potency, microbiological quality, pesticides, heavy metals, residual solvents, and other impurities, represents a critical prerequisite for ensuring consistent product quality and patient safety. The findings indicate that strengthening Ph-QMS, harmonizing national regulations with evolving EU-GMP requirements, investing in validated manufacturing and analytical processes represent principal priorities for improving regulatory compliance, enhancing international competitiveness, and supporting sustainable development of N. Macedonia's MCI.

FTIK-P16 REOLOŠKA I TEKSTURNA SVOJSTVA NANOEMULGELOVA I NJIHOV UTICAJ NA ISPORUKU IBUPROFENA U KOŽU

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Nanoemulzioni gelovi (NEG) predstavljaju savremene nosače za isporuku lekovitih supstanci, u kojima je nanoemulzija ugušćena odgovarajućim gelirajućim sredstvom. Cilj ovog rada bio je ispitivanje reoloških i teksturnih svojstava NEG sa ibuprofenom, ugušćenih različitim gelirajućim sredstvima (karbomer 980, ksantan guma, poliakrilat krospolimer-6) u poređenju sa karbomernim hidrogelom i procena njihovog uticaja na isporuku lekovite supstance u kožu.

Oscilatorna ispitivanja sprovedena su pomoću reometra MCR 102e (Anton Paar), dok je analiza teksture sprovedena na uređaju EZ-LX Texture Analyzer (Shimadzu) u dvociklusnom kompresionom testu. *In vivo* isporuka ibuprofena ispitana je *tape stripping* metodom na četiri dobrovoljca, sukcesivnim uklanjanjem slojeva kože pomoću 12 adhezivnih traka.

Svi uzorci pokazali su dominantno elastično ponašanje (G' > G"). Hidrogel je imao najveći modul elastičnosti (G'=73,47 Pa), dok su uzorci NEG pokazali niže vrednosti (G'=35,83–44,99 Pa). Među njima, poliakrilat krospolimer-6 formirao je najčvršću, a ksantan guma najslabije umreženu strukturu, što je potvrđeno i analizom teksture. *In vivo tape stripping* metodom je uočeno da uzorak sa ksantan gumom oslobađa lekovitu supstancu u najvećem stepenu u gornjim slojevima *stratum corneum*-a (SC) (22,74 μg/cm²). Kod uzorka sa poliakrilat krospolimerom-6 primećena je najveća akumulaciju ibuprofena u dubljim slojevima SC.

Izbor gelirajućeg sredstva značajno utiče na reološka i teksturna svojstva NEG, što se posledično odražava i na profil isporuke ibuprofena u kožu. Slabije umreženi gelovi favorizuju površinsku depoziciju, dok rigidnija gelska mreža omogućava dublju penetraciju ibuprofena u SC.

Zahvalnica

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FTIK-P16 EVALUATION OF RHEOLOGICAL AND TEXTURAL PROPERTIES OF NANOEMULGELS AND THEIR IMPACT ON IBUPROFEN SKIN PENETRATION

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Nanoemulgels (NEGs) are advanced drug delivery systems consisting of nanoemulsions thickened with suitable gelling agents. This study investigates the rheological and textural properties of ibuprofen-loaded NEGs thickened with different gelling agents (Carbomer 980, xanthan gum, and polyacrylate crosspolymer-6) in comparison with a carbomer-based hydrogel, and study their impact on skin drug delivery.

Oscillatory rheological measurements were performed using MCR 102e rheometer (Anton Paar), while texture analysis was conducted with an EZ-LX Texture Analyzer (Shimadzu) using a two-cycle compression test. *In vivo* drug penetration was evaluated by tape stripping in four healthy volunteers using 12 adhesive tapes.

All formulations exhibited predominantly elastic behavior (G' > G"). The hydrogel showed the highest storage modulus (G' = 73.47 Pa), indicating the strongest gel network, whereas NEGs displayed lower values (G' = 35.83–44.99 Pa). Among the NEGs, polyacrylate crosspolymer-6 produced the most rigid and highly cross-linked structure, while xanthan gum formed a weaker gel matrix. These findings were confirmed by texture analysis. Tape stripping results showed that the xanthan gum-based formulation released the highest amount of ibuprofen (22.74 μg/cm²), with most of the drug accumulating in the upper layers of the stratum corneum (SC). In contrast, the formulation containing polyacrylate crosspolymer-6 promoted greater ibuprofen accumulation in the deeper SC layers.

The choice of gelling agent significantly influences the rheological and textural properties of NEGs, which consequently affects ibuprofen penetration profile within the skin. Weaker gels favor superficial drug deposition, whereas more rigid gel networks enhance deeper ibuprofen penetration into the SC.

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FTIK-P17 NANOEMULZIJE SA ETARSKIM ULJIMA CITRUSA KAO MULTIFUNKCIONALNI KOZMETIČKI PROIZVODI

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Etarska ulja citrusa su popularne sirovine u prirodnoj kozmetici, poznate po svom karakterističnom osvežavajućem mirisu, ali i po mogućnosti da deluju kao prirodni antioksidansi i antimikrobni agensi. Međutim, zbog njihove nestabilnosti i potencijala da izazovu iritaciju kože, potrebni su novi nosači kako bi se optimizovala njihova kozmetička primena. Glavni cilj ove studije bio je ispitivanje antioksidativne i antimikrobne aktivnosti šest etarskih ulja kore citrusa (bergamot, limun, limeta, slatka pomorandža, mandarina i grejpfrut) pre i posle inkorporiranja u nanoemulzije. Nanoemulzije su pripremljene korišćenjem niskoenergetske metode inverzije faza usled promene sastava (engl. *Phase inversion composition* metoda). Poligliceril-10 laurat, surfaktant dobijen iz prirodnih izvora, korišćen je kao glavni stabilizator, dok je gliceril kaprilat bio ko-surfaktant. Optimizovane nanoemulzije sadržale su 1% etarskog ulja i etilheksil stearat kao noseće ulje i ispitivane su inicijalno i na svaka 3 meseca (veličina kapi - Z-ave, polidisperzni indeks - PDI, pH vrednost i provodljivost). Etarska ulja su inhibirala ABTS slobodni radikal sledećim redosledom: slatka pomorandža ~ mandarina (≥95%), limeta (~68%), grejpfrut (~64%), limun (~56%) i bergamot (~47%). Od svih etarskih ulja, grejpfrut, limun i limeta su bili najefikasniji u inhibiciji *C. albicans, S. epidermidis, S. aureus, P. aeruginosa i C. acnes*. Antioksidativna i antimikrobna aktivnost su bile izražene i u optimizovanim nanoemulzijama, iako rezultati nisu bili direktno uporedivi sa čistim etarskim uljima. Nakon 12 meseci čuvanja na sobnoj temperaturi, samo su nanoemulzije sa etarskim uljem limuna, limete ili grejpfruta ostale stabilne (Z-ave < 47 nm, PDI < 0,13). Stoga je potvrđena njihova potencijalna primena kao multifunkcionalnih kozmetičkih proizvoda.

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FTIK-P17 NANOEMULSIONS WITH CITRUS ESSENTIAL OILS AS MULTIFUNCTIONAL COSMETIC PRODUCTS

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Citrus essential oils are popular raw materials in natural cosmetics, known for their characteristic refreshing scent and prospective antioxidant and antimicrobial effects. However, due to their instability and potential to cause skin irritation, novel carriers are required to optimize their cosmetic application. The main goal of this study was to investigate the antioxidant and antimicrobial activity of six citrus peel essential oils (bergamot, lemon, lime, sweet orange, mandarin orange, and grapefruit) before and after incorporation into nanoemulsions. The nanoemulsions were prepared using the low-energy phase inversion composition method. The naturally derived surfactant polyglyceryl-10 laurate was used as the main stabiliser, and glyceryl caprylate was co-surfactant. The optimised nanoemulsions contained 1% essential oil and ethylhexyl stearate as the carrier oil, and were investigated initially and every 3 months (droplet size - Z-ave, polydispersity index - PDI, pH value, and conductivity). The essential oils scavenged ABTS free radical in the following order: sweet orange ~ mandarin orange (≥95%), lime (~68%), grapefruit (~64%), lemon (~56%), and bergamot (~47%). Of all the essential oils, grapefruit, lemon, and lime most notably inhibited *C. albicans, S. epidermidis, S. aureus, P. aeruginosa, and C. acnes*. The antioxidant and antimicrobial activities were also preserved in the optimized nanoemulsions, although the results were not always directly comparable to the pure essential oils. After 12 months of storage at room temperature, only nanoemulsions with lemon, lime, or grapefruit essential oil remained stable (Z-ave < 47 nm, PDI < 0.13). Therefore, their potential application as multifunctional cosmetic products was confirmed.

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FTIK-P18 DA LI BILJNI EGZOZOMI U LIPOSOMIMA IMAJU UTICAJ NA REOLOŠKE I TEKSTURNE KARAKTERISTIKE EMULZIJE STABILIZOVANE LAMELARNOM FAZOM?

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Egzozomi su vezikule koje igraju ključnu ulogu u međućelijskoj komunikaciji. U kozmetičkim proizvodima ostaju stabilni zahvaljujući inkapsulaciji u liposome i pažljivom odabiru kozmetičkih sastojaka. Cilj studije bio je da se ispita da li biljni egzozomi u liposomima (PhytoCellTec™ Exosomes, INCI: Lycium Barbarum Callus Culture Extract, Isomalt, Lecithin, Aqua; veličina vezikula 200 nm) utiču na mehanička svojstva emulzija stabilizovanih različitim emulgatorima koji formiraju lamelarne faze. Pripremljena su četiri placebo krema (stabilisana različitim emulgatorima) i četiri aktivna uzorka (odgovarajući placebo krem sa PhytoCellTec™ Exosomes) i okarakterisana pomoću reološke i teksturne analize. Odabrani emulgatori bili su: Emulgade® PL 68/50 (F1, F1a), Olivem® 1000 (F2, F2a), Phytocream® 2000 (F3, F3a) i Emulgade® Sucro (F4, F4a). Kontinualna reološka analiza je pokazala da svi uzorci, osim F4, pokazuju vremenski zavisno – tiksotropno ponašanje. Dodavanje liposoma dovelo je do povećanja viskoziteta aktivnih uzoraka i blage promene reološkog ponašanja, posebno kod uzoraka F4 i F4a. Histerezna površina je bila neznatno izmenjena kod svih uzoraka. Elastični modul (G') bio je veći od viskoznog modula (G") kod svih uzoraka, a dodavanje liposoma dovelo je do blagog povećanja oba modula kod svih uzoraka osim F4a. Dodavanje liposoma u uzorke F1a i F2a dovelo je do statistički značajnog povećanja tvrdoće i smanjenja kohezivnosti i smanjenja svih teksturnih parametara kod uzoraka F3a i F4a. Studija je potvrdila da dodavanje PhytoCellTec™ Exosomes utiče na reološke i teksturne karakteristike proizvoda, u zavisnosti od vrste upotrebljenog emulgatora.

FTIK-P18 DO LIPOSOME-ENCAPSULATED PLANT EXOSOMES HAVE AN INFLUENCE ON THE RHEOLOGICAL AND TEXTURAL CHARACTERISTICS OF THE EMULSION STABILIZED BY THE LAMELAR PHASE?

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Exosomes are vesicles that play a crucial role in intercellular communication. In cosmetic products, they remain stable thanks to liposome encapsulation and careful selection of ingredients. The aim of study was to investigate whether liposome-encapsulated plant exosomes (PhytoCellTec™ Exosomes, INCI: Lycium Barbarum Callus Culture Extract, Isomalt, Lecithin, Aqua; size of vesicles 200 nm) affect the mechanical properties of emulsions stabilized with different emulsifiers that form lamellar phases. Four placebo creams (stabilized by different emulsifiers) and four active samples (the corresponding placebo with PhytoCellTec™ Exosomes) were prepared and characterized by rheological and texture analysis. The selected emulsifiers were: Emulgade® PL 68/50 (F1, F1a), Olivem® 1000 (F2, F2a), Phytocream® 2000 (F3, F3a) and Emulgade® Sucro (F4, F4a). Continuous rheology showed that all samples, except F4, exhibited "shear-thinning" flow behavior with thixotropy. The addition of liposomes increased the viscosity of the active samples and caused a slight change in rheological behavior, especially for F4 and F4a. The hysteresis area was insignificantly altered in all samples. The storage modulus (G') was higher than the loss modulus (G") for all samples, and the addition of liposomes led to a slight increase in both moduli for all samples except F4a. The addition of liposomes in F1a and F2a resulted in a statistically significant increase in hardness and a decrease in cohesiveness, as well as a decrease in all textural parameters in F3a and F4a. The study confirmed that addition of PhytoCellTec™ Exosomes influences a product's rheological and textural characteristics, depending on the type of emulsifier used.

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FTIK-P19 UTICAJ PROTEINSKOG MATRIKSA NA *IN VITRO* OSLOBAĐANJE RUTINA I KVERCETINA IZ FILMOVA NA BAZI KOACERVATA ŽELATINA I NATRIJUM-KAZEINATA

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Rutin i kvercetin su flavonoidi sa izraženom antioksidativnom aktivnošću i potencijalom za topikalnu primenu. Njihovu efikasnost ograničavaju slaba rastvorljivost u vodi, kao i osetljivost na svetlost i kiseonik tokom čuvanja i primene. Inkorporiranje ovih supstanci u filmove može predstavljati pristup za njihovu zaštitu i kontrolisano oslobađanje. Cilj ovog istraživanja bio je ispitivanje uticaja filmova formiranih kompleksnom koacervacijom želatina i natrijum-kazeinata na *in vitro* oslobađanje rutina i kvercetina. Filmovi su sadržali 5% proteina, glicerol kao plastifikator i 5% flavonoida u odnosu na ukupnu masu proteina. Brzina oslobađanja ispitana je korišćenjem fosfatnog pufera pH 5,5 sa dodatkom 20% etanola i 1% polisorbata 20, pri 32 °C i kontrolisanim uslovima mešanja (vodeno kupatilo sa šejkerom, 50 o/min). Dobijeni rezultati pokazali su da se obe aktivne supstance produženo oslobađaju iz proteinskih filmova. Maksimum oslobađanja dostignut je nakon približno 2 h za kvercetin i 3 h za rutin i iznosio je oko 55%, odnosno 60% od inkorporirane količine supstance. Nakon dostizanja maksimuma uočen je pad izmerenih koncentracija, što može ukazivati na ograničenu stabilnost flavonoida tokom ispitivanja. Uz primenu dodatnih mera zaštite od svetlosti i kontakta sa vazduhom, koncentracije obe aktivne supstance održavane su na približno konstantnom nivou tokom 5 h, bez izraženog opadanja. Ovi rezultati ukazuju da na profil oslobađanja rutina i kvercetina iz proteinskih filmova utiču karakteristike matriksa i uslovi kojima su flavonoidi izloženi tokom ispitivanja, i potvrđuju potencijal filmova na bazi koacervata želatina i natrijum-kazeinata za inkorporiranje slabo rastvorljivih flavonoida, uz odgovarajuću zaštitu od spoljašnjih uticaja radi očuvanja stabilnosti tokom čuvanja i primene.

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FTIK-P19 INFLUENCE OF THE PROTEIN MATRIX ON THE *IN VITRO* RELEASE OF RUTIN AND QUERCETIN FROM GELATIN/SODIUM CASEINATE COACERVATE-BASED FILMS

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Rutin and quercetin are flavonoids with antioxidant activity and potential applications in dermal formulations. Their effectiveness is limited by poor aqueous solubility and susceptibility to light and oxygen during storage and use. Incorporating these compounds into films may offer protection and enable controlled release. This study investigated the influence of films formed by complex coacervation of gelatin and sodium caseinate on *in vitro* release of rutin and quercetin. The films contained 5% proteins, glycerol (plasticizer), and 5% flavonoids relative to the total protein mass. Release studies were conducted using a phosphate buffer (pH 5.5) with 20% ethanol and 1% polysorbate 20 at 32 °C under controlled mixing (shaking water bath, 50 rpm). The results showed that both actives were released from films in a sustained manner. Maximum release was reached after 2 h for quercetin and 3 h for rutin, corresponding to about 55% and 60% of incorporated amounts, respectively. After reaching maximum, a decrease in concentrations was observed, which may indicate limited flavonoid stability during the release study. When additional protection from light and air contact was applied, the concentrations of both actives remained constant for 5 h without pronounced decline. These findings suggest that rutin and quercetin release from protein films is influenced by the characteristics of the matrix and by the conditions to which flavonoids were exposed during testing. The results confirm the potential of coacervate-based films for incorporating poorly soluble flavonoids. Appropriate protection from external factors must be ensured to preserve their stability during storage and use.

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FTIK-P20 *IN SILICO* PROCENA UTICAJA KONCENTRACIJE RASTVARAČA NA MEHANIČKE OSOBINE *IN SITU* FORMIRANIH FILMOVA NA BAZI HIPROMELOZE: 3² PUN FAKTORSKI DIZAJN

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Mehanička svojstva predstavljaju ključne atribute kvaliteta polimernih filmova formiranih *in situ* na koži iz topikalnih film-formirajućih rastvora (FFR), koji direktno utiču na performanse i praktičnu primenu formulacije. Poznato je da rastvarači utiču na fleksibilnost i mehaničku otpornost polimernih filmova, međutim značaj njihove koncentracije u FFR zahteva dodatnu sistematsku evaluaciju. U ovom radu primenjen je 3² pun faktorski dizajn korišćenjem Design-Expert softvera kako bi se ispitao uticaj koncentracije makrogola 400 (0, 2,5 i 5%; X_1) i izopropanola (25, 33 i 50%; X_2) na mehanička svojstva filmova na bazi hipromeloze. Mehanička svojstva filmova određena su zateznim ispitivanjem, gde su kao odgovori praćeni zatezna čvrstoća (Y_1), izduženje pri kidanju (Y_2) i *Young*-ov modul (Y_3), a dobijeni podaci su analizirani linearnim i kvadratnim regresionim modelima. Statistička analiza pokazala je da se *Young*-ov modul i zatezna čvrstoća najbolje opisuju kvadratnim modelima (R^2 = 0,9980 i 0,9841, redom; p<0,0001), dok je izduženje pri kidanju pokazalo linearnu zavisnost od koncentracije makrogola 400 (R^2=0,7436; p=0,0028). Ovi rezultati ukazuju da je koncentracija makrogola 400 primarni faktor koji određuje mehanička svojstva filmova na bazi hipromeloze, ispoljavajući kvadratnu vezu koja obezbeđuje povoljan balans mehaničkih svojstava u opsegu 2,5–3%. Koncentracija izopropanola, međutim, nije imala statistički značajan uticaj ni na jedan mehanički parametar unutar ispitivanog opsega, uprkos svojoj većoj isparljivosti koja potencijalno može uticati na formiranje filma i organizaciju polimernih lanaca hipromeloze. Ova studija ističe značaj koncentracije makrogola 400 za postizanje poželjnih mehaničkih svojstava filma hipromeloze, dok se sadržaj izopropanola može samostalno podešavati bez ugrožavanja integriteta filma.

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FTIK-P20 *IN SILICO* EVALUATION OF THE INFLUENCE OF SOLVENT CONCENTRATION ON MECHANICAL PROPERTIES OF *IN SITU* FORMED HYPROMELLOSE-BASED FILMS: FULL FACTORIAL DESIGN

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Mechanical properties represent key quality attributes of polymeric films formed *in situ* on the skin from topical film-forming solutions (FFSs), directly influencing formulation performance and practical applicability. Although solvents are known to influence polymeric film flexibility and mechanical resistance, the effect of their concentration in FFSs requires further systematic evaluation. In this study a 3² full factorial design was applied using Design-Expert software to investigate the effects of macrogol 400 (0, 2.5, and 5%; X_1) and isopropanol concentration (25, 33, and 50%; X_2) on the mechanical properties of hypromellose-based films. The mechanical properties of the dried films were assessed by tensile testing using tensile strength (Y_1), elongation at break (Y_2), and Young's modulus (Y_3) as responses, and the data were fitted to linear and quadratic regression models. Statistical analysis revealed that Young's modulus and tensile strength were best described by quadratic models (R^2=0.9980 and 0.9841, respectively; p < 0.0001), whereas elongation at break showed a linear dependence on macrogol 400 concentration (R^2= 0.7436; p = 0.0028). These findings indicate that macrogol 400 concentration is the primary determinant of the hypromellose-based films' mechanical properties, showing a quadratic relationship with favorable balance around 2.5–3%. Isopropanol concentration, however, had no statistically significant effect on any mechanical parameter within the investigated concentration range, despite its higher volatility potentially influencing film formation and hypromellose polymer chains organization. This study highlights the importance of macrogol 400 concentration for achieving desirable mechanical properties, whereas isopropanol content can be adjusted without compromising film integrity.

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FTIK-P21 UTICAJ FORMULACIJE I HIDRODINAMIČKIH PARAMETARA NA *IN VITRO* BRZINU OSLOBAĐANJA ARBUTINA IZ FILMOVA NA BAZI HITOZANA I HIJALURONSKE KISELINE

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Arbutin je hidrosolubilna aktivna supstanca koja se koristi u farmaceutskim i kozmetičkim proizvodima namenjenim redukciji hiperpigmentacija i ujednačavanju tena. Polimerni filmovi predstavljaju pogodne nosače za njegovu lokalnu primenu, ali nepostojanje standardizovanih metoda za ispitivanje oslobađanja aktivne supstance otežava poređenje rezultata dobijenih različitim eksperimentalnim pristupima. Cilj ovog istraživanja bio je da se proceni u kojoj meri sastav formulacije i hidrodinamički uslovi utiču na *in vitro* brzinu oslobađanja arbutina iz filmova na bazi hitozana i hijaluronske kiseline. Ispitivani su filmovi sa i bez aditiva (plastifikatora i umreživača), dok je oslobađanje praćeno u fosfatnom puferu pH 5,5 pri 32 °C, primenom sistema koji obezbeđuju različite obrasce mešanja (rotaciono ili oscilatorno) i različit odnos površine filma prema zapremini medijuma. Koncentracija arbutina određivana je validiranom UV-Vis spektrofotometrijskom metodom sa dokazanom linearnošću ($R^2 > 0,999$). Rezultati su pokazali da hidrodinamički uslovi značajno utiču na profil oslobađanja arbutina i sposobnost metode da razlikuje formulacije različitog sastava. Pri uslovima sa izraženijim razblaženjem (zapremina medijuma ≥ 150 mL) koncentracije arbutina u pojedinim uzorcima bile su bliske ili ispod granice kvantifikacije, što je otežalo poređenje formulacija. Nasuprot tome, pri manjim zapreminama medijuma razlike u sastavu filmova bile su znatno uočljivije, posebno u početnoj fazi oslobađanja. Kod svih ispitivanih formulacija, najveći deo arbutina oslobođen je tokom prvih 10–15 minuta, verovatno zbog visoke rastvorljivosti aktivne supstance i izražene hidratacije polimernog filma. Rezultati potvrđuju da izbor eksperimentalnih uslova može značajno uticati na procenu bioperformansi filmova i zaključke o uticaju formulacionih parametara na oslobađanje aktivne supstance.

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FTIK-P21 INFLUENCE OF FORMULATION AND HYDRODYNAMIC PARAMETERS ON *IN VITRO* ARBUTIN RELEASE RATE FROM CHITOSAN–HYALURONIC ACID FILMS

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Arbutin is a water-soluble substance used in pharmaceutical and cosmetic products to reduce hyperpigmentation and improve skin tone. Polymeric films are suitable carriers for its topical delivery. However, the lack of standardized methods for evaluating drug release complicates comparisons between results obtained with different experimental approaches. This study evaluated how formulation composition and hydrodynamic conditions influence the *in vitro* release rate of arbutin from chitosan/hyaluronic acid-based films. Films with and without additives (plasticizers and crosslinkers) were examined. Arbutin release was monitored in phosphate buffer (pH 5.5) at 32 °C using systems with different mixing patterns (rotational or oscillatory) and varying film surface area-to-medium volume ratios. Arbutin concentration was determined using a validated UV-Vis spectrophotometric method ($R^2 > 0.999$). The results showed that hydrodynamic conditions significantly affected the release profile of arbutin and the method's ability to distinguish between formulations of different compositions. Under conditions with greater dilution (medium volume ≥ 150 mL), arbutin concentrations in some samples were close to or below the limit of quantification, making formulation comparison difficult. In contrast, at lower medium volumes, formulation-dependent differences were much more pronounced, especially during the initial stage of release. For all formulations tested, most of the incorporated arbutin was released within the first 10–15 minutes, likely due to its high aqueous solubility and rapid hydration of the polymeric film. These findings confirm that the choice of experimental conditions can significantly influence the evaluation of film bioperformance and the conclusions regarding the impact of formulation parameters on drug release.

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FTIK-P22 UTICAJ SMEŠA ARAPSKE GUME I AGARA NA STABILNOST, DISPERZNA I REOLOŠKA SVOJSTVA EMULZIJA TIPA ULJE U VODI

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Emulzije se često koriste u farmaceutskoj, kozmetičkoj, hemijskoj i prehrambenoj industriji. Cilj ovog rada je bio da se utvrdi mogućnost dobijanja stabilnih emulzija tipa ulje u vodi pomoću arapske gume (ARG) i agara (AG), kao i da se ispitaju njihova fiizičkohemijska svojstva.

Emulzije su sadržale 10% ARG (m/m) i različite koncentracije AG (0–0,4% m/m). Suncokretovo ulje je korišćeno u koncentraciji od 30% (m/m). Emulzije su pripremljene na 25 °C mešanjem uljane i vodene faze, koja je sadržala dispergovanu ARG i AG, pomoću propelerske mešalice na 2000 o/min tokom 15 min. Potom su homogenizovane rotor–stator homogenizatorom 30 min na 10.000 o/min i mešane 5 min na 2000 o/min.

Merenja površinskog napona su ukazala da ne postoje privlačna međudejstva između ARG i AG na granici faza vazduh/voda i u unutrašnjosti vodene faze. Stabilnost emulzija prema raslojavanju faza (eng. *creaming*) rasla je sa porastom koncentracije AG. Emulzije koje su sadržale više od 0,1% AG nisu pokazale vidljiv kriming tokom dve nedelje skladištenja na sobnoj temperaturi. Sauterov srednji prečnik i širina raspodele veličina čestica su se smanjivali sa povećanjem koncentracije AG do 0,1% zbog porasta viskoznosti i sprečavanja rekoalescencije. Ovi parametri su se blago povećavali na koncentracijama većim od 0,1% AG usled visoke viskoznosti, odnosno smanjenja efikasnosti homogenizacije. Reološka ispitivanja su pokazala pseudoplastično ponašanje ispitivanih emulzija i viskoelastična svojstva emulzije sa 0,4% AG.

Zaključeno je da se pomoću 10% ARG i 0,2-0,4% AG mogu dobiti stabilne emulzije, povoljnih fizičkohemijskih svojstava.

FTIK-P22 INFLUENCE OF GUM ARABIC AND AGAR MIXTURES ON THE STABILITY, DISPERSE AND RHEOLOGICAL PROPERTIES OF OIL-IN-WATER EMULSIONS

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Emulsions are frequently used in the pharmaceutical, cosmetic, chemical, and food industries. This study aimed to evaluate the feasibility of preparing stable oil-in-water emulsions using gum arabic (GA) and agar (AG), as well as to investigate their physicochemical properties.

The emulsions contained 10% (w/w) GA and different concentrations of AG (0–0.4%, w/w). Sunflower oil was used at a concentration of 30% (w/w). Emulsions were prepared at 25 °C by mixing the oil phase and the aqueous phase, containing dispersed GA and AG, using a propeller mixer at 2000 rpm for 15 min. Emulsions were then homogenized with a rotor–stator homogenizer at 10,000 rpm for 30 min, and mixed at 2000 rpm for 5 min.

Surface tension measurements indicated the absence of attractive interactions between GA and AG at the air–water interface and within the aqueous phase. The creaming stability of the emulsions increased with increasing AG concentration. Emulsions containing more than 0.1% AG exhibited no visible creaming during two weeks of storage at room temperature. The Sauter mean diameter and particle size distribution width decreased with increasing AG concentration up to 0.1%, owing to increased viscosity and reduced recoalescence. These parameters increased slightly at AG concentrations above 0.1%, due to high viscosity, which reduced homogenization effectiveness. Rheological investigations showed shear-thinning flow behavior of investigated emulsions, and viscoelastic properties of the emulsion containing 0.4% AG.

It was concluded that stable emulsions, with favorable physicochemical properties, can be prepared using 10% GA and 0.2–0.4% AG.

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FTIK-P23 UTICAJ LIPIDNIH EKSTRAKATA ŽETVENIH OSTATAKA NA STRUKTURNA I TEKSTURNA SVOJSTVA PROIZVODA ZA PRANJE LICA SA NISKIM SADRŽAJEM VODE

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Proizvodi za pranje lica sa niskim sadržajem vode predstavljaju održivu alternativu konvencionalnim formulacijama zahvaljujući smanjenoj potrošnji vode tokom proizvodnje i mogućnosti razvoja samokonzervišućih sistema zasnovanih na multifunkcionalnim sastojcima. Cilj ovog istraživanja bio je da se ispita uticaj lipidnih ekstrakata dobijenih iz žetvenih ostataka pšenice i suncokreta na strukturna i teksturna svojstva proizvoda za čišćenje lica sa niskim sadržajem vode. Pripremljene su formulacije sa pojedinačnim ekstraktima i njihovom kombinacijom, uz ukupno 3% ili 4% ugušćivača i 2% lipidnih ekstrakata. Fizičko-hemijska karakterizacija obuhvatila je određivanje pH vrednosti, provodljivosti, reoloških i teksturnih svojstava. Sve formulacije imale su pH vrednosti pogodne za primenu na koži (5,38–6,60). Relativno niske vrednosti provodljivosti (12–73 μS/cm) ukazivale su na ograničenu zastupljenost kontinuirane hidrofilne faze, što je očekivano za formulacije sa niskim sadržajem vode. Reološka ispitivanja pokazala su da sve formulacije ispoljavaju tiksotropno ponašanje. Dodatak lipidnih ekstrakata značajno je uticao na viskozitet i strukturnu organizaciju sistema, pri čemu je formulacija sa suncokretovim ekstraktom i 4% ugušćivača pokazala najvišu vrednost maksimalnog prividnog viskoziteta (≈55 Pa·s). Teksturna analiza potvrdila je izražen uticaj sastava formulacije na mehanička svojstva sistema. U poređenju sa placebo formulacijama (čvrstina ≈0,20 N; kohezivnost ≈0,03 N; konzistencija ≈2,3 mJ), formulacije sa lipidnim ekstraktima pokazale su povećane vrednosti čvrstine, kohezivnosti i konzistencije, pri čemu su najviše vrednosti zabeležene za formulaciju sa suncokretovim ekstraktom i 4% ugušćivača (≈0,73 N; ≈0,42 N i ≈7,8 mJ). Dobijeni rezultati potvrđuju da tip lipidnog ekstrakta i koncentracija ugušćivača značajno utiču na međusobnu organizaciju sastojaka u formulaciji, kao i na njena mehanička svojstva.

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FTIK-P23 INFLUENCE OF AGRO-WASTE-DERIVED LIPID EXTRACTS ON THE STRUCTURAL AND TEXTURAL PROPERTIES OF WATERLESS FACIAL CLEANSERS

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Waterless facial cleansers offer a sustainable alternative to conventional formulations by reducing water use during manufacturing and enabling the development of self-preserving systems based on multifunctional ingredients. This study investigated the effects of lipid extracts derived from wheat and sunflower crop residues on the structural and textural properties of waterless facial cleansers. Formulations containing individual extracts or their combination were prepared with total thickener concentrations of 3% or 4% and 2% lipid extracts. Physicochemical characterization included measurements of pH, conductivity, rheological, and textural properties. All formulations had pH values suitable for skin application (5.38–6.60). The relatively low conductivity values (12–73 μS/cm) indicated a limited presence of a continuous hydrophilic phase, consistent with the characteristics of waterless formulations. Rheological analysis showed that all formulations exhibited pseudoplastic and thixotropic behavior. Incorporation of lipid extracts significantly affected viscosity and the structural organization of the systems, with the formulation containing sunflower extract and 4% thickener showing the highest maximum apparent viscosity (≈55 Pa·s). Texture analysis confirmed a pronounced effect of formulation composition on the mechanical properties of the systems. Compared with placebo formulations (firmness ≈0.20 N, cohesiveness ≈0.03 N, consistency ≈2.3 mJ), formulations containing lipid extracts showed increased firmness, cohesiveness, and consistency. The highest values were observed for the formulation with sunflower extract and 4% thickener (≈0.73 N, ≈0.42 N, and ≈7.8 mJ, respectively). The results confirm that both lipid extract type and thickener concentration significantly influence the structural organization of the formulation components and the mechanical properties of waterless facial cleansers.

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FTIK-P24 UTICAJ KONCENTRACIJE PANTENOLA NA REOLOŠKA SVOJSTVA U/V KREMOVA

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Savremeni razvoj dermokozmetičkih proizvoda zahteva modifikaciju formulacije bez narušavanja kvaliteta, strukturne stabilnosti i prihvatljivosti proizvoda. Pantenol (INCI: Panthenol) je čest sastojak kozmetičkih proizvoda zbog humektantnog i kondicionirajućeg efekta, čime doprinosi hidrataciji i glatkoći kože. Cilj rada bio je ispitivanje uticaja koncentracije pantenola na reološko ponašanje U/V kremova.

Ispitivani su U/V kremovi sledećeg sastava (INCI): Aqua, Glyceryl Stearate, C12-15 Alkyl Benzoate, Isopropyl Palmitate, Dimethicone, Propylene Glycol, Ceteareth-20, Cetyl Alcohol, Sodium Polyacrylate, Polysorbate 80, Dimethicone/Divinyldimethicone/Silsesquioxane Crosspolymer, Phenoxyethanol, Ethylhexylglycerin, Tocopheryl Acetate i Lactic Acid, sa pantenolom u koncentracijama 0, 2, 4, 6, 8 i 10%. Reološka ispitivanja izvedena su na Haake MARS reometru (Thermo Scientific, Karlsruhe, Nemačka), primenom Z20 DIN cilindrične merne geometrije, pri 22 ± 0,1 °C. Kontinualnom analizom određene su krive tečenja i prividna viskoznost primenom histerezne procedure, dok su oscilatornim ispitivanjima određeni elastični modul (G'), viskozni modul (G") i tan δ u zavisnosti od frekvencije i napona smicanja.

Sve formulacije pokazale su viskoelastično ponašanje sa dominantnom elastičnom komponentom, budući da je G' bio veći od G", a tan δ manji od 1. Sa povećanjem koncentracije pantenola smanjivao se G', što ukazuje na manju otpornost strukture prema deformaciji, kao i prividna viskoznost i početni otpor uspostavljanju toka pri malim brzinama smicanja.

Rezultati ukazuju da povećanje koncentracije pantenola ne menja osnovni viskoelastični karakter U/V kremova, ali dovodi do smanjenja elastičnog modula, prividne viskoznosti i početnog otpora uspostavljanju toka. Ovaj uticaj treba uzeti u obzir pri optimizaciji formulacije dermokozmetičkog proizvoda, dok se željena reološka svojstva obezbeđuju odgovarajućim izborom i koncentracijom reoloških modifikatora.

FTIK-P24 EFFECT OF PANTHENOL CONCENTRATION ON THE RHEOLOGICAL PROPERTIES OF O/W CREAMS

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Development of dermocosmetic products requires formulation modification without compromising quality, structural stability, or product acceptability. Panthenol (INCI: Panthenol) is commonly used for its humectant and skin-conditioning effects, contributing to skin hydration and smoothness. This study investigated the effect of panthenol concentration on the rheological behavior of oil-in-water (O/W) creams.

The investigated O/W creams had the following composition (INCI): Aqua, Glyceryl Stearate, C12-15 Alkyl Benzoate, Isopropyl Palmitate, Dimethicone, Propylene Glycol, Ceteareth-20, Cetyl Alcohol, Sodium Polyacrylate, Polysorbate 80, Dimethicone/Divinyldimethicone/Silsesquioxane Crosspolymer, Phenoxyethanol, Ethylhexylglycerin, Tocopheryl Acetate, and Lactic Acid, with panthenol concentrations of 0, 2, 4, 6, 8, and 10%. Rheological measurements were performed using a Haake MARS rheometer (Thermo Scientific, Karlsruhe, Germany) with a Z20 DIN concentric-cylinder geometry at 22 ± 0.1 °C. Continuous-flow analysis included flow curves and apparent viscosity determined using a hysteresis procedure, while oscillatory measurements included the storage modulus (G'), loss modulus (G"), and tan δ as functions of frequency and shear stress.

All formulations exhibited viscoelastic behavior with a dominant elastic component, as G' exceeded G" and tan δ remained below 1. Increasing panthenol concentration reduced G', indicating lower structural resistance to deformation, and decreased apparent viscosity and initial resistance to flow at low shear rates.

Increasing panthenol concentration did not alter the fundamental viscoelastic character of O/W creams, but reduced the storage modulus, apparent viscosity, and initial resistance to flow. This effect should be considered during formulation optimization in final products, while the desired rheological properties should be ensured by selecting appropriate rheological modifiers and their concentrations.

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FTIK-P25 TEMPERATURE-DEPENDENT RHEOLOGICAL PROPERTIES OF MACROGOL-BASED HYDROPHILIC OINTMENT: IMPLICATIONS FOR MANUFACTURING AND FILLING PROCESS

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Macrogols are widely used pharmaceutical excipients due to their compatibility with numerous APIs, excellent solubilizing capacity, and ability to provide desirable rheological properties. Viscosity and melting point of macrogols are important functionality-related characteristics that influence manufacturing performance and final product quality attributes. Therefore, careful selection of macrogol grades and ratios is essential to achieve the required consistency, spreadability, and flow behaviour.

This study evaluated temperature-dependent rheological properties of macrogol-based ointment to identify the optimal filling temperature as a critical process parameter. The basis consisted of 60% Macrogol 400 and 40% Macrogol 3350. Viscosity measurements were performed using a rotational viscometer with a T-bar spindle at 3 rpm under controlled temperature conditions, while rheological properties were assessed using Anton Paar MCR92 rheometer with plate-plate geometry (PP35 Ti). Samples were analyzed at 25, 30, 35, 40 and 45 °C.

The investigated formulation exhibited pseudoplastic behavior, characterized by a flow behavior index (p) below 1. Rising temperature significantly reduced viscosity (decreased from 771667 at 25°C to 306667 mPa·s at 45 °C) and shear stress, indicating progressive weakening of the ointment's internal structure and enhanced deformability with lower viscoelastic network strength, improving ointment flow and processing. The flow curve observed at 45 °C was placed lower than at other temperatures, confirming reduced viscosity. However, results show that the ointment has undestroyed elastic behavior with preserved structural integrity in the temperature range 40-45 °C which was identified as optimal for accurate tube filling, compliance with filling mass specifications and acceptable final product texture and appearance.

FTIK-P26 ISPITIVANJE STABILNOSTI MAGISTRALNIH PREPARATA SA LIDOKAINOM I PRILOKAINOM

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U dermatološkoj praksi postoji česta potreba za primenom preparata sa lokalnim anestetičkim dejstvom koji sadrže kombinaciju lidokaina i prilokaina u različitim koncentracijama, koje nisu dostupne u obliku gotovih lekova. U radu je sprovedeno ispitivanje fizičkohemijske stabilnosti magistralnih preparata za primenu na koži sa 5% lidokaina i 7% prilokaina. Prilikom mešanja ove dve aktivne supstance nastaje eutektička smeša, tj. dolazi do likvefakcije, što može olakšati njihovo inkorporiranje u odgovarajuću podlogu na sobnoj temperaturi. U cilju izbora podloge sprovedeno je ispitivanje uzoraka pripremljenih sa *Unguentum emolliens* (MF 2008) i komercijalno dostupnim podlogama Versatile™ Rich i Pentravan®. Stabilnost uzoraka procenjena je na osnovu organoleptičkih osobina, pH vrednosti, provodljivosti i centrifugiranjem uzoraka čuvanih u frižideru (4°C) i na sobnoj temperaturi (25°C) tokom 21 dana. Sva tri uzorka zadržala su karakterističan miris i boju, ali su uočene izvesne razlike u homogenosti. Inicijalne provodljivosti iznosile su 0,0 µS/cm (*Unguentum emolliens*), 220 µS/cm (Versatile™ Rich) i 287 µS/cm (Pentravan®). pH vrednosti uzoraka bile su: 9,2, 8,1 i 7,8 istim redom. Nakon 21 dana, nije došlo do većih promena pH vrednosti i provodljivosti uzoraka, bez obzira na uslove čuvanja. Nakon centrifugiranja, uočeno je razdvajanje faza kod uzoraka izrađenih sa podlogama *Unguentum emolliens* i Pentravan®, dok su uzorci izrađeni sa podlogom Versatile™ Rich ostali homogeni. Dobijeni rezultati ukazuju da uzorci pripremljeni primenom komercijalne podloge Versatile™ Rich pokazuju najbolji profil fizičkohemijske stabilnosti te se ova podloga može koristiti kao za izradu magistralnog preparata sa 5% lidokaina i 7% prilokaina.

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FTIK-P26 INVESTIGATION OF THE STABILITY OF EXTEMPORANEOUS PREPARATIONS WITH LIDOCAINE AND PRILOCAINE

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There is a frequent need in dermatological practice for local anesthetic preparations which contain combinations of lidocaine and prilocaine in different concentrations, but no such products are commercially available. In this study, investigation of physicochemical stability of extemporaneously prepared topical creams containing 5% of lidocaine and 7% of prilocaine was performed. When these two local anesthetics are mixed, a liquid eutectic mixture is formed, which could facilitate their incorporation in an appropriate semisolid basis at room temperature. In order to determine the most suitable basis, the samples were prepared using *Unguentum emolliens* (MF 2008), and commercially available bases Versatile™ Rich and Pentravan®. Stability of the samples was evaluated by examination of organoleptic properties, determination of pH, conductivity, and via centrifugation over 21 days at 4°C and 25°C. The tested samples retained their characteristic smell and color, but changes in homogeneity were observed. The initial conductivity values for the samples with *Unguentum emolliens*, Versatile™ Rich and Pentravan® were 0.0 µS/cm, 220 µS/cm and 287 µS/cm, respectively, while pH values were 9,2, 8,1 and 7,8 respectively. After 21 days, no significant changes in pH and conductivity regardless of the storage conditions were recorded. After centrifugation, phase separation occurred in the samples prepared with *Unguentum emolliens* and Pentravan® bases, while the samples prepared with Versatile™ Rich remained homogeneous. The obtained results indicate that samples prepared using Versatile™ Rich showed the best physicochemical stability profile and that this basis could be used compounding of topical preparation with 5% lidocaine and 7% prilocaine.

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FTIK-P27 BEZBEDNOST TOPIKALNIH PROIZVODA SA BETA-HIDROKSI KISELINAMA KOJI SE NE ISPIRAJU I PRODAJU SE PREKO INTERNETA

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Beta-hidroksi kiseline (BHA), kao što su salicilna kiselina (SA) i betain salicilat (BSA), se koriste u mnogim topikalnim proizvodima koji se ne ispiraju. Cilj rada je bio da se utvrde sastav i potencijalna bezbednost proizvoda za lice sa BHA koji se ne ispiraju i prodaju se putem platforme Amazon.com.

Platforma je pretražena korišćenjem pojma „BHA *leave-on face product*“, a rezultati filtrirani opcijom „*best-seller*“. SA je bila najzastupljenija BHA. Od 40 najbolje rangiranih proizvoda, 32 su sadržala SA. Većina proizvoda (17) je sadržala SA u koncentraciji od 2%, dok je jedan proizvod sadržao višu koncentraciju (9%). Maksimalna dozvoljena koncentracija SA u kozmetičkim proizvodima koji se nanose na kožu u Evropskoj uniji i Srbiji iznosi 2%. U Sjedinjenim Američkim Državama (SAD) koncentracija SA u kozmetičkim proizvodima nije regulatorno ograničena, dok je maksimalna dozvoljena koncentracija SA u topikalnim lekovima za tretman akni koji se izdaju bez recepta (OTC lekovi) 2%. Kozmetički proizvodi i OTC lekovi se u SAD mogu prodavati putem različitih internet platformi, a ne samo preko ovlašćenih internet apoteka.

Od analiziranih proizvoda, 17 je sadržalo BHA zajedno sa alfa-hidroksi kiselinama (AHA), a osam topikalnih proizvoda je imalo AHA, BHA i polihidroksi kiseline. Trinaest proizvoda sa AHA je sadržalo upozorenje o povećanom riziku od opekotina od sunčevog zračenja, dok dvanaest nije imalo ovu informaciju.

Može se zaključiti da analizirani topikalni proizvodi sadrže uglavnom SA, pri čemu se BHA najčešće kombinuju sa AHA. Rezultati ukazuju na potrebu za savetodavnom ulogom farmaceuta pri izboru topikalnih proizvoda i informisanju korisnika o njihovoj bezbednoj primeni.

FTIK-P27 SAFETY OF BETA HYDROXY ACID-CONTAINING LEAVE-ON TOPICAL PRODUCTS SOLD ONLINE

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Beta-hydroxy acids (BHAs), such as salicylic acid (SA) and betaine salicylate (BSA), are used in many leave-on topical products. The aim of this study was to determine the composition and potential safety of leave-on BHA-containing facial products sold on the Amazon.com platform.

The platform was searched using the term “BHA leave-on face product”, and the results were filtered using the “best-seller” option. SA was the most prevalent BHA. Of 40 top-ranked products, 32 contained SA. Most products (17) had SA at a concentration of 2%, while one product had a higher concentration (9%). The maximum allowed concentration of SA in cosmetic products for skin application in the European Union and Serbia is 2%. In the United States (US), the concentration of SA in cosmetic products is not subject to a specific regulatory limit, while the maximum allowed concentration of SA in over-the-counter (OTC) topical acne drug products is 2%. In the US, cosmetic products and OTC drugs can be sold on various online platforms, and not only through authorized online pharmacies.

Of the analyzed products, 17 contained BHAs together with alpha-hydroxy acids (AHAs), while eight topical products contained AHAs, BHAs, and polyhydroxy acids. Thirteen products with AHAs included a sunburn alert, whereas twelve lacked this information.

It can be concluded that the analyzed topical products contain mainly SA, with BHAs most frequently combined with AHAs. The results indicate the need for the pharmacists´ advisory role in selecting topical products and informing users on their safe use.

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FTIK-P28 PROCENA POTENCIJALA ZA UVOĐENJE NOVOG KOZMETIČKOG PROIZVODA U PORTFOLIO

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Uvođenje novog kozmetičkog proizvoda u portfolio kompanije podrazumeva potencijalne rizike koje je potrebno pažljivo proceniti primenom multidisciplinarnog pristupa. U prikazanoj studiji slučaja sprovedena je analiza situacije koja je obuhvatila istraživanje tržišta, identifikaciju kozmetičkog proizvoda specifičnog tehnološkog dizajna, stručnu procenu njegovog sastava i aspekta bezbednosti, kao i regulatornu procenu. Kako bi se obezbedila podrška donošenju odgovarajuće poslovne odluke i procenilo da li bi izabrani kozmetički proizvod namenjen ublažavanju simptoma umornih nogu mogao da obezbedi tržišnu diferencijaciju u odnosu na postojeće proizvode, sprovedena je SWOT analiza. Na osnovu analize tržišta, identifikovan je komercijalno dostupan kozmetički proizvod koji sadrži diosmin, pantenol, mentol i sorbitol, u obliku aerosol sistema, odnosno pene sa efektom pucketanja (engl. *crackling foam*).

Kao glavne prednosti, odnosno snage identifikovano je specifično iskustvo prilikom primene, privlačna senzorijelna svojstva i jednostavna upotreba na osnovu kojih se proizvod jasno diferencira u odnosu na konvencionalne proizvode za negu kože nogu. Potencijalne slabosti obuhvatile su nedovoljno prethodno iskustvo potrošača u primeni proizvoda ovog tipa, zbog čega su potrebna detaljna objašnjenja, kao i specifična formulacija i pakovanje, praćeni visokim troškovima proizvodnje. Identifikovane su mogućnosti za postizanje prepoznatljivosti novog kozmetičkog proizvoda zasnovanog na tehnologiji pene sa efektom pucketanja, u odnosu na komercijalno dostupne gelove i kremove, kao i proširenje porfolija drugim kozmetičkim proizvodima zasnovanim na istoj tehnologiji. Kao pretnja, prepoznat je značaj navođenja odgovarajućih tvrdnji o proizvodu, njegova kategorizacija i formiranje cene.

Uspešno uvođenje novog kozmetičkog proizvoda na tržište zavisiće od postigute prihvatljivosti izabranog proizvoda za potrošače, zasnovane na prepoznatoj dodatnoj vrednosti, uz pažljivo osmišljenu marketinšku strategiju.

FTIK-P28 ASSESSING THE POTENTIAL FOR INTRODUCING A NEW COSMETIC PRODUCT INTO THE PORTFOLIO

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Introducing a new cosmetic product into a company portfolio involves potential risks that should be carefully assessed using a multidisciplinary, risk-based approach. In the presented case study, a situation analysis was conducted, including market research, identification of the product's specific technological design, expert evaluation of its composition and safety aspects, and regulatory assessment. A SWOT analysis was subsequently performed to support decision-making and determine whether a commercially available cosmetic product intended to relieve symptoms associated with heavy legs could provide meaningful technological and market differentiation to the existing portfolio. Based on the analysis of the competitive personal care market, a commercially available product containing diosmin, panthenol, menthol and sorbitol, featuring crackling foam aerosol technology was identified.

Distinctive application experience, sensory appeal and convenience of use were identified as the main strengths which could differentiate the product from conventional gels and creams. The perceived weaknesses included consumers unfamiliarity with crackling products which may require additional explanation and demonstration, as well as the formulation and packaging complexity associated with the higher production costs. The identified opportunities included the potential to stand out in a domestic market predominantly supplied by conventional gels and creams, and the potential for product-line extension to other cosmetic products based on crackling foam technology. The main threats were related to the setting of relevant product claims, product categorization/classification and pricing.

Successful market introduction will depend on demonstrating that the selected product offers meaningful consumer value beyond novelty, supported by a carefully designed marketing approach.

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FTIK-P29 IZRADA ORALNO-DISPERZIBILNIH "TABLETA IZ ŠPRICA" POGODNIH ZA PRILAGOĐAVANJE DOZE KOD POSEBNIH GRUPA PACIJENATA: PRIMENA 3D ŠTAMPANJA METODOM EKSTRUZIJE POLUČVRSTOG MATERIJALA

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Trodimenzionalna štampa predstavlja fleksibilan pristup za izradu farmaceutskih oblika lekova prilagođenih potrebama pacijenata, posebno u pogledu mogućnosti prilagođavanje doze. Oralno-disperzibilne tablete izrađene ovim pristupom pružaju dodatnu prednost jer olakšavaju primenu leka kod pacijenata sa otežanim gutanjem. Cilj ovog rada bio je izrada oralno-disperzibilnih „tableta iz šprica" pogodnih za prilagođavanje doze, primenom 3D štampanja metodom ekstruzije polučvrstog materijala.

U radu je korišćen Ultimaker 2+ štampač. U početnoj fazi ispitivane su placebo formulacije koje su sadržale različita sredstva za raspadanje, sredstva za dopunjavanje i različite odnose polimera, sredstva za raspadanje i tečne faze, u pogledu konzistencije i homogenosti smeše, mogućnosti štampanja, izgleda i raspadljivosti tableta. Ispitivan je i uticaj parametara štampanja, dimenzija tableta, geometrije i obrazaca štampanja na uspešnost metode. Optimalna placebo formulacija (5% PVP-a, 25% laktoze, 15% Desintequick-a, 15% Parteck-a i 40% tečne faze) korišćena je za štampanje tableta oblika cilindra i trougla. Laktoza je zatim zamenjena propranololom. Dobijene tablete su ispitivane u pogledu mase, dimenzija, friabilnosti, otpornosti na deformaciju, vremena raspadanja i sadržaja aktivne supstance. Sve tablete su imale ujednačenu masu i relativno ujednačenu debljinu. Prečnik je najviše varirao (do ±12% u odnosu na srednju vrednost). Sve tablete su ispunile farmakopejski zahtev za raspadljivost (≤ 3 min). Tablete oblika trougla su pokazale veću friabilnost i otpornost na deformaciju, kao i manje ujednačen sadržaj aktivne supstance, u odnosu na cilindrične tablete.

Rezultati ukazuju da optimizovana formulacija tableta oblika cilindra i primenjena metoda štampanja predstavljaju fleksibilan pristup za izradu malih serija oralno-disperzibilnih tableta sa mogućnošću prilagođavanja doze.

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FTIK-P29 PREPARATION OF ORODISPERSIBLE "TABLETS FROM SYRINGE" SUITABLE FOR DOSE ADJUSTMENT IN SPECIAL PATIENT POPULATIONS: APPLICATION OF SEMI-SOLID EXTRUSION 3D PRINTING

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Three-dimensional printing offers a flexible approach for the preparation of patient-tailored dosage forms, particularly when dose adjustment is required in special patient populations. Orodispersible tablets prepared using this approach may provide an additional advantage by facilitating administration in patients with swallowing difficulties. The aim of this study was to prepare orodispersible "syringe-printed" tablets suitable for dose adjustment using semi-solid extrusion 3D printing.

Printing was performed using an Ultimaker 2+ printer. Initially, different placebo formulations containing various disintegrants, fillers, and ratios of polymer, disintegrant, and liquid phase were evaluated in terms of mass consistency, homogeneity, printability, tablet appearance, and disintegration behavior. The influence of printing parameters, tablet dimensions, geometry, and printing patterns on printing performance was also investigated. The optimized placebo formulation consisted of 5% PVP, 25% lactose, 15% Desintequick, 15% Parteck, and 40% water mixture. This formulation was used to print cylindrical and triangular tablets. Subsequently, lactose was replaced with propranolol as a model drug. The obtained tablets were characterized regarding mass, dimensions, friability, resistance to deformation, disintegration time, and drug content. All tablets showed uniform mass and relatively consistent thickness. Diameter varied the most (up to ±12% deviation from the mean). All tablets met pharmacopoeial disintegration requirement (≤ 3 min). Triangular tablets exhibited higher friability and resistance to deformation, as well as less uniform drug content compared to cylindrical tablets.

This study indicates that the optimized formulation of cylindrical tablets and applied printing method provide a flexible approach for small-batch preparation of dose-adjustable orodispersible tablets.

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FTIK-P30 PRINTABILITY OF POLOXAMER HYDROGELS: INFLUENCE OF POLYMER CONCENTRATION AND NOZZLE DIAMETER ON SEMI-SOLID EXTRUSION 3D PRINTING

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Semi-solid extrusion (SSE) 3D printing is a versatile platform for fabricating personalized solid dosage forms with precise control over geometry and drug loading. Three P407/cefixime hydrogels containing ~20, ~40 and ~43% P407 (FA-1, FA-2 and FA-3) were prepared using the cold method and stored overnight at 4°C. Rheological characterization was performed by amplitude sweep using cone-plate geometry, measuring storage modulus, loss modulus, loss factor, complex viscosity, shear stress and torque. Printability was evaluated by filament formation through 22G and 25G plastic nozzles, followed by tablet printing and visual assessment of edge definition. The study investigated the influence of P407 concentration on rheology and printability. All formulations exhibited viscoelastic gel-like behavior and shear-thinning properties. Among the evaluated rheological parameters, storage modulus and complex viscosity most closely reflected differences in printability. FA-1 showed the lowest storage modulus ($G' \approx 31.2$ kPa) and complex viscosity ($\eta^* \approx 3.1 \times 10^6$ Pa·s), resulting in droplet formation and poorly defined tablets. FA-2 exhibited increased storage modulus ($G' \approx 37.9$ kPa) and complex viscosity ($\eta^* \approx 3.8 \times 10^6$ Pa·s), producing coherent filaments and improved print quality with the 22G nozzle. FA-3 exhibited the highest storage modulus ($G' \approx 95.7$ kPa) and complex viscosity ($\eta^* \approx 9.6 \times 10^6$ Pa·s) within the linear viscoelastic region, producing continuous filaments and well-defined tablets with both nozzles. Overall, P407 concentration played a critical role in determining printability, with FA-2 showing improved printability using the 22G nozzle, while FA-3 maintained excellent filament formation and printability with both nozzle diameters.

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FTIK-P31 ISPITIVANJE UTICAJA RASTVORLJIVOSTI I UDELA AKTIVNE SUPSTANCE NA GELIRAJUĆA SVOJSTVA INSTANT-GELIRAJUĆIH TABLETA

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Instant-gelirajuće tablete (IGT) veoma brzo formiraju gel u kontaktu sa malom količinom tečnosti, pri čemu nastaje masa meke konzistencije koja olakšava gutanje. Cilj rada bio je ispitivanje uticaja rastvorljivosti i udela aktivne supstance (AS) na gelirajuća svojstva IGT.

Kao model AS korišćeni su kofein i ibuprofen (maseni udeo: 10, 20 ili 30%), uz dodatak koprocesovanog ekscipijensa *Ludiflash*, kroskarmeloze-natrijum i magnezijum-aluminometasilikata. IGT sa i bez AS izrađene su metodom direktne kompresije i okarakterisane u pogledu variranja mase, debljine i zatezne čvrstine (TS). Kao pokazatelji gelirajućih svojstava ispitani su stepen apsorpcije vode (SAV) i teksturalne karakteristike uzoraka nakon kvašenja (sila i rad nakon utiskivanja).

Svi uzorci su pokazali prihvatljive mehaničke karakteristike (TS: 0,82–1,15 MPa). Dodatak AS doveo je do smanjenja SAV. Uzorci sa kofeinom pokazali su veći SAV u odnosu na uzorke sa ibuprofenom, pri čemu su u oba slučaja uzorci sa manjim udelom AS pokazali veći SAV (435,9 i 377,4% odnosno 380,3 i 231,5%, za uzorke sa 10 i 30 % kofeina, odnosno ibuprofena, redom). IGT sa kofeinom pokazale su niže vrednosti sile i rada prilikom utiskivanja (0,07–0,11 N, odnosno 0,10–0,14 mJ) u odnosu na placebo uzorak (0,37 N i 0,29 mJ za silu i rad prilikom utiskivanja) i IGT sa ibuprofenom (0,64–0,86 N, odnosno 0,34–0,64 mJ), što ukazuje na lakše kvašenje i mekšu strukturu nastalog gela.

Rastvorljivost i udeo AS u velikoj meri utiču na SAV i teksturalne karakteristike IGT i moraju se pažljivo optimizovati prilikom razvoja preparata prilagođenih potrebama pacijenata sa disfagijom.

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FTIK-P31 AN INVESTIGATION INTO THE MODEL DRUG SOLUBILITY AND CONTENT ON INSTANT-GEL TABLETS GELLING PROPERTIES

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Instant gel tablets (IGTs) rapidly form a gel upon contact with a small volume of liquid and turn into soft, cohesive mass, facilitating swallowing. The aim of this study was to investigate the impact of active pharmaceutical ingredient (API) solubility and content on IGT gelling properties.

Caffeine and ibuprofen were used as model APIs (10, 20, 30% w/w). Formulations contained co-processed excipient *Ludiflash*, croscarmellose sodium, and magnesium aluminometasilicate. Placebo and API-loaded IGTs were prepared by direct compression and characterized in terms of mass uniformity, thickness, and tensile strength (TS). Gelling properties were evaluated based on the water absorption ratio (WAR) and textural properties of the hydrated samples (penetration force and penetration work).

All samples exhibited acceptable mechanical properties (TS: 0.82–1.15 MPa). The API incorporation resulted in a WAR decrease. Caffeine-loaded IGTs exhibited higher WAR than ibuprofen samples. Furthermore, IGTs with lower API content exhibited greater water uptake in both cases (435.9% and 377.4% for formulations containing 10 and 30% caffeine, and 380.3% and 231.5% for formulations containing 10 and 30% ibuprofen, respectively). IGTs containing caffeine exhibited lower penetration force and penetration work (0.07–0.11 N and 0.10–0.14 mJ, respectively) than both the placebo formulation (0.37 N and 0.29 mJ) and ibuprofen-loaded IGTs (0.64–0.86 N and 0.34–0.64 mJ, respectively), indicating favorable hydration and softer gel structure.

The API solubility and content notably impacted the water uptake and textural properties of IGTs and should be carefully optimized in the development of preparations intended for patients with dysphagia.

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FTIK-P32 UTICAJ VRSTE I UDELA KOPROCESOVANIH EKSCIPIJENASA NA FARMACEUTSKO-TEHNOLOŠKE KARAKTERISTIKE ORALNO-DISPERZIBILNIH TABLETA SA IBUPROFENOM

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Oralno-disperzibilne tablete (ODT) omogućavaju olakšanu primenu leka, uz povećanu prihvatljivost za pacijente, pri čemu je optimizacijom formulacije potrebno obezbediti brzu dezintegraciju tableta, uz zadovoljavajuća mehanička svojstva. Cilj rada bio je ispitivanje funkcionalnih karakteristika koprocesovanih ekscipijensa Parteck® ODT i Prosolv® EASYtab, kao i njihov uticaj na farmaceutsko-tehnološke karakteristike ODT sa visokim udelom ibuprofena. Uzorci ODT koji su sadržali 50 ili 70% ibuprofena uz dodatak 50, odnosno 30% koprocesovanog ekscipijensa izrađeni su direktnom kompresijom i okarakterisani u pogledu variranja mase, debljine, friabilnosti, otpornosti na lomljenje i raspadljivosti (prema propisu Ph. Eur).

Svi ispitivani uzorci ispunili su zahteve Ph. Eur. za variranje mase i raspadljivost (ispod 3 minuta), uz prihvatljive vrednosti čvrstine (67–127 N) i zatezne čvrstine (1–1,68 MPa). Međutim, friabilnost ispitivanih uzoraka bila je veća od 1% (1,33 – 2,14%). Uzorci sa većim udelom koprocesovanog ekscipijensa pokazali su nešto kraće vreme dezintegracije (98 s vs. 153 s u slučaju Parteck® ODT; 92 s vs. 108 s u slučaju Prosolv® EASYtab). Iako je koprocesovani ekscipijens Parteck® ODT namenjen za izradu ODT pokazao bolju protočnost, uzorci koji su sadržali Prosolv® EASYtab pokazali su manju friabilnost i kraće vreme dezintegracije. Ovakvi rezultati u skladu su sa činjenicom da Prosolv® EASYtab predstavlja "*all-in-one*" kompozitni material koji sadrži mikrokristalnu celulozu kao sredstvo za dopunjavanje, uz dodatak sredstva za klizanje, superdezintegratora i lubrikansa.

Dobijeni rezultati pokazuju da je primenom koprocesovanih ekscipijenasa moguće izraditi ODT sa visokim udelom ibuprofena. Prosolv EASYtab pokazao je veći kapacitet razblaženja i omogućio izradu ODT povoljnijih karakteristika.

FTIK-P32 INFLUENCE OF THE TYPE AND PROPORTION OF CO-PROCESSED EXCIPIENTS ON THE PHARMACEUTICAL-TECHNOLOGICAL CHARACTERISTICS OF IBUPROFEN ORODISPERSIBLE TABLETS

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Orodispersible tablets (ODTs) facilitate drug administration and improve patient acceptability. However, formulation optimization is required to ensure rapid tablet disintegration while maintaining adequate mechanical properties. The aim of study was to evaluate functional characteristics of co-processed excipients Parteck®ODT and Prosolv®EASYtab, as well as their influence on the pharmaceutical-technological properties of ODTs containing high proportion of ibuprofen. ODT formulations containing 50 or 70% ibuprofen and 50 or 30% co-processed excipient, respectively, were prepared by direct compression and characterized in terms of mass uniformity, tablet thickness, friability, resistance to crushing, and disintegration time (according to Ph. Eur.).

All investigated formulations complied with the Ph. Eur. specifications for mass uniformity and disintegration time (below 3 minutes), exhibiting acceptable resistance to crushing (67–127 N) and tensile strength (1.00–1.68 MPa). However, friability of all tested formulations exceeded 1% (1.33–2.14%). Formulations containing higher proportion of co-processed excipient exhibited shorter disintegration times (98 s vs. 153 s for Parteck®ODT; 92 s vs. 108 s for Prosolv®EASYtab). Although the co-processed excipient Parteck®ODT, specifically designed for ODT manufacturing, demonstrated superior flowability, formulations containing Prosolv®EASYtab exhibited lower friability and shorter disintegration times. These findings are consistent with the fact that Prosolv®EASYtab is an "all-in-one" composite excipient containing microcrystalline cellulose as a filler, together with a glidant, superdisintegrant, and lubricant.

The obtained results indicate that use of co-processed excipients enables successful formulation of ODTs with high ibuprofen load. Prosolv®EASYtab demonstrated greater dilution potential and enabled preparation of ODTs with more favorable pharmaceutical-technological characteristics.

FTIK-P33 PATIENT-CENTRIC DEVELOPMENT OF SUGAR-FREE PEDIATRIC ORAL SOLUTION: IMPACT OF FLAVOR, pH AND PRESERVATIVE CONCENTRATION ON PRODUCT QUALITY

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The development of pediatric oral liquid formulations requires attaining acceptable palatability, safety, and product quality. Sugar-free formulations are particularly important for minimizing the risk of dental caries and adverse metabolic effects. The aim of this study was to develop a sugar-free pediatric oral solution containing a cough suppressant API through optimization of flavor, pH and preservative concentration while ensuring physicochemical stability and effective antimicrobial preservation.

The formulation was developed using sucralose as sweetener, hypromellose as viscosity modifier, citric acid monohydrate and sodium citrate dihydrate as buffering agents and potassium sorbate as preservative. Multiple sugar-free flavors suitable for pediatric use were evaluated in palatability study assessing taste pleasantness, sweetness balance, aftertaste, and odor acceptability. Their impact on formulation stability was assessed through appearance, pH, viscosity, and impurity profile. In parallel, 13 formulations containing potassium sorbate in concentrations up to 3.6 mg/mL at different pH values (5.0-5.5) were evaluated using the antimicrobial preservative efficacy testing in accordance with European Pharmacopoeia.

Apricot flavor demonstrated the most favorable palatability profile while maintaining formulation stability. Potassium sorbate efficacy exhibits a strong dependence on pH and concentration, demonstrating reduced antifungal performance at 1.0–2.0 mg/mL under pH 5.5. Optimal fungal reduction required 2.4 mg/mL at pH 5.5, compared to an effective threshold of 1.5 mg/mL at pH 5.0, with formulation optimization successfully meeting pharmacopoeial antimicrobial preservation requirements.

The present study demonstrates that systematic optimization of flavor, pH and preservative concentration is critical in development of a sugar-free pediatric oral solution meeting physicochemical, microbiological, and palatability requirements.

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FTIK-P34 MUKOADHEZIVNE LOZENGE SA EKSTRAKTOM PLODA *ARISTOTELIA CHILENSIS* (MAQUI BERRY): RAZVOJ I FARMACEUTSKO-TEHNOLOŠKA KARAKTERIZACIJA

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Razvoj farmaceutskih oblika sa biljnim ekstraktima predstavlja formulacioni izazov zbog njihovih specifičnih fizičko-hemijskih osobina i potencijalnog uticaja na tehnološke karakteristike gotovog proizvoda. Ekstrakt maki bobica (engl. *maqui berry extract*, MBE) pokazao je antivirulentno delovanje protiv *Candida albicans* inhibicijom filamentacije u prethodno sprovedenim pretkliničkim ispitivanjima.

Cilj rada bio je razvoj i farmaceutsko-tehnološka karakterizacija mukoadhezivnih lozengi sa MBE namenjenih produženom kontaktu sa oralnom sluznicom.

Pripremljeno je sedam formulacija mukoadhezivnih lozengi sa 30 mg i 60 mg MBE metodom direktne kompresije. Razvijen je blago efervescentni („*fuzzy*“) sistem koji tokom otapanja u usnoj duplji formira gel. Mukoadhezivnost je postignuta primenom ksantan gume (do 21%). Karakterizacija formulacija obuhvatila je određivanje prosečne mase, čvrstine, friabilnosti i mukoadhezivnih svojstava lozengi i njihovih disperzija u veštačkoj salivi. Mukoadhezija je ispitana primenom analizatora teksture EZ-LX (Shimadzu, Japan) određivanjem maksimalne sila odvajanja (F_{max}) i rada adhezije. Za statističku analizu rezultata mukoadhezije primenjena je jednofaktorska ANOVA uz *Bonferroni post hoc* test, sa statističkom značajnošću na nivou $p < 0,05$.

Većina formulacija pokazala je zadovoljavajuće farmaceutsko-tehnološke karakteristike i mogućnost uspešne inkorporacije MBE. Koncentracija ksantan gume značajno je uticala na tehnološke karakteristike i mukoadhezivnost lozengi. Prosečna masa lozengi iznosila je 772,7-964,8 mg, čvrstina 9,3-16,4 kP, a friabilnost 0,31-3,5%. Vrednosti F_{max} za lozenge bile su 0,296-0,762 N, uz rad adhezije od 0,058-0,138 mJ. Kod disperzija, F_{max} se kretao od 0,006-0,023 N, dok je rad adhezije iznosio 0,028-0,152 mJ. Formulacija L6, koja sadrži 21% ksantan gume, izdvojila se kao optimalna, pokazujući odgovarajuća farmaceutsko-tehnološka i mukoadhezivna svojstva i potencijal za lokalnu primenu MBE u usnoj duplji.

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FTIK-P34 MUCOADHESIVE LOZENGES CONTAINING *ARISTOTELIA CHILENSIS* FRUIT (MAQUI BERRY) EXTRACT: DEVELOPMENT AND PHARMACEUTICAL-TECHNOLOGICAL CHARACTERIZATION

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Development of pharmaceutical dosage forms containing botanical extracts remains challenging due to their specific physicochemical properties and impact on product performance. In previous preclinical studies, Maqui Berry Extract (MBE) demonstrated antivirulence activity against *Candida albicans* by inhibiting filamentation.

The aim of this study was development and pharmaceutical-technological characterization of mucoadhesive lozenges containing MBE for prolonged contact with the oral mucosa.

Seven mucoadhesive lozenge formulations containing 30 or 60 mg of MBE were prepared by direct compression. A mildly effervescent, “fuzzy” system, forming a gel upon dissolution in the oral cavity was developed. Mucoadhesion was achieved using xanthan gum (up to 21%). Formulations were evaluated for weight variation, hardness, friability, and mucoadhesive properties of both the lozenges and their dispersions in artificial saliva. Mucoadhesion was evaluated using an EZ-LX texture analyzer (Shimadzu, Japan) by measuring the maximum detachment force (F_{max}) and work of adhesion. Mucoadhesion data were analyzed using one-way ANOVA followed by Bonferroni post hoc test ($p < 0.05$).

Most formulations exhibited satisfactory pharmaceutical-technological characteristics and successful MBE incorporation. Xanthan gum concentration significantly affected technological properties and mucoadhesion. Lozenge mass ranged from 772.7-964.8 mg, hardness from 9.3-16.4 kP, and friability from 0.31%-3.5%. F_{max} and work of adhesion values ranged from 0.296–0.762 N and 0.058–0.138 mJ for lozenges, and from 0.006–0.023 N and 0.028–0.152 mJ for their dispersions, respectively. Formulation L6, containing 21% xanthan gum, was the optimal formulation, demonstrating suitable pharmaceutical-technological and mucoadhesive properties and potential for local delivery of MBE in the oral cavity.

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FTIK-P35 SAVREMENI MUKOADHEZIVNI FARMACEUTSKI OBLICI ZA LOKALNU TERAPIJU ORALNE KANDIDIJAZE: PREGLED ISTRAŽIVANJA OBJAVLJENIH OD 2020. GODINE

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Oralna kandidijaza predstavlja jednu od najčešćih gljivičnih infekcija usne duplje, a ograničenja konvencionalnih terapijskih pristupa podstakla su razvoj mukoadhezivnih farmaceutskih oblika za lokalnu primenu sa ciljem produženog zadržavanja na mestu primene, poboljšanja lokalne bioraspoloživosti i postizanja kontrolisanog oslobađanja lekovitih supstanci. Cilj ovog rada bio je pregled i analiza istraživanja objavljenih od 2020. godine koja se bave razvojem mukoadhezivnih preparata za terapiju oralne kandidijaze. Literatura je prikupljena primenom *text mining*-a kroz pretragu baza naučnih časopisa i filtriranje publikacija prema ključnim rečima. Analizirani radovi ukazuju da su mukoadhezivni filmovi najzastupljeniji farmaceutski oblik, dok se u manjoj meri razvijaju bukalne tablete, hidrogelovi, film-formirajući sprejevi i sistemi zasnovani na mikro- i nanonosačima. Među aktivnim supstancama dominiraju azolni antimikotici, prisutni u 35,7% formulacija, pri čemu su mikonazol i flukonazol bili najzastupljeniji pojedinačni lekovi (po 14,3%). Pored konvencionalnih antimikotika, novija istraživanja uključuju prirodna jedinjenja, antimikrobne peptide, probiotike i prenamenu postojećih lekova, poput atorvastatina. Analiza polimernih nosača pokazala je da su najčešće korišćeni hitozan i hidroksipropilmetilceluloza, zastupljeni u 21,4% formulacija, zatim pektin i ksantan guma (po 17,9%), kao i hijaluronska kiselina i natrijum-alginat (po 14,3%). Polivinilalkohol bio je prisutan u 10,7% formulacija, uglavnom u kombinaciji sa drugim polimerima radi poboljšanja mehaničkih svojstava i stabilnosti leka. Savremeni trendovi obuhvataju primenu lipidnih nanočestica, liposoma, mikročestica i 3D štampanih filmova. Rezultati analiziranih studija pokazuju da izbor polimera predstavlja jedan od ključnih faktora koji određuje mukoadhezivnost, mehaničku otpornost, sposobnost bubrenja i profil rastvaranja lekovite supstance, dok integracija naprednih nosača doprinosi unapređenju efikasnosti lokalne terapije oralne kandidijaze.

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FTIK-P35 CONTEMPORARY MUCOADHESIVE DOSAGE FORMS FOR THE LOCAL TREATMENT OF ORAL CANDIDIASIS: A REVIEW OF RESEARCH PUBLISHED SINCE 2020

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Oral candidiasis is one of the most common fungal infections of the oral cavity, and limitations of conventional therapies have encouraged the development of mucoadhesive dosage forms designed to prolong drug residence time at the site of application, improve local bioavailability, and provide controlled drug release. The aim of this study was to review and analyze research published since 2020 on mucoadhesive formulations for the treatment of oral candidiasis. The literature was collected using text mining through searches of scientific databases and filtering publications according to keywords. The analyzed studies indicate that mucoadhesive films are the most investigated dosage form, while buccal tablets, hydrogels, film-forming sprays, and micro- and nanocarrier-based systems are less frequently reported. Azole antifungals predominate among active pharmaceutical ingredients, accounting for 35.7% of formulations, with miconazole and fluconazole as the most studied drugs (14.3% each). In addition to conventional antifungals, recent research includes natural compounds, antimicrobial peptides, probiotics, and drug repurposing strategies (such as atorvastatin). Among polymeric carriers, chitosan and hydroxypropyl methylcellulose were most frequently used (21.4%), followed by pectin, xanthan gum (17.9% each), hyaluronic acid, and sodium alginate (14.3% each). Polyvinyl alcohol (10.7%) was mainly combined with other polymers to improve mechanical properties and formulation stability. Recent advances include lipid nanoparticles, liposomes, microparticles, and 3D-printed films. The reviewed studies demonstrate that polymer selection plays a crucial role in determining mucoadhesive properties, mechanical strength, swelling behavior, and drug-release profiles, while the integration of advanced carrier systems may further enhance the effectiveness of local therapy for oral candidiasis.

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FTIK-P36 MEHANIČKA KARAKTERIZACIJA TABLETA ZA ŽVAKANJE: PROCENA OTPORNOSTI NA LOMLJENJE VS ANALIZA TEKSTURE

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Tablete za žvakanje predstavljaju relativno malo zastupljen farmaceutski oblik, iako imaju značajan potencijal za unapređenje primene lekova kod pedijatrijskih i gerijatrijskih pacijenata, osoba sa disfagijom, kao i u veterinarskoj medicini. Njihova mehanička svojstva potrebno je optimizovati tokom razvoja formulacije kako bi se obezbedila odgovarajuća čvrstina, uz prihvatljivu palatabilnost i mogućnost žvakanja, čime se doprinosi boljoj adherenciji.

Cilj istraživanja bio je sveobuhvatna procena mehaničkih svojstava tableta za žvakanje primenom: (i) standardnog farmakopejskog ispitivanja otpornosti na lomljenje, uz određivanje čvrstine (F), zatezne čvrstine (TS) i indeksa težine žvakanja (CDI), i (ii) instrumentalne analize teksture (TA), kojom su određivani tvrdoća, kohezivnost i gumenost. Ispitano je deset proizvoda tipa tableta za žvakanje sa dozvolom za lek u Republici Srbiji.

Uzorci su se značajno razlikovali po sastavu, masi i dimenzijama, što je uslovilo razlike u ponašanju pri kvašenju, raspadljivosti i mehaničkim svojstvima. Čvrstina tableta bila je 52,5–260,2 N (17,0–199,0 N nakon kvašenja), zatezna čvrstina 0,60–5,88 MPa, a CDI 0,23–1,58 Nm (0,08-1,21 Nm nakon kvašenja). Vrednosti parametara TA bile su 1,82–70,39 N za tvrdoću, 0,03–0,90 za kohezivnost i 0,17–63,07 N za gumenost. Višestruka regresiona analiza pokazala je da je kohezivnost najznačajniji parameter za predviđanje vrednosti CDI, kao i da je na osnovu vrednosti parametara analize teksture moguće uspešno predvideti CDI (R^2=0,91). Dobijeni rezultati ukazuju da standardno ispitivanje otpornosti na lomljenje i analiza teksture pružaju komplementarne informacije od značaja za razvoj tableta za žvakanje i određivanje vrednosti CDI kao kritičnog svojstva kvaliteta tableta za žvakanje.

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FTIK-P36 COMPARATIVE ASSESSMENT OF CHEWABLE TABLET MECHANICAL PROPERTIES USING BREAKING FORCE METRICS AND TEXTURE ANALYSIS

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Chewable tablets remain an underutilized dosage form despite their potential to improve medicines administration in paediatric and geriatric patients, individuals with dysphagia, and veterinary medicine. Their mechanical properties should be carefully optimized to provide sufficient strength for handling while ensuring acceptable chewability and palatability, thereby promoting patient adherence.

The aim of the study was to perform comprehensive evaluation of the mechanical properties of chewable tablets using: (i) standard pharmacopoeial testing based on tablet crushing and relevant metrics, including breaking force (F), tensile strength (TS) and chewing difficulty index (CDI), and (ii) instrumental texture analysis (TA) assessing hardness, cohesiveness, and gumminess. Ten chewable tablet products with marketing authorization in the Republic of Serbia have been evaluated.

The investigated samples differed greatly with respect to their composition, weight and size resulting in differences in tablet wetting, disintegration and mechanical properties. Tablet breaking force was in the range 52.5-260.2 N (17.0-199.0 N upon wetting), TS 0.60-5.88 MPa, and CDI 0.23-1.58 Nm (0.08-1,21 Nm upon wetting). TA parameter values ranged from 1.82 to 70.39 N for hardness, from 0.03 to 0.90 for cohesiveness, and from 0.17 to 63.07 N for gumminess. Multiple regression analysis identified tablet cohesiveness as the strongest predictor of CDI, and that CDI may be successfully predicted using TA parameter values (R^2=0.91). The findings indicate that tablet breaking force testing and texture analysis provide complementary information useful for chewable tablet formulation development and assessment of CDI as a chewable tablet critical quality attribute.

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FTIK-P37 PERSONALIZOVANA FARMAKOTERAPIJA PEDIJATRIJSKIH PACIJENATA U BOLNIČKOJ PRAKSI: *UNLICENSED* I *OFF-LABEL* PRIMENA MAGISTRALNIH I GALENSKIH LEKOVA

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Farmakoterapija pedijatrijskih pacijenata često zahteva individualno prilagođavanje doze i farmaceutskog oblika leka, jer odgovarajući registrovani lekovi nisu uvek dostupni. Cilj rada bio je da se analiziraju magistralni i galenski lekovi koji se primenjuju kod pedijatrijskih pacijenata u Institutu za zdravstvenu zaštitu majke i deteta Srbije, sa posebnim osvrtom na *unlicensed* i *off-label* primenu.

Analiza je obuhvatila je 37 preparata iz bolničke prakse, od kojih je 17 klasifikovano kao *unlicensed*, a 20 kao *off-label*. Preparati su razvrstani prema farmaceutskom obliku, indikaciji, starosnoj grupi i vrsti odstupanja od odobrenih informacija o leku. Praksa primene u Institutu upoređena je sa podacima iz međunarodne literature.

Najzastupljeniji su bili farmaceutski oblici za oralnu primenu. Među *unlicensed* preparatima, oralne suspenzije činile su 47%, oralni praškovi 29%, a oralni rastvori 24%. Među *off-label* preparatima, oralne suspenzije činile su 45%, oralni praškovi 40%, dok su oralni rastvori, kremovi i masti činili po 5%. Razlozi za primenu najčešće su bile kardiološke indikacije (38%), zatim bakterijske i virusne infekcije i neurološki poremećaji (po 19%), hematološki poremećaji (16%) i metabolički i gastrointestinalni poremećaji (8%). U pogledu učestalosti, tokom jedne nedelje, 76 od 303 propisana leka (25%) primenjeno je kao *unlicensed* ili *off-label*.

Analiza pokazuje da je *unlicensed* i *off-label* propisivanje uobičajena praksa u Institutu, što ukazuje na ključnu ulogu magistralnih i galenskih lekova u zadovoljavanju specifičnih potreba pedijatrijskih pacijenata. Stoga su potrebne standardizovane formulacije, pristup relevantnim stručnim i naučnim izvorima i sistematičnije praćenje kvaliteta, stabilnosti, bezbednosti pomoćnih supstanci i ishoda terapije radi obezbeđenja bezbednije i efikasnije personalizovane farmakoterapije pedijatrijskih pacijenata.

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FTIK-P37 PERSONALIZED PEDIATRIC PHARMACOTHERAPY IN HOSPITAL PRACTICE: UNLICENSED AND OFF-LABEL USE OF EX TEMPORE AND STOCK PREPARATIONS

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Pediatric pharmacotherapy often requires individualized doses and age-appropriate dosage forms because suitable licensed products are not always available. This study aimed to analyse ex tempore and stock preparations for pediatric patients at the Institute for Mother and Child Healthcare of Serbia, with particular emphasis on unlicensed and off-label use.

A descriptive analysis covered 37 preparations used in hospital practice, of which 17 were classified as unlicensed and 20 as off-label. Preparations were categorized according to dosage form, indication, patient age group, and type of deviation from the approved prescribing information. Practice at the Institute was compared with data from the international literature.

Oral dosage forms predominated. Among unlicensed preparations, oral suspensions accounted for 47%, oral powders for 29%, and oral solutions for 24%. Among off-label preparations, oral suspensions represented 45%, oral powders 40%, while oral solutions, creams and ointments represented 5% each. Cardiological indications were most frequent (38%), followed by bacterial and viral infections and neurological disorders (19% each), hematological disorders (16%), and metabolic and gastrointestinal disorders (8%). In terms of frequency, during one week, 76 of 303 prescribed medicines (25%) involved unlicensed or off-label use.

The findings show that unlicensed and off-label prescribing is common practice at the Institute, highlighting the essential role of ex tempore and stock preparations in meeting the special needs of pediatric patients. Therefore, standardized formulations, access to relevant professional and scientific sources, and more systematic monitoring of quality, stability, excipient safety, and treatment outcomes are needed to support safer and more effective personalized pediatric pharmacotherapy.

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FTIK-P38 ISPITIVANJE STAVOVA FARMACEUTA O SAVREMENIM FARMACEUTSKIM OBLICIMA SA POBOLJŠANOM PRIHVATLJIVOŠĆU ZA PACIJENTE I MOGUĆNOSTIMA NJIHOVE IZRADE U APOTECI

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Potreba za individualizacijom terapije i poboljšanjem adherence podstakla je razvoj farmaceutskih oblika sa poboljšanom prihvatljivošću za pacijente (FOPPP) kao što su oralno-disperzibilne tablete i filmovi, lekovite lizalice i lozenge, koji omogućavaju lakšu primenu i veću fleksibilnost doziranja. Na tržištu je dostupna oprema, pribor i ekscipijensi za izradu ovih lekova u apoteci. Međutim, njihova zastupljenost u praksi je veoma ograničena. Cilj rada bio je ispitivanje stavova farmaceuta o pogodnostima primene FOPPP i mogućnostima njihove izrade u apoteci.

Istraživanje je sprovedeno korišćenjem upitnika koji je obuhvatio 12 pitanja u okviru kojih su učesnici na petostepenoj Likertovoj skali ocenjivali različite aspekte u vezi sa mogućnostima izrade i primenom FOPPP u odnosu na konvencionalne farmaceutske oblike koji se izrađuju u apoteci (podeljeni praškovi, tvrde kapsule, sirupi).

U istraživanju je učestvovao 21 ispitanik (farmaceuti sa završenim doktorskim ili specijalističkim studijama i kandidati upisani na doktorske ili specijalističke studije iz oblasti farmaceutske tehnologije). Dobijeni rezultati ukazuju da, iako prepoznaju pogodnosti FOPPP (Xsr>4,14), učesnici prednost daju konvencionalnim farmaceutskim oblicima koji se izrađuju u apoteci, ocenjujući dostupnost opreme, ekscipijenasa i pakovanja za FOPPP prosečnom ocenom manjom od 3,10, 3,43 i 3,14, redom. Kao najveći izazovi izdvojeni su nedostatak opreme i podrške poslodavaca, nedostatak pomoćnih supstanci, ograničeni podaci o stabilnosti, kao i nedovoljna obuka farmaceuta i lekara. Vrednosti standardne devijacije, koje su kod velikog broja odgovora veće od 1, ukazuju na razlike u stavovima koje se mogu pripisati nedovoljnoj informisanosti i ukazuju na potrebu za ciljanom obukom kao ključnim faktorom za širu implementaciju FOPPP u praksi.

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FTIK-P38 INVESTIGATION OF PHARMACIST PERSPECTIVES ON CONTEMPORARY PATIENT–CENTRIC DOSAGE FORMS AND THEIR COMPOUNDING POTENTIAL

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The increasing need for individualized therapy and improved medication adherence has driven the development of patient-centric dosage forms (PCDFs), such as orodispersible tablets and films, medicated lollipops, and lozenges, which facilitate drug administration and dosing flexibility. Although the equipment, devices, and excipients required for PCDFs compounding are available; however, their implementation remains limited. The aim of this study was to investigate pharmacists' perspectives on patient convenience and the feasibility of PCDFs compounding in pharmacy.

The study was conducted using a 12-item questionnaire designed to assess various aspects of PCDFs compounding and administration, compared with conventionally compounded dosage forms (powders, hard capsules, and syrups) using a five-point Likert scale.

A total of 21 respondents participated in the study, including pharmacists holding PhD or specialist degree, as well as PhD or specialization candidates in pharmaceutical technology. Although participants recognized the benefits of PCDFs (X_{ave}>4.14), results indicated higher preference for conventional dosage forms. The availability of equipment, excipients, and packaging materials required for PCDFs compounding was rated relatively low, with mean scores below 3.10, 3.43, and 3.14, respectively. The major barriers identified were the lack of appropriate equipment and employer support, limited availability of excipients, insufficient stability data, and inadequate training of pharmacists and physicians. Standard deviation values exceeding 1 for a number of responses indicated considerable variability in respondents' opinions, which may reflect limited awareness of PCDFs. These findings highlight the need for education and training as key prerequisite for the broader implementation of patient-centric dosage forms in pharmacy practice.

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FTIK-P39 PRILAGOĐAVANJE DOZE U KOMBINOVANOJ TERAPIJI AZATIOPRINOM I PREDNIZONOM: FARMACEUTSKO-TEHNOLOŠKA PROCENA DELJIVOSTI TABLETA

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Azatioprin i prednizon primenjuju se u lečenju autoimunih i inflamatornih oboljenja gde individualizacija terapije često zahteva prilagođavanje doze. Ovo se u praksi postiže deljenjem tableta, iako to može dovesti do nepouzdanosti doziranja. Cilj rada je ispitivanje farmaceutsko-tehnoloških karakteristika tableta azatioprina i prednizona sa dozvolom za lek u Republici Srbiji i mogućnosti njihovog deljenja.

Ispitana su dva proizvoda azatioprina tipa film tableta (kod jednog deljenje predstavlja *off-label* primenu) i dva proizvoda prednizona u obliku neobloženih tableta. Deljenje tableta izvedeno je ručno, upotrebom sekača i pomoću noža. Dobijeni delovi ispitani su u pogledu variranja mase, gubitka mase i friabilnosti. Kod tableta prednizona od 20 mg, ispitan je sadržaj aktivne supstance u podeljenim tabletama.

Variranje mase podeljenih tableta bilo je u okviru dozvoljenih granica (Ph. Eur), osim u slučaju kada su tablete prednizona deljene na osmine, gde je uočen visok stepen varijabilnosti (CV 8,7-34,4%). Uzorci azatioprin tableta pokazali su uporedive rezultate bez obzira da li je podeona linija namenjena za deljenje ili ne. Sadržaj prednizona u delovima tableta varirao je u rasponu 101-130%, 94-112%, i 68-150% kod uzoraka podeljenih na dva, četiri, odnosno osam delova, redom.

Dobijeni rezultati pokazuju da kod određenih proizvoda deljenje tableta može biti prihvatljivo i u situacijama kada to nije navedeno u dokumentaciji proizvođača. Međutim, podela na veći broj delova nego što je predviđeno podeonim linijama dovodi do visokog stepena varijabilnosti, što je potrebno pažljivo razmotriti prilikom *off-label* primene leka. Praktične smernice za izbor proizvoda i načina deljenja tableta značajno bi doprinele pouzdanosti doziranja i efikasnosti terapije.

FTIK-P39 DOSE ADJUSTMENT IN COMBINATION THERAPY WITH AZATHIOPRINE AND PREDNISONE: PHARMACEUTICAL TECHNOLOGICAL EVALUATION OF TABLET SUBDIVISION

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Azathioprine and prednisone are commonly used in combination for autoimmune and inflammatory diseases management where individualized therapy requires dose adjustments. This is often achieved by tablet subdivision, although it may compromise dose accuracy. The aim of this study was to perform pharmaceutical-technological characterisation of azathioprine and prednisone tablets authorized in the Republic of Serbia and evaluate their divisibility.

Two azathioprine film tablet products (one requiring off-label splitting) and two prednisone uncoated tablet products were investigated. Tablets were divided manually, using a tablet splitter, or with a knife. The resulting tablet parts were evaluated for weight variation, mass loss, and friability. For prednisone 20 mg tablets, drug content in the split-tablet parts was determined.

Weight variation of the split-tablet parts complied with European Pharmacopoeia requirement, except for prednisone tablets divided into eighths, which was associated with high variability (CV 8.7–34.4%). Both azathioprine products demonstrated comparable subdivision performance regardless of whether the score line was intended for tablet splitting. Prednisone content in tablet parts was in the range 101–130%, 94–112%, and 68–150% of the target dose after subdivision into halves, quarters, and eighths, respectively.

The results obtained indicate that subdivision of certain film tablet products may be acceptable even when not indicated by the manufacturer. However, splitting tablets into more parts than intended by the score line may result in substantial dose variability and should be approached cautiously in off-label use. Practical guidance for product and subdivision method selection to support accurate and effective dosing should be provided.

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FTIK-P40 ČVRSTE DISPERZIJE MIKONAZOL-NITRATA: UPOREDNA STUDIJA POVIDONA I UREE KAO HIDROFILNIH NOSAČA ZA POVEĆANJE RASTVORLJIVOSTI

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Mikonazol-nitrat je antimikotik BCS klase II čiju primenu ograničava niska rastvorljivost u vodi, što može nepovoljno uticati na brzinu rastvaranja i terapijsku efikasnost. Čvrste disperzije sa hidrofilnim nosačima predstavljaju jednu od najčešće primenjivanih strategija za povećanje rastvorljivosti slabo rastvorljivih lekovitih supstanci. Povidon se odlikuje izraženom hidrofilnošću, sposobnošću poboljšanja kvašenja i stabilizacije amorfnog oblika leka, dok urea kao mali hidrofilni molekul može doprineti povećanju rastvorljivosti i brzine rastvaranja poboljšanjem kvašenja lekovite supstance. Cilj rada bio je da se ispita uticaj povidona i uree kao hidrofilnih nosača u čvrstim disperzijama na rastvorljivost mikonazol-nitrata. Čvrste disperzije mikonazol-nitrata sa povidonom i ureom pripremljene su metodom isparavanja rastvarača, pri čemu je odnos lekovite supstance i nosača iznosio 1:4 (m/m). Kao kontrolni sistemi korišćeni su čista lekovita supstanca i odgovarajuće fizičke smeše. Rastvorljivost je određivana nakon 24 časa u veštačkoj salivi sa dodatkom 1% Tween 80 pri 37 °C primenom UV-Vis spektrofotometrije na 272 nm. Rastvorljivost čistog mikonazol-nitrata iznosila je 1,155 mg/mL. Fizička smeša sa povidonom povećala je rastvorljivost na 1,904 mg/mL, dok fizička smeša sa ureom nije pokazala značajno poboljšanje (1,163 mg/mL). Najveća rastvorljivost postignuta je kod čvrste disperzije sa povidonom (2,290 mg/mL), dok je čvrsta disperzija sa ureom pokazala umereniji efekat (1,601 mg/mL). Dobijeni rezultati su u skladu sa literaturnim podacima koji pokazuju da čvrste disperzije mikonazol-nitrata mogu značajno poboljšati brzinu rastvaranja. Formulacija mikonazol-nitrata u obliku čvrstih disperzija sa povidonom predstavlja efikasan pristup za povećanje njegove rastvorljivosti i može biti značajna u razvoju unapređenih farmaceutskih oblika za lokalnu primenu.

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FTIK-P40 SOLID DISPERSIONS OF MICONAZOLE NITRATE: A COMPARATIVE STUDY OF POVIDONE AND UREA AS HYDROPHILIC CARRIERS FOR SOLUBILITY ENHANCEMENT

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Miconazole nitrate is a BCS Class II antifungal agent with poor aqueous solubility, which can negatively affect dissolution rate and therapeutic efficacy. Solid dispersions with hydrophilic carriers are used to enhance solubility of poorly water-soluble drugs. Povidone exhibits strong hydrophilicity, improves wetting, and stabilizes the amorphous drug form, whereas urea, as a small hydrophilic molecule, may enhance solubility and dissolution primarily through improved wetting. This study aimed to evaluate the effect of povidone and urea as carriers in solid dispersions on the solubility of miconazole nitrate. Solid dispersions were prepared using the solvent evaporation method with a drug-to-carrier ratio of 1:4 (w/w). Pure drug and corresponding physical mixtures were used as controls. Solubility was determined after 24 h in artificial saliva containing 1% Tween 80 at 37 °C using UV–Vis spectrophotometry at 272 nm. The solubility of pure miconazole nitrate was 1.155 mg/mL. The physical mixture containing povidone increased solubility to 1.904 mg/mL, while the physical mixture with urea showed no meaningful improvement (1.163 mg/mL). The highest solubility was observed for the solid dispersion with povidone (2.290 mg/mL), whereas the urea-based solid dispersion showed a moderate increase (1.601 mg/mL). The results obtained are consistent with literature data showing that miconazole nitrate solid dispersions formulated with povidone and urea can significantly improve dissolution performance. These findings indicate that povidone-based solid dispersions are more effective than urea-based systems in enhancing the solubility of miconazole nitrate and may offer a promising strategy for improving local pharmaceutical formulations.

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FTIK-P41 PROCENA BUBRENJA VAGINALNIH TABLETA NA BAZI POLIETILENOKSIDA: UTICAJ MOLEKULSKE MASE POLIMERA I SILE KOMPRESIJE

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Kratko zadržavanje vaginalnih farmaceutskih oblika na mestu primene može ograničiti terapijsku efikasnost i zahtevati učestaliju primenu leka. Formulisanje vaginalnih tableta na bazi hidrofilnih, mukoadhezivnih polimera predstavlja jedan od pristupa za produženje kontakta preparata sa vaginalnom sluzokožom. Cilj ovog rada bio je ispitivanje uticaja molekulske mase polietilenoksida (PEO) i sile kompresije na bubrenje vaginalnih tableta izrađenih sa polietilenoksidom. Tablete su izrađene primenom PEO-a različitih molekulskih masa i dve sile kompresije, 100 kg i 500 kg. Kao medijum korišćena je veštačka vaginalna tečnost pH 4,2. Mase tableta određivane su pre potapanja i nakon 1, 3 i 5 sati inkubacije u 10 ml medijuma na 37 ± 1 °C. Merenja su izvedena u triplikatu. PEO niske molekulske mase pokazao je izraženu eroziju u svim vremenskim intervalima, nezavisno od sile kompresije, što ukazuje na ograničenu sposobnost formiranja stabilnog hidratisanog matriksa. PEO visoke molekulske mase pokazao je veći stepen bubrenja od PEO-a srednje molekulske mase, uz porast tokom vremena. Najviše vrednosti zabeležene su nakon 5 sati za PEO visoke molekulske mase: 515% pri 100 kg i 551% pri 500 kg. Kod PEO-a srednje molekulske mase sila kompresije nije imala statistički značajan uticaj ($p>0,05$), dok je kod PEO-a visoke molekulske mase značajan uticaj zabeležen samo nakon 1 sata ($p<0,05$). Rezultati ukazuju da molekulska masa PEO-a ima važniju ulogu u formiranju hidratisanog matriksa od sile kompresije. Dobijeni rezultati predstavljaju osnovu za dalju optimizaciju formulacije i ispitivanje mukoadhezivnosti, erozije i oslobađanja aktivne supstance.

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FTIK-P41 EVALUATION OF SWELLING OF VAGINAL TABLETS BASED ON POLYETHYLENE OXIDE: INFLUENCE OF POLYMER MOLECULAR WEIGHT AND COMPRESSION FORCE

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Short retention of vaginal pharmaceutical forms at the application site may limit therapeutic efficacy and require more frequent dosing. Formulating vaginal tablets with hydrophilic, mucoadhesive polymers is one approach to prolonging contact between preparation and vaginal mucosa. The aim of this work was to investigate the effect of polyethylene oxide (PEO) molecular weight and compression force on the swelling of PEO-based vaginal tablets. Tablets were prepared using PEO of different molecular weights and two compression forces, 100 kg and 500 kg. Simulated vaginal fluid at pH 4.2 was used as the medium. Tablet weights were measured before immersion and after 1, 3 and 5 hours of incubation in 10 ml of medium at 37 ± 1 °C. Measurements were performed in triplicate. Low molecular weight PEO showed marked erosion at all intervals, regardless of compression force, indicating a limited ability to form a stable hydrated matrix. High molecular weight PEO showed greater swelling than medium molecular weight PEO, with an increase over time. The highest values were recorded after 5h for high molecular weight PEO: 515% at 100 kg and 551% at 500 kg. With medium molecular weight PEO, compression force had no statistically significant effect ($p>0.05$), while with high molecular weight PEO a significant effect was observed only after 1h ($p<0.05$). Results indicate that PEO molecular weight influences hydrated matrix formation more than compression force. These findings provide a basis for further optimisation of the formulation and examination of mucoadhesiveness, erosion and drug release.

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FTIK-P42 PARTICLE SIZE DISTRIBUTION AS A CRITICAL FUNCTIONALITY-RELATED CHARACTERISTIC OF CALCIUM CARBONATE: IMPACT OF SUPPLIER VARIABILITY ON DRUG PRODUCT QUALITY

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Calcium carbonate is widely used as filler in tablet formulations. Particle size distribution (PSD) and powder flow are functionality-related characteristics (FRCs) that may influence product manufacture and critical quality attributes (CQAs). This study evaluated the effect of supplier variability in formulations manufactured by dry blending (DB) and fluid-bed granulation (FBG).

Two calcium carbonate samples from different manufacturers were evaluated. Both complied with the same internal bulk density specification (0.40–0.70 g/mL) and differed in supplier-reported PSD, with one sample classified as finer (F) and the other as coarser (C). Four laboratory trials were conducted using F and C grades in each manufacturing process. Calcium carbonate was incorporated at 20.6% w/w by DB and 40.0% w/w intragranularly during FBG. Loss on drying, flow properties and PSD were evaluated for final blends and granulates. Tablet in-process control parameters and compaction profiles were also assessed.

Although the impact of calcium carbonate variability was observed in both manufacturing processes, it was more pronounced for DB.In DB-formulations, sample F produced blend with poorer flowability compared with sample C (56.5 vs 10.2 g/100 s) and higher Carr's index (29% vs 19%). Consistent with these differences, powder compaction analysis indicated poorer tabletability and compactability of formulations containing sample F for both processes. Formulations with sample C compressed smoothly, whereas those containing sample F showed inconsistent feeding and required manual tapping and higher dosing settings.

This study demonstrates that even slight differences in the FRCs of calcium carbonate can affect the manufacturing process, compression performance, and, potentially, product CQAs.

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LBF-P1 LIST RUZMARINA KAO IZVOR BIOAKTIVNIH JEDINJENJA

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Ruzmarin (*Salvia rosmarinus* Spenn., syn. *Rosmarinus officinalis* L., Lamiaceae) je višegodišnji zimzeleni žbun široko rasprostranjen na Balkanu. List ruzmarina se koristi u tradicionalnoj medicini kao rubefacijens, karminativ i emenagog. Glavna biološki aktivna jedinjenja su fenolne kiseline (kafena i rozmarinska kiselina), flavonoidi (heterozidi luteolina, diosmetina i hesperetina) i diterpeni (karnozinska kiselina, karnozol). Ova jedinjenja pokazuju širok spektar bioloških aktivnosti, uključujući antimikrobnu, antiinflamatornu i antioksidativnu aktivnost. Iako je široko gajen u svim delovima Srbije, fitohemijska karakterizacija lista ruzmarina sa različitih lokaliteta nije dovoljno proučavana. Cilj istraživanja je bio da se okarakterišu glavne fitohemijske grupe prisutne u vodenim ekstraktima lista ruzmarina i da se istraži da li postoje značajne razlike između uzoraka prikupljenih sa različitih lokaliteta u Srbiji (Bor, Užice, Beograd i Vrbas). Vodeni ekstrakti listova (1:10) su analizirani pomoću tečne hromatografije spregnute sa masenom spektrometrijom (LC-MS). Identifikovano je 20 jedinjenja, pretežno flavonoida i fenolnih kiselina. Glavno jedinjenje bila je rozmarinska kiselina, prisutna u uzorcima iz Užica (3,83 ± 0,44 mg/g), Vrbasa (9,9 ± 1,73 mg/g) i Beograda (16,02 ± 1,36 mg/g), dok u uzorku iz Bora nije detektovana. Glavni flavonoid bio je tetrahidroksiflavon heksuronid (5,24 ± 0,12 do 13,62 ± 0,21mg/g), prisutan u uzorcima prikupljenim sa svih lokaliteta. Fenolni diterpeni nisu detektovani, što je u skladu sa njihovim pretežno lipofilnim karakterom. Dobijeni rezultati pokazuju da se fitohemijski profil vodenih ekstrakata lista ruzmarina iz Srbije značajno razlikuje u zavisnosti od geografskog porekla, naročito u sadržaju rozmarinske kiseline, što može uticati na biološku aktivnost.

LBF-P1 ROSEMARY LEAVES AS SOURCE OF BIOACTIVE COMPOUNDS

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Rosemary (*Salvia rosmarinus* Spenn., syn. *Rosmarinus officinalis* L., Lamiaceae) is a perennial evergreen shrub widely distributed in the Balkan region. Rosemary leaf is used in traditional medicine as a rubefacient, carminative and emmenagogue. The main biologically active compounds present are phenolic acids (caffeic and rosmarinic acid), flavonoids (luteolin, diosmetin and hesperetin heterosides) and diterpenes (carnosic acid, carnosol). These compounds exhibit a wide range of biological activities, including antimicrobial, anti-inflammatory and antioxidant effects. Although it is widely cultivated in Serbia, phytochemical characterization of rosemary leaf from different localities across the country remains insufficiently explored. The study aimed to characterize the main phytochemical groups in aqueous rosemary leaf extracts and investigate differences between samples from four localities in Serbia (Bor, Užice, Belgrade and Vrbas). Aqueous leaf extracts (1:10) were analyzed by liquid chromatography coupled with mass spectrometry (LC-MS). Analysis identified 20 compounds, predominantly flavonoids and phenolic acids. The main compound was rosmarinic acid, present in samples from Užice (3.83 ± 0.44 mg/g), Vrbas (9.9 ± 1.73 mg/g) and Belgrade (16.02 ± 1.36 mg/g), while it was not detected in the sample from Bor. The principal flavonoid detected was tetrahydroxyflavone hexuronide (5.24 ± 0.12 to 13.62 ± 0.21 mg/g), present in all samples. Phenolic diterpenes were not detected, which is consistent with their predominantly lipophilic character. These findings show that the phytochemical profile of aqueous rosemary leaf extracts from Serbia differs significantly depending on geographical origin, especially in the content of rosmarinic acid, which may affect biological activity.

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LBF-P2 HEMOMETRIJSKA ANALIZA KOMPOZICIJE FLAVONOIDA ODABRANIH TAKSONA RODA *STACHYS* SA BALKANSKOG POLUOSTRVA

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Biljke roda *Stachys* L. (Lamiaceae), poznate pod narodnim nazivom čistac, tradicionalno se koriste kod različitih upala, prehlade i kašlja, gastrointestinalnih tegoba i za zarastanje rana. Njihov fitohemijski profil obuhvata prisustvo flavonoida, fenolkarboksilnih kiselina, feniletanskih heterozida, tanina, iridoida, terpenoida i sterola. Najveće bogatstvo taksona ovog roda zabeleženo je na području Mediterana, dok se centar diverziteta taksonomski složene grupe *Stachys recta* nalazi na Balkanskom poluostrvu. U ovom radu sprovedena je statistička analiza kompozicije flavonoida odabranih predstavnika roda *Stachys* sa Balkanskog poluostrva radi procene hemotaksonomskog značaja ovih metabolita i utvrđivanja odnosa među ispitivanim taksonima. Kvalitativna i kvantitativna analiza metanolnih ekstrakata nadzemnih delova biljaka u cvetu izvršena je primenom tečne hromatografije sa masenom spektrometrijom (LC–MS). Ukupno je detektovano 60 jedinjenja, pri čemu je utvrđena velika sličnost flavonoidnog profila među ispitivanim taksonima, sa manjim kvalitativnim i/ili kvantitativnim razlikama. Dominantna su bila dva flavonoida, i to 7-*O*-[6‴-*O*-acetil-alozil-(1→2)]-glikozidi izoskutelareina i 4-*O*-metilhipolaetina. U cilju utvrđivanja obrazaca fitohemijske varijabilnosti među ispitivanim uzorcima, dobijeni rezultati hemijske analize su obrađeni primenom multivarijantnih statističkih metoda: nemetričkog multidimenzionalnog skaliranja (nMDS) i analize glavnih komponenti (PCA). nMDS ordinacija pokazala je grupisanje većine uzoraka grupe *S. recta*, što je posledica visokog stepena sličnosti u flavonoidnim profilima. Dodatno, u PCA analizi, kao variable koje najviše doprinose diferencijaciji taksona unutar grupe identifikovano je 15 flavonoida, uključujući 12 glikozida hipolaetina i metilhipolaetina, dva glikozida apigenina i jedan glikozid metilizoskutelareina. Dobijeni rezultati podržavaju postojeću taksonomsku klasifikaciju grupe *S. recta* i potvrđuju značaj flavonoida kao hemotaksonomskih markera za ovaj rod.

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LBF-P2 CHEMOMETRIC ANALYSIS OF FLAVONID COMPOSITION OF SELECTED *STACHYS* TAXA FROM BALKAN PENINSULA

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Stachys L. (Lamiaceae) taxa, commonly known as woundworts, are widely used in traditional medicine for treatment of various inflammatory conditions, colds and coughs, gastrointestinal disorders, and wound healing. Their phytochemical profile comprises the presence of flavonoids, phenolic acids, phenylethanoid glycosides, tannins, iridoids, terpenoids, and sterols. The highest richness of this genus was recorded in Mediterranean region, while taxonomically complex *Stachys recta* group has its centre of diversity in Balkan Peninsula. This study statistically evaluated the flavonoid composition of selected Balkan *Stachys* representatives to assess the chemotaxonomic significance of these metabolites and clarify relationships among the investigated taxa. Qualitative and quantitative analyses of methanol extracts of flowering aerial parts of the plants were performed using liquid chromatography–mass spectrometry (LC–MS). A total of 60 compounds were detected, revealing a generally homogeneous flavonoid profile across the investigated taxa, with minor qualitative and/or quantitative variations. The predominant constituents were isoscutellarein and 4-*O*-methylhypolaetin 7-*O*-[6‴-*O*-acetyl-allosyl-(1→2)]-glucosides. To explore patterns of phytochemical variation, the obtained results of chemical analysis were subjected to the multivariate statistical methods: non-metric multidimensional scaling (nMDS) and principal component analysis (PCA). nMDS ordination showed close clustering of the most samples of *S. recta* group, indicating a high similarity of flavonoid profiles. Additionally, PCA identified 15 flavonoids as the main contributors to taxon discrimination, including 12 hypolaetin and methylhypolaetin glycosides, two apigenin glycosides, and one methylisoscutellarein glycoside. Overall, the results supported the current taxonomic circumscription of *S. recta* group and confirmed the significance of flavonoids as chemotaxonomic markers for the genus.

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LBF-P3 ISPITIVANJE HEMIJSKOG SASTAVA I ANTIOKSIDANTNOG POTENCIJALA KORA TRI VRSTE RODA *QUERCUS* L.

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Cilj rada bio je hemijska karakterizacija i procena antioksidantnog potencijala suvih vodenih ekstrakata (dekokta, 20 g/l) kora tri vrste hrasta: lužnjaka (*Quercus robur* L.), kitnjaka (*Q. petraea* (Matt.) Liebl.) i medunca (*Q. pubescens* Willd.), koje prema *Ph. Eur.* predstavljaju biološki izvor taninske biljne droge *Quercus cortex*. U fitoterapiji dekokti kore hrasta se primenjuju za tretman blage dijareje, manjih inflamacija sluzokože usne duplje i kože, i ublažavanje svraba i peckanja kod hemoroida. U pogledu kompozicije sekundarnih metabolita, prethodno su uglavnom ispitivani alkoholni i vodenoalkoholni ekstrakti kora *Q. robur* i *Q. petraea*, dok su dekokti ove tri vrste samo sporadično analizirani. Biljni materijal je sakupljen na dva lokaliteta u Srbiji. Kore ispitivanih vrsta zadovoljile su zahteve kvaliteta *Ph. Eur.* za biljnu drogu *Quercus cortex*. U suvim dekoktima sadržaj ukupnih polifenola, određen spektrofotometrijski, kretao se od 146,18–330,52 mg/g. LC-MS analizom ustanovljeno je da suvi dekokti imaju identičan kvalitativni sastav (okarakterisano je po 13 polifenolnih jedinjenja u svakom ekstraktu, uključujući heterozide elagne kiseline detektovane u korama po prvi put); razlike među ekstraktima ogledale su se u sadržaju pojedinačnih komponenti. U ekstraktima kora *Q. petraea* i *Q. robur* najzastupljeniji je bio izomer epigalokatehina (1,17% i 0,84%, g/100 g suvog ekstrakta), dok je u ekstraktu *Q. pubescens* najzastupljeniji bio katehin (0,61%). Ukupni sadržaj svih detektovanih jedinjenja u ekstraktima kretao se od 1,76–4,90%. Značajan antioksidantni potencijal ekstrakata sve tri kore utvrđen je FRAP (5,87–7,74 mmol Fe^{2+}/g) i DPPH testom (IC_{50}=14,48–17,62 μg/ml). Najbolji hemijski i biološki profil ustanovljen je za koru kitnjaka, *Q. petraea*.

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LBF-P3 INVESTIGATION OF CHEMICAL COMPOSITION AND ANTIOXIDANT POTENTIAL OF THE BARK OF THREE *QUERCUS* L. SPECIES

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The aim of the study was to chemically characterize and evaluate the antioxidant potential of dry bark aqueous extracts (decoctions, 20 g/L) of three oak species: pedunculate (*Quercus robur* L.), sessile (*Q. petraea* (Matt.) Liebl.), and downy oak (*Q. pubescens* Willd.), which represent biological sources of tannin-containing herbal drug *Quercus cortex* according to Ph. Eur. In phytotherapy, oak bark decoctions are used to treat mild diarrhoea, minor oral mucosa and skin inflammations, and symptoms associated with haemorrhoids. Previously, secondary metabolites have predominantly been studied in *Q. robur* and *Q. petraea* barks alcoholic and hydroalcoholic extracts, whereas decoctions of these three species were only sporadically investigated. Plant material was collected from two localities in Serbia. All three investigated barks complied with Ph. Eur. quality requirements for *Quercus cortex*. Total phenolic content in dry decoctions, determined spectrophotometrically, ranged 146.18–330.52 mg/g. LC–MS analysis revealed that the dry decoctions had an identical qualitative composition (in each extract, 13 polyphenolic compounds were characterized, with ellagic acid glycosides detected in the barks for the first time); interspecies differences were reflected in individual constituents' contents. Epigallocatechin isomer predominated in *Q. petraea* and *Q. robur* extracts (1.17% and 0.84%, g/100 g dry extract), whereas catechin was the most abundant in *Q. pubescens* extract (0.61%). Total content of all detected compounds ranged 1.76–4.90%. Significant antioxidant potential was demonstrated by both FRAP (5.87–7.74 mmol Fe^{2+}/g) and DPPH assay (IC_{50}=14.48–17.62 μg/mL). The most favourable chemical and biological profile was demonstrated for *Q. petraea* bark.

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LBF-P4 FARMAKOGNOZIJSKO ISPITIVANJE HERBE RANJENIKA, *Anthyllis vulneraria* L. (Fabaceae)

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Ranjenik ili belodun (*Anthyllis vulneraria* L., Fabaceae) rasprostranjen je na planinskim pašnjacima Evrope, severne i južne Afrike, kao i jugoistočne Azije. U narodnoj medicini koristi se u obliku obloga za zarastanje rana, ogrebotina, uboda i manjih opekotina, dok se infuz primenjuje kod tegoba respiratornog sistema, za jačanje organizma i kao blag diuretik. U nadzemnim delovima biljke do sada su identifikovana jedinjenja iz klasa flavonoida, tanina, saponozida i proteini. U ovom istraživanju analiziran je nadzemni deo biljke u fazi cvetanja, prikupljen u podnožju planine Rtanj (istočna Srbija) u julu 2024. godine i prirodno osušen. Primenom farmakopejskih metoda određeni su sadržaji vlage, ukupnog pepela, tanina i flavonoida u biljnoj drogi. Biljni materijal ekstrahovan je 50% etanolom, a dobijeni suvi ekstrakt analiziran metodom tečne hromatografije sa masenom spektrometrijom (LC–MS). Sadržaj vlage iznosio je 8,62%, a ukupnog pepela 9,19%, što je u skladu sa propisanim vrednostima za većinu oficinalnih biljnih droga. Sadržaj flavonoida iznosio je 0,78% (izraženo kao hiperozid), a tanina 0,24% (izraženo kao pirogalol). LC–MS analizom etanolnog ekstrakta detektovano je više od 30 jedinjenja, pretežno flavonola, heterozida kvercetina i kemferola, kao i njihovih metil-derivata. Najzastupljenija komponenta bio je izokvercitrin (7,36 mg/g). Utvrđeni hemijski profil i visok sadržaj bioaktivnih flavonoida (oko 5%) predstavljaju dobru osnovu za razvoj analitičkih metoda za identifikaciju i kontrolu kvaliteta biljne sirovine, kao i za buduću primenu ekstrakata *A. vulneraria* u kozmetičkim i drugim biljnim proizvodima.

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LBF-P4 PHARMACOGNOSTIC INVESTIGATIONS ON KIDNEY VETCH, *Anthyllis vulneraria* L. (Fabaceae)

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Anthyllis vulneraria L. (Fabaceae), commonly known as kidney vetch, is widely distributed in mountain grasslands across Europe, North and South Africa, and Southeast Asia. In traditional medicine, it is applied topically as poultices to promote the healing of wounds, abrasions, insect bites, and minor burns, while infusions are used to relieve respiratory ailments, as a general tonic, and as a mild diuretic. Previous phytochemical studies have identified flavonoids, tannins, saponins, and proteins in the aerial parts of the plant. In the present study, the aerial parts of A. vulneraria*were collected at the flowering stage from the foothills of Mt. Rtanj (Eastern Serbia) in July 2024 and naturally air-dried. Pharmacopoeial methods were used to determine moisture, total ash, tannin, and flavonoid contents. The plant material was extracted with 50% ethanol, and the dry extract was characterized by liquid chromatography–mass spectrometry (LC–MS). The moisture and total ash contents were 8.62% and 9.19%, respectively, both complying with the limits established for the most official herbal drugs. Total flavonoid and tannin contents were 0.78% (expressed as hyperoside) and 0.24% (expressed as pyrogallol), respectively. By LC–MS analysis more than 30 compounds were detected, predominantly flavonols, quercetin and kaempferol glycosides, and their methylated derivatives. Isoquercitrin was the major constituent (7.36 mg/g). The characteristic phytochemical profile and high flavonoid content (approximately 5%) provide a basis for developing analytical methods for the identification and quality control of *A. vulneraria* plant material and support the future application of its extracts in cosmetic and other plant-based products.

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LBF-P5 *IN VIVO* PROCENA ANTIINFLAMATORNOG POTENCIJALA GELA SA INKAPSULIRANIM EKSTRAKTOM INDUSTRIJSKE KONOPLJE BOGATIM KANABIDIOLOM

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Kanabidiol (CBD) predstavlja jedan od najznačajnijih nepsihoaktivnih kanabinoida industrijske konoplje (*Cannabis sativa* L.) zahvaljujući dokazanom antiinflamatornom i antioksidativnom dejstvu. Međutim, njegovu primenu ograničavaju nepovoljne fizičko-hemijske osobine: slaba rastvorljivost u vodi, osetljivost na svetlost i brza degradacija, čineći ga pogodnim kandidatom za inkapsulaciju. Cilj istraživanja bila je procena in vivo antiinflamatornog delovanja gela sa lipozomski inkapsuliranim natkritičnim ekstraktom industrijske konoplje bogatim CBD-om (L-CBD) primenom modela akutne inflamacije izazvane karagenanom kod pacova. Antiinflamatorna aktivnost procenjena je merenjem debljine šape pre i 1, 2, 3 i 4 časa nakon indukcije inflamacije. Ispitivani gel upoređen je sa komercijalnim preparatom sa ekstraktom konoplje (K-CBD), placebo gelom sa praznim lipozomima (L) i kremom sa ibuprofenom (IBU) kao pozitivnom kontrolom. Određen je stepen inhibicije edema, kao i parametri oksidativnog stresa: lipidna peroksidacija (TBARS), aktivnosti superoksid-dismutaze (SOD) i katalaze (CAT) i koncentracija redukovanog glutationa (GSH). Ispitivane formulacije pokazale su vremenski zavisan antiinflamatorni efekat. Statistički značajno smanjenje edema u odnosu na netretiranu kontrolu uočeno je od trećeg časa nakon indukcije inflamacije u grupama tretiranim uzrcima L-CBD, IBU i K-CBD. Najveći stepen inhibicije edema ostvaren je primenom IBU (77,1%), dok je L-CBD postigao inhibiciju od 60,4%, a K-CBD od 56,3% nakon četiri časa. Takođe, L-CBD je značajno smanjio lipidnu peroksidaciju i povećao aktivnosti SOD i CAT u odnosu na netretiranu grupu, dok koncentracija GSH nije pokazala statistički značajne promene. Dobijeni rezultati ukazuju da gel sa lipozomski inkapsuliranim natkritičnim ekstraktom industrijske konoplje bogatim CBD-om poseduje antiinflamatorno i antioksidativno dejstvo, što ukazuje na potencijal ove formulacije za razvoj novih topikalnih antiinflamatornih preparata.

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LBF-P5 *IN VIVO* EVALUATION OF THE ANTI-INFLAMMATORY POTENTIAL OF A GEL CONTAINING A LIPOSOMALLY ENCAPSULATED CBD-RICH SUPERCRITICAL HEMP EXTRACT

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Cannabidiol (CBD) is one of the major non-psychoactive cannabinoids of industrial hemp (*Cannabis sativa* L.) due to well-documented anti-inflammatory and antioxidant properties. However, its application is limited by poor aqueous solubility, light sensitivity, and rapid degradation, making CBD a suitable candidate for encapsulation. The aim of this study was to evaluate anti-inflammatory activity of a gel containing a liposomally encapsulated CBD-rich supercritical hemp extract (L-CBD) using carrageenan-induced acute paw edema model in rats. Anti-inflammatory activity was assessed by measuring paw thickness before and 1, 2, 3, and 4 h after inflammation induction. The investigated gel was compared with commercially available hemp extract formulation (K-CBD), a placebo gel containing empty liposomes (L), and ibuprofen cream (IBU) as a positive control. Edema inhibition, lipid peroxidation (TBARS), superoxide dismutase (SOD), catalase (CAT), and reduced glutathione (GSH) levels were evaluated. All tested formulations exhibited a time-dependent anti-inflammatory effect. A statistically significant reduction in paw edema in comparison to untretaed contol was observed from the third hour after carrageenan administration in the L-CBD, IBU, and K-CBD groups. After 4h, the highest edema inhibition was achieved with ibuprofen (77.1%), whereas L-CBD and K-CBD produced 60.4% and 56.3% inhibition, respectively. In addition, L-CBD significantly reduced lipid peroxidation and increased SOD and CAT activities compared with the untreated group, while no significant changes in GSH levels were observed. These findings demonstrate that the gel containing a liposomally encapsulated CBD-rich supercritical hemp extract exhibits anti-inflammatory and antioxidant activity, highlighting its potential for the development of novel topical anti-inflammatory formulations.

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LBF-P6 OD PRIRODNIH SIROVINA DO SAVREMENE DERMOKOZMETIKE: *IN VIVO* PROCENA HIDRATANTNOG I DEPIGMENTACIONOG POTENCIJALA ULJANOG EKSTRAKTA PLODA DIVLJE JABUKE

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Prirodne bioaktivne supstance se koriste u razvoju dermokozmetičkih proizvoda zbog potencijala da unaprede zdravlje i izgled kože uz povoljan bezbednosni profil. Biljni ekstrakti bogati polifenolnim jedinjenjima (PF) i voćnim kiselinama (VK) interesantni su zbog svog hidratantnog i depigmentacionog potencijala. Plod divlje jabuke predstavlja značajan prirodni izvor ovih bioaktivnih jedinjenja i potencijalnu sirovinu za razvoj dermokozmetičkih proizvoda.

Cilj rada bio je *in vivo* ispitivanje hidratantnog i depigmentacionog potencijala krema sa uljanim ekstraktom ploda divlje jabuke (EPDJ), poreklom iz Srbije (*Malus sylvestris* (L.) Mill., Rosaceae), standardizovanim na 7% PF i 2,6% VK.

Dermokozmetički krem formulisan je sa 6% EPDJ (dobijen digestijom u suncokretovom ulju) i stabilizovan prirodnim, biodegradabilnim alkil-poliglukozidnim emulgatorima. *In vivo* ispitivanje sprovedeno je na zdravim ispitanicima 60 i 180 minuta nakon primene krema, određivanjem električne kapacitance (EK), transepidermalnog gubitka vode (TEGV) i melanin indeksa (MI) kože pomoću uređaja Multi Probe Adapter System MPA®9 (Courage&Khazaka). Rezultati su prikazani kao apsolutne promene u odnosu na bazalne vrednosti.

Nakon 60 i 180 minuta zabeležen je porast EK (9,10±2,54 i 13,3±16,77, redom) i smanjenje TEGV (-1,34±0,61 i -0,78±0,69, redom) u odnosu na bazalne vrednosti. Primena krema dovela je i do smanjenja MI u odnosu na bazalne vrednosti (-0,60±9,61 nakon 60 i -2,20±9,78 nakon 180 minuta).

Kratkotrajna *in vivo* studija pokazala je povećanje hidratacije kože i smanjenje MI nakon primene krema sa EPDJ. Dobijeni rezultati ukazuju na mogućnost primene EPDJ kao prirodne bioaktivne sirovine u razvoju dermokozmetičkih proizvoda namenjenih nezi i ujednačavanju tona kože.

LBF-P6 FROM NATURAL RAW MATERIALS TO MODERN DERMOCOSMETICS: *IN VIVO* EVALUATION OF HYDRATION AND DEPIGMENTATION POTENTIAL OF WILD APPLE FRUIT OIL EXTRACT

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Natural bioactive substances are used in development of dermocosmetic products due to their potential to improve skin health and appearance, with favorable safety profile. Plant extracts rich in polyphenolic compounds-PC and fruit acids-FA are interesting because of their hydration and depigmentation potential. Wild apple fruit-WAF represents significant natural source of these bioactive compounds and potential raw material for development of dermocosmetic products.

The aim of study was *in vivo* evaluation of hydration and depigmentation potential of cream containing oil extract of wild apple fruit-EWAF, originated from Serbia (*Malus sylvestris* (L.) Mill., Rosaceae), standardized to 7% PP and 2.6% FA.

Dermocosmetic cream was formulated with 6% EWAF (obtained by digestion in sunflower oil) and stabilized by natural, biodegradable alkyl-polyglucoside emulsifiers. *In vivo* study was conducted on healthy volunteers, 60 and 180 minutes after cream application, by determining electrical capacitance-EC, transepidermal water loss-TEWL and melanin index-MI using Multi Probe Adapter System MPA®9 (Courage&Khazaka). Results were presented as absolute changes compared to baseline values.

After 60 and 180 minutes, an increase in EC (9.10±2.54 and 13.3±16.77, respectively) and decrease in TEWL (-1.34±0.61 and -0.78±0.69, respectively) were observed compared to baseline. Cream application also led to reduction in MI compared to baseline (0.60±9.61 after 60 and -2.20±9.78 after 180 minutes).

Short-term *in vivo* study demonstrated increase in skin hydration and reduction in MI after application of cream containing EWAF. Obtained results suggest potential application of EWAF as natural bioactive raw material for development of dermocosmetic products intended for skin care and skin tone uniformity.

LBF-P7 PRELIMINARNA PROCENA BEZBEDNOSTI LIPOSOMA SA ETARSKIM ULJEM I ETANOLNIM EKSTRAKTOM ALEPSKOG BORA (*PINUS HALEPENSIS* MILLER, PINACEAE) NAKON PRIMENE NA KOŽI

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Poslednjih godina posebno interesovanje privlače liposomske formulacije za dermalnu primenu koje sadrže etarska ulja i/ili biljne ekstrakte, budući da liposomi omogućavaju kontrolisano oslobađanje aktivnih komponenti, unapređuju njihovu stabilnost i interakciju sa površinskim slojevima kože, čime mogu doprineti poboljšanju bioraspoloživosti i bezbednosnog profila aktivnih komponenti. Za potrebe ispitivanja pripremljene su četiri liposomske disperzije na bazi Phosal 40 IP i prečišćene vode: placebo disperzija, disperzija sa etarskim uljem, disperzija sa etanolnim ekstraktom alepskog bora (*Pinus halepensis* Miller, Pinaceae) i disperzija sa njihovom kombinacijom. Cilj istraživanja bio je da se proceni preliminarni bezbednosni profil ispitivanih liposomskih disperzija primenom neinvazivnih biofizičkih metoda na koži zdravih dobrovoljaca. Etarsko ulje izolovano je destilacijom vodenom parom pomoću Clevenger-ove aparature, dok je ekstrakt dobijen Soxhlet ekstrakcijom sa 70% etanolom. Ispitivanje je sprovedeno kao dvostruko slepa, 24-časovna studija pod okluzijom na 13 zdravih dobrovoljaca. Bezbednost formulacija procenjena je određivanjem pH kože, transepidermalnog gubitka vode (TEWL), električne kapacitivnosti (EC), eritema indeksa (EI) i melanin indeksa (MI). Nijedna od ispitivanih formulacija nije izazvala statistički značajne promene biofizičkih parametara kože u odnosu na bazalne vrednosti i odgovarajuće kontrole. Stabilne vrednosti TEWL ukazale su na očuvan integritet epidermalne barijere, dok je odsustvo značajnih promena eritema i MI potvrdilo da formulacije nisu izazvale iritaciju niti poremećaje pigmentacije kože. Ispitivane liposomske formulacije pokazale su dobru lokalnu podnošljivost i povoljan preliminarni bezbednosni profil nakon 24-časovne primene pod okluzijom, što predstavlja osnovu za njihovo dalje ispitivanje i razvoj kao bezbednih sistema za topikalnu isporuku biljnih bioaktivnih jedinjenja.

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LBF-P7 PRELIMINARY SAFETY ASSESSMENT OF LIPOSOMAL FORMULATIONS CONTAINING *PINUS HALEPENSIS* MILLER ESSENTIAL OIL AND ETHANOLIC EXTRACT AFTER APPLICATION ON THE SKIN

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Liposomal formulations developed for dermal delivery of essential oils and/or plant extracts have attracted increasing attention in recent years because they provide controlled release of active compounds, improve their stability and interaction with the skin, thereby enhancing the bioavailability and safety profile of plant-derived bioactive compounds. For this study, four liposomal dispersions based on Phosal 40 IP and purified water were prepared: a placebo dispersion, dispersions containing essential oil or the ethanolic extract of *Pinus halepensis* Miller (Pinaceae), and a dispersion containing both components. The aim of this study was to evaluate the preliminary safety profile of these liposomal dispersions using non-invasive biophysical methods on the skin of 13 healthy volunteers. The essential oil was isolated by steam distillation using Clevenger apparatus, whereas the extract was obtained by Soxhlet extraction with 70% ethanol. A randomized, double-blind, 24-hour occlusive study was conducted on 13 healthy volunteers. Skin safety was assessed by measuring skin pH, transepidermal water loss (TEWL), electrical capacitance (EC), erythema index (EI), and melanin index (MI). None of the tested formulations induced statistically significant changes in the evaluated skin biophysical parameters compared with baseline values and the corresponding controls. Stable TEWL values indicated preserved epidermal barrier integrity, while the absence of significant changes in erythema and MI confirmed that the formulations did not induce skin irritation or pigmentation disorders. The investigated liposomal formulations showed good local tolerability and a favorable preliminary safety profile, providing a basis for their further development as safe topical delivery systems for plant-derived bioactive compounds.

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LBF-P8 HEMIJSKI SASTAV ETARSKIH ULJA PLODOVA *MACROSELINUM LATIFOLIUM* I *TOMMASINIA ALTISSIMA* (APIACEAE)

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Cilj rada bio je ispitivanje hemijskog sastava etarskih ulja izolovanih iz plodova vrsta *Macroselinum latifolium* (M. Bieb.) Schur i *Tommasinia altissima* (Mill.) Reduron, koje se svrstavaju u rod *Peucedanum* u širem smislu (sensu lato, s.l.), kao i statističko poređenje dobijenih rezultata sa dostupnim literaturnim podacima za prethodno ispitivane vrste roda *Peucedanum* u užem (sensu stricto, s.s.), širem (s.l.) i najširem smislu (uključujući vrste koje se danas više ne svrstavaju u ovaj rod). Etarska ulja su izolovana destilacijom vodenom parom u aparaturi po Klevendžeru, dok je njihov hemijski sastav analiziran GC-FID/MS metodom. Poređenje sa ranije ispitivanim vrstama izvršeno je hemometrijskim pristupom primenom multivarijantne statističke metode nemetričkog multidimenzionalnog skaliranja (nMDS).

U oba uzorka identifikovano je po 40 jedinjenja, pri čemu su monoterpenski ugljovodonici bili dominantna grupa, sa udelom od 85,7% u etarskom ulju *M. latifolium* i 73,5% u etarskom ulju *T. altissima*. U etarskom ulju *M. latifolium* najzastupljeniji su bili *α*-pinen (48,9%), koeluirajuća smeša limonena i *β*-felandrena (22,4%) i mircen (6,7%). U etarskom ulju *T. altissima* dominirala je smeša limonena i *β*-felandrena (53,9%), a po zastupljenosti su je sledili *α*-pinen (8,1%) i *p*-cimen (7,6%). Multivarijantna statistička analiza obuhvatila je 15 vrsta, odnosno 27 uzoraka etarskih ulja (25 prethodno ispitivanih i dva analizirana u ovom radu), kao i 85 varijabli (identifikovanih jedinjenja). Dva uzorka etarskog ulja analizirana u ovom radu su se, kao i većina uzoraka ulja prethodno ispitivanih vrsta roda *Peucedanum* u širem smislu (s.l.), jasno odvojila od uzoraka ulja vrsta roda *Peucedanum* u užem smislu (s.s.).

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LBF-P8 CHEMICAL COMPOSITION OF ESSENTIAL OILS FROM THE FRUITS OF *MACROSELINUM LATIFOLIUM* AND *TOMMASINIA ALTISSIMA* (APIACEAE)

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The aim was to investigate the chemical composition of essential oils isolated from the fruits of *Macroselinum latifolium* (M. Bieb.) Schur and *Tommasinia altissima* (Mill.) Reduron, which are classified within the genus *Peucedanum* in the broad sense (sensu lato, s.l.), as well as to statistically compare the obtained results with available literature data for previously investigated species of the genus *Peucedanum* in the narrow (sensu stricto, s.s.), broad (s.l.), and broadest sense (including species no longer assigned to this genus). Essential oils were obtained by hydrodistillation using a Clevenger-type apparatus, while their composition was analyzed by GC-FID/MS. Comparison with previously studied species was performed using a chemometric approach; a multivariate statistical method, non-metric multidimensional scaling (nMDS), was applied.

In both samples, 40 compounds were identified, with monoterpene hydrocarbons being the dominant group, accounting for 85.7% in *M. latifolium* essential oil and 73.5% in *T. altissima* oil. In *M. latifolium* oil, the most abundant were *α*-pinene (48.9%), a co-eluting mixture of limonene and *β*-phellandrene (22.4%), and myrcene (6.7%). In *T. altissima* oil, the predominant was a mixture of limonene and *β*-phellandrene (53.9%), followed by *α*-pinene (8.1%) and *p*-cymene (7.6%). Multivariate statistical analysis included 15 species, i.e., 27 essential oil samples (25 previously investigated and two from this study), and 85 variables (identified compounds). The two essential oil samples from this study, as well as most oil samples from previously investigated *Peucedanum* in the broad sense (s.l.) species, clearly separated from oil samples of *Peucedanum* in the narrow sense (s.s.) species.

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LBF-P9 POLLEN MAPPING, MORPHOLOGY AND CHARACTERIZATION AS A PHARMACOGONOSTIC TOOL FOR MEDICINAL PLANTS AUTHENTICATION

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To ensure the quality and regulatory compliance of herbal medicinal products, authentication of medicinal plants should be performed as a fundamental prerequisite. The increasing demand for botanical products, coupled with the widespread occurrence of adulteration, substitution, and misidentification of medicinal plant materials, emphasises the need for reliable and complementary identification techniques. Besides routinely employed pharmacognostic investigations, pollen morphology has emerged as an important yet underutilized tool for botanical authentication. The remarkable diversity of pollen grain morphology can support species identification, particularly when conventional pharmacognostic tools are insufficient or when herbal materials are fragmented, powdered, or otherwise processed.

This short review aims to summarize the fundamental principles of pollen morphology examinations which include pollen size, shape, symmetry, polarity, as well as, aperture type, exine architecture, and surface ornamentation, highlighting their taxonomic significance in distinguishing medicinal species and closely related taxa. Recent scientific papers applying advanced microscopic techniques, including not only light microscopy (LM), but also scanning electron microscopy (SEM), confocal laser scanning microscopy, and digital image analysis, are discussed with particular emphasis on their contributions to high-resolution morphological characterization and improved identification accuracy. Our research is also supported by data providing the growing role of computer-assisted image recognition and artificial intelligence in automated pollen identification, offering new opportunities for standardized and high-throughput authentication workflows in pharmaceutical laboratories. Additionally, pollen mapping provides insights into shifts in the geographic distribution of medicinal plants under changing environmental conditions, thereby supporting future conservation strategies and the sustainable utilization of medicinal plant resources.

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LBF-P10 ELECTRON BEAM IRRADIATION OF *CANNABIS SATIVA*: CHEMICAL PROFILE AND STERILIZATION EFFECTIVENESS

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Cannabis sativa L. (hemp) contains cannabinoids and terpenes of growing therapeutic interest. Ensuring microbiological safety of hemp raw material is essential, yet sterilization may alter its chemical composition. This study investigated the impact of electron beam radiation at 2 kGy on four hemp varieties with respect to cannabinoid and terpene profiles, free radical generation, and sterilization effectiveness.

Four hemp varieties were irradiated at 2 kGy using a linear electron accelerator. Cannabinoid content was assessed by UHPLC-DAD, terpene profile by GC-MS, macromolecular structural integrity by FT-IR spectroscopy, free radical presence by electron paramagnetic resonance (EPR), and microbiological quality by standard dilution plating.

Irradiation at 2 kGy completely eradicated all detected microorganisms across all four varieties. EPR analysis confirmed an elevated concentration of free radicals following irradiation, with partial recombination of unstable radicals occurring over several hundred hours. HPLC analysis revealed minor but measurable losses of CBD, CBD-A, THC, CBC, CBG, and CBN, with the magnitude being variety-dependent — one variety showed the greatest reduction (up to ~27%), while the others exhibited losses not exceeding 16%. GC-MS analysis demonstrated variety-specific changes in terpene profiles, including disappearance of certain volatile compounds and emergence of new ones post-irradiation. FT-IR spectra confirmed no significant degradation of macromolecular structures.

Electron beam radiation at 2 kGy constitutes an effective sterilization method for hemp raw material, yielding microbiologically pure products. However, minor chemical alterations in cannabinoid and terpene profiles are observed, underscoring the importance of variety-specific assessment during hemp processing and quality control.

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LBF-P11 BERBERINE IN WOUND HEALING: A MULTIFUNCTIONAL THERAPEUTIC AGENT

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Berberine, a naturally occurring isoquinoline alkaloid, has attracted considerable scientific interest due to its broad spectrum of biological activities and promising therapeutic potential in wound management.

This review aims to critically evaluate the role of berberine as a multifunctional bioactive compound in wound healing and to explore its potential synergistic effects within combination strategies with other bioactive molecules. By integrating current evidence on its antioxidant, anti-inflammatory, antimicrobial, and tissue regenerative activities, this review highlights the potential of berberine-based combination strategies to simultaneously target multiple mechanisms involved in impaired wound healing. A literature search was conducted using scientific databases, including PubMed, Scopus, and Web of Science, using relevant keywords related to berberine and wound healing. The selected studies were critically analyzed to summarize the molecular mechanisms through which berberine influences different phases of the wound healing process and to identify evidence supporting its potential role in combination approaches. Current evidence indicates that berberine contributes to wound repair by reducing oxidative stress, promoting cellular proliferation and extracellular matrix formation, modulating inflammatory responses, and exhibiting antimicrobial activity against wound-associated pathogens.

The novelty of this review lies in emphasizing berberine not only as an individual therapeutic agent but also as a promising component of multifunctional combination strategies aimed at enhancing wound healing through complementary and potential synergistic modulation of key biological processes.

This review provides a comprehensive perspective on the therapeutic potential of berberine and supports further investigation of berberine-based combination strategies as innovative approaches for improved wound management.

LBF-P12 ČAJEVI OD PLODA CRNE MALINE: KOMPARATIVNA ANALIZA HEMIJSKOG SASTAVA I FARMAKOLOŠKIH AKTIVNOSTI INFUZA I DEKOKTA

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Crna malina (*Rubus occidentalis* L., Rosaceae) predstavlja značajan izvor polifenolnih jedinjenja, posebno antocijana i elagnih tanina, koji su povezani sa značajnim farmakološkim aktivnostima. Zbog svog nutritivnog i terapeutskog potencijala, ova vrsta se gaji u mnogim regionima sa umerenom klimom, uključujući i Srbiju. Cilj ovog istraživanja bio je komparativna analiza hemijskog sastava i *in vitro* farmakoloških aktivnosti liofilizovanih infuza i dekokta ploda crne maline pripremljenih. Spektrofotometrijskim analizama utvrđene su razlike u sadržaju ukupnih polifenola (56,49 i 60,81 mg GAE/g), tanina (9,90 i 15,26 mg GAE/g) i antocijana (24,29 i 4,81 mg CGE/g) kod infuza i dekokta, redom. HPLC analizom utvrđeno je da su dominantna polifenolna jedinjenja antocijani (cijanidin-3-sambubiozid, cijanidin-3-glukozid i cijanidin-3-rutinozid), uz fenolkarboksilne kiseline (protokatehinska i elagna kiselina), flavanol (katehin) i flavonole (rutin i izokvercitrin). U pogledu farmakoloških aktivnosti, čajevi od ploda crne maline pokazali su izraženu antioksidantnu aktivnost, potvrđenu DPPH (IC_{50}: 98,62 i 95,74 μg/mL), ABTS (IC_{50}: 25,00 i 31,74 μg/mL) i FRAP (1,25 i 1,05 mmol Fe^{2+}/g) testovima za infuz i dekokt, redom. Takođe, zabeleženi su značajni inhibitorni efekti prema α-amilazi (IC_{50}: 2,17 i 1,89 mg/mL), α-glukozidazi (IC_{50}: 57,77 i 31,53 μg/mL) i pankreasnoj lipazi (IC_{50}: 1,64 i 1,46 mg/mL). Dobijeni rezultati ukazuju da čajevi od ploda crne maline predstavljaju značajan izvor polifenolnih jedinjenja sa izraženim antioksidativnim, hipoglikemijskim i hipolipemijskim svojstvima, što podržava njihovu potencijalnu primenu kao funkcionalnih napitaka i prirodnih terapeutskih sredstava.

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LBF-P12 BLACK RASPBERRY FRUIT TEAS: COMPARATIVE ANALYSIS OF CHEMICAL COMPOSITION AND PHARMACOLOGICAL ACTIVITIES OF INFUSION AND DECOCTION

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Black raspberry (*Rubus occidentalis* L., Rosaceae) is an important source of polyphenolic compounds, particularly anthocyanins and ellagitannins, which are associated with significant pharmacological activities. Due to its nutritional and therapeutic potential, this species is cultivated in many temperate regions worldwide, including Serbia. This study aimed to conduct a comparative analysis of the chemical composition and *in vitro* pharmacological activities of lyophilized infusion and decoction of black raspberry fruit. Spectrophotometric analyses revealed differences in the content of total phenolics (56.49 and 60.81 mg GAE/g), tannins (9.90 and 15.26 mg GAE/g), and anthocyanins (24.29 and 4.81 mg CGE/g) for infusion and decoction, respectively. HPLC analysis revealed anthocyanins (cyanidin-3-sambubioside, cyanidin-3-glucoside, and cyanidin-3-rutinoside) as the predominant polyphenolic compounds, along with phenol carboxylic acids (protocatechuic acid and ellagic acid), flavanol (catechin), and flavonols (rutin and isoquercitrin). Regarding pharmacological activities, black raspberry fruit teas showed pronounced antioxidant activity, confirmed by DPPH (IC_{50}: 98.62 and 95.74 μg/mL), ABTS (IC_{50}: 25.00 and 31.74 μg/mL), and FRAP (1.25 and 1.05 mmol Fe^{2+}/g) assays for infusion and decoction, respectively. Significant inhibitory effects were also observed against α-amylase (IC_{50}: 2.17 and 1.89 mg/mL), α-glucosidase (IC_{50}: 57.77 and 31.53 μg/mL), and pancreatic lipase (IC_{50}: 1.64 and 1.46 mg/mL). These findings suggest that black raspberry fruit teas are a valuable source of polyphenolic compounds with promising antioxidant, hypoglycemic, and hypolipidemic properties, supporting their potential application as functional beverages and natural therapeutic agents.

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LBF-P13 ZELENI EKSTRAKTI PLODA CRNE MALINE KAO ODRŽIVI IZVORI ANTIOKSIDATIVNIH JEDINJENJA: POTENCIJALNA PRIMENA U SAVREMENOJ FARMACIJI

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Zelena ekstrakcija u poslednjih nekoliko godina dobija na značaju zbog primene ekološki prihvatljivih rastvarača i koncepta održivog razvoja u farmaceutskoj i kozmetičkoj industriji. Plod crne maline predstavlja značajan izvor bioaktivnih jedinjenja sa izraženim antioksidativnim potencijalom, zbog čega postoji veliko interesovanje za razvoj efikasnih i bezbednih metoda ekstrakcije.

Cilj ovog rada bio je ispitivanje sadržaja polifenolnih jedinjenja (PP) i antioksidativnog potencijala (AP) u ekstraktima ploda crne maline (*Rubus occidentalis* L., Rosaceae), gajene u Srbiji, dobijenim različitim metodama ekstrakcije i rastvarača.

Ekstrakti su izrađeni u droga:ekstrakt odnosu 1:5 (m:V) metodom maceracije i ultrazvučne ekstrakcije primenom glicerol-voda sistema, kao i prirodnih dubokih eutektičkih rastvarača (NADES) na bazi glicerola i imunske kiseline. Ukupan sadržaj PP određen je Folin-Ciocalteu testom, a AP primenom FRAP metode.

Rezultati su pokazali da su ekstrakti dobijeni primenom NADES sistema i ultrazvučne ekstrakcije imali najviši sadržaj PP (39,94±1,24 mg GAE/g), u poređenju sa glicerol–voda sistemom i maceracijom (31,62±0,37 mg GAE/g). Slično, ovi ekstrakti su pokazali značajno viši AP (892,81 ± 5,61 μmol Fe^{2+}/g) u odnosu na konvencionalno dobijene ekstrakte (692,40±10,61 μmol Fe^{2+}/g). NADES sistemi omogućili su efikasniju ekstrakciju PP i mogu predstavljati efikasnu i održivu alternativu konvencionalnim rastvaračima, dok je ultrazvučna ekstrakcija pokazala veću efikasnost u odnosu na maceraciju.

Dobijeni rezultati ukazuju da ekstrakti ploda crne maline gajene u Srbiji predstavljaju značajan izvor antioksidativnih polifenolnih jedinjenja sa potencijalnom primenom u farmaceutskoj i kozmetičkoj industriji.

LBF-P13 GREEN EXTRACTS OF BLACK RASPBERRY FRUIT AS SUSTAINABLE SOURCES OF ANTIOXIDANT COMPOUNDS: POTENTIAL APPLICATION IN MODERN PHARMACY

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Green extraction has gained increasing importance in recent years due to the application of environmentally friendly solvents and the concept of sustainable development in the pharmaceutical and cosmetic industries. Black raspberry fruit represents a valuable source of bioactive compounds with pronounced antioxidant potential, resulting in considerable interest in the development of efficient and safe extraction methods. The aim of this study was to evaluate the content of polyphenol compounds (PP) and antioxidant potential (AP) in extracts of black raspberry fruit (*Rubus occidentalis* L., Rosaceae) grown in Serbia, obtained using different extraction methods and solvents.

Extracts were prepared in drug:extract ratio of 1:5 (m/V) by maceration and ultrasonic extraction using glycerol–water system, as well as natural deep eutectic solvents (NADES) based on glycerol and citric acid. Total polyphenol content (TPC) was determined by Folin–Ciocalteu assay, while AP was assessed by FRAP method.

The results showed that the extracts obtained using NADES system and ultrasonic extraction had the highest TPC (39.94±1.24 mg GAE/g), compared to the glycerol-water system and maceration (31.62±0.37 mg GAE/g). Similarly, these extracts showed significantly higher AP (892.81±5.61 μmol Fe^{2+}/g) compared to conventionally obtained extracts (692.40±10.61 μmol Fe^{2+}/g). NADES systems enabled more efficient extraction of PP and might represent an effective and sustainable alternative to conventional solvents, while ultrasonic extraction showed greater efficiency compared to maceration.

The obtained results indicate that green extracts of black raspberry fruit grown in Serbia represent a valuable source of antioxidant polyphenolic compounds with potential application in the pharmaceutical and cosmetic industry.

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LBF-P14 PREGLED TRADICIONALNE UPOTREBE, HEMIJSKOG SASTAVA I BIOLOŠKE AKTIVNOSTI KORNJAČINE TRAVE (*THALICTRUM MINUS* L.)

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Kornjačina trava (*Thalictrum minus* L., Ranunculaceae) je zeljasta višegodišnja biljka koja spontano raste u umerenim i subarktičkim oblastima Evrope, Azije i Afrike. U srpskoj narodnoj medicini nadzemni delovi ove biljne vrste koriste se kod različitih oboljenja jetre, uključujući žuticu i druga stanja koja se u narodnoj medicini povezuju sa poremećenom funkcijom jetre. Rod *Thalictrum* ima dugu tradiciju primene u narodnoj medicini brojnih zemalja, posebno Rusije, Japana i Kine, gde se najčešće navodi upotreba kod žutice.

Cilj rada bio je da se pregledom dostupne literature sagledaju etnobotanički, farmakološki i fitohemijski podaci o vrsti *T. minus*. Pregled literature sproveden je pretragom baza PubMed i ScienceDirect za period 2016–2025. godine, pri čemu su analizirani radovi koji se odnose na tradicionalnu primenu, fitohemijski sastav i biološku aktivnost *T. minus*.

Za ovu vrstu postoji ograničena, ali rastuća baza novijih dokaza. Identifikovan je ograničen broj savremenih istraživanja (2016–2025), uključujući tri originalna rada i jedan pregledni članak o rodu *Thalictrum*. Pregledom dostupnih radova utvrđeno je da *T. minus* pokazuje antibakterijski, antiinflamatorni, antioksidativni, antiholinesterazni i antiproliferativni potencijal u preliminarnim ispitivanjima, što je u skladu sa tradicionalnom primenom kod infektivnih i inflamatornih stanja.

Dobijeni rezultati ukazuju da je *T. minus* nedovoljno istražena biljka, pri čemu dostupni podaci ukazuju na opravdanost detaljnijih fitohemijskih, farmakoloških i toksikoloških ispitivanja radi procene njenog potencijala u savremenoj fitoterapiji.

Zahvalnica

Posebnu zahvalnost izražavamo travaru Novku Vidojkoviću na neprocenjivoj pomoći tokom terenskog rada, preliminarnoj identifikaciji vrste *Thalictrum minus* L., kao i na podeljenim informacijama o njenoj primeni u narodnoj medicini.

LBF-P14 OVERVIEW OF TRADITIONAL USES, CHEMICAL COMPOSITION AND BIOLOGICAL ACTIVITY OF MEADOW RUE (*THALICTRUM MINUS* L.)

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Meadow rue (*Thalictrum minus* L., Ranunculaceae) is a herbaceous perennial widely distributed across temperate and subarctic regions of Europe, Asia, and Africa. In Serbian folk medicine, the aerial parts of this species are used for liver-related disorders, including jaundice and other conditions traditionally associated with impaired liver function. The genus *Thalictrum* has a long history of traditional use in several countries, especially Russia, Japan, and China, where its best-known indication is jaundice.

The aim of this study was to review the available ethnobotanical, pharmacological, and phytochemical literature on *T. minus*. The methodology involved a literature search of the PubMed and ScienceDirect databases covering the period from 2016 to 2025, focusing on studies related to the ethnobotanical use, phytochemical composition and biological activity of *T. minus*.

Thalictrum minus has a limited but expanding recent evidences, with at least three directly relevant studies published between 2016 and 2025, plus one major genus-level review article. The available evidence shows that *T. minus* possesses antibacterial, anti-inflammatory, antioxidant, anticholinesterase, and preliminary antiproliferative activities, which is broadly consistent with its traditional use for infectious and inflammatory conditions. Overall, the findings suggest that *T. minus* is still an insufficiently characterised plant, while the available data support future studies focused on phytochemical, pharmacological, and toxicological investigations to better assess its therapeutic potential in modern phytotherapy

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LBF-P15 POLIFENOLNI SASTOJCI NEKIH POTENCIJALNIH SUPER NAMIRNICA

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Neke biljke se smatraju superhranom zbog svog bogatog nutritivnog profila i potencijalne koristi za zdravlje. Jedna od takvih je moringa (*Moringa oleifera* Lam.), drvo rasprostranjeno u tropskim i suptropskim regionima. Listovi moringe su bogati esencijalnim nutrijentima, uključujući proteine, amino kiseline, vitamine i minerale, kao i brojnim bioaktivnim jedinjenjima koja se povezuju sa različitim biološkim aktivnostima. Cilj ovog rada bio je da se uporedi sadržaj hlorofila, ukupnih polifenola (UP), kao i polifenolni profili komercijalno dostupnog praha lista moringe sa uzorcima liofilizovanog maslačka, pšenične i ječmene trave. Sadržaj hlorofila je određen spektrofotometrijski. Listovi moringe sadržali su 1,01 mg/g hlorofila, dok su ostali uzorci pokazali više vrednosti, u rasponu od 1,38 mg/g u ječmenoj travi, do 1,93 mg/g u maslačku i 2,02 mg/g u pšeničnoj travi. Ukupni polifenoli su određeni korišćenjem FC reagensa i izraženi kao ekvivalenti galne kiseline (EGK). Listovi moringe imali su najveću vrednost UP (19,41 mg EGK/g), zatim je sledio maslačak (13,25 mg EGK/g), dok je vrednost UP pšenične i ječmene trave bila znatna manja (8,79 i 7,32 mg EGK/g, redom). Suvi ekstrakti svih uzoraka pripremljeni su korišćenjem 80% etanola i analizirani LC-MS tehnikom. Ekstrakt lista moringe karakterisalo je prisustvo nekoliko fenolkarboksilnih kiselina i heterozida flavonola, prvenstveno derivata kvercetina i kemferola. Ekstrakt maslačka bio je naročito bogat fenolkarboksilnim kiselinama, sa cihorijumskom kiselinom koja je bila najzastupljenija. Ekstrakte pšenične i ječmene trave karakterisali su uglavnom C- i O-heterozidi apigenina i luteolina. Dobijeni rezultati daju osnovu za dalja istraživanja bioloških aktivnosti i potencijalne primene ovih biljaka kao sastojaka funkcionalne hrane i nutraceutika.

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LBF-P15 PHENOLIC CONSTITUENTS OF SOME POTENTIAL SUPERFOODS

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Some plants are regarded as superfoods due to their dense nutritional profiles and potential health benefits. One such plant is moringa (*Moringa oleifera* Lam.), a common tree in tropical and subtropical regions. Moringa leaves are rich in essential nutrients, including proteins, amino acids, vitamins, and minerals, as well as numerous bioactive compounds associated with diverse biological activities. The aim of this study was to compare the chlorophyll, total phenolic content (TPC), and phenolic profiles of commercially available moringa leaf powder with those of lyophilized dandelion, wheatgrass and barley greens. Chlorophyll content was determined spectrophotometrically. Moringa leaves contained 1.01 mg/g chlorophyll, whereas the other samples exhibited higher levels ranging from 1.38 mg/g in barley greens to 1.93 mg/g in dandelion and 2.02 mg/g in wheatgrass. TPC was determined using the FC assay and expressed as gallic acid equivalents (GAE). Moringa leaves had the highest TPC (19.41 mg GAE/g), followed by dandelion (13.25 mg GAE/g), while wheatgrass and barley greens contained lower amounts (8.79 and 7.32 mg GAE/g, respectively). Dry extracts of all samples were prepared using 80% ethanol and analyzed by LC-MS. Moringa extract was characterised by the presence of several phenolic acids and flavonol glycosides, primarily quercetin and kaempferol derivatives. Dandelion extract was particularly rich in phenolic acids, with cichoric acid being the most abundant. Wheatgrass and barley greens were characterized by C- and O-glycosides of apigenin and luteolin. Obtained results support further studies on the biological activities and potential applications of these plants in functional foods and nutraceuticals.

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LBF-P16 MODULATORNI EFEKTI EKSTRAKTA LISTA *VISCUM ALBUM* L. NA OKSIDATIVNE PROMENE IZAZVANE HLORPIRIFOSOM I IMIDAKLOPRIDOM U TESTISU PACOVA

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Pesticidi mogu narušiti funkciju muškog reproduktivnog sistema, delom putem oksidativnog stresa u testisima. U ovom radu ispitivani su efekti ekstrakta lista *Viscum album* L. (VAE) na oksidativno-antioksidativni status testisa pacova izloženih hlorpirifosu (CPF) i imidaklopridu (IMI). Mužjaci Wistar pacova podeljeni su u osam grupa (n=6): kontrola, CPF, IMI, VAE1, CPF+VAE1, CPF+VAE2, IMI+VAE1 i IMI+VAE2. CPF (35 mg/kg) i IMI (70 mg/kg) primenjivani su oralno dva puta nedeljno tokom četiri nedelje, dok je VAE primenjivan intraperitonealno dva puta nedeljno u dozama od 350 mg/kg (VAE1) ili 175 mg/kg (VAE2). VAE je hemijski okarakterisan sadržajem ukupnih fenola (94,38±0,62 mg ekvivalenata galne kiseline/g), flavonoida (65,24±0,23 mg ekvivalenata rutina/g), ukupnom antioksidativnom aktivnošću (128,65±0,92 mg ekvivalenata askorbinske kiseline/g), kao i fenolnim jedinjenjima detektovanim hromatografskom analizom, među kojima su najzastupljeniji rutin, kempferol, kvercetin i apigenin. U tkivu testisa određivani su lipidna peroksidacija (LPO), redukovani glutation (GSH), oksidovani glutation (GSSG), kao i aktivnosti superoksid dismutaze (SOD), katalaze (CAT), glutation peroksidaze (GSH-Px), glutation reduktaze (GR) i glutation-S-transferaze (GST). Podaci su analizirani jednofaktorijalnom ANOVA analizom i Tukey/Dunnett's T3 testovima. CPF je povećao LPO u testisu u odnosu na kontrolu, dok je CPF+VAE1 smanjio LPO u odnosu na CPF grupu. CPF i IMI su povećali aktivnost SOD, dok su IMI+VAE1 i IMI+VAE2 smanjili aktivnost SOD u odnosu na IMI. Aktivnost CAT bila je povećana u IMI grupi u poređenju sa kontrolom. CPF je povećao aktivnost GST, dok su CPF+VAE1 i CPF+VAE2 smanjili GST u odnosu na CPF. Rezultati ukazuju da VAE moduliše markere oksidativnog stresa izazvanog insekticidima u testisu pacova.

LBF-P16 MODULATORY EFFECTS OF *VISCUM ALBUM* L. LEAF EXTRACT ON CHLORPYRIFOS- AND IMIDACLOPRID-INDUCED OXIDATIVE CHANGES IN RAT TESTICULAR TISSUE

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Pesticides can impair male reproductive function, partly through oxidative stress in the testes. In this study, the effects of *Viscum album* L. leaf extract (VAE) on the oxidative-antioxidative status of the testes of rats exposed to chlorpyrifos (CPF) and imidacloprid (IMI) were investigated. Male Wistar rats were divided into eight groups (n=6): control, CPF, IMI, VAE1, CPF+VAE1, CPF+VAE2, IMI+VAE1, and IMI+VAE2. CPF (35 mg/kg) and IMI (70 mg/kg) were administered orally twice weekly for four weeks, while VAE was administered intraperitoneally twice weekly at 350 mg/kg (VAE1) or 175 mg/kg (VAE2). VAE was characterized by total phenolic content (94.38±0.62 mg gallic acid equivalents/g), flavonoid content (65.24±0.23 mg rutin equivalents/g), total antioxidant activity (128.65±0.92 mg ascorbic acid equivalents/g), and phenolic compounds detected by chromatographic analysis, among which rutin, kaempferol, quercetin, and apigenin were the most abundant. Lipid peroxidation (LPO), reduced glutathione (GSH), oxidized glutathione (GSSG), and activities of superoxide dismutase (SOD), catalase (CAT), glutathione peroxidase (GSH-Px), glutathione reductase (GR), and glutathione-S-transferase (GST) were determined in testicular tissue. Data were analyzed using one-way ANOVA and Tukey/Dunnett's T3 tests. CPF increased LPO in the testes compared with control, whereas CPF+VAE1 decreased LPO compared with the CPF group. CPF and IMI increased SOD activity, while IMI+VAE1 and IMI+VAE2 decreased SOD activity compared with IMI. CAT activity was increased in the IMI group compared with the control. CPF increased GST activity, whereas CPF+VAE1 and CPF+VAE2 decreased GST activity compared with CPF. The results indicate that VAE modulates markers of insecticide-induced oxidative stress in rat testes.

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D-P1 HRANA ZA POSEBNE MEDICINSKE NAMENE NA TRŽIŠTU REPUBLIKE SRBIJE: VRSTE I KARAKTERISTIKE

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Hrana za posebne medicinske namene predstavlja kategoriju dijetetskih proizvoda namenjenih za potpunu ili delimičnu ishranu osoba sa ograničenom, smanjenom ili poremećenom sposobnošću unosa hrane, varenja, apsorpcije ili metabolizma hranljivih sastojaka, kao i pacijenata sa posebnim nutritivnim potrebama koje nije moguće zadovoljiti modifikacijom uobičajene ishrane.

Cilj ovog rada bio je da se dobije uvid u zastupljenost, vrste i karakteristike hemijskog sastava ovih proizvoda na tržištu Republike Srbije.

Prema podacima iz baze Ministarstva zdravlja Republike Srbije, od oko 900 proizvoda iz kategorije hrane za posebne medicinske namene, najveći broj pripada kategoriji nutritivno nepotpunih namirnica sa povećanim sadržajem vitamina, minerala i drugih biološki aktivnih sastojaka. Od nutritivno potpunih proizvoda, sa standardnim ili prilagođenim sastavom i sadržajem nutrijenata, najzastupljenje su enteralne formule, namenjene primeni putem sonde ili oralno, naročito kod pacijenata sa malnutricijom. Posebnu kategoriju čine proizvodi za ishranu odojčadi, uključujući formule za prevremeno rođenu decu, bezlaktozne i hipoalergene formule, kao i proizvodi namenjeni osobama sa fenilketonurijom i drugim metaboličkim bolestima. Analiza deklarisanog hemijskog sastava ukazuje da ovi proizvodi, pored uobičajenih hranljivih sastojaka često sadrže prebiotike, specifične masne kiseline i druge bioaktivne sastojke, uključujući i sastojke nove hrane, a u cilju modulacije imunskog odgovora i inflamacije. Hrana za posebne medicinske namene je dostupna u apotekama, a određeni proizvodi se koriste isključivo u zdravstvenim ustanovama.

Rastuća zastupljenost ovih proizvoda na tržištu kao i inovacije u njihovim formulacijama ukazuju na potrebu za kontinuiranom edukacijom zdravstvenih radnika i potrošača o njihovom značaju i pravilnoj primeni.

D-P1 FOODS FOR SPECIAL MEDICAL PURPOSES ON THE SERBIAN MARKET: TYPES AND CHARACTERISTICS

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Foods for special medical purposes are products intended for the complete or partial nutrition of individuals with a limited, reduced, or impaired capacity to ingest, digest, absorb, metabolise, or excrete ordinary food or certain nutrients, as well as for patients with specific nutritional requirements that cannot be met by modification of the normal diet alone.

This study aimed to provide insight into the prevalence, types, and chemical composition characteristics of these products available on the Serbian market.

According to the Ministry of Health of the Republic of Serbia's database, among about 900 products, the majority are nutritionally incomplete with high doses of vitamins, minerals, and other bioactive compounds. Among nutritionally complete products, enteral formulas with standard or adapted nutrient composition intended for oral or tube feeding are predominant, particularly in patients with malnutrition. A specific category includes infant products, such as formulas for preterm infants, lactose-free and hypoallergenic formulas, as well as products intended for individuals with phenylketonuria and other metabolic disorders. The analysis of declared composition indicates that these products often contain, in addition to standard nutrients, prebiotics, specific fatty acids, and other bioactive compounds, including novel food ingredients, to modulate immune response and inflammation.

Foods for special medical purposes are available in pharmacies, while certain products are intended exclusively for use in healthcare institutions; the growing market of these products, together with innovations in their formulations, highlights the need for continuous education of healthcare professionals and consumers on their importance and appropriate use.

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D-P2 SADRŽAJ VITAMINA D U KONZERVIRANIM PROIZVODIMA OD RIBE DOSTUPNIM NA TRŽIŠTU SRBIJE

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Nedostatak i insuficijencija vitamina D predstavljaju značajan javnozdravstveni problem u Srbiji, s obzirom na to da je unos ovog vitamina hranom uglavnom nedovoljan, a samo mali broj namirnica prirodno sadrži značajne količine vitamina D. Konzervirani proizvodi od ribe predstavljaju jedan od najznačajnijih prehrambenih izvora ovog vitamina. Prema preporukama Evropske agencije za bezbednost hrane (EFSA), adekvatan dnevni unos (AI) vitamina D za odrasle iznosi 15 µg/dan. Cilj ovog istraživanja bio je određivanje sadržaja vitamina D u konzerviranim proizvodima od ribe dostupnim na tržištu Srbije i procena njihovog doprinosa adekvatnom dnevnom unosu. Sadržaj vitamina D određen je primenom validirane metode tečne hromatografije visokih performansi sa fotodiodnim detektorom (HPLC–PDA). Analizirano je trideset uzoraka konzervisane tunjevine i sedamnaest uzoraka konzervisanih sardina dostupnih na tržištu Srbije. Sadržaj vitamina D u konzervisanoj tunjevini kretao se od 1,01 do 9,22 µg/100 g, dok je u konzervisanim sardinama iznosio 2,19 do 10,65 µg/100 g. Konzumiranjem porcije od 100 g konzervisane tunjevine obezbeđuje se približno 6,7–61,5%, dok porcija od 100 g konzervisanih sardina obezbeđuje 14,6–71,0% adekvatnog dnevnog unosa vitamina D prema preporukama EFSA. Dobijeni rezultati ukazuju na značajnu varijabilnost sadržaja vitamina D među komercijalno dostupnim konzerviranim proizvodima od ribe. Ipak, konzervisana tunjevina i sardine predstavljaju vredan prehrambeni izvor vitamina D i mogu značajno doprineti ostvarivanju adekvatnog dnevnog unosa vitamina D u populaciji Srbije.

D-P2 VITAMIN D CONTENT IN CANNED FISH PRODUCTS AVAILABLE ON THE SERBIAN MARKET

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Vitamin D deficiency and insufficiency remain significant public health concerns in Serbia, as dietary intake is generally inadequate and only a limited number of foods naturally contain substantial amounts of vitamin D. Canned fish products are among the most important dietary sources of this vitamin. According to the European Food Safety Authority (EFSA), the adequate intake (AI) of vitamin D for adults is 15 µg/day. The aim of this study was to determine the vitamin D content in canned fish products available on the Serbian market and to estimate their contribution to the adequate daily intake. Vitamin D content was determined using a validated high-performance liquid chromatography method coupled to photodiode array detection (HPLC–PDA). Thirty canned tuna samples and seventeen canned sardine samples collected from the Serbian market were analyzed. The vitamin D content in canned tuna ranged from 1.01 to 9.22 µg/100 g, while canned sardines contained 2.19 to 10.65 µg/100 g. Consequently, a 100 g serving of canned tuna provided approximately 6.7–61.5% of the EFSA adequate intake, whereas a 100 g serving of canned sardines provided 14.6–71.0% of the adequate daily intake. The obtained results indicate considerable variability in vitamin D content among commercially available canned fish products. Nevertheless, canned sardines and tuna may be valuable dietary sources of vitamin D and can substantially contribute to adequate daily intake in the Serbian population.

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D-P3 STAVOVI I PRAKSE U VEZI SA UPOTREBOM DODATAKA ISHRANI U REPUBLICI SRBIJI I ZEMLJAMA REGIONA

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Dijetetski suplementi (DS) predstavljaju koncentrovane izvore vitamina, minerala i drugih supstanci sa nutritivnim ili fiziološkim efektima. Iako njihova popularnost kontinuirano raste, u pojedinim regionima i zemljama i dalje nedostaju podaci o učestalosti njihove upotrebe i stavovima potrošača prema ovim proizvodima. Cilj ovog istraživanja bio je da se proceni učestalost, stavovi, prakse i faktori povezani sa upotrebom DS u Republici Srbiji i zemljama regiona. Istraživanje je sprovedeno među odraslom populacijom u Srbiji, Crnoj Gori i Republici Srpskoj (Bosna i Hercegovina) u periodu od jula do oktobra 2024. godine, korišćenjem onlajn upitnika. Upitnik je sadržao 46 pitanja koja su obuhvatala sociodemografske i ekonomske karakteristike, kao i karakteristike životnog stila, uključujući navike u ishrani. Rezultati su pokazali da je više od 70% ispitanika konzumiralo najmanje jedan DS u prethodnoj godini. Najčešće korišćeni bili su vitaminski i/ili mineralni suplementi, zatim probiotici, omega-3 masne kiseline i biljni suplementi. Glavni razlog za upotrebu DS bio je očuvanje opšteg zdravlja, dok su specifičniji razlozi bili podrška imunskom sistemu i povećanje nivoa energije. Upotreba DS bila je povezana sa povoljnijim zdravstvenim stanjem i zdravijim životnim navikama ispitanika. Samoprocena nivoa znanja i faktori povezani sa upotrebom DS razlikovali su se među ispitanicima iz različitih zemalja. Neželjene efekte povezane sa upotrebom DS prijavilo je 4% ispitanika. Rezultati ovog istraživanja pružaju uvid u učestalost upotrebe i obrasce korišćenja DS u Srbiji i okolnim zemljama. Međutim, potrebna su dalja istraživanja kako bi se identifikovali načini za promociju racionalne i bezbedne upotrebe DS.

D-P3 ATTITUDES AND PRACTICES REGARDING FOOD SUPPLEMENT USE IN SERBIA AND NEIGHBORING COUNTRIES

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Food supplements (FS) are concentrated sources of vitamins, minerals, and other substances with nutritional or physiological effects. Despite their increasing popularity, data on their use and related practices remain limited in some regions and countries. This study aimed to assess the prevalence, attitudes, practices, and factors associated with FS use in Serbia and countries in the region. The survey was conducted among adults in Serbia, Montenegro, and the Republic of Srpska (Bosnia and Herzegovina) between July and October 2024 using an online self-administered questionnaire. The questionnaire included 46 items covering sociodemographic, economic, and lifestyle characteristics, including dietary habits, as well as FS-related items. Overall, more than 70% of respondents reported consuming at least one FS in the previous year. The most frequently used FS were vitamin and/or mineral supplements, followed by probiotics, omega-3 fatty acids, and herbal products. The primary reason for FS use was maintaining general health, while more specific motivations included immune support and increased energy. FS use was associated with more favorable health status and lifestyle habits. Self-reported knowledge, beliefs regarding FS, and factors influencing consumers' intention to use FS differed among countries. Adverse effects related to FS use were reported by 4% of participants. These findings provide important insights into the prevalence and patterns of FS use in Serbia and countries in the region. Further research is needed to develop strategies promoting the rational and safe use of FS.

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D-P4 SADRŽAJ KOFEINA U NAPICIMA PRIPREMLJENIM OD RAZLIČITIH PROIZVODA OD KAFE DOSTUPNIH NA TRŽIŠTU SRBIJE

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Kafa je jedan od najpopularnijih napitaka koji privlači značajnu istraživačku pažnju zbog svog hemijskog sastava i povezanih zdravstvenih efekata. Dok umereno konzumiranje kafe (do 400 mg kofeina dnevno) može imati povoljne zdravstvene efekte, prekomeran unos može dovesti do nervoze, nesanice, kardiovaskularnih i drugih neželjenih efekata. Sadržaj kofeina u napicima od kafe zavisi od vrste zrna kafe, stepena prženja, načina pripreme, kao i veličine porcije. Cilj ovog istraživanja bio je određivanje sadržaja kofeina u napicima od mlevene (7 uzoraka), instant (7 uzoraka) i filter kafe (7 uzoraka) dostupnoj na tržištu Srbije. Sadržaj kofeina u pripremljenim napicima određen je primenom tečne hromatografije visoke efikasnosti sa detektorom sa nizom fotodioda (HPLC-DAD), u skladu sa propisom Ph.Eur. za određivanje kofeina u biljnim drogama. Za preračun sadržaja kofeina po porciji, za sve vrste napitaka korišćena je porcija zapremine 100 mL. Napici od mlevene kafe sadržali su veće koncentracije kofeina (0,70–1,52 mg/mL) u poređenju sa instant (0,51–0,77 mg/mL) i filter kafom (0,70–1,21 mg/mL). Prosečan sadržaj kofeina po porciji iznosio je 118,72±39,46 mg za mlevenu kafu, 63,09±9,43 mg za instant kafu i 98,42±13,87 mg za filter kafu. Dobijeni rezultati ukazuju da preporučeni bezbedni dnevni unos kofeina za odrasle (400 mg/dan) može biti prekoračen konzumiranjem tri porcije mlevene kafe, šest porcija instant kafe ili četiri porcije filter kafe. Dalja istraživanja hemijskog sastava napitaka od kafe i procena njihovog unosa su neophodni u cilju procene koristi i rizika povezanih sa konzumiranjem kafe.

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D-P4 CAFFEINE CONTENT IN BEVERAGES PREPARED FROM DIFFERENT COFFEE PRODUCTS AVAILABLE ON THE SERBIAN MARKET

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As one of the most popular beverages, coffee has attracted considerable research interest regarding its chemical composition and associated health effects. While moderate coffee consumption (up to 400 mg of caffeine per day) may provide health benefits, excessive intake can lead to nervousness, insomnia, cardiovascular, and other adverse effects. The caffeine content in coffee beverages depends on the type of coffee bean, roast level, brewing method, and serving size. This study aimed to determine the caffeine content in ground (7 samples), instant (7 samples), and filter coffee (7 samples) available on the Serbian market. The caffeine content in prepared coffee beverages was determined by high-performance liquid chromatography with a photodiode array detector (HPLC-DAD) in accordance with Ph.Eur. procedure for determining caffeine in herbal drugs. For calculating caffeine content, a serving size of 100 mL was used for all coffee beverages. Ground coffee beverages contained higher caffeine levels (0.70–1.52 mg/mL) compared to instant (0.51–0.77 mg/mL) and filter coffee (0.70–1.21 mg/mL). The average caffeine content per serving was 118.72±39.46 mg for ground coffee, 63.09±9.43 mg for instant coffee, and 98.42±13.87 mg for filter coffee beverages. These results suggest that the recommended safe daily intake of caffeine for adults (400 mg/day) could be exceeded with three servings of ground coffee, six servings of instant coffee, or four servings of filter coffee. Further studies on the chemical composition of coffee beverages and assessments of their consumption are needed to clarify ongoing controversies regarding the benefits and risks of coffee intake.

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D-P5 ANALIZA KVALITETA MASLINOVOG ULJA NA TRŽIŠTU REPUBLIKE SRBIJE

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Maslinovo ulje predstavlja važan prehrambeni proizvod zbog visokog sadržaja mononezasićenih masnih kiselina, prirodnih antioksidanasa i bioaktivnih jedinjenja koja imaju pozitivni uticaj na ljudsko zdravlje. S obzirom na to da domaće tržište u potpunosti zavisi od uvoza, otvara se pitanje kontinuiteta kvaliteta i bezbednosti. Cilj rada je ispitivanje kvaliteta komercijalno dostupnih maslinovih ulja na tržištu Republike Srbije određivanjem osnovnih parametara kvaliteta i oksidativne stabilnosti. U periodu februar-maj 2026. godine analizirano je 30 uzoraka devičanskog i ekstra devičanskog maslinovog ulja dostavljenog od strane fitosanitarne inspekcije. Ispitivanja su obuhvatala određivanje kiselinskog broja, peroksidnog broja, jodnog broja, sadržaja vode standardnim analitičkim metodama. Dobijene vrednosti upoređene su sa propisanim kriterijumima kvaliteta. Rezultati analiza pokazali su da se vrednosti kiselinskog broja (slobodne masne kiseline kao oleinska) kreću u opsegu od 0,24 do 0,95 % ulja što odgovara kriterijumima za devičansko i ekstra devičansko maslinovo ulje. Peroksidni broj iznosio je od 5,96 do 8,87 mmol O_2/kg ulja, ukazujući na zadovoljavajući stepen oksidativne stabilnosti uzoraka. Određeni jodni broj kretao se u rasponu od 80,1 do 91,9 g I_2/100 g ulja, što potvrđuje prisustvo nezasićenih masnih kiselina karakterističnih za maslinovo ulje. Sadržaj vode u analiziranim uzorcima bio je nizak i iznosio je od 0,03 do 0,17%, čime je potvrđena dobra stabilnost i adekvatni uslovi čuvanja proizvoda. Na osnovu dobijenih rezultata zaključeno je da većina analiziranih uzoraka maslinovog ulja sa tržišta RS zadovoljava propisane kriterijume kvaliteta. Kontinuirana kontrola fizičko-hemijskih parametara značajana je za očuvanje kvaliteta proizvoda, zaštitu potrošača i sprečavanje oksidativnih promena tokom skladištenja i distribucije.

D-P5 ANALYSIS OF OLIVE OIL QUALITY ON THE MARKET OF THE REPUBLIC OF SERBIA

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Olive oil is an important food product due to its high content of monounsaturated fatty acids, natural antioxidants, and bioactive compounds that provide health benefits. As the Serbian market is fully dependent on imports, ensuring product quality and safety is of particular importance. The aim of this study was to evaluate the quality of commercially available olive oils on the market of Republic of Serbia by determining key quality parameters and oxidative stability.Between February and May 2026, 30 samples of virgin and extra virgin olive oil supplied by the phytosanitary inspection service were analyzed. The study included the determination of acid value, peroxide value, iodine value, and water content using standard analytical methods. The obtained results were compared with the prescribed quality standards.The acid value (expressed as free fatty acids, calculated as oleic acid) ranged from 0.24% to 0.95%, meeting the requirements for virgin and extra virgin olive oils. The peroxide value ranged from 5.96 to 8.87 mmol O_2/kg, indicating satisfactory oxidative stability. The iodine value ranged from 80.1 to 91.9 g I_2/100 g, confirming the presence of unsaturated fatty acids characteristic of olive oil. Water content was low, ranging from 0.03% to 0.17%, indicating good stability and appropriate storage conditions.The results showed that most olive oil samples available on the Serbian market comply with the prescribed quality standards. Continuous monitoring of physicochemical parameters is essential for maintaining product quality, protecting consumers, and preventing oxidative deterioration during storage and distribution.

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D-P6 STAVOVI I ZAINTERESOVANOST FARMACEUTA ZA EDUKACIJU IZ OBLASTI SPORTSKE SUPLEMENTACIJE I SPORTSKE FARMACIJE

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Upotreba sportskih suplemenata među profesionalnim sportistima i rekreativcima je u stalnom porastu. Farmaceuti imaju važnu ulogu u edukaciji korisnika, međutim, sportska farmacija i antidoping nisu dovoljno zastupljeni u formalnom obrazovanju i programima kontinuirane edukacije farmaceuta. Cilj istraživanja bio je ispitati stavove i zainteresovanost farmaceuta za dodatnu edukaciju iz oblasti suplementacije u sportu.

Sprovedeno je prospektivno opservaciono istraživanje u periodu od marta do maja 2026. godine putem online upitnika koji je distribuiran putem društvenih mreža Instagram, Facebook i Linkedin. Statistička analiza izvršena je u softveru SPSS.

U istraživanju je učestvovalo ukupno 282 farmaceuta. Bromatologiju je tokom studija pohađalo 267 ispitanika (94%), dijetetiku 96 (34%), a sportsku farmaciju 42 farmaceuta (15%). Većina ispitanika (79,8%) do sada nije učestvovala u edukacijama na temu sportske suplementacije ili dopinga. Na pitanje o zainteresovanosti za učešće u stručnoj edukaciji iz oblasti sportske farmacije, 268 ispitanika (95%) odgovorilo je potvrdno, dok je više od 70% ispitanika iskazalo zainteresovanost za dodatnu edukaciju iz ove oblasti. Neki od oblika edukacije za koje su ispitanici bili najviše zainteresovani bili su: webinari (47,2%), stručni priručnici/vodiči za praksu (44%) i online kursevi sa interaktivnim sadržajem (34,8%). Kao teme za buduće edukacije, farmaceuti su najčešće navodili: interakcije suplemenata sa lekovima i drugim suplementima (78,4%); bezbednost, kontaminaciju i neželjene efekte suplemenata (72,7%); principe sportske ishrane (67,7%); antidoping propise (66,7%). Rezultati istraživanja ukazuju da među farmaceutima postoji visok nivo interesovanja za edukaciju iz oblasti sportske suplementacije i sportske farmacije.

D-P6 PHARMACISTS' ATTITUDES TOWARD AND INTEREST IN EDUCATION ON SPORTS SUPPLEMENTATION AND SPORTS PHARMACY

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The use of sports supplements among professional athletes and recreational exercisers is continuously increasing. Pharmacists play an important role in providing counseling and education on supplement use; however, sports pharmacy and anti-doping topics remain insufficiently represented in formal pharmacy education and continuing professional development programs. The aim of this study was to assess pharmacists' attitudes and interest in education related to sports supplementation and sports pharmacy.

A prospective observational study was conducted between March and May 2026 using an online questionnaire distributed through Instagram, Facebook, and LinkedIn. Statistical analysis was performed using SPSS software.

A total of 282 pharmacists participated in the study. During their undergraduate education, 267 respondents (94%) had completed courses in bromatology, 96 (34%) in dietetics, and only 42 (15%) in sports pharmacy. Most respondents (79.8%) had not previously participated in any educational activities related to sports supplementation or anti-doping. When asked about their interest in participating in professional education in sports pharmacy, 268 respondents (95%) answered positively, while more than 70% expressed interest in additional education in the field of sports pharmacy. Preferred educational formats included webinars (47.2%), professional handbooks/practice guides (44.0%), and interactive online courses (34.8%). The most frequently selected topics for future education were interactions between supplements and medications or other supplements (78.4%), safety, contamination, and adverse effects of supplements (72.7%), principles of sports nutrition (67.7%), and anti-doping regulations (66.7%).

The findings indicate a high level of interest among pharmacists in education related to sports supplementation and sports pharmacy.

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D-P7 POVEZANOST KONTINUIRANE SUPLEMENTACIJE PROBIOTICIMA SA UČESTALOŠĆU RESPIRATORNIH INFEKCIJA I OPORAVKOM NAKON INFEKCIJE KOD SPORTISTA: PROSPEKTIVNA PRE-POST STUDIJA

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Fizička aktivnost ima direktan uticaj na imunski sistem. Taj uticaj može biti pozitivan ili negativan, u zavisnosti od intenziteta i obima fizičke aktivnosti. Postoji direktna zavisnost rizika od respiratornih infekcija gornjih disajnih puteva i intenziteta vežbanja, gde se sa povećanjem intenziteta vežbanja značajno povećava rizik od tih infekcija.

Cilj sprovedenog istraživanja je procena povezanosti kontinuirane upotrebe probiotika i učestalosti respiratornih infekcija, definisanih prema samoprijavljenim simptomima i/ili lekarskoj dijagnozi, kod sportista.

U istraživanju je učestvovalo 63 sportista (44 muškarca i 19 žena), koji su se bavili različitim sportovima: fudbalom, košarkom, atletikom, veslanjem. Istraživanje je trajalo od oktobra 2024. do aprila 2026. godine. Sprovedena je prospektivna pre-post studija u kojoj su ispitanici predstavljali sopstvenu kontrolu, pri čemu je poređen period bez suplementacije (oktobar 2024-april 2025. godine) sa periodom suplementacije probioticima (oktobar 2025-april 2026. godine). Tokom perioda suplementacije korišćeni su probiotski preparati koji su sadržavali *Lactobacillus*, *Bifidobacterium* i kvasac *Saccharomyces boulardii* u dnevnoj dozi od najmanje 5 milijardi CFU. Svake godine sportisti su anonimno ispunjavali anketni list u papirnoj formi.

Sekundarni ishodi uključivali su subjektivnu procenu sposobnosti održavanja treninga tokom infekcije.

Broj infekcija gornjih disajnih puteva po sportisti je prve godine bio 2,3 ± 0,4 (11,1% sportista nije imalo respiratornu infekciju), a druge godine 0,9 ± 0,3 (36,5% sportista nije imalo respiratornu infekciju). Druge godine su se sportisti 2,1 ± 0,3 dana ranije vraćali u pun trening nakon respiratorne infekcije.

Rezultati ukazuju na povezanost kontinuirane probiotske suplementacije sa manjom učestalošću respiratornih infekcija tokom meseci kada su one češće i kraćim prekidom trenažnog procesa.

D-P7 ASSOCIATION OF CONTINUOUS PROBIOTIC SUPPLEMENTATION WITH THE INCIDENCE OF RESPIRATORY INFECTIONS AND POST-INFECTION RECOVERY IN ATHLETES: A PROSPECTIVE PRE–POST STUDY

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Physical activity directly influences the immune system, with its effects depending on exercise intensity and volume. While moderate exercise may enhance immune function, high-intensity training is associated with an increased risk of upper respiratory tract infections (URTIs).

The aim of this study was to evaluate the association between continuous probiotic supplementation and the incidence of respiratory infections, defined by self-reported symptoms and/or physician diagnosis, in athletes.

A total of 63 athletes (44 men and 19 women) participating in football, basketball, athletics, and rowing were enrolled. The study was conducted from October 2024 to April 2026 as a prospective pre–post study in which each participant served as their own control. During the first year, participants did not receive probiotic supplementation, whereas during the second year they received probiotics containing *Lactobacillus*, *Bifidobacterium*, and *Saccharomyces boulardii* at a daily dose of at least 5 billion CFU, from early October to the end of March. Participants completed anonymous paper-based questionnaires annually. A secondary outcome was the subjective assessment of the ability to maintain training during respiratory infections.

The mean number of URTIs per athlete decreased from 2.3 ± 0.4 in the first year (11.1% of athletes reported no infections) to 0.9 ± 0.3 in the second year (36.5% reported no infections). Athletes also returned to full training 2.1 ± 0.3 days earlier following respiratory infection during the supplementation period.

Continuous probiotic supplementation was associated with a lower incidence of respiratory infections during peak infection seasons and a shorter interruption of the training process.

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D-P8 ANALIZA PRISUSTVA ADITIVA U "ZERO" PROIZVODIMA DOSTUPNIM NA TRŽIŠTU REPUBLIKE SRBIJE

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U savremenoj ishrani sve veći broj potrošača bira „zero" proizvode, odnosno proizvode bez dodatog šećera i sa smanjenom energetskom vrednošću. Njihova popularnost povezana je sa povećanom svešću o značaju prevencije gojaznosti, dijabetesa i drugih hroničnih nezaraznih bolesti. Iako se često smatraju zdravijom alternativom konvencionalnim proizvodima, njihova formulacija zahteva primenu različitih prehrambenih aditiva radi očuvanja senzorskih i tehnoloških karakteristika.

Cilj ovog rada bio je da se utvrdi prisustvo i učestalost prisustva aditiva u „zero" proizvodima dostupnim na tržištu Republike Srbije, kao i da se sagleda njihov značaj sa aspekta bezbednosti i regulatornih zahteva. Analizirano je 30 proizvoda iz različitih kategorija, uključujući gazirane napitke, energetska pića, proteinske proizvode, jogurte i konditorske proizvode, na osnovu podataka sa deklaracija proizvođača.

Rezultati su pokazali da su najčešće korišćeni aditivi zaslađivači aspartam, acesulfam-K i sukraloza, koji omogućavaju postizanje intenzivne slatkoće uz minimalnu energetsku vrednost. Često su bili prisutni i limunska kiselina kao regulator kiselosti, kao i prehrambene boje radi očuvanja karakterističnog izgleda proizvoda. Stabilizatori i zgušnjivači, poput guar i ksantan gume, identifikovani su ređe, dok su konzervansi, uključujući natrijum-benzoat i kalijum-sorbat, uglavnom bili zastupljeni u napicima.

Rezultati ukazuju na značaj aditiva u formulaciji „zero" proizvoda, kao i na potrebu za kontinuiranim praćenjem njihovog unosa, pravilnim deklarisanjem i edukacijom potrošača radi omogućavanja bezbednog i informisanog izbora hrane.

D-P8 ANALYSIS OF THE PRESENCE OF FOOD ADDITIVES IN "ZERO" PRODUCTS AVAILABLE ON THE MARKET OF THE REPUBLIC OF SERBIA

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In contemporary nutrition, an increasing number of consumers choose "zero" products, characterized by the absence of added sugar and reduced energy value. Their growing popularity is associated with increased awareness of the importance of preventing obesity, diabetes mellitus, and other chronic non-communicable diseases. Although often perceived as healthier alternatives to conventional products, their formulation requires the use of various food additives to maintain desirable sensory and technological properties.

The aim of this study was to determine the presence and frequency of food additive use in "zero" products available on the market of the Republic of Serbia and to evaluate their significance from safety and regulatory perspectives. Thirty products from different categories, including carbonated beverages, energy drinks, protein products, yogurts, and confectionery products, were analyzed based on ingredient declarations provided by manufacturers.

The results showed that the most frequently used additives were the sweeteners aspartame, acesulfame-K, and sucralose, which provide intense sweetness with minimal caloric contribution. Citric acid was also commonly used as an acidity regulator, while food colorings were frequently added to preserve the characteristic appearance of products. Stabilizers and thickeners, such as guar gum and xanthan gum, were identified less frequently, whereas preservatives, including sodium benzoate and potassium sorbate, were predominantly present in beverages.

The findings highlight the important role of food additives in the formulation of "zero" products and emphasize the need for continuous monitoring of additive intake, accurate product labeling, and consumer education to ensure safe and informed dietary choices.

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D-P9 KOMPARATIVNA ANALIZA DEKLARISANIH DOZA KALCIJUMA I MAGNEZIJUMA U DODACIMA ISHRANI U ODNOSU NA PREPORUČENE DNEVNE UNOSE

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Dodaci ishrani sa mineralima predstavljaju važan segment proizvoda namijenjenih očuvanju i unapređenju zdravlja odrasle populacije. Među najzastupljenijim mineralima u dodacima ishrani izdvajaju se kalcijum i magnezijum zbog njihove značajne uloge u održavanju zdravlja kostiju, normalne funkcije mišića i nervnog sistema, kao i brojnih metaboličkih procesa.

Cilj ovog rada bio je da se izvrši komparativna analiza deklarisanih doza kalcijuma i magnezijuma u dodacima ishrani dostupnim na tržištu Republike Srpske u odnosu na preporučene dnevne unose propisane važećim Pravilnikom o dodacima ishrani za odraslu populaciju.

Istraživanje je obuhvatilo analizu deklaracija proizvoda, procjenu usklađenosti sadržaja minerala sa regulatornim zahtjevima, kao i identifikaciju mogućih odstupanja u pogledu minimalno i maksimalno dozvoljenih količina.

Rezultati pokazuju da većina analiziranih dodataka ishrani sadrži kalcijum i magnezijum u dozama usklađenim sa propisanim vrijednostima, iako su zabilježene razlike u procentualnom učešću preporučenog dnevnog unosa između pojedinih proizvoda.

Zaključuje se da su kontinuirana kontrola kvaliteta i sastava dodataka ishrani, kao i adekvatno informisanje potrošača, od ključnog značaja za bezbjednu i racionalnu primjenu kalcijuma i magnezijuma u odrasloj populaciji.

D-P9 COMPARATIVE ANALYSIS OF DECLARED CALCIUM AND MAGNESIUM DOSES IN DIETARY SUPPLEMENTS IN RELATION TO RECOMMENDED DAILY INTAKES

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Mineral dietary supplements represent an important segment of products intended for the preservation and improvement of adult health. Calcium and magnesium are among the most commonly used minerals due to their significant role in maintaining bone health, normal muscle and nervous system function, as well as numerous metabolic processes.

The aim of this study was to perform a comparative analysis of the declared doses of calcium and magnesium in dietary supplements available on the market of the Republic of Srpska in relation to the recommended daily intakes prescribed by the current Regulation on Dietary Supplements for the adult population.

The research included the analysis of product declarations, assessment of compliance of mineral content with regulatory requirements, and identification of possible deviations regarding minimum and maximum permitted quantities.

The results indicate that most analyzed dietary supplements contain calcium and magnesium in doses compliant with the prescribed values, although significant differences were observed in the percentage contribution to the recommended daily intake among individual products.

It can be concluded that continuous quality and composition control of dietary supplements, as well as adequate consumer information, are essential for the safe and rational use of calcium and magnesium in the adult population.

D-P10 PERSONALIZOVANA SUPLEMENTACIJA U APOTECI: KONCEPT DIGITALNE PODRŠKE FARMACEUTU UZ PRIMENU VEŠTAČKE INTELIGENCIJE

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Savetovanje o dodacima ishrani često je složeno. Korisnici neretko uzimaju više proizvoda uz redovnu terapiju, ne mogu precizno da navedu ukupan dnevni unos mikronutrijenata putem dodataka ishrani, a tegobe zbog kojih traže savet često su nespecifične. U takvoj situaciji farmaceut procenjuje opravdanost i bezbednost suplementacije, interakcije i potrebu za laboratorijskom proverom ili upućivanjem lekaru.

Cilj rada je prikazati koncept farmaceutske usluge u kojoj digitalni alat pomaže farmaceutu da sistematično prikupi i sagleda relevantne podatke, bez preuzimanja stručne odluke.

Koncept je oblikovan prema uobičajenom toku savetovanja u apoteci. Predviđeni unos obuhvata podatke o ishrani, simptomima, životnim navikama, hroničnim stanjima, terapiji i korišćenim dodacima ishrani. Sistem bi podatke objedinjivao, prikazivao procenjeni unos mikronutrijenata i upozoravao na moguća dupliranja, interakcije i druge okolnosti koje zahtevaju dodatni oprez. Komponenta veštačke inteligencije bila bi ograničena na obradu, povezivanje i pregledno prikazivanje informacija.

Kao rezultat konceptualnog rada definisan je tok usluge od razgovora i unosa podataka do farmaceutske procene i obrazložene preporuke. Mogući ishodi su uvođenje ili korekcija suplementacije, savet o vremenu primene, laboratorijska provera ili upućivanje lekaru.

Predloženi pristup mogao bi da olakša dokumentovanje podataka i unapredi doslednost savetovanja o suplementaciji, uz zadržavanje farmaceuta kao odgovornog donosioca odluke. Praktičnu vrednost koncepta potrebno je proveriti nakon izrade prototipa, stručne validacije pravila i pilot-primene u apotekama.

D-P10 PERSONALIZED SUPPLEMENTATION IN COMMUNITY PHARMACY: A CONCEPT OF DIGITAL AND ARTIFICIAL INTELLIGENCE SUPPORT FOR PHARMACISTS

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Counselling on dietary supplements is often complex. Users frequently combine several products with regular medication, cannot reliably report their total daily micronutrient intake, and seek advice for nonspecific complaints. In this setting, the pharmacist must assess the need for supplementation, its safety, possible ingredient duplication and interactions, and whether laboratory testing or medical referral is warranted.

To present a pharmacy service concept in which a digital tool helps the pharmacist collect and review relevant information systematically, without replacing professional judgment.

The concept was designed around the usual sequence of counseling in a community pharmacy. The proposed input includes diet, symptoms, lifestyle, chronic conditions, current medication, and dietary supplement use. The system would integrate these data, display estimated micronutrient intake, and flag possible duplication, interactions, and other circumstances requiring caution. The artificial intelligence component would be limited to processing, linking, and presenting information in a clear form.

The conceptual work produced a service pathway extending from the patient interview and data entry to pharmacist assessment and a documented recommendation. Possible outcomes include starting or modifying supplementation, advising on timing of use, recommending laboratory testing, or referring the user to a physician.

The proposed approach could support more consistent documentation and counseling on dietary supplement use while keeping the pharmacist responsible for the final decision. Its practical value should be assessed after prototype development, expert validation of the decision rules, and pilot use in community pharmacies.

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