ASOS 2024

6TH YOUNG SCIENTISTS' DAY

Department of Chemistry
Josip Juraj Strossmayer University of Osijek

BOOK OF ABSTRACTS

ORGANISERS:

6TH YOUNG SCIENTISTS' DAY

6th Young Scientists' Day Conference
December 5th 2024, Osijek, Croatia

BOOK OF ABSTRACTS

Znanstveni skup mladih istraživača
5. prosinca 2024. godine, Osijek, Hrvatska

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Enhancing stability and biological activity of bioactive components extracted with deep eutectic solvents: A novel approach to sustainable extraction
Faculty of Food Technology Osijek

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Postharvest challenges related to apple storage
Faculty of Food Technology Osijek

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Enrichment of eggs with n-3 polyunsaturated fatty acids and the impact of egg consumption on human health
Faculty of Agrobiotechnical Sciences Osijek

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Lucija Galić
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Biofortification of leafy vegetables and soybean with selenium
Faculty of Agrobiotechnical Sciences Osijek

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IntechOpen Limited, London, United Kingdom

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6TH YOUNG SCIENTISTS' DAY

ASOS 2024

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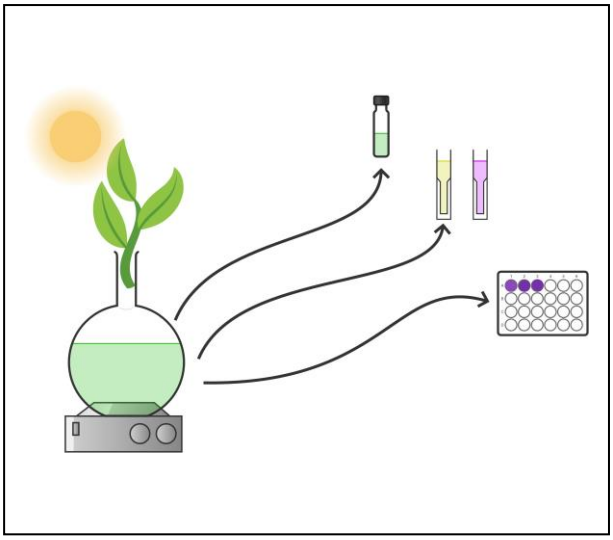
Presentation abstracts

ORAL PRESENTATION

Poboljšanje stabilnosti i biološke aktivnosti bioaktivnih komponenti ekstrahiranih eutektičkim otapalima: novi pristup održivoj ekstrakciji
Enhancing stability and biological activity of bioactive components extracted with deep eutectic solvents: A novel approach to sustainable extraction

***Martina Jakovljević Kovač*[1,*], *Mario Komar*[1], *Valentina Pavić*[2], *Maja Molnar*[1]**

[1]*Faculty of Food Technology Osijek, Josip Juraj Strossmayer University of Osijek, Franje Kuhača 18, 31000 Osijek, Croatia*
[2]*Department of Biology, Josip Juraj Strossmayer University of Osijek, Cara Hadrijana 8/A, 31000 Osijek, Croatia*
[*]*mjakovljevic@ptfos.hr*



Over the past two decades, deep eutectic solvents (DESs) have garnered significant attention for a wide range of applications due to their easy synthesis, cost-effective starting materials and adaptable physicochemical properties. DESs are formed through the combination of a hydrogen bond acceptor (HBA) and a hydrogen bond donor (HBD), resulting in a eutectic mixture with a melting point lower than that of the individual components. This study aimed to evaluate the potential of both hydrophilic and hydrophobic DESs for the extraction of bioactive compounds (phenolic acids, diterpenes and cannabinoids) from sage (*Salvia officinalis* L.), industrial hemp (*Cannabis sativa* L.) and nettle (*Urtica dioica* L.). Extracts were prepared using different extraction techniques (mixing and heating, ultrasound-assisted extraction and mechanochemical extraction). The resulting extracts were analyzed for their chemical composition via high-performance liquid chromatography (HPLC), assessed for antioxidant activity using the DPPH radical scavenging assay and evaluated for antibacterial efficacy through determination of the minimum inhibitory concentration (MIC) for each extract.

Hydrophilic acid-based DESs proved to be the most effective for extraction of phenolic acids and diterpenes, while hydrophobic, menthol-based DESs with carboxylic acids proved as most effective for cannabinoid extraction. The type of DESs, along with the applied extraction techniques and conditions, demonstrated both high extraction efficiency and selectivity for phenolic acids, diterpenes, and cannabinoids. Testing of extracts with the highest bioactive content at specific time intervals over three months indicated that DESs positively influence the preservation of most bioactive compounds, particularly when stored at room temperature. Most extracts obtained with DESs exhibited superior antioxidant and antibacterial activities compared to those extracted with conventional solvents. According to the obtained results, replacing organic solvents with DESs in extraction not only minimizes environmental impact but also enhances selectivity. Furthermore, combined with innovative extraction methods, this approach further reduces energy and time consumption.

Keywords: *phenolic acid, cannabinoids, HPLC, antibacterial activity, antioxidant activity*

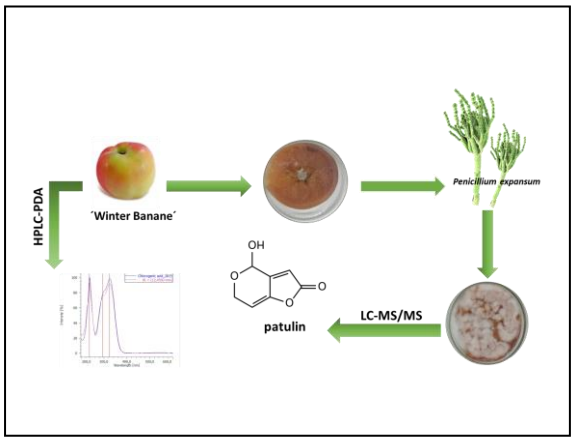
ORAL PRESENTATION

Izazovi vezani za skladištenje jabuka nakon berbe
Postharvest challenges related to apple storage

Ana-Marija Gotal Skoko[1,*], Ivana Flanjak[1], Martina Skendrović Babojelić[2], Michael Sulyok[3], Rudolf Krska[3,4], Tihomir Kovač[1], Ante Lončarić[1]

[1]Faculty of Food Technology Osijek, Josip Juraj Strossmayer University of Osijek, Franje Kuhača 18, 31000 Osijek, Croatia
[2]Department of Pomology, Faculty of Agriculture, University of Zagreb, Svetošimunska 25, 10000 Zagreb, Croatia
[3]Department of Agrobiotechnology (IFA-Tulln), Institute of Bioanalytics and Agro-Metabolomics, University of Natural Resources and Life Sciences Vienna (BOKU), Konrad Lorenzstr. 20, A-3430 Tulln, Austria
[4]Institute for Global Food Security, School of Biological Sciences, Queen's University Belfast, University Road, Belfast, Northern Ireland BT7 1NN, UK

*amgotal@ptfos.hr



Postharvest apple-related fungal diseases, mainly caused by *Penicillium expansum*, account for 25-50% of total yearly global fruit loss. To avoid that issue, apples are kept in cold storage at temperatures around 0 °C for several months. Beside economic consequences, *P. expansum* is food safety threat since it biosynthesises mycotoxin patulin. One of control strategies for food safety issue minimization is apple varieties selection. Based on that, the resistance of selected traditional ´Bobovec´, ´Winter Banana´, ´Zelenika´ and commercial apple varieties ´Idared´, ´Golden Delicious´ and ´Fuji´ to *P. expansum* CBS 325.38 infection was analysed after harvesting in 2021. and after six-month cold storage period. At both time-points polyphenol profile and resistance to *P. expansum* infection were examined. The polyphenol profile was analysed by HPLC-PDA method (Lončarić et al., 2014), while resistance to *P. expansum* infection was performed according to Ballester et al. (2017). Patulin concentration in *P. expansum* infected samples was carried out using the ´dilute and shoot´ LC-MS/MS method of Sulyok et al. (2020). The results showed that ´Bobovec´ had the highest content of catechin, epicatechin, myricetin, procyanidin B1 and B2 after six months of storage, ´Winter Banana´ the highest content of chlorogenic acid and rutin, ´Zelenika´ the highest content of phloridzin, ´Idared´ the highest content of quercetin. Zelenika' and 'Bobovec' had the longest average growth time of the *P. expansum* colony to reach a diameter of 9 cm´. Furthermore, the results showed that patulin was only detected in ´Idared´ and ´Zelenika´ during storage. The results suggest that polyphenols in apples contribute to their resistance to fungal infections and to patulin biosynthesis, which emphasises the importance of selecting apple varieties with higher polyphenol content.

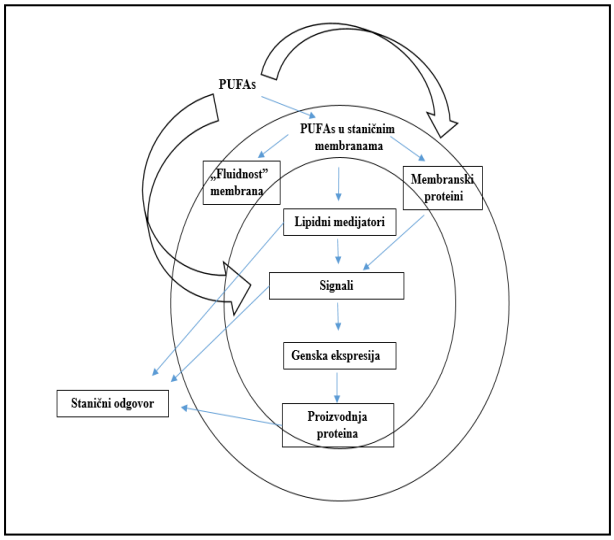
Keywords: *polyphenols, Penicillium expansum, fungal diseases, patulin*

ORAL PRESENTATION

Obogaćivanje jaja s n-3 polinezasićenim masnim kiselinama i utjecaj konzumacije jaja na ljudsko zdravlje
Enrichment of eggs with n-3 polyunsaturated fatty acids and the impact of egg consumption on human health

Ana Radanović[1,*], Zlata Kralik[2,3], Gordana Kralik[2,3]

[1]Inisight consulting, Vijenac Murse 4, Osijek, Croatia
[2]Faculty of Agrobiotechnical Sciences Osijek, J.J. Strossmayer University of Osijek, Vladimir Prelog 1, Osijek, Croatia
[3]Scientific Center of Excellence for Personalized Health Care, Josip Juraj Strossmayer University of Osijek, Trg Svetog Trojstva 3, 31000 Osijek, Croatia
[*]azelicos@gmail.com



Eggs are an excellent source of nutrients for humans and are considered a readily available source of protein around the world. Recent studies are focused on investigating the possibilities of enriching table eggs with n-3 polyunsaturated fatty acids (n-3 PUFA) to make them a natural source of that nutricine. This study elaborates the process of enriching table eggs with n-3 polyunsaturated fatty acids (n-3 PUFA) and presents the effect of such enriched eggs on human health. The experiment was performed on 480 TETRA SL laying hens divided into three groups. Feeding mixtures contained 5% of oils (K = soybean oil, P1 = 3.5% linseed oil + 1.5% fish oil, P2 = 3% linseed oil + 2% fish oil). Referring to the content of α-linolenic acid (ALA), eicosapentaenoic acid (EPA), and docosahexaenoic acid (DHA), eggs of P1 and P2 groups were significantly richer in n-3 PUFA than eggs of the control group ($p = 0.001$). Atherogenic (AI), thrombogenic (TI), and hypo/hypercholesterolemic (HHI) indexes of egg yolks were more favourable in enriched eggs than in conventional eggs. Fatty acid profiles in the blood of examinees that consumed conventional and enriched eggs (treatments K and P1, respectively) differed significantly in total saturated fatty acids (ΣSFA) ($p = 0.041$) and in the content of ALA ($p = 0.010$). The consumption of n-3 PUFA-enriched eggs lowered the Σn-6 PUFA/Σn-3 PUFA ratio in the examinees' blood serum (27%) and had a favourable effect on some blood biochemical indicators. This research confirmed the assumption that the use of a combination of fish and linseed oil in mixtures for laying hens in an amount of up to 5% will increase the content of omega-3 in table eggs, but it was not confirmed that the consumption of these eggs in a short period of time (21 days) has a positive effect on human health.

Keywords: *n-3 PUFA, fatty acid profile, egg health index, cardiovascular disease, functional food*

The research was financed by the European Structural and Investment Funds awarded to the Croatian National Scientific Center of Excellence for Personalized Care to health (KK.01.1.1.01.0010).

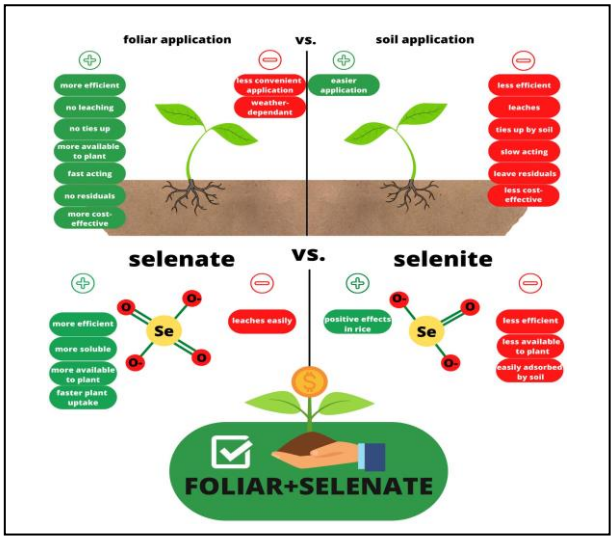
ORAL PRESENTATION

Biofortifikacija lisnatog povrća i soje selenom
Biofortification of leafy vegetables and soybean with selenium

***Lucija Galić*[1,*], *Zdenko Lončarić*[1]**

[1]*Faculty of Agrobiotehnical Sciences Osijek, Vladimira Preloga 1, Osijek, Hrvatska*

[*]*lucija.galic@fazos.hr*



Selenium (Se) is an essential micronutrient for humans, animals, and microorganisms, with benefits for plants. Dietary selenium deficiency is a global issue linked to soil selenium availability. Selenium is vital in antioxidant processes and for reproductive and immune system functions. Biofortification has emerged as a key strategy for increasing selenium in plants and plant-based foods.

This dissertation analyzes selenium biofortification of wheat, corn, barley, and rice. Results show foliar application is often more effective than soil application, with selenate generally outperforming selenite, except in rice biofortification where selenite is more efficient. A model predicting water-soluble selenium in soils was developed using samples from Croatia, Bosnia and Herzegovina, and Serbia.

Physiological responses of soybean seedlings to drought stress were assessed in two cultivars, Lucija and Sonja, grown from biofortified seeds. Selenium acted as an antioxidant in Lucija and as a prooxidant in Sonja. Parameters such as ascorbic acid, total phenols, proline, antioxidant activity, and lipid peroxidation were analyzed under osmotic stress.

The study also examined substrates, revealing a vermicompost and peat mixture enhances selenium biofortification and lamb's lettuce yield. Additionally, biofortification with sodium selenate and selenium nanoparticles in hydroponic cultivation of "baby leaf" vegetables (lamb's lettuce and amaranth) was explored. Lamb's lettuce benefited from selenium nanoparticles, while amaranth showed variable responses.

Key findings include the positive correlation of water-soluble selenium in soils with organic matter and other soil properties. Selenium-biofortified soybean seeds may alleviate water stress in some cultivars and enhance antioxidant activity in others. Vermicompost can reduce reliance on commercial substrates, and selenium biofortification can help meet dietary selenium requirements. Selenium nanoparticles improved lamb's lettuce yield and leaf count in hydroponic systems.

This research underscores selenium's potential to enhance plant nutrition and resilience.

Keywords: *biofortification, selenium, prediction model, leafy vegetables, growing media*

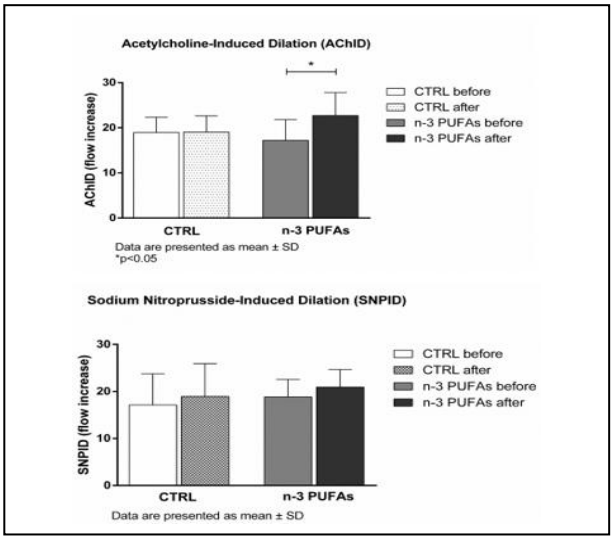
ORAL PRESENTATION

Učinak konzumacije pilećeg mesa obogaćenog n-3 polinezasićenim masnim kiselinama (n-3 PUFAs) na mikrovaskularnu funkciju kod zdravih mladih ispitanika

Effect of consumption of chicken meat enriched with n-3 polyunsaturated fatty acids (n-3 PUFAs) on microvascular function in healthy young people

***Tihana Nađ*[1,2,*], *Darjan Kardum*[2,3], *Ivana Jukić*[4,5*]**

[1]*Klinika za pedijatriju, Klinički bolnički centar Osijek, J. Huttlera 4, 31000 Osijek;*
[2]*Katedra za pedijatriju, Medicinski fakultet Osijek, J. Huttlera 4, 31000 Osijek;*
[3]*Odjel za neonatologiju, Opća bolnica Zadar, Bože Peričića 5,23000 Zadar;*
[4]*Katedra za fiziologiju i imunologiju, Medicinski fakultet Osijek, J. Huttlera 4, 31000 Osijek;*
[5]*Znanstveni centar izvrsnosti za personaliziranu brigu o zdravlju, Trg Sv. Trojstva 3, Osijek.*
[*]*ivana.jukic@mefos.hr*



Recent research within the Scientific Center of Excellence for Personalized Health Care has shown that consumption of n-3 polyunsaturated fatty acids (n-3 PUFAs) fortified eggs had a benefictial effect on microvascular reactivity in healthy young subjects of both sexes. Present study aimed to evaluate the effects of n-3 PUFAs enriched chicken meat consumption on microvascular function in healthy young volunteers. 39 healthy young participants were included in this double-blind, placebo-controlled, randomized, interventional study (registered at ClinicalTrials.gov (NCT05725486). All participants consumed approximately 500 g of quick-roasted chicken meat for 21 days, and were divided in two groups: Control group (N=20) – regular chicken meat and n-3 PUFAs group (N=19) – chicken meat enriched with n-3 PUFAs. Anthropometric, hemodynamic and biochemical measurements were performed to all participants. Laser Doppler flowmetry (LDF) was used to assess the forearm skin microvascular endothelium-dependent /-independent vasodilation by iontophoresis of acetylcholine (ACh) and sodium nitroprusside (SNP), respectively. All measurements were performed before and after each dietary protocol. The study protocol and procedures met the standards of the latest revision of the Declaration of Helsinki and were approved by the Ethics Committee of the Faculty of Medicine, University of Osijek, Osijek, Croatia (Cl: 602-04/23-08/03; No: 2158-61-46-23-125). After a 3-week dietary protocol, the microvascular response to ACh was significantly increased in the n-3 PUFAs group, while there was no difference in the Control group. In both groups, microvascular response to SNP was not changed compared to the basal values. Results of the present study indicate a beneficial effect of n-3 PUFAs consumed in enriched chicken meat on endothelium-dependent vasodilation in healthy young people.
Acknowledgments: Scientific Center of Excellence for Personalized Health Care, J.J. Strossmayer University of Osijek (Grant Number: KK.01.1.1.01.0010), and Faculty of Medicine Osijek Institutional Research Projects IP-05-MEFOS-2023 (PI Ivana Jukić).

Keywords: *functional food, omega-3 polyunsaturated fatty acid, microcirculation, vascular function, endothelium*

ORAL PRESENTATION

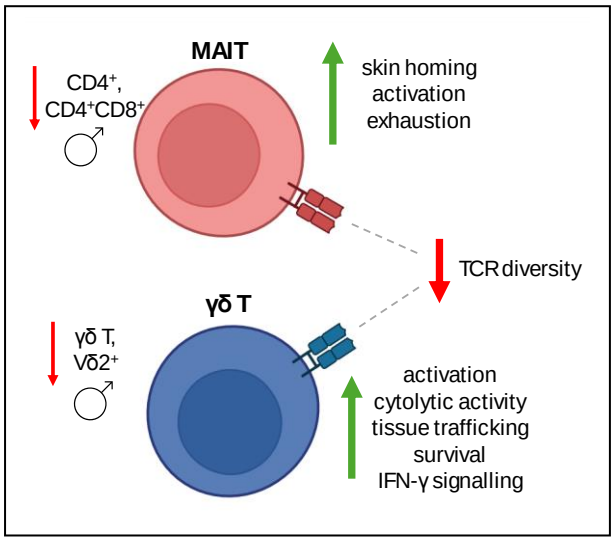
Distribucija, fenotip i TCR profil cirkulirajućih MAIT i γδ T stanica u psorijazi vulgaris

The distribution, phenotype, and TCR profiles of circulating MAIT and γδ T cells in psoriasis vulgaris

Maja Jirouš Drulak*[1,*], Vera Plužarić[1,2], Marija Šola[2], Martina Mihalj[1,2], Barbara Viljetić[1], Teuta Opačak-Bernardi[1], Daniel Arsovski[3], Daniela Moreno Vicencio[3], Mohamed Hamed[3], Priyanka Chevour[3], Péter Balogh[4], Mario Štefanić[1], Martin Davey[3], Stana Tokić[1]

[1]*Faculty of Medicine Osijek, J. Huttlera 4, Osijek, Croatia*
[2]*University Hospital Osijek, J. Huttlera 4, Osijek, Croatia*
[3]*Warwick Medical School, CV4 7AL, Coventry, United Kingdom*
[4]*University of Pécs Medical School, Szigeti St. 12, Pécs, Hungary*

[*]*mjirous@mefos.hr*



Psoriasis vulgaris (PV) is a chronic immune-mediated skin disease with systemic implications. While conventional T cells are well-established drivers of PV pathogenesis, the roles of unconventional subsets, including γδ T and mucosal-associated invariant T (MAIT) cells, remain underexplored despite their suggested contribution to disease-related inflammation.

To clarify their involvement, we investigated the distribution, phenotype and functional attributes of circulating MAIT and γδ T cells in PV using flow and spectral cytometry, along with bulk RNA sequencing for targeted transcriptomic analysis and T cell receptor (TCR) profiling.

Compared to healthy controls, male psoriasis patients displayed reduced frequencies of total γδ T cells and their Vδ2 subset within the $CD3^+$ T cell compartment, as well as diminished $CD4^+$ and $CD4^+CD8^+$ MAIT subsets, a pattern not observed in female patients. Transcriptomic profiling revealed that γδ T cells from PV patients upregulated genes associated with T cell activation (*ZAP70*, *CD3E/D/G*, *CD247*), cytotoxicity (*PRF1*, *GZMA*, *SRGN*, *NKG7*), tissue trafficking (*KLF2*, *CXCR4*, *SELL*), survival (*CORO1A*, *CD47*, *HLA-E*), type 1 immunity (*TBX21*, *IRF1*), and IFN-γ signalling (*IFITM1*, *ISG20*), while MAIT cells showed no transcriptomic changes. Spectral cytometry, however, identified increased expression of activation marker CD69 on MAIT cells and their skin-homing CLA^+ subset in PV, with the frequency of CLA^+ MAIT cells and their expression of immune checkpoint receptor PD-1 positively correlating with disease severity (PASI). Additionally, TCR profiling revealed an age-associated decline in clonotypic diversity in both γδ T and MAIT cells of affected individuals, with this decline being more pronounced in γδ T cells, driven by the expansion of dominant clones and the loss of low-frequent ones.

Altogether, these findings demonstrate significant alterations in the distribution, activation, and clonotypic diversity of circulating γδ T and MAIT cells in psoriasis, highlighting their contributions to chronic inflammation and opening new avenues for further research.

Keywords: *psoriasis vulgaris, γδ T cells, MAIT cells, T cell activation, clonotypic diversity*

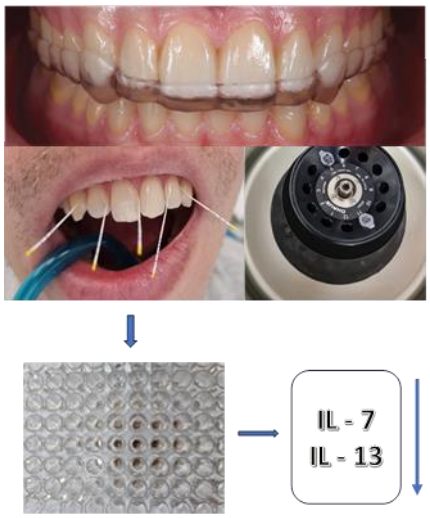
ORAL PRESENTATION

Koncentracije proupalnih citokina u sulkusnoj tekućini kod pacijenata s temporomandibularnim poremećajima liječenih stabilizacijskom udlagom
Concentrations of pro-inflammatory cytokines in gingival crevicular fluid in patients with temporomandibular joint disorders treated with stabilization splint

Renata Sikora[1,2,3*], Anita Matić[1], Robert Smolić[1], Martina Čalušić Šarac[1,2], Miroslav Sikora[1,2], Martina Smolić[1]

[1]*Faculty of Dental Medicine and Health Osijek, J. J. Strossmayer University of Osijek, 31000 Osijek, Croatia*
[2]*Health Center Osijek-Baranja County, 31000 Osijek, Croatia*
[3]*Faculty of Medicine Osijek, J. J. Strossmayer University of Osijek, 31000 Osijek, Croatia*

[*]rsikora@fdmz.hr



The etiopathogenesis of temporomandibular disorder (TMD) is multifactorial and complex, so new insights into its pathophysiology are needed. Numerous studies have investigated the molecular biomarkers of TMD from various tissue samples and body fluids however, no study has investigated gingival crevicular fluid (GCF). The aim of the study was to examine whether stabilization splint (SS) administration leads to changes in the concentrations of pro-inflammatory cytokines and to investigate whether there is a correlation between the GCF cytokines level and the chronic pain intensity and clinical parameters. This prospective cohort study enrolled 36 patients diagnosed with painful TMD according to the diagnostic criteria for TMD (DC/TMD). The GCF samples were collected at baseline before SS therapy (T0) and at follow-up one month (T1) and three months (T2) after the start of the treatment. Luminex® xMAP® technology with customized Multiplex Immunoassays (Invitrogen™, Thermo Fisher Scientific, Vienna) was used for multicomplex quantitative analysis of pro-inflammatory cytokines (interleukin 1 beta (IL-1β), interleukin 6 (IL-6), interleukin 7 (IL-7), interleukin 8 (IL-8), interleukin 13 (IL-13), tumor necrosis factor-alpha (TNF-α). Patients filled out Croatian versions of questionnaires from Axis II DK/TMP: Graded Chronic Pain Scale (v2) (GCPSv2) and Jaw Function Limitation Scale-20 (JFLS-20). The statistical analysis showed that the GCF levels of IL-7 (Friedman's test, $p = 0.008$) and IL-13 (Friedman's test, $p = 0.003$) were significantly decreased at T2. The GCF level of IL-13 was in negative correlation with chronic pain grade score at T2 (Rho = -0,333), while the GCF level of IL-8 was in positive correlation with mobility limitation (Rho = 0,382) at T1. The results of our study suggest that the GCF could be a valuable medium for assessing molecular biomarkers and that IL-7 and IL-13 levels in GCF could be used for monitoring TMD patients treated with SS, however further investigation is needed.

Keywords: *biomarkers, gingival crevicular fluid, Interleukin-7, interleukin-13*

ORAL PRESENTATION

Galen i oholost života: demokratizacija apoteoze kroz umijeće i filozofiju
Galen and the pride of life: the democratization of apotheosis through art and philosophy

Ivan Včev[1,*], Damir Matanović[2], Ivica Kelam[1]

[1]Fakultet za dentalnu medicinu i zdravstvo, Crkvena 21, HR – 31000 Osijek, Hrvatska
[2]Fakultet za odgojne i obrazovne znanosti, Cara Hadrijana 10, HR – 31000, Osijek, Hrvatska

[*]ivcev@fdmz.hr

The aim of this research is to analyse Galen's perspective on the final end of human acts and to present its historical context. This will be achieved through a genealogy of the "pride of life." According to this doctrine, the final end of human action is apotheosis, achievable through natural means. Accordingly, this study will trace the accidental transformations of this doctrine, from Homer, through Plato, to Galen, uncovering its various ethical formulations along with their underlying psychology and educational implications. Thus, the investigation begins with Homer, the first educator of Greece, who placed apotheosis in heroic glory, attainable through a great deed – directing subsequent generations toward this goal through the idealization of heroes, primarily Achilles, as a model for imitation. Plato, seeking to dethrone Homer, establishes Socrates as a new ideal, envisioning apotheosis as the knowledge of the Good accessible only to philosophers. Finally, Galen of Pergamon aims to achieve apotheosis through a life dedicated to art, which he spiritualized (primarily medicine) by synthesizing it with philosophy; he posits Hippocrates as the educational ideal worthy of emulation. This demonstrates – contrary to the prevailing opinion of scholars from the 19th century to the present, which holds that there is nothing original in Galen's ethics – Galen's contribution to ancient ethics, which consists of the democratization of apotheosis, now made accessible to the third estate through the philosophization of art, particularly medicine.

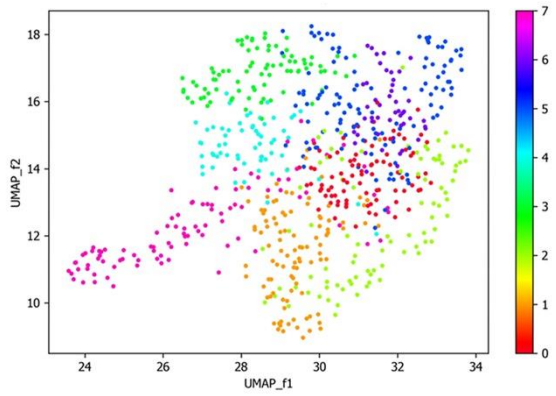
Keywords: Galen, pride of life, apotheosis, genealogy, history of medical ethics

ORAL PRESENTATION

Dvokrilci (Diptera) planinskih potoka: istraživanje neistraženog svijeta vodenih kukaca
Diptera in mountain streams: Exploring the unexplored

Viktorija Ergović[1,*], Miran Koh[1], Dubravka Čerba[2], Marija Ivković[3], Zlatko Mihaljević[3], Đurađ Milošević[4]

[1]University of Osijek, Department of Biology, Cara Hadrijana 8/a, 31000 Osijek, Croatia
[2]Water Research Institute, National Water Reference Laboratory of Slovakia, Department of Aquatic Ecosystems Research and Assessment, Nábr. arm. gen. L. Svobodu 5, 81249 Bratislava, Slovakia
[3]University of Zagreb, Faculty of Science, Department of Biology, Ravnice 48, 10000 Zagreb, Croatia
[4]University of Niš, Department of Biology and Ecology, Višegradska 33, 18000 Niš, Serbia
**viktorija.ergovic@biologija.unios.hr*



Aquatic insects play a crucial role in the ecosystem dynamics of mountain streams, also serving as important indicators of water quality and environmental health. These streams are defined by their geographical position, hydromorphology, physical and chemical water parameters, that influence and shape their habitat variability and consequently macroinvertebrate diversity. In this study, we collected macrozoobenthos using benthos hand net (500 µm mesh) from 14 streams across three mountains in the Pannonian lowland ecoregion: Papuk, Psunj, and Medvednica. Our main focus was dipteran fauna. Sampling was conducted during three seasons: summer 2020, spring, and autumn 2021. *In situ* we measured and assessed altitude and hydromorphological characteristics (streambed width, water velocity, depth, hardness, substrate composition), and for the measurements of environmental parameters (water temperature, oxygen saturation and concentration, conductivity, pH) Hach HQ4300 probes were used. We collected 673 samples, and 210 taxa were identified, including 82 species, of which 69 % were Chironomidae. Redundancy analysis and variation partitioning revealed distinct drivers of community composition: spatial factors strongly influenced Diptera communities on Medvednica, while environmental variables (water temperature and oxygen content) were more significant on Papuk and Psunj. The proximity between sampling sites increased Diptera dispersal rates, emphasizing the role of spatial factors influencing community patterns. Orthocladiinae species were the most abundant and the most frequent individuals on all mountains in all sampling periods. This research also resulted in two new records for Croatian Chironomidae fauna *Paraboreochlus minutissimus* (Strobl, 1894) and *Cyphomella cornea* Saether, 1977. Given the limited research on mountain streams Diptera in Croatia, this study highlights the need for more comprehensive investigations. Regular sampling and extensive datasets are essential to understand community variability and predict responses to climate change, contributing to the conservation and management of these vital ecosystems.

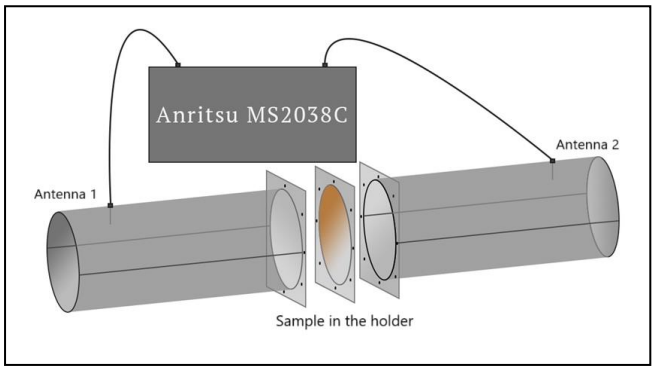
Keywords: Chironomidae, freshwater ecology, community patterns, Papuk, Psunj, Medvednica

ORAL PRESENTATION

Zaštita od prodora mikrovalova dodatkom nanočestica u glinene opeke
Protection against microwave penetration by adding nanoparticles to clay bricks

Jelena Brdarić Kosanović[1,*], Berislav Marković [2], Ivan Vrdoljak[3], Ivana Miličević [3]

[1] *Josip Juraj Strossmayer University of Osijek, Department of Chemistry, Cara Hadrijana 8/A, 31000 Osijek*
[2] *Josip Juraj Strossmayer University of Osijek, Faculty of Dental Medicine and Health, Crkvena 21, 31000, Osijek*
[3] *Josip Juraj Strossmayer University of Osijek, Faculty of Civil Engineering and Architecture, Osijek, Vladimira Preloga 3, 31000, Osijek*
[*] *jbrdaric@kemija.unios.hr*



Fast development and widespread use of mobile telephony that uses a specific wavelength in the microwave region of electromagnetic spectrum, causes a growing interest in the protection against the penetration of radiation through building materials. While most of the studies focus on concrete, in this study fired clay bricks with added different nanomaterials (clay composites) were investigated. Microwave radiation penetration was measured using spectrum analyzer in the frequency range from 1.5 to 6 GHz that covers all the frequencies currently used in mobile telephony: LTE 1800 (2G, 1.8 GHz), LTE 2100 (3G, 2.1 – 2.3 GHz), LTE 2600 (4G, 2.6 – 2.7 GHz), and NR3500 (5G, 3.4 – 3.8 GHz), on two-component fired clay disks (clay with 5 % of: antimony tin oxide - ATO, titanium dioxide – TiO_2, and fly ash – FA) and three-component samples that contained clay and a combination (2.5 % + 2.5 %) of mentioned nanomaterials. All the used materials were systematically characterized: specific surface area (B.E.T.), thermogravimetry (TGA), electron microscopy (SEM – morphology and particle size), phase analysis (X-ray diffraction), and chemical and mineralogical analysis (X-ray and optical emission spectroscopy). In order to determine the usability of prepared composite materials as construction elements, standard solid bricks were made from three-component mixtures and their water absorption and compressive strength were determined. The results of the research show that the addition of the tested nanomaterials to the clay significantly reduces the penetration of electromagnetic radiation in the microwave region, and at the same time improves the tested physical and mechanical properties.

Keywords: *nanomaterials, microwave radiation, clay, EM transmission, electromagnetic radiation shielding*

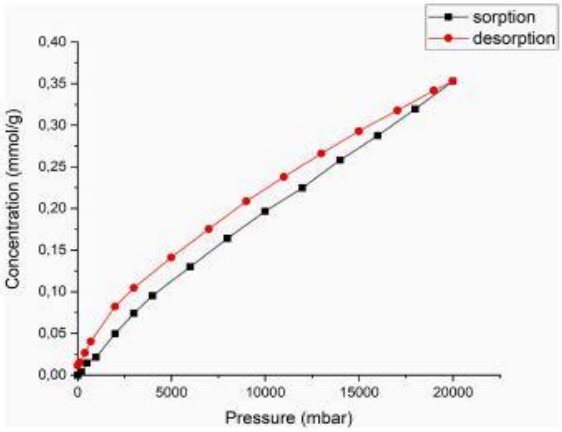
ORAL PRESENTATION

Uporaba N4O4-donorskih makrocikličkih Schiffovih baza za hvatanje toksičnih plinova
Utilization of N4O4-donor macrocyclic Schiff bases for toxic gas capture

***Milenko Korica*[1], *Tomislav Balić*[1,*]**

[1]*Josip Juraj Strossmayer University of Osijek, Department of Chemistry, Ulica cara Hadrijana 8A,Osijek,Croatia*

[*]*tbalun@kemija.unios.hr*



The search for efficient methods to detect and remove hazardous gases such as SO_2, H_2S, and CO_2 is a key challenge in modern science. Among the materials explored, porous organic compounds, particularly imine-based macrocyclic structures, have gained attention as viable solutions. This study focuses on the sorption properties of a porous N4O4-donor macrocyclic Schiff base for gases including NH_3, SO_2, Cl_2, CO_2, and H_2S. Through a single-crystal-to-single-crystal transformation process, five inclusion compounds were synthesized: $1\times NH_3$, $1\times SO_2$, $1\times Cl_2$, $1\times CO_2$, and $1\times H_2S$. Structural analysis using single-crystal X-ray diffraction revealed significant insights into the host-guest interactions. For instance, in the $1\times CO_2$ inclusion compound, the CO_2 molecule was situated within the plane of the macrocyclic ring and stabilized by weak C–O···π interactions. Conversely, no substantial interactions between the host and guest were observed in the $1\times NH_3$ system. Thermal stability, evaluated using the Ton – Tb parameter, ranged from 93°C for $1\times NH_3$ to 132°C for $1\times H_2S$, confirming the formation of thermally robust inclusion compounds. Despite the reactive and corrosive nature of the gases studied, FT-IR and powder X-ray diffraction confirmed that the molecular and crystal structure of the host remained unchanged during the sorption process. Additionally, the activated material demonstrated a moderate CO_2 uptake of 0.35 mmol/g at 298 K. With its remarkable thermal stability, retention of structural integrity upon gas sorption, and unique optical properties identified through solid-state UV–Vis spectroscopy, this material shows strong potential for applications in the detection of toxic gases.

Keywords: *Macrocycles*, *Schiff Bases, Toxic gasses*

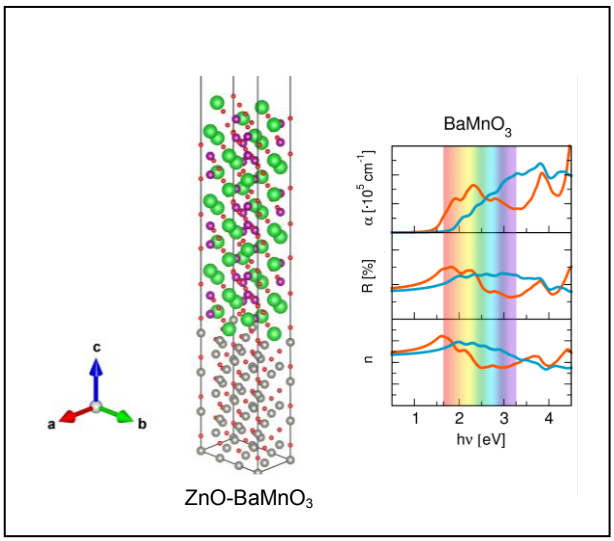
ORAL PRESENTATION

Solarne ćelije sa anorganskim perovskitima
Solar cells with inorganic perovskites

Ivan Kovač [1,*]

[1]*Josip Juraj Strossmayer University of Osijek, Department of Physics, Trg Ljudevita Gaja 6, Osijek, Croatia*

[*]*ikovac@fizika.unios.hr*



Perovskite materials brought a lot of attention to solar cell research as they seemed like perfect replacement for still mostly used silicon. Despite their astonishing increase in power conversion efficiency from around 3% to over 25% in recent years, there is still no large-scale commercialization due to several instability issues. As many of the instability issues were tied to the use of organic methylammonium cation in the most prominent $CH_3NH_3PbI_3$ perovskite, inorganic perovskites started gaining traction. Throughout the last few years, research has shown that inorganic perovskites are largely more stable and have competitive efficiency to that of organic-inorganic counterparts. In our research on inorganic perovskite absorbers, we investigated several manganite perovskites ($CaMnO_3$, $SrMnO_3$, $BaMnO_3$, $LaMnO_3$) and their electronic and optical properties. Investigation of optical properties included both theoretical and experimental research. Most of the investigated inorganic perovskites showed as promising candidates for absorber materials in solar cells. As perovskite solar cells are composed of five layers of different materials, our next goal is to investigate interface properties of several inorganic perovskites with surrounding electron transport materials in form of metal oxides. Interface properties are one of the most important areas to investigate to improve efficiency and stability of perovskite solar cells. For our theoretical research on perovskite materials and their interfaces, we are using density functional theory (DFT) which enables us to gain information on material properties of interest.

I would like to acknowledge the support from Croatian Science Foundation (HRZZ) under the grant HRZZ-IP-2018-01- 5246 and HRZZ-DOK-2021-02-2147 and thank all of the collaborators on the projects: from Josip Juraj Strossmayer University of Osijek, Department of Physics, Maja Varga Pajtler, Matko Mužević, Denis Stanić and Igor Lukačević, from Ruđer Bošković Institute in Zagreb, Andreja Gajović, Krunoslav Juraić, Milivoj Plodinec, Daniel Meljanac, Davor Gracin, Tihana Čižmar, Vedran Kojić, Mario Bohač, from Faculty of Chemical Engineering and Technology in Zagreb, Jelena Macan, Vilko Mandić, Andreja Žužić, from Institute of Physics in Zagreb, Nikša Krstulović, from Faculty of Geotechnical Engineering in Zagreb, Ivana Grčić, Marko Petric, Igor Petrović, Ivana Melnjak, Lucija Radetić, and from International Centre for Theoretical Physics in Trieste, Ralph Gebauer and Nicola Seriani (throughout HPC-Europa3 project under Horizon 2020 programme).

Keywords: Absorbers, DFT, inorganic perovskites, interfaces, solar cells

ORAL PRESENTATION

Nove reprezentacije funkcije distribucije McKay I_ν Besselove slučajne varijable
New representations for the distribution function of McKay I_ν Bessel random variable

***Nataša Ujić*[1,*], Dragana Jankov Maširević[1], Tibor Pogány[2,3]**

[1]*School of Applied Mathematics and Informatics, J. J. Strossmayer University of Osijek, Trg Ljudevita Gaja 6, 31000 Osijek, Croatia*
[2]*Institute of Applied Mathematics, John von Neumann Faculty of Informatics, Óbuda University,1034 Budapest, Hungary*
[3]*Faculty of Maritime Studies, University of Rijeka, 51000 Rijeka, Croatia*

[*]*nujic@mathos.hr*

Although Bessel functions are related to German astronomer Friedrich Wilhelm Bessel who investigated solutions of one of Kepler's equations of planetary motion around 1817, some of these functions were introduced earlier by a Swiss mathematician Daniel Bernoulli who studied the oscillations of a chain suspended by one end. Bessel differential equation is a homogeneous, linear, second order ordinary differential equation whose solutions are Bessel function of the first kind J_ν and Bessel function of the second kind Y_ν. Similarly, modified Bessel function of the first and second kind, I_ν and K_ν, respectively, are solutions of appropriate modified Bessel differential equation. These functions have many applications in different scientific fields. For example, they often appear in probability and statistics. In 1932 McKay introduced random variable with probability density function given in terms of modified Bessel functions of the first and second kind, while in 1973 McNolty presented its generalization. We derive two new representations for cumulative distribution function of McNolty's random variable using second mean-value theorems for definite integrals and properties of Lambert *W* function. Our newly obtained formulae can be more convenient for practical purposes, since in some problems computation of McNolty's distribution function can be a bit challenging. In addition, we also point out the connection of the mentioned distribution function with the incomplete Lipschitz-Hankel integral and the Rice I_e-function, which are very useful in telecommunications.

Keywords: *modified Bessel function of the first kind, McKay I_ν Bessel distribution, Lambert W function, second mean-value theorem for definite integrals*

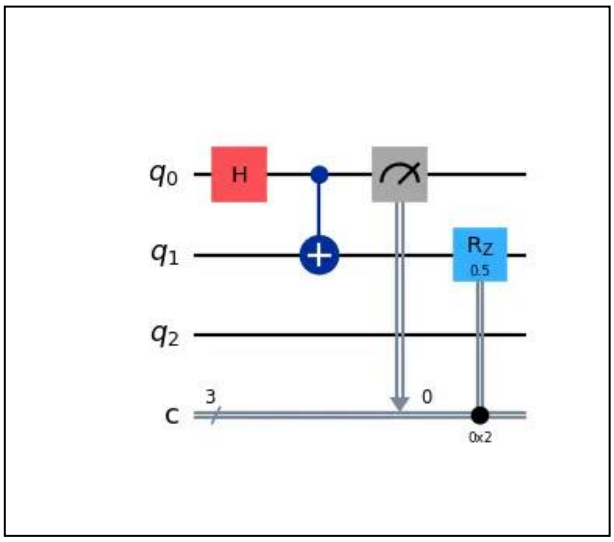
ORAL PRESENTATION

Usporedba standardnih i kvantnih računala u minimizaciji QUBO
Comparison of standard and quantum computers in minimizing QUBO

***Tomislav Prusina*[1,*]**

[1]*School of Applied Mathematics and Informatics, J. J. Strossmayer University of Osijek, Trg Ljudevita Gaja 6, 31000 Osijek, Croatia*

[*]*tprusina@mathos.hr*



In this study, we aimed to evaluate the performance of quantum computers against standard computers on the task of minimizing Quadratic Unconstrained Binary Optimization (QUBO) problems. We conducted a benchmark comparing the efficiency and accuracy of the state-of-the-art optimization software Gurobi (executed on a standard CPU) with the quantum computing platform D-Wave. Our findings indicate that while quantum computers exhibited remarkable processing speeds, they often failed to consistently return optimal solutions due to inherent uncertainty in their operational mechanisms. In contrast, standard computers equipped with advanced optimization algorithms were not only able to solve these optimization problems accurately but also did so with comparable speed. These results suggest that, despite the revolutionary architecture of quantum computers tailored for such tasks, current standard algorithms on classical architectures remain more reliable for achieving optimal solutions in QUBO problems. This insight highlights the need for further refinement in quantum computing algorithms to overcome existing limitations and harness their full potential in optimization tasks.

Keywords: optimization, benchmark, Gurobi, D-Wave, quantum computing.

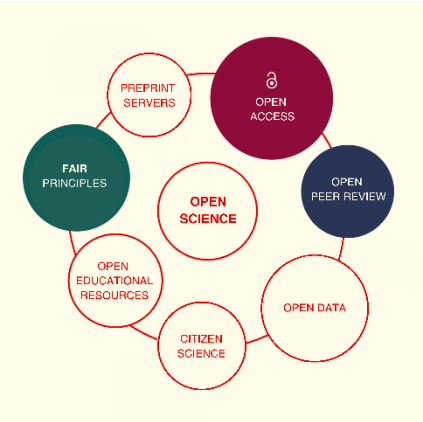
ORAL PRESENTATION

Uvod u otvorenu znanost
Introduction to Open Science

Silvija Šafranko[1,*]

[1]*IntechOpen Limited, London, United Kingdom*

[*]*silvija@intechopen.com*



Open Science can be defined as an approach emphasizing the sharing of knowledge, transparency, and accessibility, making scientific information readily available to all levels of society. It is grounded in the principles of inclusion, fairness, equity, and collaboration, aiming to transform how research is conducted and valued. Its aim is to make research more open to participation, review, critique, enhancement, and reuse, ultimately benefiting the global community. As a natural progression from Open Access, Open Science expands the focus to include transparency in research processes, reproducibility of results, and collaborative knowledge sharing, addressing the evolving needs of the academic and scientific community. IntechOpen Journals embrace Open Science policies to help support the changing needs of academics in these fast-moving research areas, aiming to improve the quality and availability of scholarly communication by promoting and practicing Open Access publications and Open Data. This lecture will discuss key developments and future outlooks in Open Science with young researchers, highlighting the importance of Open Science implementation and its overall impact on current scientific publishing.

Keywords: *open science, open data, scientific publishing, IntechOpen Journals*