October, 21st-23rd 2016, Sarajevo
www.pmf.unsa.ba/hemija/kongres/

2nd International Congress of Chemists and Chemical Engineers of Bosnia and Herzegovina

# Book of Abstracts

**Special Issue of**
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Organising committee's Welcome

On behalf of the Organizing and Scientific Committees, Society of Chemists and Technologists of Canton Sarajevo and the Faculty of Science in Sarajevo, it is our great pleasure and honour to invite you to the **2nd International Congress of Chemists and Chemical Engineers of Bosnia and Herzegovina**, to be held in Sarajevo on October 21st-23rd, 2016 in the Hollywood Hotel.

The Congress will cover different areas of chemistry and chemical technology and offer an opportunity for scientists to exchange latest research findings and ideas and develope a collaboration with colleagues from Bosnia and Herzegovina and from all around the world.

We hope that you will have a fruitful, interactive and enjoyable Congress.

We are all looking forward to welcoming you in Sarajevo.

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21 - 23. October 2016.

| *FINAL PROGRAMME* | |
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| | *Friday, 21.10.2016.* |
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| **10:30-11:00** | **Opening Ceremony** |
| **11:15-12:00** | Keynote lecture: Dr. Sci. Roderick Bates, Nanyang Technological University, Singapore<br>*Catalysis: "Awakening Affinities" for Organic Synthesis* |
| **12:00-12:30** | Coffee break |
| **12:30-12:50** | Development and Validation of the Mathematical Model for Synthesis of Maleic Anhydride from n-butane in Fixed Bed Reactor<br>Ervin Karić |
| **12:50-13:10** | Mathematical Modeling and Simulation of the Composting Process in a Pilot Reactor<br>Edisa Avdihodžić |
| **13:10-13:30** | Temperature controlled regeneration strategy for in situ onboard regeneration of mobile desulfurization units<br>Rafael Neubauer |
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| **15:30-16:15** | Keynote lecture: Dr. Sci. Kurt Kalcher, Karl-Franzens University of Graz, Austria<br>*Electrochemical Sensors: State of the Art and Future* |
| **16:15-17:00** | Keynote lecture: Dr. sci. Igor Pašti, University of Belgrade, Serbia<br>*Computational design of electrocatalysts for hydrogen evolution reaction – From electronic structure to nanometer scale* |


21 - 23. October 2016.

| | |
|---|---|
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| **11:30-12:00** | Coffee break |
| **12:00-12:20** | The Effect of Natural Graphite Pretreatment on Electrochemical Behavior of Graphene Oxide<br>Dževad Kozlica |
| **12:20-12:40** | Modified Mortars with the Polymers Addition for Thermal Insulation Systems of Polystyrene<br>Namir Halilović |
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| **15:00-16:00** | Royal Society of Chemistry - presentation |
| **16:00-16:20** | Green Processing using Alternative Supercritical Fluids<br>Maša Knez Hrnčič |


21 - 23. October 2016.

| | |
|---|---|
| **16:20-16:40** | Chemical Characterization of Historical Slag from Gornji Potocari<br>Almir Olovčić |
| **16:40-17:00** | Total Phenolics Compounds and Antioxidant Activity of *Stachys turcomanica*<br>Ataye Salehi Esmaeil |
| **17:00-17:20** | Effect of Packaging and Storage Conditions on Stability of Perindopril Tablets<br>Belma Pehlivanović |
| **17:20-17:40** | Chemical Composition of the Essential Oil and Antimicrobial Activity of Aqueous and Methanolic Extracts of *Scrophularia khorassanica*<br>Sani Mohamadi |
| **17:40-18:10** | Closing ceremony |
| **20:00** | **Gala dinner (Sponsored by Alphachrom)** |
| | ***Sunday, 23.10.2016*** |
| **Possibility of sightseeing tours of Sarajevo or other cities of Bosnia and Herzegovina if there is enough interested participants** | |

# PLENARY LECTURES

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Abstract

PL-01

# Catalysis: "Awakening Affinities" for Organic Synthesis

**Roderick W. Bates**

*Division of Chemistry and Biological Chemistry, School of Physical and Mathematical Sciences, Nanyang Technological University, Singapore, Singapore*

**Keywords:**

catalysis,
synthesis,
alkaloids

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**Abstract:**

The use of catalysis is now ubiquitous in organic synthesis. In this talk, I will discuss how we have employed both Brønsted and Lewis acid catalysis, as well as transition metal catalysis, for the synthesis of alkaloid natural products. We have also begun to explore the use of bimetallic catalysis to enhance the reactivity of some substrates in substitution reactions. In this form of catalysis, two metals are used to perform different roles within a single catalytic system. In addition, we have developed a new design principle to enhance selectivity in organometallic catalysis. This has already been found useful for the synthesis of drug molecules. The development of this new concept illustrates how hypotheses must evolve as new experiments are conducted.

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Abstract

PL-02

# Computational Design of Electrocatalysts for Hydrogen Evolution Reaction – From Electronic Structure to Nanometer Scale

**Igor A. Pašti**

*Faculty of Physical Chemistry, University of Belgrade, Belgrade, Serbia*

**Keywords:**

hydrogen evolution reaction, catalyst design, electrocatalysis.

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**Abstract:**

Hydrogen evolution reaction (HER) is one of the most important electrocatalytic reactions, considering both practical and theoretical aspects. Long time ago an idea had appeared to link the physical properties of the electrocatalyst with its HER performance. This idea has evolved over the years and now we have some quite well defined catalytic activity descriptors which can be used to both explain and predict activity. Computational methods have been proven as extremely valuable in describing physical and chemical properties of solid surface, allowing for rather accurate predictions of novel materials with enhanced HER activities. In this contribution we shall address the main aspects of the computational design of HER electrocatalysts, starting from the concept of the catalytic activity descriptor and the electronic structure level to nanometer domains. Such level of description requires multiscale approach to address phenomena at different temporal and spatial domains. In specific, the attention will be paid to novel thin layer HER catalysts and the formation of supported HER catalysts where boundary phenomena play extremely important role in enhancing HER activity.

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Abstract

PL-03

# Methodologies and Concentration Levels of Persistent Organics in the Environment

**Semra Guven Tuncel**

*ChemistryDepartment , Middle East Technical University, Ankara, Turkey*

**Keywords:**

Persistent organic pollutants,
polycyclic aromatic hydrocarbons,
Soxhlet extraction,
Ultrasonic bathextraction,
Solid phase extraction,
Solid phase micro extraction.

**Abstract:**

Persistent organic pollutants (POPs) including PAHs (PolyAromaticHydrocarbons), PCBs (PolyChlorinatedbiPhenyls) and pesticides had became a threat for enviroment in turn to human health in recent two decades. It is important to understand the chemistry of these pollutants in order to develop control strategies and policy frame work. Our group in theMiddle East Technical University has been studying POPs composition in various environmental matricies in Turkey since 1994.

The extraction procedures for the determination of oder ate level polycyclic aromatic hydrocarbons (PAH) and pesticides in soil, water, plant and sediment samples had been optimized and validated. The methods optimized were Soxhlet extraction, Ultrasonic bathextraction, Solid phase extraction and Solid phase micro extraction (SPME). In order to search out the main factors affecting extraction efficiencies of the methods, factorial design was used. The best extraction method was chosen and optimum values for main factors were selected for the development of the extraction methods used for PAH and pesticides determination in different sample matrix. As an analytical tool GC_MASS or GC_flame ionization detectors. Optimized and validated methodologies are used to determine POPs in the air of capital city Ankara, sediments of Mediterranean, well water, soil and lastly in the exported agricultural products.

Concentration levels in the above cases will be presented, compared with other countries and discussed considering their sources and effects on the natural environment and human health.Various conclusions we derived from 20 years of our research in the major parts of the country will be presented in this talk.

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*Abstract*

PL-04

# New Insights into Traded Medicinal and Aromatic Plants of Turkey

**K. Hüsnü Can Başer**

*Department of Pharmacognosy, Faculty of Pharmacy, Near East University, Lefkoşa (Nicosia), N. Cyprus*

**Keywords:**
medicinal and aromatic plants.

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**Abstract:**

Flora of Turkey is rich and diverse with over 10.000 flowering plant species and excee 12.000 taxa. It comprises 33% of endemic plants. 1/3 of the flora consists of aromatic pl and ca. 1000 plant species are used in folk medicine. Flora of Turkey is well documente 11 volumes of Flora of Turkey and the East Aegean Islands (1965-2001). Turkey exp annually $200 million worth of medicinal and aromatic plants to the World markets. review will report on the export situation of some selected medicinal and aromatic plan Turkey such as Opium poppy (*Papaver somniferum*), Rose products (*Rosa damasce* Oregano (*Origanum, Thymus, Thymbra, Satureja, Coridothymus*), sage (*Salvia fruticos officinalis*), mint (*Mentha spicata, M. piperita*), laurel (*Laurus nobilis*), liquorice (*Glycyr glabra*), gypsophila (*Gypsophila* spp.), Salep (Orchidaceae plants), aniseeds (*Pimpi anisum*), linden flower (*Tilia* spp.), etc.

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*Abstract*

PL-05

# Aqueous Solvation of Charges and Hydrophobic Groups

**Vojko Vlachy**

*University of Ljubljana, Ljubljana, Slovenia*

**Keywords:**

solvation models,
Wertheim's integral equation theory.

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**Abstract:**

Much of biology depends on proteins interacting with each other – pairwise or in aggregates – all mediated by water and ions. Understanding the aqueous solvation of electrolytes, simple and complex, is therefore important for biology, as also for industry. But today's solvation models mostly apply to dilute solutions and, despite being supported by all-atom simulations, do not yield good results for thermodynamic properties. In recent years we applied statistical-mechanics to such systems. We used Wertheim's integral equation theory, which is well suited for systems of molecules with directional forces. Such an approach is able to treat mixture of water molecules, ions and proteins, with all the species treated on equal footing. We will begin the presentation with aqueous solutions of alkali halides to show the effects of ionic sizes of salt–forming ions on osmotic properties of the solution. Next, we will ask ourselves how the presence of hydrophobic groups affects the solution energetics? We will conclude the presentation with discussion of the protein self–association; we will show that, in all the examples presented here, one of the crucial parameters is the free energy of hydration of interacting ions and charged groups. The theory will be supported by our own measurements.

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Abstract

PL-06

# Electrochemical Sensors: State of the Art and Future

**Kurt Kalcher**

*Institut of Chemistry – Analytical Chemistry, Karl-Franzens University, Graz, Austria*

**Keywords:**

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**Abstract:**

Electrochemical sensors are the oldest type of chemical sensors and are still gaining increasing interest in research and practical applications. In particular, the discovery of new materials and modifications of carbon as well as the rapid advances in technologies with nano-sized materials have exerted a strong impact on the development of new electrochemical sensors.

A central focus will be put on electrochemical biosensors, such as enzyme- and DNA-base devices. Biosensors contain a biological component in the recognition element (receptor) of the sensor, which allows rather specific determination of corresponding substrates. Their functional principles will be explained and documented with practical examples.

# ORAL PRESENTATIONS

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Abstract

OP-01

# Development and Validation of the Mathematical Model for Synthesis of Maleic Anhydride from *n*-butane in Fixed Bed Reactor

**Petric, I., Karić, E.***

*Department of Chemical Engineering, Faculty of Technology, University of Tuzla, Tuzla, Bosnia and Herzegovina*

**Abstract info**

Received: 13/05/2016
Accepted: 01/07/2016

**Keywords:**

modeling,
*n*-butane,
maleic anhydride,
fixed bed reactor,
simulation,
kinetic models

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**Abstract:** The aims of this study were: development of the mathematical model for numerical simulation of partial oxidation *n*-butane to maleic anhydride in fixed bed reactor and validation of developed mathematical model with real process data from industrial reactor located in the Global Ispat Coke Industries Ltd. Lukavac. Mathematical model is consisted of differential equations that describe mass balances of each species, energy balance, stoichiometry of reactions, pressure drop, kinetic model. Numerical software package Polymath with Runge-Kutta-Fehlberg method was used for numerical solution of differential equations. The developed mathematical model was validated with three process data sets of five measured variables (temperature, pressure, concentration of *n*-butane, concentration of carbon dioxide, concentration of carbon monoxide) and with application of ten kinetic models from literature. Comparison of simulation results and measured data showed a good agreement for three kinetic models. For the chosen kinetic model, profiles of temperature, molar flows, conversion of *n*-butane and selectivity of maleic anhydride were also presented.

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Abstract

OP-03

# Chemical Characterization of Historical Slag from Gornji Potocari

**Olovčić, A.[a], Memić, M.[a], Kevilj-Olovčić, A.[a,*], Ramić, E.[b]**

[a] *Department of Chemistry, Faculty of Science, University of Sarajevo, Sarajevo, Bosnia and Herezegovina*

[b] *Faculty of Pharmacy, University of Sarajevo, Sarajevo, Bosnia and Herezegovina*

**Abstract info:**

Received: 01/07/2016
Accepted: 01/09/2016

**Keywords:**

historical slag,
AAS,
metals,
galena,
sphalerite,
silver oxide.

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**Abstract:** In this work, metallic slag from abandoned mine in Gornji Potočari was analyzed. Evidence of mining activities can be seen in a form of large slag pits found throughout the field. Four samples of slag from different depths and parts of pits were chosen for analysis. Samples were grounded, powdered and weighted in the laboratory. Dissolution was performed with concentrated HCl and it was heated. The solution was filtered through blue ribbon filter paper and diluted to volume of 100 mL. Analysis was performed on Varian 240 FS AAS. Total of 9 metals were analyzed: Cr, Cu, Mn, Co, Ni, Cd, Pb, Ag, Zn and Fe. Results were recalculated on oxides and presented as mass fractions of oxides. Results showed high content of $Fe_2O_3$ (35.66-46.70 %), PbO (6.32-11.55 %) and ZnO (1.46-8.56 %). Trace amounts of chromium, nickel, cobalt, copper, manganese and cadmium were also found. Content of $Ag_2O$ (0.0050-0.020 %) co-related with content of PbO, supporting thesis that initial ore used was galena (PbS) which always contains some silver. High zinc content shows sphalerite (Zn,Fe)S) was also used in the processes. Both of the minerals can be found in Srebrenica area in large quantities.

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Abstract

OP-04

# Expression of Superoxide Dismutase Enzyme in Stress Conditions

**Politeo, O.[a,*], Carev, I.[a], Ferhatović Hamzić, L.[b]**

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[b] *Ruđer Bošković Institute, Zagreb, Croatia*

**Abstract info:**

Received: 30/06/2016
Accepted: 14/07/2016

**Keywords:**

SOD,
rat model,
stress conditions,
WST method.

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**Abstract:** Reactive oxygen species (ROS) play a key role in the initiation and progression of many human diseases. Superoxide anion radical ($O_2^{\bullet-}$), arising continuously in the cells, is one of the most important and biologically relevant ROS radicals in living organisms. Superoxide dismutase (SOD) is an enzyme important in the process of cellular responses to stress conditions. Using WST spectrophotometric method, it is investigated the effect of insulin dependent diabetes mellitus (IDDM) on the SOD expression of tissues in aging rats. For this purpose, rat model for IDDM was established by streptozotocin application. The rats were randomly divided into 4 groups of animals: DM-2W (streptozotocin treated and sacrificed after 2 weeks of diabetes), control-2W (control group sacrificed after 2 weeks of the experiment), DM-1Y (streptozotocin treated and sacrificed after 1 year of diabetes) and control-1Y (control group sacrificed after 1 year of the experiment). Results showed overexpression of SOD enzyme in both of DM-2W and DM-1Y groups compared with control groups of rats. In comparison the expression of the enzyme in both of DM-2W and DM-1Y groups, the stronger overexpression of the enzyme in the first one group was registered. That could be explained by fading of defence system of organism.

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*Abstract*

**OP-05**

# Mathematical Modeling and Simulation of the Composting Process in a Pilot Reactor

**Avdihodžić, E.*, Petric, I.**

*Department of Chemical Engineering, Faculty of Technology, University of Tuzla, Tuzla, Bosnia and Herzegovina*

**Abstract info:**

Received: 13/05/2016
Accepted: 26/09/2016

**Keywords:**

mathematical modeling,
simulation,
composting process,
kinetics,
pilot reactor.

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**Abstract:** In this paper, a mathematical model for composting process with engineering approach was presented. The model describes n-th order kinetics of composting process (mesophilic-thermophilic phase) with mass and heat balances in the process. Verification of the model was performed using experimental data obtained from a pilot reactor. Measured dynamic state variables used for a verification of the model were: organic matter mass, water mass in a mixture, amount of oxygen and carbon dioxide, temperature of mixture and the temperature of gas phase.

The developed mathematical model was implemented in numerical software package MATLAB. Three kinetic parameters were estimated using Marquardt method.

Global sensitivity analysis and statistical F test showed that the model is valid for predicting the change in five dynamic state variables. The advantage of the model is that it can be applied to the composting process with mixtures of different compositions in reactors with different volumes.

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Abstract

OP-06

# Modified Mortars with the Polymers Addition for Thermal Insulation Systems of Polystyrene

**Krdžalić, E.[b,c], Halilović, N.[a,c,*], Mujkanović, A.[b]**

[a] *Department of Chemistry, Faculty of Science, University of Sarajevo, Sarajevo, Bosnia and Herzegovina*

[b] *Faculty of Metallurgy and Materials Science, University of Zenica, Department of Chemistry, Zenica, Bosnia and Herzegovina*

[c] *KOMOCHEM, Visoko, Bosnia and Herzegovina*

**Abstract info:**

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thermal insulation,
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**Abstract:** At the time of the increasing shortage of fossil fuels and their rising prices, energy saving is the main topic. For example, in Germany in the housing sector 75% of the total energy is consumed for the air conditioning in the household, mainly for heating. Today, all new buildings must meet the standards for energy efficiency. The fastest and most efficient way to save energy for heating and improving the climate inside the building is thermal insulation of external walls of the building. In this paper, polymer-cementitious adhesive for bonding and reinforcing, its composition, characteristics and mechanism of binding to the substrate was processed. The influence of the redispersed polymer on the characteristics of polymer-cement mortar for external thermal insulation has been examined in details.

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Abstract

OP-07

# Green Processing using Alternative Supercritical Fluids

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**Keywords:**
vanillin,
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solubility,
argon,
carbon dioxide.

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**Abstract:** In the scientific literature the contributions about supercritical fluid phase equilibria are discussing mostly the systems with conventional supercritical fluids, especially supercritical $CO_2$. In the present work, investigation of non-conventional supercritical fluids was taken into consideration. Prior to performing preliminary extraction experiments, solubility of pure vanillin as a representative of natural vanillins and Ortho ethyl vanillin as a synthetic vanillin in argon was measured at temperatures of 40 °C, 60 °C and 80 °C and at pressures up to 500 bar. Maximal solubility of vanillin is obtained at a temperature of 40°C and a pressure of 438 bar, approx. 0.015 g/g.

For Ortho ethyl vanillin highest solubility was attained at pressures above 300 bar and at lower temperatures; about 0.5 g/g. Generally, solubility of Ortho ethyl vanillin in $CO_2$ is lower, approx. 0.18 g/g at a temperature of 80°C and a pressure of 300 bar.

The content of vanillin was determined after extraction of vanilla pods with argon and $CO_2$ at temperatures of 25°C, 40°C and 60°C and at pressures of 150 bar and 300 bar. Extracts obtained by batch solvent extraction technique and supercritical extraction were examined for the content of vanillin. Despite mass yields higher than 50 % appear in case of conventional extraction, content of vanillin in extracts, obtained by supercritical extraction is higher. This clearly demonstrates that supercritical fluids are more selective solvents for vanillins than conventional ones. Due to high solubilities of vanillin and Ortho ethyl vanillin in argon it can be summarized that argon is a suitable processing media also for artificial vanillins.

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Abstract

OP-08

# Temperature Controlled Regeneration Strategy for in Situ onboard Regeneration of Mobile Desulfurization Units

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Fuel,
desulfurization,
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Fuel cells are a very promising technology for future energy supply. However, this technology is very sensitive to sulfur and thus fuel desulfurization is an indispensable requirement. Adsorptive desulfurization is a promising technology due to its simplicity, which makes it attractive especially for smaller or mobile applications. In situ onboard regeneration of the used adsorbent is still challenging due to limited space and lack of solvents.

An Ag-$Al_2O_3$ adsorbent was prepared by incipient wetness impregnation. The adsorption on Ag-$Al_2O_3$ was investigated by equilibrium and breakthrough experiments. The used adsorbent was then regenerated in air at elevated temperatures. The results showed high desulfurization and regeneration performance for different fuels. Within this work, a novel temperature controlled regeneration strategy was developed. The combination of high heating rates and variable air flow rates was used to control the temperature within the adsorber. This novel regeneration strategy is up to 75% faster in comparison to other air based strategies and showed high regeneration efficiency without thermal destruction of Ag-$Al_2O_3$.

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Abstract

OP-09

# The Effect of Natural Graphite Pretreatment on Electrochemical Behavior of Graphene Oxide

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**Abstract info:**

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**Keywords:**

graphene oxide, electrochemical reduction, supercapacitors, pseudocapacitance.

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**Abstract:** Irreversible electrochemical behavior of graphene oxide, prepared by oxidation and exfoliation via improved Hummers method was compared for natural graphite flakes with particle size bellow 40 μm and between 40 and 50 μm, with and without treatment with hydrofluoric acid. It is shown that highest relative increase in capacitance occurs upon electrochemical reduction of HF-pretreated graphite flakes with particle size bellow 40 μm. It is also shown that capacitance follows sharp increase and subsequent gradual decrease with increment of cathodic polarization. Obtained results are discussed in terms of higher accessible surface area, irreversible reduction of oxygen groups contributing to pseudocapacitance and the increase of conductivity upon restoration of delocalized π electron system.

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Abstract

OP-10

# Synthesis and Electrochemical Performances of $Li_3V_2(PO_4)_3$/C Based Materials in Non-aqueous Electrolyte

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Lithium ion batteries,
$Li_3V_2(PO_4)_3$/C,
cathode material,
electrochemical performance

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**Abstract:** $Li_3V_2(PO_4)_3$/C (LVP/C) and Fe doped LVP/C composite materials were synthesized by sol-gel and solid state methods, with different carbon sources. Electrochemical performances were investigated by cyclic voltammetry, electrochemical impedance spectroscopy and galvanostatic charge/discharge. Cyclic voltammetry measured between 3.0 V and 4.3 V vs. $Li/Li^+$ shows that all samples have monoclinic structure, and that during cycling 2 out of 3 lithium ions are deintercalated/intercalated. Electrochemical impedance spectroscopy measurement results shows that doped samples have higher charge transfer resistance ($R_{ct}$), and that samples synthesized by solid state route with glucose as carbon source have lowest $R_{ct}$. Galvanostatic measurements in potential range between 2.5 V and 4.3 V vs. $Li/Li^+$ shows that doped materials have better cyclic stability. Materials synthesized by solid state route have highest initial capacity of 126 mAh/g for pristine LVP/C and 120.9 mAh/g for Fe doped LVP/C.

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*Abstract*

# Effect of Packaging and Storage Conditions on Stability of Perindopril Tablets

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**Abstract info:**

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perindopril,
tablets.

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**Abstract:** Stability of a pharmaceutical product may be defined as the capability of a particular formulation in a specific container to remain within its physical, chemical, microbiological and toxicological specifications. Perindopril is a nonsulfhydryl prodrug that belongs to the angiotensin-converting enzyme (ACE) inhibitor class of medications. Perindopril is used to treat essential hypertension, congestive heart failure and to reduce the cardiovascular risk of individuals with hypertension. The aim of this study was to evaluate stability and quality of Perindopril tablets in dosage form of 2 mg, 4 mg and 8 mg over time. Tablets were packed in two different packaging materials: PVC/PVdC/Al blisters and Al/Al blisters and stored at accelerated (40ºC/75%RH) and long-term (25ºC/60%RH) storage conditions. The physical and chemical stability of the products was measured after 3 and 6 months of storage. The effects of humidity and temperature and two different packaging materials on Perindopril tablets were examined through determination of assay, related substances, dissolution and water content. The high-performance liquid chromatography analysis was used for determination of parameters, with use of C8 column 150 x 4.0 m x 5µm and the optimized mobile phase of isocratic flow at 0.5 mL/min and detector set at 215 nm. The results show significant decrease of assay for Perindopril tablets packed in PVC/PVdC/Al blisters. After evaluation of stability data at both storage conditions and in both packaging materials, Al/Al blisters maintained better pharmaceutical performance of tested product.

# POSTER PRESENTATIONS

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Abstract

PP-AEC-01

# Optimisation and Validation of HPLC Method for Identification and Quantification Homosalate in Sunscreens

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**Abstract info:**

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homosalate,
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validation

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**Abstract:** Homosalate is a UV filter used in sunscreens and cosmetics for skin protection purposes. It can provide substantial skin protection against UVB radiation. The maximum authorized concentration for homosalate in sunscreens is 10% according to EU and Japanes legislation, whereas the US Federal Drug Administration authorizes maximum concentration of 15%.

The aim of this research was to develop and validate a high pressure liquid chromatography method for identification of homosalate and determination of his content in sunscreens products. The chromatographic separation was achieved on a stationary phase $C_{18}$ using a mobile phase: A solution (water + 0.1% formic acid) and B solution (acetonitrile + 1% formic acid) with a gradient elution at a flow rate of 0.5 ml/min. The optimum conditions for homosalat analysis were investigated. The calibration curve showed good linear regression with UV detection at the wawelength of 306 nm. The correlation coefficient was 0.9998. The method is simple, selective and reproducible and it is suitable for the determination of homosalate in commercial sunscreen products. Homosalate was determined in the 6 sunscreen samples in which was declared as an active ingredient, and was identified and quantitated in one sample in which was not declared as an active ingredient.

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*Abstract*

PP-AEC-02

# Application of Grapefruit Peel as Biosorbent for Removal of Copper(II), Lead(II), Cadmium(II) and Zinc(II) from Aqueous Solution

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biosorption,
heavy metals,
grapefruit peel,
FAAS

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**Abstract:** Much attention has been made towards adsorbent materials to be used in heavy metal removal from polluted water and various techniques are applied such as chemical, physical and biological techniques. These conventional technologies are expensive due to non-regenerable materials used, high cost and generation of toxic sludge. This study was designed for using less expensive and much frequently available material (minced grapefruit peel) to remove copper, lead, cadmium and zinc ions from aqueous solution, by using flame absorption spectrometry (FAAS). The efficacy of grapefruit peel biomass which is modified with $HNO_3$ and NaOH was tested for the removal of copper, lead, cadmium and zinc metal ions using batch experiments in binary metal solution under controlled experimental conditions. Batch mode adsorption studies were performed by varying parameters such as pH, contact time and adsorbent dose. It is found that metal sorption increases with increasing pH of solution and contact time. Results indicated that optimum conditions for all metals are pH = 5, contact time of 120 min and dose of biosorbent of 2 g/L with recovery values of 68%, 83%, 70% and 62% for Cu, Pb, Cd and Zn, respectively.

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Abstract

PP-AEC-03

# Determination of Heavy Metals in the Flower and Leaf of Primrose (*Primula officinalis*)

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heavy metals

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**Abstract:** Primrose (*Primula officinalis*) is a perennial herbaceous plant, whose importance is reflected primarily in the treatment of lung disease, fainting and heart palpitations. It is used as a sedative, diaphoretic and diuretic. The content of heavy metals in plants depends on the type of the plant and its habitat, and their presence is often an indicator of contamination of an area. For the analysis were used primrose leaf and flower, harvested from three different locations (Novi Travnik, Sarajevo and Živinice), dried and stored under appropriate conditions. All samples were prepared according to the appropriate procedure and the concentration of three heavy metals (Pb, Cd, As) was determined by atomic absorption spectroscopy. The results showed that the flower harvested in Novi Travnik contains the highest amount of lead. The measured concentration in the flower was 1.03 mg/L, while the leaf contains half the amount of the same metal, i.e. 0.51 mg/L. The amount of Cd determined in samples is very small, the highest concentration shows the leaf sample harvested in Sarajevo and it contains 0.012 mg/L. Arsenic content was below the limit of quantification methods used for all analyzed samples of primrose. In average, all samples showed descending order of metals concentration, i.e. Pb> Cd>As.

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Abstract

PP-AEC-04

# Spatial and Seasonal Variation of PAHs Concentration in the Spreča River

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Spreča,
Modrac

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**Abstract:** The largest part of river Spreča flows through the heavily populated region of Tuzla canton, and it is also area of mining-industrial zone. This study monitors the PAHs content during one year in the part of flow Spreča river which is extremely exposed to these pollutants. Content of PAHs in the river has been analyzed on the three locations: before Modrac lake, in the lake and on the mouth of Spreča into river Bosna. Determination of PAHs in the water was performed by HPLC techniques with fluorescence detection, and after liquid-liquid extraction. For analysis it was chosen 8 PAHs recommended by EU directive. Generally, among all tested PAHs, the greatest concentration was found for naphthalene. On the mouth of Spreča to Bosna, it was found high concentration of all tested PAHs, especially fluoranthene. Except naphthalene, content of all other PAHs is significantly higher on the mouth of Spreča than two locations before. Only concentration of naphthalene significantly varies during seasons and it is higher during winter period. High level of naphthalene probably comes from coal mining area of Banovići-Živinice which is before Modrac lake. High level of fluoranthene and other PAHs, probably comes from coke-chemical industry situated after lake accumulation.

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Abstract

PP-AEC-05

# Determination of Low Concentrations of Anionic Surfactant in Effluents

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anionic surfactant sensor, potentiometric titration, effluents, Savitzky-Golay method

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**Abstract:** Anionic surfactants (ASs) are the most efficient group of surfactants so they are widely used in different types of industry. Because of their influence on ecosystem, it is of great importance to determinate even low concentrations of ASs in environmental samples. It is also very important to monitor ASs concentrations in industrial processes as well as in industrial effluents to prevent negative impact on the environment.Anionic surfactant selective electrode with dimethyldioctadecylammonium-tetraphenylborate (DDA-TPB) and carbon powder incorporated in liquid membrane is used for determination of ASs using potentiometric titration method. Twenty water samples grouped in four categories (effluents from households, food industry, detergent industry and surface water from river Drava near the wastewater discharge) are analysed.

The sensor showed excellent selectivity, high sensitivity, thus enabling the accurate determination of very low ASs concentrations in complex systems as industry wastewaters. Savitzky-Golay method, developed by Barak, was used for reliable calculations of equivalence points from the titration curves with poorly defined inflexions, during determination of very low concentrations of ASs. Accuracy of determination was verified using reference method for ASs determination (Methylene blue active substances method, MBAS).

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*Abstract*

PP-AEC-06

# Untreated Tangerina Peel *(Citrus reticulata)* as Biosorbent for the Removal of Cd(II), Cu(II), Pb(II) and Zn(II) from Aqueous Solutions

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**Abstract info:**

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biosorbent, *Citrus reticulata*, removal, heavy metals, FAAS, *recovery*.

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**Abstract:** This paper is about research into ability of minced non-modificated peel of *Citrus reticulata* to extract Cd, Cu, Pb and Zn ions from aqueous samples and the parameters necessary for the process. The concentrations of the metal ions retained in the solutions were determined by flame atomic absorption spectrometry (FAAS) method. FTIR analysis of the biosorbent showed many groups like carboxyl, hydroxyl, phenol which are probably responsible for absorption of metal ions, appearing on specific wave positions. The extraction of metals was favorable at pH 5 within the optimal contact time of 2 hours while the effective adsorbent dosage was 4 g/L. The maximum adsorption obtained under optimal conditions was 63.8%, 86.5%, 90.2% and 62.7% for Cd, Cu, Pb and Zn, respectively. The results indicate that usage of household waste such as this, could be an excellent biosorbent for removal of Cu and Pb, and good sorbent for removal of Cd and Zn on a large scale and create effective, cheap and efficient method in treating wastewater.

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Abstract

PP-AEC-07

# Silica Gel-Molybdenum(VI) Oxide as a New Sorbent for Solid Phase Extraction of Cd(II), Cu(II), Mn(II) and Pb(II)

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silica,
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preconcentration,
trace metals,
FAAS.

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**Abstract:** Molybdenum(VI) oxide functionalized silica gel was prepared and investigated for selective solid phase extraction of trace Cd(II), Cu(II), Mn(II) and Pb(II) prior to its determination by flame atomic absorption spectrometry (FAAS). The obtained sorbent was characterized by Fourier Transform Infrared Spectroscopy, which indicated the presence of polymolybdates and molybdenum oxide onto sorbents surface. The optimized operating conditions, selected as a compromise between sensitivity and analytical frequency were: sample pH 9, sample flow rate of 4 mL/min, mass of sorbent 100 mg, sample volume of 250 mL, and eluent ($HNO_3$) concentration of 0.25 mol/L. According to the definition of International Union of Pure and Applied Chemistry, the detection limits ($3\sigma$) of this method were 3.71, 13.87, 2.35 and 7.65 µg/L for Cd, Cu, Mn and Pb, respectively. The relative standard deviation under optimum conditions is less than 4.0% ($n=11$), with recoveries of 90% (Cd), 99% (Cu), 97% (Mn) and 93% (Pb). The method is simple, rapidly applicable for the determination of studied metal ions from pure multielement aqueous solutions.

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Abstract

PP-AEC-08

# Content of Cd, Cu, Fe, Mn, Pb and Zn in Hair Dyes

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hair dye,
heavy metals,
FAAS.

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**Abstract:** The use of hair dyes has been suggested as a risk factor for several types of skin allergy/contact dermatitis and even cancer in epidemiologic studies. Lack of appropriate permissible limits for the content of metals in hair dyes raises greater interest among researches. For this reason, twelve hair dye products from local market in Sarajevo, Bosnia and Herzegovina were analysed for metal content using atomic absorption spectrometry, flame technique. The hair dyes were of several brands and different types (synthetic and plant dyes) and included three shades (black, blonde and red). The concentration of heavy metals in μg/g are ranged as follows: Cd (0.26 – 1.44), Cu (1.37 – 12.75), Fe (2.98 – 500.08), Mn (0.05 – 82.37), Pb (4.39 – 23.42) and Zn (3.56 – 79.03). The highest content of all analysed metals in the different shades were obtained for the plant dyes. The only exception is found in the synthetic blonde dye for Zn. Based upon the results, the highest content of analysed metals in different types of hair dyes revealed the following order: blonde > black > red hair shade.

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PP-AEC-09

# Spatial Assessment of PM and Ozone in the Atmospheric Boundary Layer at Plitvice Lakes

**Kovač-Andrić, E.*, Šrajer Gajdošik, M.**

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meteorological parameters,
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**Abstract:** Particulate matter (PM), nitrogen dioxide and ground-level ozone have been considered as pollutant with the greatest impact on human health and the environment. Emissions of many pollutants have been reduced in the past few decades, but their concentrations are still high causing decreased air quality. Data on hourly concentrations of ozone, $PM_{10}$ and $PM_{2.5}$ have been analyzed in the period from 2012 till 2014 and compared with meteorological parameters: temperature, relative humidity, wind speed and direction), at the monitoring station Plitvice Lakes. Concentrations of PM were higher during the winter period, cause of the increased combustion of biomass and fossil fuels. The highest ozone concentrations measured during the spring period usually occur as characteristic of the Earth's northern hemisphere and as a consequence of stratospheric intrusions. Data analysis showed positive correlation between ozone and temperature and wind speed but significantly negative correlation between ozone and relative humidity. Furthermore, PM negatively correlated with air temperature while with the other analyzed parameters the correlation was positive. Such results were expected due to the formation chemistry of the observed pollutants. All measured values do not exceeded limit values given in EU air quality guidelines

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PP-AEC-10

# Characterisation of the New Sensor for Anionic Surfactant Determination Based on Tetraoctadecylammonium-Tetraphenylborate

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**Abstract:** Anionic surfactants are the most significant type of surfactants, commercially. The standard reference methods for their determination are methylene blue active substances method (MBAS) and two-phase titration. Although these methods are frequently applied, they suffer from many drowbacks such as lack of ability to be automated and miniaturized and use of toxic and carcinogenic organic solvents. Due to the fact that it is necessary to monitor anionic surfactants concentration in environment, as well as in industrial processes and products, there is a need to improve existing sensors and methods for their determination.

A new liquid membrane type of anionic surfactant selective electrode based on tetraoctadecylammonium-tetraphenylborate (TODA-TPB) is constructed. Three electrodes with different percentage of electroactive material (1%, 3% and 5%) are compared. The best response characteristics and the highest jump in equivalence point during potentiometric titration of anionic surfactants exhibited electrode with 3% of electroactive material so that electrode is selected for further characterization.

The selected sensor exhibits a Nernstian response for analyzed anionic surfactants (sodium dodecyl sulfate and sodium dodecylbenzenesulfonate) and excellent selectivity performance. The applicability of the sensor is demonstrated by succesfull determination of anionic surfactants in real samples (commercial detergents and effluents).

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*Abstract*

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# Modelling of Heavy Metals in the Soils of Children Playgrounds

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soil pollution,
children playgrounds,
heavy metals,
modelling,
correlation coefficient.

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**Abstract:** Models could be used to simulate target variable responses to changes in very complex systems such as soils polluted by heavy metals. Chemical soil properties such as pH in $H_2O$, pH in 1 mol/L KCl, humus and $CaCO_3$ could influence metal mobility and can be used to assess impact of various antropogenic activities. The soil samples were collected from playgrounds located in different areas of Sarajevo. Heavy metals: Cd, Pb, Cu and Zn and basic soil chemical properties were determined. Statistical analysis was conducted to obtain the correlation coefficient of two selected variables in a data sample, as a normalized measurement of how the two are linearly related. Determined content (mg/kg) for Cd, Pb, Cu and Zn in the spring season were in the ranges of: 0.91-2.15; 26.69-118.97; 19.14-80.21; 75.85-161.45 and in the autumn season were in the ranges of: 0.80-2.14; 41.07-152.71; 29.46-140.74; 71.77-199.04, respectively. The results showed that the highest correlation coefficient was 0.78, for the total content of Cd in the soils in regard to the content of humus in spring season and this indicates a strong and positive correlation. Public children playgrounds in Sarajevo city can be considered areas at high health risk.

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Abstract

PP-AEC-12

# Modelling of Heavy Metal Distribution in the River Sediment

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river sediment,
river water,
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correlation coeficient.

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**Abstract:** Models could be used as tools for quantifying and ranking the importance of influencing factors. River sediments are important sinks for heavy metals (Pb, Cd, Cu and Zn) and play a significant role in the remobilization of contaminants in aquatic system. The sediment samples of Bosna river were investigated for the content of Pb, Cd, Cu and Zn. Parameters that affects water quality in environment such as biochemical oxygen demand (BOD), chemical oxygen demand (COD), dissolved oxygen (DO) and oxygen saturation (OS) were measured in river water samples. Statistical analysis was performed to obtain the correlation coefficient of two selected variables in a data sample, as a normalized measurement of how the two are linearly related. The total contents of heavy metals in the sediment samples were found to be in the ranges (mg/kg): 7.2–56.3 for Pb, 2.18–5.1 for Cd, 21.3–84.3 for Cu, and 36.5–123.6 for Zn. The results showed that the highest correlation coefficient was 0.87 for the total content of Cd in the sediment in regard to the content of BOD of river water and this indicates a strong and positive correlation.

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Abstract

PP-AEC-13

# The Determination of Iron Levels in Menthae Tea (*Mentha piperita* L.)

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**Abstract info:**

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**Keywords:**

iron,
menthae tea,
dry digestion

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**Abstract:** Menthae tea (*Mentha piperita* L.) is one of the most widely consumed herbal teas. This tea is recognized as a drink that may have several health benefits, primarily due to the presence of nutritional elements especially essential micro and ultramicro elements. In this study we investigated the content of iron in menthae tea samples found in a local market in Sarajevo. The preparation of the samples was done by dry digestion in triplicate while levels of iron were analyzed by spectrophotometry. The amounts of iron were ranged from 275.6 mg Fe/kg to 354.6 mg Fe/kg. All tested menthae tea samples showed high iron levels that can supply enough daily iron requirements in humans.

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Abstract

PP-AEC-14

# Levels of Pb, Cr and Cd in Soil Samples from Sarajevo and Central Bosnia Canton Areas

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**Abstract info:**

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soil,
chromium,
lead,
cadmium,
contamination,
FAAS.

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**Abstract:** The aim of this study was to assess the degree of soil contamination. Due to the high threat to human health and the ecosystem from metals; the levels of Pb, Cr and Cd in soil samples were investigated in Sarajevo and the Central Bosnia Canton. The concentrations of metals were determined by flame atomic absorption spectrometry (FAAS). The range of the metals observed in soil in the Sarajevo Canton were Cd (nd – 4.22), Pb (21.60 – 152.89) and Cr (12.60 – 69.46) mg $kg^{-1}$ respectively. However, the range of metals analyzed in samples collected from the Central Bosnia Canton were Cd (nd in all soil samples), Pb (nd – 238.54) and Cr (14.81 – 89.50) mg $kg^{-1}$, respectively. The degree of soil contamination for all soil samples was calculated. The degree of soil contamination by Cr for all soil samples does not belong to the group of polluted soils. Considering the degree of soil contamination by Pb, two samples from the area of Sarajevo Canton and one sample from Central Bosnia Canton belong to the group of polluted soils, whereas two samples from Sarajevo Canton area belong to the group of Cd polluted soils.

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*Abstract*

PP-AEC-15

# Verification of Standard Method BAS ISO 7890-3:2002: Water Quality – Determination of Nitrates

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**Abstract info:**

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**Keywords:**

raw and potable water,
nitrogen nitrate ($N\text{-}NO_3$),
concentration,
UV-Vis spectrophotometry method,
verification.

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**Abstract:** UV-Vis spectrometry measurements are frequently used for determination of nitrogen nitrate ($N\text{-}NO_3$) concentration in raw and potable water. Method is based on spectrometric measurement of the yellow compound formed by reaction of sulfosalicylic acid with nitrate in alkaline solution. Samples were collected, preserved and stored according to the standard procedure. Method BAS ISO 7890 3:2002 was modified by using an optical path length of 10 mm instead of 40 mm listed in the standard due to which concentrations of standard solutions were increased. Measurements were conducted by using Varian Cary 50 Probe UV Visible spectrophotometer. Method verification was performed by evaluating sensitivity, linear range, limit of detection (LOD), limit of quantification (LOQ) and interferences. The calibration curve was linear in the range from 0.2 to 1 mg/L, with correlation coefficient of 0.9946. Values for LOD and LOQ were 0.052 and 0.1523 mg/L $N\text{-}NO_3$, respectively. Determined $N\text{-}NO_3$ concentration in the different samples of potable water were 2.68 mg/L; 3.07 mg/L and 3.49 mg/L. Determined $N\text{-}NO_3$ concentration in natural spring water was 9.32 mg/L. Obtained results were below 10 mg/L of $N\text{-}NO_3$ concentration which is maximum allowed concentration for potable water. Verified method can be successfully applied to raw and potable water.

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# Development of an Optical pH Sensor Based on Sol-Gel Immobilization

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**Keywords:**

sol-gel,
pH sensor,
immobilization.

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**Abstract:** The aim of paper was to prepare optical sol-gel sensor for pH determination during acid-base titrations. The sol-gel technology is being increasingly used in optical chemical sensors development. Sol-gels are prepared from two precursor molecules, tetraetoxysilane (TEOS) and propyltrimethoxysilane (pTriMOS) in ethanol as a solvent and HCl solution as a catalyst. The selected pH dye molecules Bromocresol purple and Bromocresol green and their combinations were immobilized inside the gel structure. The immobilization of the sensing layer was proceeded by spin-coating technique. Two types of sensor layer carriers were used, microscope cover slip and PVC foil. Immobilized pH dyes showed almost the same properties as "free" pH dyes in the solution. The influence of the amount of the pH indicator dyes on the UV-Vis absorbance was investigated. The leaching effect in water was observed on all sensor layers. The sensing layer was attached to the bifurcated "Y type" optical fiber to measure the UV-Vis absorbance change during the pH titration, and to determinate the equivalence point of the acid-base titration.

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Abstract

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# Electrochemical Behavior of L-cysteine on Mixed Silver-Copper Sulfides: Analytical Applicability via Tentative Reaction Mechanism

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cysteine,
determination.

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**Abstract:** Electrochemical behavior of L-cysteine on three different materials, prepared by co-precipitation of the mixed metals ions ($Cu^{2+}$, $Ag^{+}$) and $S^{2-}$ at different mole ratio (1:0.5; 1:1; 1:1.8) has been investigated. X-ray diffractometry (XRD) of prepared materials showed that all three materials consisted of ternary sulfides while in two powders metallic silver was founded. Prepared materials exhibit different electrical resistance and solubility. The influence of pH (5, 7, 9) on the redox activity of L-cysteine functional groups, on the prepared materials, were investigated by cyclic voltammetry. Redox processes of functional groups (thiol and carboxylic) that take place on electrode surfaces, along with investigation of possible fouling effect, were monitored by electrochemical impedance spectroscopy. Significant influence of materials solubility, at various pH, on electrochemical behavior of L-cysteine were noticed. Tentative reaction mechanism for oxidation of thiol group at pH 5 and 7 was proposed for material consisted of jalpaite doped with Ag. Also, quasi-reversible process attributed to the redox activity of carboxylic group was noticed at all three prepared materials. The excellent electrocatalytic performances of L-cysteine on prepared materials are very promising for applicability of prepared electrodes in voltammetric or amperometric determination of cysteine.

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*Abstract*

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# A Novel, Low-cost, Disposable Wooden Pencil Graphite Electrode for Peroxide Determination

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Peroxide,
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peroxidase,
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**Abstract:** The major focus of today`s chemical sensors and biosensors is to develop a cheap, easy-to-fabricate and user-friendly sensors. Glassy-carbon electrodes are costly and time consuming, compared to the proposed simple and low-cost wooden pencil graphite electrodes (WPG). The WPG electrodes are disposable; and after polishing, they could be used to fabricate a new sensor. Except the price, they possess a structural stability trough the wooden shell. Hydrogen peroxide ($H_2O_2$) is a very reactive molecule that plays an important role in the pathology of many diseases. Peroxidase is an antioxidative enzyme which is found in many cells types. It has an important role in the removing of $H_2O_2$ from the organism. Reaction of the decomposition of $H_2O_2$ is followed after peroxidase is trapped in the Nafion film and immobilized onto the WPG electrode (2HB graphite type).

For the purpose of this paper, method of cyclic voltammetry was used to gain the basic information about the redox potentials of the reagents. The qualitative and quantitative information about the redox reactions occurring in the substrate could be analysed. The results indicated the current increases with the increase of substrate ($H_2O_2$) concentration. With the increase of the scan rate, separation between anodic and cathodic peak was also increasing. In conclusion; the WPG electrodes could be used as a cheap substitution to the expensive glassy carbon electrodes for $H_2O_2$ determination.

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*Abstract*

**PP-AEC-19**

# Variability of PM10 Mass Concentrations in Sarajevo Air

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pollution,
PM10,
particle mass concentrations,
seasonal variation,
Sarajevo.

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**Abstract:** As one of the main pollutants in the atmosphere, PM10 (particles with the size of less than 10 μm) are an important focus due to their significant effect on human health. PM10 collection was performed at an urban site in Sarajevo during different seasons. Twenty-four-hour ($n$ = 115) and one-hour samples ($n$ = 72) of PM10 were collected with Sven Leckel medium-volume sampler at a flow rate of 2.3 $m^3$ $h^{-1}$ on quartz Whatman-QMA filters. Mass concentrations of PM10 fraction were determined by using the gravimetric method. Obtained average PM10 (24-h) concentrations were 88.8 μg $m^{-3}$ (February 2011), 28.8 μg $m^{-3}$ (April 2012), 30.2 μg $m^{-3}$ (July 2012), 23.3 μg $m^{-3}$ (June 2013), 26.8 μg $m^{-3}$ (August/September 2013), 59.7 μg $m^{-3}$ (November 2013), 100.8 μg $m^{-3}$ (January/February 2014) and 89.6 μg $m^{-3}$ (February 2015). The highest and the lowest average PM10 concentrations were observed during winter and summer, respectively. The average values during the winter period are surpassing the European Union 24-h air quality standard for PM10 (50 μg $m^{-3}$). The study of diurnal cycles of PM10 (1-h) concentrations showed two distinct peaks during morning and afternoon/night rush hours. Assessment of PM10 concentrations in different seasons is useful in policy making decisions upon aiming to improve the air quality in Sarajevo.

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Abstract

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# Verification and Application of Standard Method, BAS EN 26777:2000 for Determination of Nitrites in Domestic Water

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raw and potable water;
nitrogen nitrite ($N\text{-}NO_2$) concentration;
UV-Vis spectrophotometry;
method verification.

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**Abstract:** UV-Vis spectrometry measurements are frequently used for determination of nitrogen nitrite ($N\text{-}NO_2$) concentration in raw and potable water. Method is based on spectrometric measurement of the pink compound formed by reaction of N-(1-naphtyl)-1,2-diaminoethan dichloride (in presence of 4-aminobenzene sulfonamide reagens) with nitrite in acidic solution. pH level must be in range 1.9 ± 0.1 for optimal working conditions. Samples from different locations were collected, preserved and stored according to the standard procedure. Measurements were conducted on 540 nm by using a Varian Cary 50 Probe UV Visible spectrophotometer. Method verification was performed by evaluating sensitivity, linear range, limit of detection (LOD), limit of quantification (LOQ) and interferences. The calibration curve was linear in the range from 0.10 to 0.80 mg/L, with correlation coefficient of 0.9994. Values for LOD and LOQ were 0.022 and 0.073 mg/L $N\text{-}NO_2$, respectively. This method can be used if concentration of calcium ion in water is not higher than 250 mg/L and concentration of iron(II) ion is between 200-400 µg/L. Determined $N\text{-}NO_2$ concentration in different samples of domestic water were below LOQ. Verified method can be successfully applied to the determination of nitrites in raw and potable water.

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Abstract

PP-AEC-21

# Effects of $Ni^{2+}$, $Mn^{2+}$ and $Zn^{2+}$ on Total Chromium Determination in Aqueous Solution

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total chromium;
model aqueous solutions;
effect of $Ni^{2+}$, $Mn^{2+}$, $Zn^{2+}$;
FAAS.

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**Abstract:** Determination of total chromium (Cr) is important as it is a waste product of various industries and one of the major pollutants in the environment. The aim of the present study was to show the possibility of quantitative determination of total chromium in the presence of $Ni^{2+}$, $Mn^{2+}$ and $Zn^{2+}$ which are added into model aqueous solutions as chloride or nitrate salts at a concentration range of 100-1000 mg/L. Total chromium was determined by flame atomic absorption spectrometry (FAAS). The recovery values for total chromium were lower than 90% in the presence of $Ni^{2+}$, $Mn^{2+}$ and $Zn^{2+}$ chloride salts if the concentration of these ions was higher than 500 mg/L, 500 mg/L and 1000 mg/L, respectively. $Zn^{2+}$ nitrate salt in the concentration range of 100-1000 mg/L does not affect the total chromium determination. The lowest recovery for total chromium (<48%) was obtained for $Ni^{2+}$ nitrate salt in the whole concentration range. Total chromium recovery at the 100 mg/L $Mn^{2+}$ nitrate salt addition was 86%. The proposed method was successful applied on model aqueous solutions. Further studies are needed to be applied on the quantitative determination of total chromium in the presence of $Ni^{2+}$, $Mn^{2+}$ and $Zn^{2+}$ on real samples.

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**PP-AEC-22**

# Determination of Selected Metals of River Waters that Flow in the Vicinity of Metal Processing Industry

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metal,
river water,
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FAAS,
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UV-Vis.

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**Abstract:** River water quality is one of the most important concerns in the environment. The aim of this study was to determine the level of selected metals, in river water that flows in the vicinity of metal processing industry. Samples were collected from four rivers near Sarajevo area (Vogošća, Ilijaš, Misoća and Vareš). The concentrations of Cr(III), Cu, Mn, Fe, Ni, Cd, Pb, Zn, Ca and Mg were determined by flame atomic absorption spectrometry (FAAS), K and Na were determined by atomic emission spectrometry (AES) and Cr(VI) was determined by ultraviolet-visible spectrometry (UV-Vis). The concentration range (mg/L) of selected metals was: Mn, 0.010-0.064; Fe, 0.086-0.290; Zn, 0.299-1.908; Ca, 63-79; Mg, 7.1-22; Na, 3.4-4.5; K, 0.937-1.575. The obtained concentrations for Cr(III), Cr(IV), Cd, Cu, Ni and Pb were lower than the limit of detection of the applied methods. The concentrations of the determined metals were within the World Health Organization guideline levels for river water samples, and did not appear to have a significant negative impact on the river water quality.

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Abstract

PP-AEC-23

# Kinetic Spectrophotometric Determination of *N*-acetylcysteine ethyl Ester using Bicinchoninic Acid

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*N*-Acetylcysteine ethyl ester,
Bicinchoninic acid,
Kinetic spectrophotometry,
Fixed time method.

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**Abstract:** *N*-acetylcysteine ethyl ester (NACET) according to reported data has the potential to substitute NAC as a mucolytic agent, as a paracetamol antidote and as a glutathione related antioxidant. NACET once it is administered quickly enters the cells where it is transformed to NAC and cysteine. A novel kinetic spectrophotometric method of analysis is developed for the determination of NACET with the use of Bicinchoninic acid (2-(4-Carboxyquinolin-2-yl)quinoline-4-carboxylic acid, BCA), a highly sensitive and specific reagent for $Cu^{+}$-ions. The proposed method is based on a reduction reaction of a $Cu(BCA)_2^{2+}$ complex by NACET (analyte) to a purple $Cu(BCA)_2^{+}$ complex in a phosphate buffer solution. The absorbance of the generated complex is measured at 562 nm. The parameters optimized included: pH of the reaction solution, the effect of temperature, the molar ratio of $Cu^{2+}$/NACET, the molar ratio of BCA/NACET and the molar ratio of $Cu^{2+}$/BCA. The effect of interfering substances was also investigated. A fixed time method was utilized for the construction of a linear calibration graph from $4.0\times10^{-7}$ to $1.0\times10^{-4}$ mol $L^{-1}$ of NACET by the use of the kinetic spectrophotometric method where the detection limit was $1.6\times10^{-7}$ mol $L^{-1}$.

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Abstract

PP-AEC-24

# The Total of Iron Levels in Tea (*Camellia sinensis* L.)

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iron,
tea (*Camellia sinensis* L.),
dry digestion.

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**Abstract:** Tea (*Camellia sinensis* L.) is one of the most popular nonalcoholic beverage, consumed by the worldwide due to its medicinal, refreshing and mild stimulant effects. Tea plays a major role in intake of a number nutritional trace elements in humans. The aim of this study was to determined of the total content of iron in tea samples (black and green tea) from different brand manufactures. The preparation of the samples was done by dry digestion while the total content of iron was analyzed on spectrophotometer "*Spectronic Genesys 2*". The concentrations of iron in black tea were ranged from 71.7 mg Fe/kg to 278.4 mg Fe/kg, and from 74.43 mg Fe/kg to 137.55 mg Fe/kg for green tea samples. Our results showed that consumption of tea (black and green teas) may have beneficial effects to humans.

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Abstract

PP-AEC-25

# Flow Injection Spectrophotometric Determination of *N*-acetylcysteine Ethyl Ester Based on the Reduction of Copper(II)-bicinchoninic Acid Complex

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**Keywords:**

*N*-Acetylcysteine ethyl ester,
Bicinchoninic acid,
Flow injection.

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**Abstract:** A flow injection method of analysis was developed for the determination of a lipophilic cell-permeable cysteine derivative *N*-Acetylcysteine ethyl ester (NACET). NACET compared to its congener *N*-acetylcysteine possesses enhanced pharmacokinetic features. Once administered NACET quickly enters the cells where it is transformed to NAC and cysteine. The proposed method is based on a reduction reaction of an apple green $Cu(BCA)_2^{2+}$ complex to a purple $Cu(BCA)_2^{+}$-complex by NACET in a phosphate buffer solution. The absorbance of the generated $Cu(BCA)_2^{+}$ complex is measured at 562 nm. Recorded peak height was used as a quantitative variable in the flow injection procedure. The absorbance of the formed $Cu(BCA)_2^{+}$, was recorded as a function of time with a recording frequency of 5 $s^{-1}$. The linearity of the proposed flow injection method was obtained over the range $2.0\times10^{-6}$ mol $L^{-1}$ – $1.0\times10^{-4}$ mol $L^{-1}$ NACET, where the limit of detection was $6.6\times10^{-7}$ mol $L^{-1}$. Relative standard deviation obtained by measuring ten replicates of $4\times10^{-5}$ mol $L^{-1}$ NACET was found to be 0.7 %. Analytical frequency was 72 analysis per hour.

# POSTER PRESENTATIONS

Biochemistry and Biotechnology

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Abstract

PP-BB-02

# Evaluation of the Steroid Receptor Binding Affinity of Some Selected Steroid Derivatives by Fluorescent Cellular Biosensor

**Bekić, S.S.[a]*, Marinović, M.A.[b], Plavša, J.J.[b], Petri, E.T.[b], Jovanović-Šanta, S.S.[a], Sakač, M.N.[a], Nikolić, A.R.[a], Ćelić, A.S.[b]**

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**Abstract info:**

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steroid receptors,
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YFP,
steroid derivatives,
steroidogenesis.

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**Abstract:** Since a large number of biologically active steroid derivatives exhibit antiproliferative potential on tumor cells by inhibiting steroidogenic enzymes or blocking the activity of steroid receptors, many of these compounds have been synthesized. On the other hand, some steroid derivatives activate steroid hormone signaling pathways, which is significant for hormone replacement therapy (HRT). We were interested in the mechanism of action of some androstane and estrane derivatives, so we developed fluorescent cellular biosensors in *Saccharomyces cerevisiae* by expressing the ligand binding domain of steroid receptors fused with yellow fluorescent protein (YFP). The principle of the assay is based on the fluorescent resonance energy transfer (FRET) between two YFP molecules after ligand binding induced dimerization of steroid receptors. Selected compounds were evaluated for steroid receptor binding affinity. Our highly specific, nonradioactive and economical assay may have a wide range of applications - from identification and binding affinity quantification of androgen and estrogen receptor ligands, such as potential anticancer or HRT drugs, to the screening of environmental endocrine disruptors.

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Abstract

PP-BB-03

# Antiproliferative Activity of Selected Extracts of Autochtonous *Ganoderma pfeifferi* (Bres. 1889) in Relation to Total Phenols (Serbia)

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antiproliferative, *Ganoderma pfeifferi*, phenolics.

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**Abstract:** *Ganoderma* is a basidiomycetous genus of white-rot fungi which have been used for medicinal purposes for centuries, particularly in Asian countries: China, Japan and Korea. Nowadays, a large number of bioactive components of *Ganoderma* origin (triterpenes, polysaccharides, phenolics), are widely used in pharmaceutical and food industry. Nevertheless, distribution of the species *G. pfeifferi* which is limited to the Europe contains sesquiterpenoids, triterpenoids, sterols and phenolics with antiproliferative activity.

With an aim to determine an antiproliferative activity of ethanolic and water extracts of autochtonous *G. pfeifferi* (Begečka jama) in relation to the content of total phenols (TPH), MTT assay and Folin-Ciolcateu method were used.

The obtained results for ethanolic extracts showed higher content of TPH (43.69±2.60 and 23.13±1.91 mg eq GA/g d.w., respectively) than water extracts as well as better antiproliferative activity against MCF-7 breast cancer cells after subacute incubation (24h) (154.05±12.92 and 653.35±10.19 μg/mL, respectively) with high correlations determined between them ($R^2$=0.96 and $R^2$=0.72, respectively). Water extracts caused better inhibition of cell proliferation than ethanolic extracts after 72h incubation (49.25±1.72 and 76.69±12.10 μg/mL, respectively) with high correlations noticed with total phenolic content ($R^2$=0.92 and $R^2$=0.91, respectively). A high correlation obtained for TPH and antiproliferative activities in examined extracts indicates high effects of phenols on examined activities. These results can be of great importance for the assessment of quality of products and extracts derived from *Ganoderma pfeifferi*.

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Abstract

PP-BB-04

# Potential of *Ganoderma pfeifferi* Extracts in Antiviral Activity on Bacteriophage Model

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**Abstract:** *Ganoderma pfeifferi* (Bres 1889) is saprotrophic basidiomycetous fungi, which is autochtonous for Europe. In contrast to *G. applanatum* and *G. lucidum*, from which a number of biologically and pharmacologically active compounds such as triterpenes and polysaccharides have been isolated, *G. pfeifferi* is one of the mycochemically less well-examined species of the genus *Ganoderma* which sterols, triterpenes and farnesyl hydroquinones have been prooved to possess antiviral activity.

The aim of this study was to investigate the antiviral properties of autochtonous *G. pfeifferi* originated from Begečka jama (Vojvodina, Serbia). The extraction of fungal material was prepared in three solvents: ethanol (EtOH), water ($H_2O$) and DMSO after ethanolic extraction while the antiviral activity was tested on model virus vB_BbrS_LK3 (fam. Siphoviridae). Virions were incubated with various concentrations of extracts (0.20-300 mg/mL) during 30 min at 37 °C and their infectivity after the treatment was determined by plaque assay. The results are expressed as percentages of inactivated virions by extracts in regard to their initial number. The highest antiviral activities on this bacteriophage were exhibited by DMSO extracts at 10-200 mg/mL (21.4-83.3%), while $H_2O$ and EtOH extracts showed less antiviral potential at 0.2-100 mg/mL (1.8-22.2% and 10.9-28.8%, respectively). Considering the fact that analyzed extracts showed different level of antiviral activities, we assumed that less polar compounds such as triterpenes (lucialdehyde B, D, ganoderone C, ganoderal A) showed potential for inactivation of model virus. This should be further confirmed using selected extract components.

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Abstract

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# Separation and Determination of Antioxidative Histidine Dipeptides by Microchip Capillary Electrophoresis with $C^4D$ Detection

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anserine,
carnosine,
$C^4D$ detector,
histidine
dipeptides,
microchip electrophoresis,
poultry meat

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**Abstract:** Carnosine (ß-alanyl-L-histidine) and anserine (ß-alanyl-N-methyl histidine) are naturally occurring bioactive histidine dipeptides. Their multifunctional biological functions include: anti-oxidation, anti-glycation, pH buffering and anti-aging. These remarkable substances have broad therapeutic area of applications. Histidine dipeptides are usually determined by HPLC using various detection principles. Microchip electrophoresis (MCE) is a miniaturized mode of capillary electrophoresis (CE) in which analysis is performed in microchannels.

In the presented investigation a home-made MCE device was used to quantitate two biologically important histidine dipeptides, carnosine and anserine, using capacitively coupled contactless conductivity detection ($C^4D$). $C^4D$ is a simple and universal electrochemical detection method which does not require derivatization of the dipeptides before analysis. The developed method was used to determine carnosine and anserine in breast and thigh muscle of poultry meat. Histidine dipeptides were electrophoretically separated in run time of 120 s using acidic electrophoretic buffer (pH 2.7). The limit of detections for the dipeptides in the mixture were 0.10 µM for carnosine and 0.16 µM for anserine. Standard addition method was used to determine the accuracy and precision of the method.

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Abstract

PP-BB-06

# Isolation and Purification of Metallothionein from Honey Bees (*Apis mellifera*) Using Metal Ion Affinity Chromatography

**Nikolić, T.*, Tutulugdžija, A., Kojić, D., Orčić, S., Petri, E., Ćelić, A., Purać, J.**

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metallothionein,
honey bee,
chromatography,
SDS-PAGE.

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**Abstract:** Metallothioneins are a group of low-molecular weight, cysteine-rich proteins that bind potentially toxic metals, such as zinc, copper, cadmium and nickel. Metallothioneins play a significant role in metal homeostasis and detoxification, and are involved in defence against stress caused by toxic metals, alkylating agents, drugs, bacterial endotoxins and viruses. Because their expression is induced by various stimuli, they are considered to be good biomarkers in medicine and ecology. Metallothioneins are ubiquitous proteins described in a large number of insects such as *Drosophila* spp., *Anopheles gambiae* and *Musca domestica*, however they have not been identified in *Apis mellifera* and other Hymenoptera species. Given the various roles of this protein in the cell, its characterization could contribute to our understanding of the molecular responses of honeybees to environmental stress. The aim of this study was to develop a rapid and economic method for metallothionein purification from honey bees taking advantage of its natural ability to chelate metal ions. Metallothionein was purified by metal ion affinity chromatography via a HisTrap column and evaluated by SDS-PAGE. This represents the first step in obtaining pure metallothionein from honey bees which will be further used to analyze its function and structural properties.

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Abstract

PP-BB-07

# Chemical Composition and Antioxidant Activity of Extracts From *Teucrium polium* subsp. *capitatum* (L.) Arcang.

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*Teucrium polium* L.,
methanol extract,
essential oil,
antioxidant activity.

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**Abstract:** The subject of this work was the essential oils and methanolic extracts from *Teucrium polium* subsp. *capitatum* (L.) Arcang. (Lamiaceae). The purpose of this study was to determine the antioxidant activity (AA) of *T. polium* and composition of essential oil. The process of obtaining the essential oil was carried out by distillation in Clevenger type apparatus. Chemical analysis of the oil was done using gas chromatography and mass spectrometry (GC/MS). The methanolic extracts were prepared by ultrasonic extraction. Total phenolic content (TPC) was measured by Folin-Ciocalteu assay. Antioxidant activity of methanolic extract and essential oil was determined by two methods, DPPH and FRAP method. Thirty components were identified in essential oil, representing 91.2% of all the components. The most abundant group of compounds in oil was sesquiterpenes (60%), followed by oxygenated sesquiterpenes (24%), and the rest were monoterpenes. The TPC in the methanol extract was 115.5±14.5 mg GAE/g $_{\text{dry extract}}$ (flavonoids 60.7 ± 11.2 mg GAE/g $_{\text{d.e.}}$ and non-flavonoids 54.8±5.3 mg GAE/g $_{\text{d.e}}$). Very good AA was reached by methanolic extracts ($IC_{50}$ = 1 mg/mL), while the essential oil had 13.1% of inhibition at a concentration of 2.5 mg/mL. According to FRAP method, methanolic extract also showed better AA: 1.6 mg/mL of the methanol extract was equivalent to 2.4 mmol/L of $Fe^{2+}$. The results obtained for *T. polium* were compared with already known antioxidants: gallic acid and butylated hydroxytoluene.

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Abstract

PP-BB-08

# Total Phenolic Content of Meadow Bee Honey from Bosnia and Herzegovina

**Tahirović, I. [a,*], Drljepan, N.[a], Dizdar, M.[a], Buza, N.[a], Čopra-Janićijević, A.[a], Subašić, M.[a], Toromanović, J.[b], Kurtagić, H.[c]**

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Total phenolic content
Folin-Ciocalteu
Bee honey.

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**Abstract:** Honey has been used as a food and medical product since the earliest times. Honey is rich in phenolic acids and flavonoids, which exhibit a wide range of biological effects and act as natural antioxidants. In this study, the total phenolic contents of forty-three (43) meadow bee honeys from Bosnia and Herzegovina were evaluated [sage honey (7), honey from winter savory (7), and mixed meadow honey (29)] by the Folin-Ciocalteu method. Analyzed samples were collected in the period 2013-2015. Total phenolic contents (TPC) of honey samples varied from 5.26 (sage honey from Stolac) to 84.45 mgGAE/100 g honey (winter savory honey from Konjic). The present study confirms that Bosnian honey contains significant content of phenolic antioxidants that may have therapeutic potential. It was confirmed that dark-colored honeys had higher TPC than those light-colored. Overall, our results indicated that there were significant seasonal variations in the TPC over the three-year period.

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Abstract

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# Kinetic Features of Acetylcholinesterase Inhibitor *δ*-terpinene

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inhibition

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**Abstract:** Alzheimer's disease (AD) is the most common form of dementia in modern society. It is estimated that there are less than 1% occurrence in population of people between 60 and 64 years old, while there is an exponential increase in older populations. Main symptoms of AD include disruption or loss of higher brain functions (*i.e.* memory, judgment, thought processes, speech and others). Inhibition of acetylcholinesterase (AchE) enzyme is crucial for ameliorating the symptoms in the first stages of AD and is the only pharmacotherapy to date.

The aim of this paper was to test the inhibitory activity of *δ*-terpinene, naturally occurring monoterpene, on AChE and to determine the type and kinetic parameters of inhibition using various linear plots (*i.e.* Lineweaver-Burk, Eadie-Hofstee, Hanes-Woolf and Eisenthal – Cornish-Bowden).

It was concluded that *δ*-terpinene exhibits mixed type of inhibition which was shown to be concentration dependent. Also, AChE inhibition kinetic parameters (*i.e.* $K_M$, $V_{max}$, $K_M^{app}$, $V_{max}^{app}$, $K_I$ *and* $K'_I$) were determined.

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Abstract

PP-BB-10

# Evaluation of the Total Phenolic Content of Forest Bee Honey Samples from Bosnia and Herzegovina

**Tahirović, I.[a,*], Šljivo, E.[a], Dizdar, M.[a], Buza, N.[a], Čopra-Janićijević, A.[a], Subašić, M.[a], Toromanović, J.[b], Kurtagić, H.[c]**

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**Abstract:** Honey is a natural food product produced when the nectar and sweet deposits from plants are gathered, modified and stored in the honeycomb by honey bees. It has multiple physiological effects, and one of the most important is antioxidant activity which is attributed to the content of phenolic compounds. In this study, forest bee honey samples (33) from Bosnia and Herzegovina were analyzed to determine their total phenolic contents (TPC). These samples consisted of acacia (9), mixed forest (9), chestnut (7), mountain (5), and linden (3) honeys. The TPC was determined by the Folin–Ciocalteu method. The results of the study showed that TPC differ widely among different honey types. Phenolic content ranged from 4.57 mgGAE/100 g (linden honey from Cazin, 2014) to 270.41 mgGAE/100 g (mountain honey from Bjelašnica, 2013). The highest TPC had dark samples of honey, while the lowest TPC were found in pale honeys. It was also confirmed that TPC of honey is affected by climate changes during the year, so analyzed chestnut honey (Cazin-Brezova Kosa) collected in 2013, had 98.26 mgGAE/100 g, while the same sort of honey (from the same location) collected in 2014 (which was abundant rainfall), had 69.27 mgGAE/100 g.

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*Abstract*

**PP-BB-11**

# Phenolic Profile and Biological Activity of Muskat Hamburg Grape Juice and Wine

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Muskat Hamburg;
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antioxidant activity,
wine,
young wine,
grape juice.

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**Abstract**: Worldwide wine is known not only as popular beverage, but also as one of the oldest antiseptics, painkillers or remedies for treatment of gastrointestinal disorders. The aim of this study was to examine phenolic profile and antioxidant activity of juice, young wine and wine of Muscat Hamburg variety grown in Fruška Gora (Serbia) vineyards, which to the best of our knowledge, has never been characterized. Quantitative analysis of 47 phenolic compounds was performed using the LC-MS/MS technique, while quantification of 5 anthocyanin glucosides was done by HPLC-UV/VIS technique: 26 compounds were detected, epicatechin was dominant flavonoid, while malvidin-3-*O*-glucoside was dominant anthocyanin in young wine and wine. The antioxidant potential of samples was determined using tests related to free radical (DPPH$^{\bullet}$) and reactive nitrogen species ($^{\bullet}$NO) scavenging ability, potential to inhibit lipid peroxidation and reducing power, measured by FRAP assay. Considering antioxidant potential, young wine exhibited the highest activity in all applied tests, except $^{\bullet}$NO scavenging assay.

This paper reports novel and valuable data about phenolic profile and biological activity of Muscat Hamburg wine and its related dietary products. Moreover, obtained results in this work implicate that examined grape products can be regarded as a promising source of natural antioxidants.

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*Abstract*

**PP-BB-12**

# Chemical Characterisation and Antioxidant Potency of Italian Riesling Variety Wine and Grape Juice from Fruška Gora Region

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Italian riesling,
wine,
phenolic profile,
antioxidant activity;
acetilcholinesterase inhibition.

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**Abstract:** Numerous reports confirm positive effect of grapes, grape juices and wines in treatment of various disorders, such as cardiovascular and neurodegenerative diseases, cancer and ageing.

In this study the grape juice, young wine and wine from Italian Riesling, grown on Fruška Gora vineyards, Serbia, were analyzed by in-depth polyphenolic profile characterization, as phenolics are main ”offenders“ for biopotential of plants, and determination of biological activities, such as antioxidant and neuroprotective. An LC-MS/MS technique was used to evaluate the quantitative content of 47 phenolic compounds in samples. Applied analyses of selected phenols resulted in detection of 19 of 47 compounds, with the lowest content in grape juice. Antioxidant properties were evaluated using spectrophotometric tests, based on measuring the radical scavenging effect on nitric oxide (NO) and diphenylpicrylhydrazyl radical (DPPH), and reducing power (FRAP) assay. Neuroprotective effect was estimated through acetylcholinesterase inhibition. Considering biological potential, young wine sample exhibited the best activity in all assays, except the NO radical scavenging assay, in which wine showed highest potential.

Obtained results support further utilization of grapes and its products as agents with valuable biopotential. Also, new scientific data is presented since this is the first comprehensive analysis of Italian Riesling variety from Fruška Gora.

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Abstract

PP-BB-13

# Levels of Myeloperoxidase in Plasma of Patients with Type 2 Diabetes Mellitus without Cardiovascular Complications

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**Keywords:**

diabetes mellitus, myeloperoxidase (MPO), cardiovascular complications, oxidative stress.

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**Abstract:** It is unknown if the increased concentrations of inflammatory markers and oxidative stress are the cause or the consequence of cardiovascular complications in type 2 diabetes mellitus (DM). In this paper, we have shown the correlation of concentration of myeloperoxidase (MPO) as a prooxidative and inflammatory marker with the rest of biochemical and clinical parameters.

Case-control research has been conducted in a group of 50 patients with type 2 DM without any cardiovascular complications and 30 controls.

Statistically, the mean value of the MPO concentration in the plasma of patients with type 2 DM (16.87±4.93 ng/mL) is significantly higher than the MPO concentration in controls (3.72±1.87 ng/mL) ($p^{**}<0.001$; t=16,938; Student t-test) A significant correlation of the concentration of MPO with fasting blood glucose (FBG) (Pearson's correlation coefficient r=0.490; $p^{**}<0.001$), CRP (Pearson r=0.401; $p^{**}<0.001$) and HbA1c (Pearson r=0.294; $p^{*}<0.05$) has been determined in type 2 DM patients.

In physiological conditions and conditions of chronic inflammation and hyperglycemia, MPO is continuously being released from neutrophils. Hyperglycemia is the cause, not the consequence of the increased concentration of MPO. With a good glycemic control (HbA1c=6.57±1.06), MPO does not represent the risk factor for the development of diabetic cardiovascular complications.

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Abstract

PP-BB-15

# Evaluation of Troponin I ES Assay on the Vitros 5600 Analyser

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Troponin I,
Myocardial Infarction,
Quality Control.

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**Abstract:** Troponin I (cTnI) is a protein normally found in muscle tissue that regulates the calcium dependent interaction of actin and myosin. Troponin I assay can be used as an aid in the differential diagnosis of acute coronary syndrome to identify acute myocardial infarction. Measurements of Troponin I ES were performed by immunoassay on Vitros 5600 analyser. Precision was evaluated consistently with CLSI (Clinical and Laboratory Standards Institute) document EP5. Two replicates of each of 3 control samples were tested on 2 separate occasions per day on at least 20 different days. Analytical assessment of Troponin I ES determination comprised within-run and between-run imprecision. Within-run imprecision on the commercially controls for ECi/EciQ system 1 is 3.8% and 4.9% for ECi/EciQ system 2; between-day imprecision for ECi/EciQ system 1 is 6.8% and 7.1% for ECi/EciQ system 2. Total of 75 samples of patients from routine laboratory workload were simultaneously analyzed for Troponin I ES and Abbott STAT cTnI levels. Constructed calibration curve (y=1.95x+4.73) showed good correlation coefficient $r^2$=0.96. The presented results of the verification methods for determination of Troponin I ES on the Vitros 5600 analyzer showed acceptable accuracy and precision.

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Abstract

PP-IC-01

# Hydrophilically Modified Silicones in the Nanoparticle Suspensions

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silicones,
nanoparticle suspensions,
acoustic spectroscopy.

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**Abstract:** The silicones are synthetic polymeric materials of special type that combine the properties of inorganic and organic polymers. As with all materials, silicones have certain inherent properties (low reactivity, low compatibility with water and a small solubility in polar and non-polar solvents), which limit their application. In order to expand the possibility of their use in a variety of complex systems (suspensions, emulsions), hydrophobic silicones are chemically modified by grafting hydrophilic groups in the molecule. These modified silicones have to adsorb at the interfaces (liquid / liquid, liquid / solid), thus enabling system stabilization (dispersion).

The aim of this work is to examine the influence of the small molecular weight hydrophilically modified silicones on the properties (stability) of the nanoparticle ($TiO_2$ and ZnO) suspensions. Several hydrophilically modified silicones from various manufacturers (Elkay® Silicones, Dow Corning Xiameter®) were characterized (viscosity) in aqueous solutions at different pH values, and in a three non-polar solvents (DMSO, ethanol, hexane). Acoustic spectroscopy was used to examine the influence of silicone addition on the suspension properties (particle size, ζ-potential), and the absorption onto the nanoparticles was tested by thermogravimetry. The results confirm the potential use of hydrophilically modified silicones in dispersed systems.

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Abstract

PP-IC-02

# Application of Potassium Birnessite Thin Film/FTO Modified Electrodes as Nonenzymatic Sensors for Hydrogen Peroxide

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$H_2O_2$,
potassium birnessite,
thin films,
nonenzymatic sensors,
FTO-fluorine doped tin oxide.

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**Abstract:** We have developed a new kind of simple and cost effective nonenzymatic amperometric sensor based on potassium birnessite thin film modified FTO electrode for detection and quantification of hydrogen peroxide. The film is deposited on the FTO surface using dip coating method from two aqueous solutions containing manganese(II) chloride and potassium permanganate, respectively. The material used for working electrode modification is examined with XRPD and FTIR in order to estimate the chemical composition and structure. AFM is used to characterize the surface morphology of the thin film. The electrochemical and sensing properties are investigated using cyclic voltammetry and chronoamperometry. All electrochemical measurements are carried out in three electrode system using phosphate buffer solution ($HPO_4^{2-}/H_2PO_4^-$) with pH = 7.5 as electrolyte in the presence of atmospheric oxygen. The best results are obtained under oxidation potential in concentration range of $H_2O_2$ from 10 up to 1500 µM. The lowest detection limit was 10 µM and the sensitivity of the sensor was 353 $\mu A \cdot cm^{-2} \cdot mM^{-1}$ (in concentration range 10-50 µM). The calibration plot is associated with a linear regression line and coefficient of $R^2$ = 0.99.

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Abstract

PP-IC-03

# Design of Nonenzymatic Amperometric Sensor for $H_2O_2$ Based on Electrodes Modified with Nanoscaled $MnCO_3$ Thin Films

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**Keywords:**

hydrogen peroxide, manganese(II) carbonate, nonenzymatic sensors.

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**Abstract:** The present study is related to the development of nonenzymatic amperometric sensors for detection of hydrogen peroxide ($H_2O_2$). The designed sensors are based on manganese(II) carbonate thin film modified electrodes. The films are deposited on electroconductive fluorine doped $SnO_2$-coated glass substrates using chemical bath deposition method. Thin film chemical composition and structural analysis are studied using XRPD and FTIR. The electrochemical properties and sensitivity towards $H_2O_2$ are examined using cyclic voltammetry and chronoamperometry. Thin films with three different thicknesses of 75 and 100 nm are used. The electrochemical experiments are carried out in a phosphate buffer solution with $c(K_2HPO_4/KH_2PO_4)$ = 0.1 M and pH = 7.5 and wide concentration range of hydrogen peroxide from 0.1 to 25 mM is investigated. The best results are obtained under oxidation potential when using 75 nm $MnCO_3$ thin film and concentrations of $H_2O_2$ from 0.1 up to 10 mM. The lowest detection limit was 90 µM and the sensitivity of the sensor was 2.00 $\mu A \cdot cm^{-2} \cdot mM^{-1}$. The calibration plot is associated with a linear regression line and coefficient of $R^2 = 0.99$.

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Abstract

PP-IC-04

# FT-IR Spectroscopy Investigation of Cobalt(II) – CT DNA Interaction in Water Solution

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FT-IR difference spectroscopy,
Vibrational bands,
$Co^{2+}$ ion,
DNA structure.

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**Abstract:** According to the fact that vibrational bands of nucleobases and phosphodiester groups are sensitive to structural and electronic perturbations, Fourier transform infrared (FTIR) difference spectroscopy was used to determine the metal ion binding sites and the effect of cation complexsation on DNA secondary structure. Since the cobalt complexes showed significant biological importance, at first part of our examinations this method was used to investigate the interaction of calf thymus DNA with $Co^{2+}$ ion in buffered solution using $Co^{2+}$ / DNA molar ratios of 1/20, 1/40, 1/60 and 1/80. The spectra were recorded 2h after initial mixing of DNA and metal cation solution. Solution spectra were taken using $CaF_2$ cell and 100 scans. A good substraction was performed by the flat baseline around 2200 $cm^{-1}$, where the water combination mode was present. The difference spectra [(DNA) + (metal cation) – (DNA)] were obtained, using the band 968 $cm^{-1}$ as internal reference. This band exhibited no major spectral changes on DNA complexsation and is cancelled, upon substraction.

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Abstract

PP-IC-05

# Synthesis and Characterization of New Type of Hybrid Materials Based on Graphite and Polyhedral Oligomeric Silsesquioxane (POSS) Derivatives

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POSS,
graphene oxide,
hybride material.

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**Abstract:** The thin graphene platelets have remarkable properties such as high surface area, superior stiffness, strength, thermal and electrical conductivity, electronic transport properties, chemical and thermal inertness and by its properties can be used as polymeric nanocomposites, liquid crystalline devices, lithium ion battery, fuel cell, catalysts, sensors, transistors, actuators, and flexible displays. Graphene oxide (GO) sheets have epoxide (bridging oxygen atom), carbonyl (C=O) and hydroxyl (–OH) groups as basic functional groups.

A silsesquioxane is an organosilicon compound with the empirical chemical formula $RSiO_{3/2}$ where Si is the element silicon, O is oxygen and R is either hydrogen or an alkyl, alkene, aryl, arylene group. A nanostructure consisting of rectangular polyhedral oligomeric silsesquioxane (***POSS***) compounds have large application area as nanocomposites and catalysts.

In this study, a new type of hybrid materials based on Graphite and POSS derivatives were synthesized and characterized. The POSS derivative was synthesized from *N*-(2-Aminoethyl)-3-aminopropyltrimethoxysilane (AEPTMS) by using hydrolytic condensation reaction. Glutaraldehyde was used as crosslinking agents. After that, hybrid material was synthesized by imine formation between primer amine groups of POSS derivative and graphene oxide and aldehyde groups of crosslinking agent. Salicylaldehyde was used to form Schiff bases of hybrid material by the reaction of the aldehyde group with the free amine group of hybrid material. The characterization of the prepared hybrid materials was carried out by elemental analysis (C, H, N), ICP-MS (Si), FT-IR, CP-MAS $^{13}C$ NMR and TG-DTA techniques.

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Abstract

PP-IC-06

# Antimicrobial Activity of Ruthenium(III) Complex with *N*-phenyl-5-nitro-salicylideneimine

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ruthenium(III) complex,
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antibacterial activity,
MIC,
MBC.

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**Abstract:** The antimicrobial properties of Schiff bases and their ruthenium complexes are of great importance and are the subject of intensive research in various fields of medicinal chemistry. Here, we present the results of antimicrobial characteristics of the new ruthenium complexes synthesized with Schiff base derived from 5-nitrosalicylaldehyde and aniline. The complex was synthesized by the modifed synthetic procedure, and the formulation and characterization was performed based on resaults of UV/Vis spectrophotometry, infrared spectroscopy and ESI ToF mass spectrometry. It was found that *N*-phenyl-5-nitro-salicylideneimine acts as an anionic bidentate O,N-donor ligand which is coordinated to the ruthenium via azomethine nitrogen and phenolic oxygen. Assumed formula of molecular ion $[C_{26}H_{18}Cl_2N_4O_6Ru]^-$, was confirmed in the mass spectrum of the complex, (m/z: 653.96408). The *in vitro* antimicrobial activity of synthesized ligands and the corresponding complexes were tested by micro-dilution technique and agar plate assay for determination of minimum inhibitory concentracion (MIC) and minimum bactericidal concentration (MBC). Results were compared to the corresponding positive controls. The antibacterial activity of the complexes was higher than the one of the ligands alone. However, their antibacterial activity was lower in comparison to the positive controls. The compounds showed a higher antibacterial activity against tested Gram-positive bacteria (*Staphylococcus aureus* ATCC 33591 and ATCC 29213), whereas against the Gram-negative bacteria (*Pseudomonas aeruginosa* ATCC 27853, *Escherichia coli* ATCC 25922, *Klebsiella pneumoniae* ATCC 700603) were ineffective.

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Abstract

PP-IC-07

# Synthesis, Characterization and Antitumor Activity of the New Ruthenium(III) Complex with Schiff Base Derived from 5-methylsalicylaldehyde and methylamine

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Ruthenium(III) complex,
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MTT assay.

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**Abstract:**: Ruthenium complexes are presently receiving great attention in the fields of biological, pharmaceutical and medicinal chemistry as antitumor and antimicrobial agents. Here, we are reporting the synthesis, characterization and antitumor activity of a new Ru(III) complex with bidentate anionic Schiff base derived from 5-methylsalicylaldehyde and methylamine. Formulation and characterization of compound were made on the basis of ESI ToF mass spectrometry, UV-Vis spectrophotometry and IR spectroscopy. The evidence for Schiff's bases coordination to ruthenium through azomethine nitrogen and phenolic oxygen was detected analysing shifts of azomethine group toward lower values of wave numbers and ones of phenolic group to higher values wave numbers in the IR spectra of compound. High resolution mass spectra were recorded in the negative ESI ionization mode, where the anionic component was detected as $[C_{18}H_{20}N_2O_2Cl_2Ru]^-$ ion, (m/z: 467.99558), which confirmed the assumed molecular formula of the compound. *In vitro* antitumor activity of complex was determined on human tumor cell lines derived from myelogenous leukemia (K562), alveolar basal adenocarcinoma (A549), and one non-tumor human fetal lung fibroblast cell line (MRC-5). Cytotoxicity data in terms of $IC_{50}$ values (μM) were obtained by MTT assay after 48 h of drug action. The average $IC_{50}$ values showed high cytotoxicity of the complex, that qualifies it for further research, including research *in vivo*.

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*Abstract*

PP-IC-08

# Synthesis and Characterization of Ru(III) Complexes with Thiosemicarbazide-based Ligands

**Ljubijankić, N.[a*], Tešević, V.[b], Grgurić-Šipka, S.[b], Jadranin, M.[c], Begić S.[a], Buljubašić, L.[a], Markotić, E.[a], Ljubijankić, S.[d]**

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ruthenium,
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salicylaldehyde,
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ONS tridentate ligand.

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**Abstract:** Thiosemicarbazones have been the subject of studies because of their variable bonding modes, promising biological activity and structural diversity. Among the most examined compounds of this group is certainly salicylaldehyde thiosemicarbazone. The synthesis of transition metal complexes with thiosemicarbazone ligands has been receiving considerable attention due to the potentially useful chemotherapeutic properties of both ligands and complexes as antitumor and antibacterial activities. In this paper, we report the synthesis and characterization of salicylaldehyde thiosemicarbazone complexes with Ru(III). Three ruthenium(III) complexes of the type $Na[RuL_2]$ (where L = dibasic tridentate thiosemicarbazone ligand), have been synthesized. Ligand general formula (X)N-NH-C(S)-$NH_2$, were prepared through the condensation reaction of salycilaldehide and its derivatives (X = salicylaldehyde, 5-Cl-salicylaldehyde, 5-Br-salicylaldehyde) with thiosemicarbazide. Complexes have been formulated and characterized by mass spectrometry, infrared and electronic spectra. The data show the formation of a complex with a 1:2 metal:ligand stoichiometries. The ligands coordinated as a ONS tridentate dianion through the oxygen atom of the deprotonated phenolic OH-group, the azomethine nitrogen atom and the sulfur atom after deprotonation of the thiosemicarbazide residue in its thiol form. ESI ToF mass spectrometry confirmed existence of $[C_{16}H_{14}N_6O_2S_2Ru]^-$, $[C_{16}H_{12}N_6O_2S_2Cl_2Ru]^-$ and $[C_{16}H_{12}N_6O_2S_2Br_2Ru]^-$ ions with m/z values at 487.96567, 555.88615 and 643.78526, respectively.

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Abstract

PP-IC-09

# Spectroscopic Investigations of Co(II) and Cu(II) Interaction with Imatinib Mesylate and Capecitabine

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copper,
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FTIR,
UV spectroscopy,
microscopic analysis.

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**Abstract:** Cobalt and copper are present as trace elements in biological systems and they are very important for the activity of many enzymes with different functions in the body. Their biological functions derive from the possibility of potential interaction of their M(II) ions with O, N and S donor atoms of various ligands and biomolecules in the organism. Capecitabine and imatinib mesylate (ImM) are synthetic organic compounds which are used in a treatment of some oncological diseases, disturbing homeostasis of biological system.

In this study, UV and FTIR spectroscopic methods are used to investigate metal-ligand interactions and products of their interaction at physiological conditions using model test systems.

FTIR spectrum of Co(II)-capecitabine model systems show lack of absorption bands characteristic for -OH (at 3230 $cm^{-1}$) and C=O groups positioned at pyrimidine cycle (at 1718 $cm^{-1}$) for pure capecitabine. It indicates on interaction of Co(II) ion with capecitabine via O-donor atoms. FTIR spectrum of pure ImM deviates from spectrum of Co(II)-ImM system at 1250-1050 $cm^{-1}$ wavelength region. This region corresponds to peaks characteristic for mesylate ions ($O_3S$-$CH_3$), which indicates on interaction between Co(II) and donor atoms containing molecule ligands (O and/or S).

UV results for model systems of M(II) with capecitabine and ImM show similar absorption bands as those of pure ligand, while absobances are different (except for Cu(II)-ImM). Since these investigations are done at approximately at physiological conditions, it is expected that, after application of these ligands as pharmacological agents, the same interactions are happening in the human body.

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Abstract

PP-IC-10

# Distribution of Some Heavy Metals in the Process of Cement Clinker Production using Alternative Fuels

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toxic metals,
cement clinker,
alternative fuels.

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**Abstract:** Coal is usually used as a primary fuel in the production of cement clinker. In order to preserve natural resources such as fossil fuels, limestone, clay, gypsum etc., alternative fuels and raw materials that are by-products of other industrial processes are now used as a substitute for coal and natural raw materials. The use of alternative fuels may have some benefits (waste management, energy utilization, reduction of harmful gases) and disadvantages (entry of toxic heavy metals in the clinker, cement and concrete or its emission). In this study were investigated total input and distribution of volatile and semi-volatile metals as Hg, Sb, Cd, Tl and Pb in the process of clinker production in the cement factory in Lukavac (FCL) while burning coal or mix of coal and alternative fuels and their co-incineration in the production of cement clinker. As alternative fuels were used waste tires and residue derived fuels (RDF) composed of combustible part of municipal waste: wood 5-10%, 5-10% paper, plastics 60-70%, 5-8% rubber, textiles 5-10% and others 5%. The results showed that the intake of these metals decreased in order: Tl > Pb > Hg > Sb > Cd during coal combustion. Factors of increased metal input during co-incineration of waste tires and coal were greater (F > 1) than during co-incineration of coal and decreased in order: Pb > Tl ≈ Hg ≈ Sb ≈ Cd. Factors of increased metal input during co-incineration of RDF and coal was greater than 1 only for Sb while for the other investigated metals were less than 1. Distribution of these metals was investigated in solid products, clinker and cement clinker dust as well as their emissions in the atmosphere.

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*Abstract*

**PP-IC-11**

# Synthesis and Characterization of Fe(III) Complexes with Salicylaldehyde Thiosemicarbazone

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**Keywords:**

Fe(III),
thiosemicarbazone,
ONS,
tridentate ligand,
DFT.

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**Abstract:** Metal complexes with thiosemicarbazonato ligands have been investigated due to their possible antitumor, antifugal and antiviral properties. Thiosemicarbazone ligand has several potential donor sites that allows it to bind to the metal through sulfur atom, hydrazine nitrogen atom and phenolic oxygen atom. The iron(III) complex with salicylaldehyde thiosemicarbazone (STSC) ligand of general formula $Na[Fe(STSC)_2]$ was prepared and characterized using UV/Vis spectrophotometry, infrared spectroscopy and ESI ToF mass spectrometry. Infra-red spectrum of the ligand and complex indicate the existence of dianionic tridentate nature of ligand which undergo coordination to metal ion with ONS donor atom sets. Band due to ν (C=N) vibration was shifted towards lower frequencies in a complex (1603 $cm^{-1}$) when compared with a ligand (1616 $cm^{-1}$) confirming coordination of a given ligand *via* azomethine nitrogen. Shift in (C-O) group frequency towards a higher values in IR spectra of the complex (1304 $cm^{-1}$) when compared to the ligand (1263 $cm^{-1}$), confirms coordination of a ligand via phenol oxygen. Due to their great importance, the structural aspects of newly synthesized complexes have been investigated using density functional theory (DFT) methods at B3LYP level with a 6-311++G (d,p) basis set to explore the geometries and electronic features of proposed compounds. Good correlation between experimental IR and calculated spectra was found. The lowest energy transition from the UV-Vis spectrum related to metal-to-ligand charge transfer (MLCT) was correlated to the HOMO-LUMO calculated energies.

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Abstract

PP-IC-12

# Oxidative Decomposition of Quercetin in Presence of Ruthenium(III)

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**Abstract info:**

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**Keywords:**

Ruthenium, quercetin, decomposition, spectroscopy.

**Abstract:** **S**ince NAMI-A (Imidazolium tetrachloro(dimethylsulphoxide-*S*)(imidazole)ruthenate(III)) and KP1019 (Indazolium tetrachlorobis(indazole) ruthenate(III)) entered clinical trials neither one of substantially new ruthenium based complex showed promising biological properties. In light of persuasive ruthenium potential to improve activity of biologically active ligands and positive health effects of flavonoids, we aimed to investigate possibilities of ruthenium to bind quercetin, since there are no described efforts on synthesis of ruthenium flavonoid (quercetin) complexes. We investigated reaction of quercetin with ruthenium trichloride hydrate under mild reaction conditions applying wet-synthesis and liquid assisted mechanochemical ball grinding. Reaction conditions regarding atmosphere, solvent, temperature, molar ratio and coordinating nature of anion were systematically changed. Reaction products were separated by column chromatography and fractions were selectively analyzed. Ruthenium containing species were analyzed by vibrational and electronic spectroscopy, MALDI-TOF/TOF mass spectrometry, elemental analysis, thermogravimetry and conductometry. Furthermore HPLC-DAD was applied to confirm complexity of reaction mixtures. In all cases we found that ruthenium induced oxidative decomposition of quercetin and that 2,3,4-trihydroxybenzoic acid was bound to ruthenium(II) in neutral or anionic complex species. Results clearly suggest that new design of synthetic approach toward ruthenium-quercetin complexes needs to be utilized.

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*Abstract*

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# Synthesis and Characterization of Novel Neutral Complex Compounds Ru(III) with Schiff Bases and *N*-heterocycles

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Ru(III),
neutral complex,
Schiff base,
pyridine,
pyrimidine.

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**Abstract:** In last decades ruthenium complexes have been the subject of huge interest due to their many significant activities, especially anticancer and catalytic activities. Compounds containing pyridine and pyrimidine ring systems are of therapeutic importance. Two novel neutral complex compounds of Ru(III) with Schiff bases derived from 5-X-salicyladehyde where X=Cl or Br and aniline and *N*-heterocycles (pyridine or pyrimidine) have been synthesized. The compounds with the general formula $[RuCl(N\text{-}5\text{-}X\text{-}salim)_2B]$ where X=Cl for B=Py, and X=Br for B=Pym have been characterized by elemental analysis (CHN), MALDI-TOF/TOF mass spectrometry (m/z: 677.9889 for X=Py, and 766.8804 for X=Pym), FT-IR spectroscopy, UV/Visible spectrophotometry and cyclic voltammetry. In the octahedral environment coordination of the Ru(III) to the imine nitrogen and phenolic oxygen atoms of the Schiff bases and nitrogen atom of pyridine or pyrimidine occurred. MALDI TOF/TOF mass spectrometry confirmed existence of the neutral molecules. Redox property of complexes has been determined using cyclic voltammetry.

# POSTER PRESENTATIONS

Biological Chemistry

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Abstract

PP-BC-01

# Influence of Conditions and Methods of Extraction on Chemical Composition of Basil Extracts (*Ocimum basilicum* L.)

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basil,
phenols,
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antioxidants

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**Abstract:** Basil (*Ocimum basilicum* L.) is one of the commonly cultivated plants around the world, especially in Asia, Europe and North America. Usage of basil is widespread due to its rich content and balanced ratio of vitamins, minerals and various phenolic compounds, characterized as main carriers of its antioxidant activity. The objective of this study is to determine the influence of conditions and methods of extraction on chemical composition of basil extracts.

Determination of phenolic compounds (phenolic acids and flavonoids) of 44 basil extracts was performed using HPLC. The extraction was performed during five different periods of time (10 and 30 minutes, 24, 48 and 72 hours) and with 7 different solvents (water, methanol and ethanol in different concentrations).

All extracts showed presence of a large number of phenolic components. Concentration of phenolic acids (chlorogenic, *p*-hydroxybenzoic, caffeic, ferulic, vanillic, cinnamic and rosmarinic) varied from 0.002 to 0.113 mg/mL. Concentration of flavonoid components (apigenin, quercetin, naringenin, rutin) ranged from 0.002 to 0.333 mg/mL.

The analysis showed that extraction conditions (time, solvent polarity and method of extraction) had a great impact on chemical composition of obtained extracts.

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Abstract

PP-BC-02

# Evaluation of the Degree of Susceptibility of Gram-positive, Gram-negative Bacteria and Fungi to the Effects of Garlic

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*Allium sativum* L.,
garlic,
antibiotic,
antimicrobial,
antiviral drugs.

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**Abstract:** The use of antibiotics should be limited, especially for pregnant women, nursing mothers and children, because of potential adverse effects such as toxicity, allergic reactions and other complications caused by antibiotic therapy. Because of this, interest in plants, as potential sources of new antimicrobial and antiviral drugs was reaffirmed. *Allium sativum* L., commonly known as garlic is been used for thousands of years as food and medicine in many cultures. Garlic acts as an antibiotic and fungicide, consequently, the objectives of this study were: *in vitro* tested antimicrobial activity of fresh and thermally processed juice of garlic, on samples of domestic (B&H) and imported garlic. Degree of susceptibility of Gram-positive, Gram-negative bacteria and fungi to the effects of garlic was estimated. Fresh and thermally processed (domestic and imported) garlic showed stronger antimicrobial activity against Gram-positive compared to Gram-negative bacteria. The strongest antimicrobial activity in the conducted experiments showed fresh domestic garlic (B&H).

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*Abstract*

PP-BC-03

# Conventional Extraction of the Biologically Active Compounds from Different Species of Mushrooms Family Polyporaceae

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total phenols,
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fatty acids;

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**Abstract:** Mushrooms overall contain a lot of polysaccharides, triterpenes, vitamins, phenolic compounds, fatty acids, which show positive effects on human body. Some species of mushrooms contain many healthy ingredients that are scientifically proven to have anti-bacterial and anti-viral properties.

Conventional extraction of several different types of mushrooms from the family Polyporaceae (*Stereum hirsutum, Gleophyllum odoratum, Fomes fomentarius, Trametes versicolor, Ganoderma applanatum, Fomitopsis pinicola, Trametes gibbosa, Trametes hirsuta, Laricifomes officinalis, Piptoporus betulinus)*, collected at various locations across Slovenia, was performed. The influence of certain types of habitat (oak, beech, spruce or fir) on the extraction yields was observed. Extractions were carried out in hexane at temperature of T = 342 K for 3 h (solvent boiling temperature). From the obtained extracts antioxidant activity and total phenolic content was measured. Afterwards characterization of the fatty acids was performed using gas chromatography (GC-MS/FID).

The extraction yield was between 0.54 and 6.44%. Inhibition of DPPH radical was in the range from 0.38% to 5.24%, and the amount of total phenols was from 9.3 to 19.6 mg of gallic acid per gram of extract. The highest extraction yield was obtained from the *Fomitopsis pinicola*, and this extract showed a highest amount of total phenols and DPPH radical scavenging activity.

# POSTER PRESENTATIONS

Organic and Medicinal Chemistry

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Abstract

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# Synthesis of New Nitrogen Heterocycles with Potential Antibacterial Activity

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nitrogen heterocycles,
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**Abstract:** Nitrogen heterocycles are a class of heterocyclic organic compounds with a wide range of biological activities. A series of nitrogen heterocycles containing long alkyl and polyalkyl chains was prepared in the form of quaternary salts. Using one-step procedure, salts with a $C_{18}H_{37}$ alkyl *N*-substituents and Br counter anions were prepared in overall yields of 60-90%. The procedure is convenient, mild and generally gives rise to exclusive *N*-alkylation. Their chemical and spectral properties were briefly discussed. Their antibacterial activity will be tested.

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*Abstract*

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# Phenyl isothiocyanate: Synthesis and Biological Potential

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phenyl isothiocyanate synthesis, antioxidant activity, anticancer activity, cholinesterase inhibition, NMR.

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**Abstract:** The sulfur-containing compounds, glucosinolates, a class of secondary metabolites are found in almost all plants of the order Capparales, in particular in the family Brassicaceae (e.g. broccoli and other cabbages). Glucotropaeolin, a glucosinolate associated with an uncommon endogenous glucohydrolase-myrosinase (E.C.3.2.1.147), operates like precursor to phenyl isothiocyanate. In order to investigate its biological properties the pure phenyl isothiocyanate was obtained by one-pot synthesis by reaction of aniline with $CS_2$ in aqueous $K_2CO_3$ solutions affording the dithiocarbamate intermediate, which was further desulfurized with cyanuric acid at 0°C to provide the corresponding phenyl isothiocyanate. The obtained compound was confirmed by GC-MS and spectroscopic techniques (FTIR, 1D and 2D NMR). Phenyl isothiocyanate was tested for its antioxidative (using FRAP, DPPH and Briggs-Rauscher methods), anticancer (using MTT method), and cholinesterase inhibitory activities (using Ellman method). These investigations confirmed this secondary metabolite to be a compound of primary interest.

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Abstract

PP-OMC-04

# Structure-activity Relationship of 4-Hydroxybenzoic Acid Derivatives as Potential Antioxidants

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structure-activity relationship, 4-hydroxybenzoic acid derivatives, antioxidant activity.

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**Abstract:** 4-Hydroxybenzoic acid and a number of its derivatives are well-known compounds with various biological properties (antimicrobial, antimutagenic, hypoglycemic, antiviral, antioxidant, etc.). In this study three derivatives of 4-hydroxybenzoic acid were prepared ethyl 4-hydroxybenzoate, 4-(cyanomethoxy) benzoic acid, and ethyl 4-(cyanomethoxy)benzoate, and tested for their antioxidant and butyrylcholinesterase inhibition activity. To find the relationship between structure and antioxidant activity four different methods were applied: DPPH radical scavenging, ABTS method, Ferric Reducing Antioxidant Power (FRAP) and Metal Chelating Activity. The butyrylcholinesterase inhibition was carried out using a colorimetric method based on Ellman's reaction. Also, in order to explore the theoretical-experimental consistency, quantum chemical calculations were performed using Spartan ´10 software. The obtained descriptors from these calculations were plotted against experimental data to establish correlation between theoretical and experimental data sets.

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Abstract

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# Naringenin and Naringin as Antioxidants: A Comparative Study

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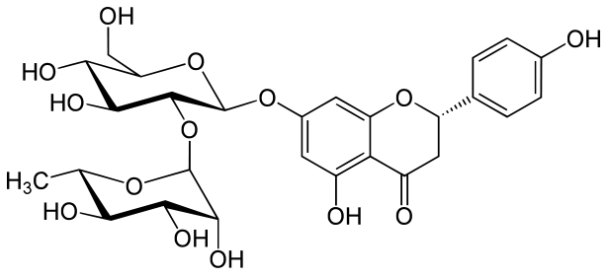
**Keywords:**

antioxidant activity,
naringenin,
naringin.

**Abstract:** Citrus flavanones, where naringin and its aglycone naringenin belong, constitute an important series of flavonoids with diverse biologic activities. In this study *in vitro* antioxidant activity of naringenin and naringin was determined. Eleven methods were selected in order to cover a diversity of mechanistic approaches: DPPH and Galvinoxyl radical scavenging, ABTS, DMPD; methods based on reduction of transition metals: Ferricyanide, FRAP, Bathophenanthroline, Phosphomolybdenum, and M(II) (M = Fe, Cu, Zn) chelating activity assays. In comparison to naringin, naringenin showed higher antioxidant activity in all tests, except of Fe(II) and Cu(II) chelating activity. In addition, acetylcholinesterase and butyrylcholinesterase inhibition was determined. Both flavonoids showed good ability to inhibit these enzymes compared to galantamine, which is used for the treatment of mild to moderate Alzheimer's disease.

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Abstract

PP-OMC-06

# Effect of pH to the Oxidation of Thiobenzamide with Cr(VI) Reagent

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thiobenzamide,
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Cr(VI),
UV spectrophotometry.

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**Abstract:** Antibacterial, antiviral, anti-inflammatory, anti-mycobacterial etc. activity of organic compounds with thioamide functional group is reason for being part of many medicaments which are used for treatment of *Mycobacterium tuberculosis* infections. The products of metabolic degradation in living organisms of these medicaments is based on the redox reactions. Therefore, the aim of this work was to examine the oxidation of thiobenzamide, as a model compound.

The oxidation of thiobenzamide with Cr(VI) reagent in different reaction media was monitored by UV spectrophotometric method. In the acidic medium (pH=1-5) oxidation was occurred instantly in the direction of producing thiobenzamide-*S*-oxide, over the time 3,5-diphenyl-1,2,4-thiadiazole was the second product. Thiobenzamide-*S*-oxide was the only product of the oxidation with Cr(VI) reagent in the basic medium at pH=8-13. In the neutral medium, at pH=7.3 which is characteristic for a great number of biological processes in living organisms, the first detected oxidation product was thiobenzamide-*S*-oxide and after 50 minutes benzamide and benzonitrile were produced.

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Abstract

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# Sequential Pd-Catalyzed Arylation of Quinoline Derivatives

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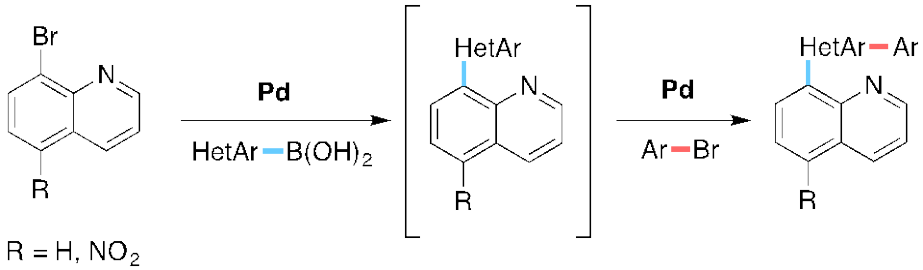
arylation,
C–H activation,
Pd.

**Abstract:** A series of 8-heteroaryl substituted quinolines was synthesised by direct C–H arylation of five-membered heteroarenes or by Pd-catalyzed coupling of arylboronic acids with 8-bromoquinoline derivatives. The use of (benzo)thiophenyl or (benzo)furanyl boron coupling building blocks enabled further C–H functionalization on the five-membered heteroaryl ring with arylbromides in a one-flask to synthesise a variety of polyconjugated molecular architectures. In addition, we have demonstrated that our single-flask multicoupling approach successfully allowed the preparation of a 2,5-non-symmetrically diarylated furanyl quinoline product by implementing two consecutive arylation steps.

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*Abstract*

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# Comparative Analysis of Composition and Antioxidant Activity of *Satureja montana* L. Essential Oil from Two Localities

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**Abstract:** Chemical composition of hydrodistilled essential oil (EO) of *Satureja montana* L. from Blidinje (Sample 1) and Neum (Sample 2), BiH was determined by coupled technique Gas chromatography/mass spectrometry (GC/MS). The content of EO based on dry weight of the plant material was 0.69% for Sample 1 and 0.27% for Sample 2. A total of 48 components were identified in Sample 1 accounting 93.1% of the oil composition, and a total of 38 components were identified in Sample 2 accounting 95.2% of the oil composition. GC/MS analysis showed different chemical composition for examined samples. Sample 1 is characterized by the presence of the high percentage of oxygenated monoterpenes (48.9%) and aromatic compounds (32.1%). Sample 2 is characterized by the presence of the high percentage of aromatic compounds (82.9%). Predominate constituents in Sample 1 are linalool (41.7%) and thymol (21.3%), and predominate constituents in Sample 2 are carvacrol (41.5%) and thymol (39.0%). Antioxidant activity was tested using two methods, ABTS and DPPH. The results of antioxidant activity of EO, obtained by ABTS assay, were not in agreement with the results for DPPH method, although these methods have similar reaction mechanism. Scavenging activity for ABTS method, expressed as $IC_{50}$ values, for sample 1 was 3.168 ± 0.031 mg/mL, while $IC_{50}$ for Sample 2 was 0.0092 ± 0.0005 mg/mL. Scavenging activity for DPPH method, expressed as $IC_{50}$ values, for Sample 1 was 0.144 ± 0.007 mg/mL, while $IC_{50}$ for Sample 2 was 0.246 ± 0.005 mg/mL.

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Abstract

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# Spectrofluorimetric Determination of Total Coumarins in Various *Fraxinus* species from Bosnia and Herzegovina

**Balić, S.[a], Miovčić, D.[a], Šehić, A., Klepo, L.[a]*, Čulum, D.[a], Čopra-Janićijević. A.[a], Tahirović, A.[b]**

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*Fraxinus*,
total coumarins,
scopoletin,
spectrofluorimetry

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**Abstract:** A simple and sensitive spectrofluorimetric method was used for the determination of total coumarins calculated as scopoletin (SCO) in various Fraxinus species from Bosnia and Herzegovina (*Fraxinus ornus*, *Fraxinus excelsior* and *Fraxinus angustifolia* Vahl.). Extracts were prepared by Soxhlet and ultrasound extraction using 70% ethanol. Results obtained from calibration curve show that range of total coumarins in *Fraxinus ornus* varied from 0.326±0.003 to 3.880±0.006 mg SCO/g extract, in *Fraxinus excelsior* from 0.1689±0.0004 to 2.990±0.010 mg SCO/g extract and in *Fraxinus angustifolia* Vahl. from 0.128±0.001 to 6.131±0.002 mg SCO/g extract. The highest (ultrasound extraction) and the lowest content (Soxhlet extraction) of total coumarins was found in the sample of *Fraxinus angustifolia* Vahl.

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Abstract

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# Determination of Esculin, Esculetin and Scopoletin in Extracts of *Fraxinus ornus* L. and *Fraxinus excelsior* L. by HPLC-ED

**Tomić, Z.[a], Bošnjak, I.[a], Čulum, D.[a] Čopra-Janićijević A.[a], Klepo, L.[a,*], Tahirović, A.[b]**

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*Fraxinu*,
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Scopoletin,
HPLC-ED.

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**Abstract:** Ash tree is the common name for *Fraxinus* species in Oleaceae family. Carriers of the biological activity in *Fraxinus* species are: hydroxycoumarins, secoiridoid glucosides, phenylethanoids, flavonoids, etc. In this work qualitative and quantitative analysis of coumarins in *Fraxinus excelsior* L. and *Fraxinus ornus* L. from Bosnia and Herzegovina has been performed. Ethanolic extracts from leaves and bark of the investigated plants were prepared using Soxhlet and ultrasound extraction. Esculin, esculetin and scopoletin were determined using HPLC-ED method. The contents of esculin in the sample of *Fraxinus ornus* L. ranged from 0.60-3.37 mg/g, esculetin from 2.92-36.9 mg/g and scopoletin from 6.04-22.87 mg/g dry material. Results obtained for *Fraxinus excelsior* L. shows that the range of esculetin was varied from 0.06-0.49 mg/g and content of esculin was varied from 0.09-0.32 mg/g dry material. Scopoletin was not detected.

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Abstract

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# Hemoglobin $HbA_1c$ and Glucose Blood Levels of Diabetic Patients

**Tahirović, I.[a,*], Mahovac, E.[a], Dizdar, M.[a], Mahmutović, O.[b], Lepara, Z.[c], Ajanović, A.[d]**

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diabetes mellitus,
$HbA_1c$,
glucose.

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**Abstract:** Diabetes mellitus (DM) is defined as an absolute or relative lack of insulin, or a state of chronic hyperglycemia, which occurs as a disorder of secretion and action of insulin. Hemoglobin $A_1c$ ($HbA_1c$) is a minor, yet stable Hb form which is produced *in vivo* by post-translational modification with glucose. In the last 30 years in biochemical laboratory practice $HbA_1c$ became a "gold standard" for clinical monitoring of DM. Glucose and $HbA_1c$ levels were measured in 100 patients suffering from DM. The levels of $HbA_1c$ and glucose were analyzed at different time periods with three months difference. The results were analyzed by appropriate statistical methods, to determine whether there are statistically significant differences between the two measurements of blood glucose levels and $HbA_1c$. A spectrophotometric method was used to determine the level of $HbA_1c$, while glucose was determined using an enzymatic-colorimetric method on biochemical analyzer. It was found that in 61 of the total number of subjects, the levels of $HbA_1c$ and glucose were significantly reduced after the second measurement (about three months after the first measurement). In the remaining 39 subjects the levels of $HbA_1c$ and glucose were significantly increased after the second measurement ($p^*<0.05$, ANOVA) which leads to the conclusion that their condition worsened.

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Abstract

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# Determination of Phenolic Compounds in *Crataegus* Extract by HPLC-ED Analysis

**Kuljanin, G.[a], Rizvo, L.[a], Ajanović, A.[a], Čulum, D.[a], Vidic, D.[a], Čopra-Janićijević, A.[a]*, Tahirović, A.[b], Klepo, L.[a], Bašić, N.[b]**

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gallic acid,
chlorogenic acid,
Rutin.

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**Abstract:** The aim of this study was the qualitative and quantitative determination of selected phenolic compounds in *Crataegus macrocarpa*, *Crataegus rhipidophyla* Gand., and *Crataegus subsphaericea.* Soxhlet and ultrasound ethanol extraction were used for isolation of phenolic compounds from fruits, flowers and leaves. Chromatographic determination of isolated compounds was performed using HPLC-ED method. In analyzed samples of *C.macrocarpa* content of gallic acid ranged from 0.004-0.082 mg/g of dry weight, chlorogenic acid from 0.19-8.70 mg/g of dry weight and rutin from 4.22-13.49 mg/g of dry weight. The presence of gallic acid in samples of *C. rhipidophyla* Gand. was in the range of 0.024-0.068 mg/g of dry weight, chlorogenic acid in the range from 2.63-3.99 mg/g of dry weight and rutin from 1.23-8.21 mg/g of dry weight. The obtained results showed that the range of gallic acid was from 0.0013-0.018 mg/g of dry weight in samples of C. *subsphaericea,* the content of chlorogenic acid was from 0.22-1.79 mg/g of dry weight, and rutin was ranged from 0.03-3.95 mg/g of dry weight.

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Abstract

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# Total Flavonoids and TLC Analysis of Three *Crataegus* Species

**Hot, D.[a], Čulum, D.[a], Vidic, D.[a], Tahirović, A.[b], Klepo, L.[a], Čopra-Janićijević. A.[a]***

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Flavonoids,
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TLC.

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**Abstract:** Hawthorn fruits, leaves, and flowers contain a number of chemical constituents, such as flavonoids, oligomeric proanthocyanidins (OPCs), triterpene acids, organic acids, sterols, and trace amounts of cardioactive amines. Among these, flavonoids and OPCs are the two major groups of bioactive components.

The aim of this study was the determination of flavonoids and phenolic acids in three species of genus *Crataegus* L. Extracts obtained from leaves and flowers, and fruits of *Crataegus x subsphaericea*, *Crataegus x macrocarpa* and *Crataegus rhipidophylla* were prepared by ultrasound and Soxhlet extraction using ethanol as a solvent. Rutin, hyperoside, vitexin, caffeic and chlorogenic acid were confirmed in all samples while quercetin and rutin were not identified in any sample using TLC method. The content of total flavonoids was determined by colorimetric method with $AlCl_3$, and results were expressed as equivalents of rutin (RE) and quercetin (QE). The highest content of flavonoids was found in *Crataegus subsphaericea* (leaves and flowers), 75.26 mg RE/g extract, and lowest in *Crataegus rhipidophylla* (fruits), 0.02 RE/g extract. Results expressed as equivalents of quercetin showed that the highest content was found in *Crataegus rhipidophylla* (fruits), 1.2 mg QE/g extract, and the lowest content in *Crategus macocarpa* (fruits) 0.08 mg QE/g extract.

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*Abstract*

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# DPPH Free Radical Scavenging Ability of Some Bee Honey Samples from Bosnia and Herzegovina

**Tahirović, I.[a*], Bojadžić, S.[a], Dizdar, M.[a], Džudžević-Čančar, H.[b], Toromanović, J.[c], Uzunović, A.[d], Ajanović, A.[e], Mahmutović, O.[f]**

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antioxidant activity,
bee honey,
DPPH.

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**Abstract:** In this study, antioxidant activity (AOA) of different bee honey samples from Bosnia and Herzegovina was analyzed by spectrophotometric method using the DPPH free radical. The AOA was calculated from the calibration curve equation, which has been made by measuring relative inhibition (*RI*, %) for different concentrations of Trolox. All results are expressed in micromoles of Trolox equivalent per mass of honey ($\mu mol_{TE}$/100 g). It was found that the highest AOA (261.42 $\mu mol_{TE}$/100 g) had heather honey (Konjic-Brđani, collected in 2014), and the lowest AOA (14.63 $\mu mol_{TE}$/100 g) had acacia honey (Gradačac, collected in 2014). Based on these results, it was possible to make a conclusion that bee honey from Bosnia and Herzegovina has significant AOA. It was confirmed that AOA of honey is affected by climate changes and 2014 was rainy year. Analyzed chestnut honey (Cazin-Brezova Kosa) collected in 2013, had AOA of 104.04 $\mu mol_{TE}$/100 g, while the same sort of honey, from the same location, collected in 2014 had significantly lower AOA of 25.38 $\mu mol_{TE}$/100 g.

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Abstract

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# Studies on the Antioxidant Activity of Bee Honey Samples from Bosnia and Herzegovina by Phosphomolybdenum Assay

**Tahirović, I.[a,*], Lepara, L.[a], Dizdar, M.[a], Toromanović, J.[b], Džudžević-Čančar, H.[c], Mahmutović, O.[d], Uzunović, A.[e], Ajanović, A.[f]**

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phosphomolybdenum assay.

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**Abstract:** Although today many well-known positive properties of bee honey, one of the earliest identified is the antioxidant activity (AOA), which is attributed to its complex chemical composition. The aim of this study was to determine the AOA of seventy-three (73) different honey samples from the area of Bosnia and Herzegovina by phosphomolybdenum assay. It has been analyzed different types of honey: meadow honey (27), forest honey (9), honey from acacia (8), chestnut honey (7), honey from heather (7), sage honey (7), mountain honey (5) and linden honey (3). All analyzed samples were produced in the period 2013-2015. The results showed that the highest AOA [expressed in mmol ascorbic acid equivalents per mass of honey ($mmol_{AAE}$/100 g)] had a sample of meadow honey from Stolac (18.89 $mmol_{AAE}$/100 g), while the lowest AOA had a sample of sage honey from the same location (6.39 $mmol_{AAE}$/100 g). The results of AOA showed a variation within the same honey types, which supports the well-known fact that the chemical composition of honey depends on many factors (the botanical origin of honey plants, climatic factors, geographical area, etc.).

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Abstract

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# Comparison of Extraction Methods for Isolation of Sertraline from the Human Urine

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sertraline,
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solid phase extraction,
GC/MS

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**Abstract:** The aim of this work was comparison of extraction methods for isolation of sertraline from human urine. In order to select optimal extraction method the following criteria was used: complexity of analysis, duration of analysis, costs, recovery and grade. Sertraline belongs to a class of drugs called selective serotonin reuptake inhibitors (SSRIs). It is commonly prescribed to treat depression, obsessive-compulsive disorder, panic disorder, social anxiety disorder, premenstrual dysphoric disorder, and post-traumatic stress disorder. Liquid-liquid extraction (LLE-Toxi Tubes A) and solid phase extraction (SPE) on two different solid phases (SPE-Bond Elut C18 cartridges and SPE-XAD-2 resin) were used for isolation of sertraline. Blank urine samples were spiked with therapeutic (0.05 mg/L), toxic (0.25 mg/L) and lethal (2.0 mg/L) concentrations of sertraline standard. Analysis of sertraline was performed on coupled system gas chromatography/mass spectrometry GC/MS. The results of our research revealed that LLE was more suitable compared to SPE, with emphasis on the Toxi Tubes A extraction method which gave the best results of analysis.

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Abstract

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# Synthesis, Structural Characterization and Effects of Modified Synthetic Methods on the Yield of Benzyl Alcohol

**Džudžević-Čančar, H.[a*], Dedić, A.[a], Lakota, I.[a], Muratović, S.[b], Alispahić, A.[a], Mandal, Š.[a], Kahrović, E.[c]**

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benzyl alcohol,
Cannizzaro reaction,
Lucas test,
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**Abstract:** Phenylmethanol, known as benzyl alcohol (BA), naturally occurs in many plants and fruits, and it is constituent of essential oils of jasmine, hyacinth and garlic. Possesses antimicrobial, antifungal and antibacterial activity. In EU it is a permitted food additive. As many synthetic preservatives, benzyl alcohol can affect the immune system, gradually causing allergic reactions. Because of its chemical reactivity with other components of the preservative giving aldehydes, mostly carcinogenic formaldehyde, the EU limits the content of BA in some cosmetic products on 1% and classifies it as „moderately hazardous". Benzyl alcohol is synthesized using Cannizzaro reaction which is generally known for its yield around 50% for products formed even under ideal conditions. The aim of this study was to determine the influence of used chemicals as a nucleophile-base, their concentration and solvents on the yield of BA. NaOH and KOH water solutions were used in these modified procedures. Liquid-liquid extraction and distillation of products were performed. Yield of dry product was 61.7% before, and 55.2% after distillation for procedure with NaOH, and 54.1% and 51.5% for KOH. The chemical characterization was performed by using Lucas test which proved BA as secondary alcohol. Structural characterization was performed by FTIR, comparing obtained results with standard FTIR picks of BA from FLUKA database. Picks of OH group were 1209, 1026 and 1029 $cm^{-1}$ for standard, as well as products of both procedures, and it confirmed the structure of synthesized products. It's evident that modified synthetic method does not significantly affect the yield increase. Postsynthetic processes, extraction and distillation if performed carefully and precisely, may contribute to the yield increase.

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Abstract

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# Quinazoline-directed Selective Functionalization of $sp^2$C–H Bonds Catalyzed by Ru(II) Complexes

**Požgan, F.*, Štefane, B., Grošelj, U., Svete, J.**

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**Abstract:** Methodologies for regioselective carbon-carbon bond-forming reactions usually employ transition metal-catalyzed cross-couplings between organic (pseudo)halides and organometallic reagents. The major drawback of these reactions is that organometallic derivatives are frequently not commercially available or their preparation from the corresponding arenes involves a number of synthetic steps. On the other hand, the direct arylation of C–H bonds represents a more ecologically and economically attractive alternative to classical cross-couplings due to minimizing atomic waste.

We have already demonstrated that phenylpyrimidines can be *ortho*-functionalized via C–H bond activation with both, electron-rich and electron-poor aryl bromides by using Ru(II)-carboxylate catalyst system. Here we demonstrate that (2-aryl)- or ((2-aryl)vinyl)-substituted quinazolines can be selectively arylated with both, electron-rich and electron-poor aryl halides, *via* C–H bond cleavage in the presence of ruthenium catalysts thus leading to highly conjugated systems.

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*Abstract*

**PP-OMC-19**

# Phenolic Content and Antioxidant Activity of Mistletoe (*Viscum album* ssp. *album* Beck.) from Selected Trees

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ABTS
FRAP

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**Abstract:** Leaves and stems of mistletoe (*Viscum album* ssp. *album* Beck.) collected from four different hosts (*Betula* L., *Tilia cordata* Mill., *Robina pseudoacacea* L., and *Salix alba* L.) were analyzed for content of phenolic compounds and antioxidant activity. Total phenols were determined by Folin Ciocalteu method, total flavonoids by $AlCl_3$ method, total phenolic acids with Arnow reagent, and acid butanol assay was applied for determination of total proanthocyanidins. $DPPH^{\bullet}$, $ABTS^{\bullet+}$ and FRAP methods were used for determination of total antioxidant activity (TEAC) using Trolox as a standard. Contents of bioactive compounds were in range for phenols 7.02-13.52 mg gallic acid equivalents $g^{-1}$ d.w., flavonoids 2.29-5.05 mg rutin equivalents $g^{-1}$ d.w., phenolic acids 0.61-2.84 mg caffeic acid equivalents $g^{-1}$ d.w. and proanthocyanidins 0.63-4.83 mg leucocyanidin equivalents $g^{-1}$ d.w. Generally, leaves had higher a content of flavonoids and proanthocyanidins than the stems. Mistletoe collected from *Robina pseudoacacea* L. and *Salix alba* L. had higher capacity in leaves (31.25-86.89 µmol Trolox $g^{-1}$) while mistletoe from *Betula* L. and *Tilia cordata* Mill. had higher antioxidant capacity in stems (45-67.71 µmol Trolox $g^{-1}$). In addition, antioxidant activity was highly correlated with total phenols, phenolic acids and proanthocyanidins.

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*Abstract*

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# Effect of Extraction Method on Phenolic Content and Antioxidant Activity of Common Whitebeam (*Sorbus aria* (L.) Crantz) Fruit

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**Abstract:** The effect of different extraction techniques using 80% aqueous methanol as a solvent, on the phenolic content and antioxidant activity of common whitebeam (*Sorbus aria* (L.) Crantz) fruit was investigated. Folin-Ciocalteu method, $AlCl_3$ method, Arnow reagent, pH differential method, and acid butanol assay were used for determination of phenolic compounds. Ultrasound (sweep mode) extracts had the highest contents of total phenols (49.11 mg gallic acid equivalents $g^{-1}$ d.w.) and total anthocyanins (0.52 mg cyaniding chloride equivalents $g^{-1}$ d.w.). Highest contents of total flavonoids (2.47 mg rutin equivalents $g^{-1}$ d.w.), phenolic acids (12.05 mg caffeic acids equivalents $g^{-1}$ d.w.) and proanthocyanidins (52.13 mg cyaniding equivalents $g^{-1}$ d.w.) were observed in microwave extracts. Antioxidant activity was investigated by three different assays: $DPPH^{\bullet}$, $ABTS^{\bullet+}$ and FRAP. Methanol extracts exhibited strong antioxidant activity measured in terms of Trolox equivalents antioxidant capacity (TEAC) (290.19 - 341.14, 242.07 - 331.99, 293.13 - 354.31 µmol of Trolox $g^{-1}$ with $DPPH^{\bullet}$, $ABTS^{\bullet+}$ and FRAP assays, respectively. In general, TEAC of microwave extracts was found to have the highest antioxidant capacity. Correlations were observed between total phenolic acids ($r^2$ = 0.8882 - 0.9739) and total proanthocyanidins ($r^2$ = 0.7194 - 0.9628) with antioxidant activity. Microwave-assisted extraction showed obvious advantages in terms of extraction efficiency and antioxidant activity of extracts within shortest extraction time.

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Abstract

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# Extraction and Spectroscopic Characterization of Oleic Acid from Refined and Unrefined Olive Oil

**Džudžević-Čančar, H.[a,*], Dedić, A.[a], Bibić, N.[a], Kahrović, E.[b], Tahirović, I.[b], Zahirović, A.[b], Đedibegović, J.[c]**

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fatty acids,
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**Abstract:** The role of olive oil in human nutrition and its health effects are generally associated with high oleic acid content. Oleic acid as antioxidant reduces risk of cardiovascular and heart disease by reduction of harmful LDL cholesterol. Six samples of olive oil from different producers were used in this work for extraction of oleic acid. Samples used in this study were declared, refined (1 and 2), unrefined extra virgin olive oil (3 and 4) and undeclared unrefined "homemade" oil (5 and 6). The conventional extraction and purification method have been modified and improved in order to make all processes easier and more efficient. Amounts of extracted oleic acid were: 68.24%, (Sample 1), 81.91% (Sample 2), 82.89% (Sample 3), 89.42% (Sample 4), 80.44% (Sample 5), 84.99% (Sample 6). These values were compared with the declared values of the manufacturers on the content of unsaturated fatty acids in their oils. As the amount of oleic acid is the quality indicator of olive oil, for this purpose, peroxide and iodine numbers for each sample were determined. Peroxide numbers in 1g of olive oil for samples 1 to 6 were 10, 11, 14, 14, 13 and 13 nmol$O_2$/kg, respectively. Iodine numbers in 100 g of olive oil in the same samples were: 81, 80, 83, 86, 85 and 84 g $I_2$ respectively. Both peroxide and iodine values are in good correlation with referent values. Structure of all six oleic acid samples after extraction and purification were confirmed by FTIR spectroscopy and boiling point determination.

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Abstract

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# Impact of Temperature and Degreasing Methods on the Content of Extracted Casein from Whole Milk, Skimmed Liquid and Powdered Milk and Preparation of Casein Glue

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casein,
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milk,
glue.

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**Abstract:** Caseins are a family of phosphoproteins, which consist of four distinct genetic product αs1, αs2, β and κ casein. Casein in milk is in the form of casein micelles. It can be used as a food, and for technical purposes in paints, cosmetics, and different types of adhesives. Casein glue is extremely waterproof, has high bonding strength and good biodegradation, which makes it very easy to work with.

Extraction of casein from skimmed liquid (procedure 1) and powdered milk (procedure 2) with 0.9% fat was done by the isoelectric precipitation method under the 40 °C and room temperature. Chemical and mechanical methods (procedure 3 and 4) for fat removal were used for whole milk with 2.8 % fat at room temperature. Precipitation of casein in those cases was followed the degreasing. The obtained results for amount of casein were dependent on the extraction methods used. As the producer declared, the protein content is calculated in relation to the quantity of milk used for extraction and the results were 3.4 g in skimmed milk samples and 3.0 g in whole milk. The amount of extracted casein from procedures 1-4, after several days of drying were 3.2, 3.39, 5.83 and 3.87 g respectively. Comparison of those results show enlarged yields for the procedure 3 and 4, due to residual fat content in the final product. Declared amount of casein was got by subtracting the declared content of fat from the amount of the product obtained in procedure 3 and 4. Extraction of casein from heated skimmed powdered milk gave best results and the mechanical degreasing method is more suitable than chemical one. Dry glue was prepared using the same method for all four samples of extracted casein. Mixing dry glue with water, liquid glue was prepared. The quality of the subsequently prepared casein glue depended on the quality of the obtained casein.

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Abstract

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# Spectrophotometric Determination of Total Monoterpenes Content in Essential Oil of Selected Aromatic Plants

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total monoterpenes,
essential oil,
aromatic plants.

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**Abstract:** Determination of total monoterpenes (TM) in essential oil of *Satureja montana* L., *Rosmarinus officinalis* L., and *Lavandula* spp. was performed by a modified spectrophotometric method. The essential oil (EO) was isolated by hydro-distillation, and the highest yield was 0.69% for *S. montana*, 0.63% for *Lavandula* spp and 0.49% for *R.officinalis*. Preliminary examination was performed by TLC and presence of linalool was confirmed in all samples of EO. Determination of TM was made with 2% vanillin in sulfuric acid (2:1) as reagent. Results were expressed as equivalent of linalool (EL) or equivalent of $\alpha$-pinene (EP), per gram of EO and per gram of plant material (PM).

The highest content of TM was found in EO of *S. montana* 634 mg EL/g EO, and the lowest in EO of *R.officinalis* 325 mg EL/g EO. When results were expressed as equivalent of EP, the highest content of TM had *Lavandula* spp. 525 mg EP/g EO, and the lowest *R. officinalis* 99 mg EP/g EO.

*Satureja montana* had the highest content of TM per gram of PM, 4.36 mg EL/g PM, while almost the same content was found in *S. montana* and *Lavandula* spp. when the results were expressed as EP per g of PM, 3.30 mg EP/g PM and 3.33 mg EP/g PM respectively. This modified spectrophotometric method allowed determination of low concentration of terpenes in easy and simple way.

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*Abstract*

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# Chemical Composition and Antioxidant Activity of *Micromeria juliana* L. Essential Oil

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aromatic plants.

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**Abstract:** Chemical composition of hydrodistilled essential oil (EO) of *Micromeria juliana* L. was determined by gas chromatography-mass spectrometry (GC/MS). The content of EO, based on the dry weight of the plant material, collected before flowering, was low (0.15%). A total of 62 components were identified in *M. juliana* EO accounting for 93.9% of the oil composition. The examined sample was characterized by the presence of the high percentage of oxygenated monoterpenes (60.2%) and oxygenated sesquiterpenes (15.5%). Five constituents predominated in the EO, being verbenone (13.1%), terpinene-4-ol (10.3%), *trans*-verbenol (8.4%), borneole (8.1%), and *trans*-pinocarveole (7.8%). Antioxidant activity (AA) was tested using two methods, ABTS and DPPH. The results on AA, obtained by ABTS assay, were not in agreement with the results for DPPH method, although they have similar reaction mechanisms. Scavenging activities for ABTS method, indicated as $IC_{50}$ values for EO was 1.08 ± 0.03 mg/mL, while $IC_{50}$ for BHT was 0.043 ± 0.003 mg/mL. With maximum available concentration of EO, 12 mg/mL, antioxidant activity obtained by DPPH method was just 30%.

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Abstract

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# Novel C-5 Hydroxypropyl Pyrimidine Nucleosides: Synthesis and Structural Characterization

**Salihović, M.[a], Osmanović, A.[b*], Špirtović-Halilović, S.[b], Veljović, E.[b], Roca, S.[c], Šapčanin, A.[a], Završnik, D.[b]**

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C-5 hydroxypropyl pyrimidine;
*N*-acyclic nucleosides;
base promoted hydrolysis.

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**Abstract:** An interest in acyclic nucleoside analogues began in mid-1970s when acyclovir was first reported as a potent anti-herpes drug. Large arrays of uracil non-nucleoside derivatives synthesized after acyclovir possess variety of chemotherapeutic properties including anticancer, antiviral and antimicrobial activities. Moreover, many purine and pyrimidine nucleoside analogues have been the object of intensive chemical and pharmacological investigation due to their potential activity as antiviral, particularly anti-HIV agents. Taking into account the pharmacological potential of the cited class of compounds, C-5 hydroxypropyl pyrimidine nucleosides bearing acyclic side chain were synthesized as new nucleoside mimetics. The target *N*-acyclic C-5 hydroxypropyl pyrimidine nucleosides were obtained in good yields after base promoted hydrolysis of *N*-3-(2,3-dihydroxypropyl)-5-(3-hydroxypropyl)-2-methoxypyrimidin-4-one and *N*-3-[4-hydroxy-(3-hydroxy methyl)butyl]-5-(3-hydroxypropyl)-2-methoxypyrimidin-4-one. The structures of all synthesized compounds were confirmed by nuclear magnetic resonance (NMR) and infrared (IR) spectroscopic techniques in addition to the use of elemental analysis method (CHN). Novel nucleoside analogues will be subjected to *in vitro* antiviral, antiproliferative and antimicrobial evaluation.

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Abstract

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# *In vitro* Antioxidant Activity of Quercetin and Rutin

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**Abstract info:**

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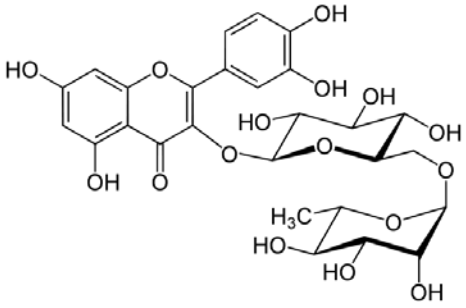
**Keywords:**

antioxidant activity,
quercetin,
rutin.

**Abstract:** Flavonoids have attracted considerable interest because of their potentially beneficial effects on human health; they have been reported to have antiviral, antiallergic, antiplatelet, antiinflammatory, antitumor and antioxidant activities. In this study *in vitro* antioxidant activity of quercetin and rutin was determined. Eleven methods were selected in order to cover a diversity of mechanistic approaches: DPPH and Galvinoxyl radical scavenging, ABTS, DMPD; methods based on reduction of transition metals: Ferricyanide, FRAP, Bathophenanthroline, Phosphomolybdenum, and M(II) (M = Fe, Cu, Zn) chelating activity assays. In most of these tests quercetin showed the highest antioxidant activity in comparison to rutin. Moreover, quercetin and rutin showed higher antioxidant activity in all methods, except of phosphomolybdenum method, in comparison to BHT used as a standard. In addition, acetylcholinesterase and butyrylcholinesterase inhibition was determined.

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# POSTER PRESENTATIONS

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Abstract

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# Evaluation of Antioxidant Activity of Selected Medicinal Plants Using the Briggs-Rauscher Oscillating Reaction

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**Abstract:** The Briggs-Rauscher oscillating reaction can be used as test for antioxidant activity of pure compounds and food extracts which are consumed daily, like fruits, vegetables, juices, etc. By addition of substances with antioxidant ability to the Briggs-Rauscher reaction mixture, there is an immediate quenching of oscillations, and after a certain time the oscillations start again. The time of no oscillations or inhibition time is proportional to the amount of the antioxidant added. In this study, the Briggs-Rauscher reaction was used to determine antioxidant activity of extracts of selected medicinal plants: rosemary (*Rosmarinus* spp.), savory (*Satureja* spp.), mountain tea (*Sideritis* spp.) and hibiscus (*Hibiscus* spp.). The plant extracts were prepared by the process of maceration with water and ethanol as solvent, at room temperature. The Briggs-Rauscher reaction was performed in a stationary, constantly stirred reactor with an accurately defined concentrations of reactants at temperature of 25°C. Changes in the Briggs-Rauscher reaction mixture were followed potentiometrically with platinum and silver-silver chloride electrodes. Preliminary studies have shown that ethanolic extracts of rosemary, mountain tea and hibiscus have much less antioxidant activity than the corresponding aqueous extract, while the ethanolic extract of savory had greater antioxidant activity than aqueous extract. Aqueous extract of mountain tea showed the best ability to inhibit oscillations, i.e. the highest antioxidant activity comparing to all other samples.

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Abstract

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# Application of the Briggs-Rauscher Reaction for Measurement of Antioxidant Activity of Coffee

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Coffee,
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Briggs-Rauscher reaction,
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**Abstract:** Coffee is one of the most commonly consumed hot beverages in Bosnia and Herzegovina. The positive effect of coffee consummation on human health is usually attributed to bioactive substances found in coffee that have antioxidant activity. The antioxidant activity of coffee depends on several factors such as geographic origin and the type of coffee, storage and roasting of green coffee, preparation method of the coffee drink and a variety of additives. In this paper, the Briggs-Rauscher oscillating reaction is used to assess the antioxidant activity of twelve different samples of coffee available in the local markets. All tested samples of coffee were prepared in the same manner by boiling for 5 minutes. The Briggs-Rauscher reaction system consisted of appropriate ratio of aqueous solution of hydrogen peroxide, potassium iodate, manganese(II) sulfate, malonic acid, sulfuric acid and starch as indicator. Changes in the Briggs-Rauscher reaction mixture were monitored as a change in potential between the platinum electrode and the silver-silver chloride electrode at room temperature. The addition of antioxidants in the Briggs-Rauscher reaction mixture leads to immediate shutdown of oscillation. Inhibition time i.e. the time to stop the oscillation is proportional to the amount and properties of added antioxidants. Tested samples of coffee showed different times of inhibition. The best ability to inhibit oscillations i.e. the highest antioxidant activity showed a sample of 100% Arabica, and the lowest activity sample of instant coffee known as 3 in 1.

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Abstract

PP-PTC-03

# Two Parameter Adsorption Isotherm Models of Polyphenol Adsorption onto *β*-glucan

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**Abstract:** Many studies have shown that polyphenols can interact with various food ingredients such as lipids, proteins and dietary fibers and these interactions can affect polyphenol bioactivities. The aim of this study was to obtain information about interactions between polyphenols (phloretin, phloridzin and cyanidin-3-galactoside) and *β*-glucan (dietary fiber) by studying adsorption experiments. Model solutions consisted of different concentrations of polyphenols and *β*-glucan and adsorption was carried out 16 hours at 25°C. Unadsorbed polyphenols were separated from adsorbed by ultrafiltration and their concentrations were determined by spectrophotometric Folin-Ciocalteu method. Experimental results were modelled with two parameters adsorption isotherm models (Freundlich's, Langmuir's, Dubinin-Radushkevich's, Tempkin's and Hill's models). The results showed that adsorption was favorized between all polyphenols and *β*-glucan, especially between phloridzin and *β*-glucan. All polyphenols were physically bonded onto *β*-glucan. Phloretin showed the highest adsorption capacity.

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Abstract

PP-PTC-04

# Antioxidant Activity of Some Xanthen-3-ones: Theoretical Investigation of Substituents Effects

**Špirtović-Halilović, S.[a]*, Salihović, M.[b], Osmanović, A.[a], Veljović, E.[a], Nuhanović, M.[c], Završnik, D.[a]**

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Xanthenes,
bioavailability.

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**Abstract:** Development of new antioxidants is constantly under research because of their ability to prevent or at least significantly reduce the damage caused by free radicals. Thus antioxidant compounds may become important in preventing and/or treating diseases such as: atherosclerosis, Alzheimer, cancer, aging process and central nervous degeneration. The experimental measurement of bond dissociation energy (BDE) is not easy and requires a great deal of care. Theoretical calculations of BDE, using for example density functional theory (DFT) method, have been useful for elucidating the high capacity of the OH groups of phenolic antioxidants to react by H-transfer. BDE calculations were conducted for substituted xanthen-3-ones, using DFT at B3LYP level and 6-31G* basis set in vacuum-phase. Results of BDE values for xanthene derivatives ranged from 85.01945 to 98.32893 kcal $mol^{-1}$. $E_{HOMO}$, as alternative parameter of antioxidant activity, was calculated and showed good correlation as well. Furthermore, physicochemical properties included in Lipinski's rule of 5 and polar surface area were calculated to determine compounds' solubility properties and their appropriateness for oral intake in humans.

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# Inhibitory Effect of Phenylboronic Acid on Horseradish Peroxidase Activity

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phenylboronic acid, horseradish peroxidase, inhibition.

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**Abstract:** The previous studies investigated the kinetic parameters and inhibition mechanisms of halogenated boroxine dipotassiumtrioxohydroxytetrafluorotriborate ($K_2[B_3O_3F_4OH]$) on enzymes catalase and human carbonic anhydrases. To investigate closely the mechanism of inhibition, it is interesting to test inhibition effect of other boron containing substances on similar enzymes. In this work, the activity of horseradish peroxidase (HRP) was investigated in the presence of phenyilboronic acid of 2, 4 and 6 mM concentration. The HRP activity assay was performed by the measurement of guaiacol peroxidation by $H_2O_2$**.** The initial rate of HRP catalytic reaction to oxidize guaiacol was measured spectrophotometrically by following the increase of absorbance at 470 nm of the reaction mixtures within the first few minutes in absence and in presence of inhibitor. The rate of guaiacol peroxidation decreases in presence of phenylboronic acid. Lineweaver-Burk plots were linear and plotted the family of straight lines intersected in one point on the abscissa indicating non-competitive type inhibition, where the inhibitor and the substrate may both be bound to the enzyme at any given time. Inhibitor reduces the activity of the enzyme and binds equally well to the enzyme whether or not it has already bound the substrate. Inhibition constant was determined using Dixon plot, Ki = 2.36 mM.

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*Abstract*

PP-PTC-06

# Horseradish Peroxidase Inhibition by Dipotassium trioxohydroxytetrafluorotriborate, $K_2[B_3O_3F_4OH]$: Evaluation of an Electrochemical Method - Chronoamperometry

**Herenda, S.[a], Ostojić, J.[a]*, Bešić, Z.[a], Đokić, N.[a], Galić, B.[a], Milos, M.[b]**

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immobilization,
chronoamperometric method.

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**Abstract:** Most recent *in vivo* and *in vitro* studies suggest dipotassium trioxohydroxytetrafluorotriborate, ($K_2[B_3O_3F_4OH]$), as a promising new therapeutic for cancer diseases. In the present study, this boron heterocyclic compound was investigated as an inhibitor of the horseradish peroxidase (HPR) by electrochemical method.

The peroxidase catalyzes the conversion of hydrogen peroxide and the reaction was monitored in the absence and in the presence of $K_2[B_3O_3F_4OH]$. Electrochemical tests were performed in the classical three-electrode system, using techniques cyclic voltammetry and chronoamperometry. Cyclic voltammetry technique was used to research the influence of different substrate concentration on the activity of the enzyme peroxidase trapped in a layer of Nafion and graphene, immobilized on the glassy carbon (GC) electrode. For the purpose of these recordings, we have used the following conditions: potential range from -0.7 V to 1.0 V, pH = 7, and a constant potential of 0.9 V was imposed on the working electrode. The kinetics of the reaction was consistent with classical Michaelis-Menten model. By chronoamperometric technique values of Michaelis-Menten constant ($K_m$) were determined and Lineweaver-Burk diagram indicates that this is a non-competitive inhibition.

**Acknowledgements:** This work has been supported in part by Croatian Science Foundation under the project number (IP-2014-09-6897).

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*Abstract*

PP-PTC-07

# Chronoamperometric Determination of the Michaelis-Menten Constants of Immobilized Peroxidase

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**Abstract info:**

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**Keywords:**

enzymes,
peroxidase,
immobilization,
chronoamperometric method.

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**Abstract:** Enzymes are very efficient catalysts for biochemical reactions. Enzymes, like other catalysts, increase rate of reactions by providing an alternative reaction pathway of lowering activation energy. Nowdays, enzymes in an immobilized form so that they may be retained for further catalysis has very intensive use. Biosensor materials have been a fast – growing research field over the past several decades due to their potential application in a various analytical tasks, such as medical diagnostics, food industry, water quality control, health safety, environmental monitoring, pharmaceutics, and bioassays. As a result, various kinds of biosensor materials, including carbon nanotubes, titanate nanotube, inorganic particles, nanoporous spheres, and polymer membranes, have been prepared as enzyme carriers by using established strategies for enzyme immobilization.

The aim of this study was to determine the kinetic parameters, Michaelis-Menten constants ($K_m$) and maximum velocity ($V_{max}$) using chronoamperometry. Amperometric biosensor for the determination of $H_2O_2$ based on immobilized peroxidase on glassy carbon electrode by Nafion film is presented. The enzyme activity was measured at pH 7. The addition of hydrogen peroxide increases the chronoamperometric current. The linear detection ranges for $H_2O_2$ is between $3.8 \times 10^{-4}$ mol $dm^{-3}$ and $2.1 \times 10^{-3}$ mol $dm^{-3}$, at a constant potential of 0.9 V.

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*Abstract*

PP-PTC-08

# Investigation of the Effect of Ranitidine on the Peroxidase Activity on a Modified Glassy Carbon Electrode

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**Abstract info:**

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**Keywords:**

inhibition enzyme,
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cyclic voltammetry,
chronoamperometry.

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**Abstract:** Ranitidin is a reversible, competitive blocker of histamine H2 receptors which are located in the parietal gastric mucosa. It also reduces the secretion of gastric acid.

According to other histamine receptors (Hj and H3) as well as to receptors in which it operates the second mediator (e.g., acetylcholine), no effect, and no allergic reactions. Peroxidase enzyme is classified in the group of oxidoreductase, which catalyzes the oxidation of the substrate by a hydrogen peroxide.

Glassy carbon is a popular electrode material, chemically inert, impermeable by gas and has relatively high reproducibility for the electrochemical measurements. In this study an electrochemical method, based on which, the influence of the active substance to the selected enzyme is used. Cyclic voltammetry measurements were conducted at a scan rate of 50 mV/s and potential range between -1.00 V to 0.7 V and chronoamperometry at a constant potential of 0.9 V.

Ranitidine is shown as a non-competitive inhibitor thereby reducing the occurrence of proven symptomatic diseases in the organism.

**Acknowledgements:** This work has been supported by the pharmaceutical company "Hemofarm".

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Abstract

PP-PTC-09

# Ionic Association and the Formation of Triple Ions of Cesium Bromide in Binary Mixture of Butan-2-ol and Water

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cesium bromide,
butanol-2-ol + water mixture,
ion pairs,
triple ions,
thermodynamic quantities

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**Abstract:** Molar conductivity of cesium bromide in binary mixture of butan-2-ol and water with 90 mass. % alcohol content was measured at five temperatures in the range from 15 °C to 35 °C. Data were processed using conductivity models based on the Fuoss-Hsia equation. The limiting molar conductivity of electrolyte ($\Lambda_o$) and the thermodynamic equilibrium constant for the ion-association reaction ($K_A$) were derived at each temperature. Thermodynamic quantities of the association reaction ($\Delta G^o$, $\Delta H^o$ and $\Delta S^o$), as well as the activation enthalpy of the ionic movement ($\Delta H^{\ddagger}$) were derived at 25 °C. The limiting concentration for the triple ion formation was estimated. The formation of triple ions was investigated assuming equal equilibrium constants of triple cation and anion, $K_T^+ = K_T^- = K_T$. The limiting molar conductivity of triple ions ($\Lambda_o^T$), the constant $K_T$ and the thermodynamic quantities of the triple ion formation were derived.

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Abstract

PP-PTC-10

# The Growth Mechanism and Electrochemical Properties of the Oxide film on Aluminium in Simulated Acid Rain

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**Abstract info:**

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**Keywords:**

aluminium,
anodic film,
simulated acid rain,
cyclic voltammetry,
electrochemical impedance spectroscopy,
atomic absorption spectrometry.

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**Abstract:** The growth mechanism and properties of the oxide films on aluminium were studied in simulated acid rain (*pH* 4.5) by electrochemical techniques, cyclic voltammetry and electrochemical impedance spectroscopy. The potentiodynamic formation of anodic oxide film on aluminium surface was described in terms of high field model. This is justified by the obtained values of kinetic parameters: the electric field strength (~$10^6$ V $cm^{-1}$), ionic conductivity through the film (~$10^{-12}$ S $cm^{-1}$) and half jump distance (~0.15 nm). The structural and protective properties of passive oxide films formed spontaneously at the open circuit potential were studied using electrochemical impedance spectroscopy in the wide frequency range. The impedance data shows that protective passive oxide film on aluminium can be formed spontaneously at the open circuit potential in the studied solution with a resistance over 100 kΩ $cm^2$. The concentration of the metallic ions released into solution and measured by atomic absorption spectrometry was in accordance with the results obtained from the electrochemical techniques.

# POSTER PRESENTATIONS

Chemistry of Advanced Materials

(CAM)

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Abstract

PP-CAM-01

# Electroless Ni–P Deposition on AZ91D Magnesium Alloy Prepared by Dodecylphosphonic Acid Pretreatment Coating

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magnesium,
electroless,
nickel plating,
pretreatment coating,
silane.

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**Abstract:** Magnesium and its alloys, with one quarter of the density of steel and only two-thirds that of aluminium and a strength to weight ratio that far exceeds either of these, fulfill the role admirably as an 'ultra light weight' alloy. Therefore, magnesium alloy parts are used in a variety of applications, such as in automotive and aerospace equipment. Though magnesium has excellent properties, the high chemical reactivity results poor corrosion resistance. One of the most effective ways to prevent corrosion is to coat them. Among the various coating techniques the electroless nickel plating is of special interest. Electroless plating of magnesium alloy needs special bath formulations and pre-treatment procedure due to the microstructural heterogeneity. In the present work, a dodecylphosphonic acid was proposed as the pretreatment coating between Ni–P coating and AZ91D magnesium alloy substrate. The silane coupling agent was adopted as connector between pretreatment films and palladium ion with catalysis. Then, the electroless Ni–P deposition on the pretreatment coating was undertaken by using the plating bath.

Electrochemical behavior of the unmodified and modified magnesium AZ91D alloy substrate were analyzed by EIS and voltammetry methods, while the microstructure of the films was observed using analytical surface methods.

# POSTER PRESENTATIONS

Chemical Engineering

(CE)

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Abstract

PP-CE-01

# The Phosphate Removal Efficiency by Electrocoagulation Wastewater Using Iron and Aluminum Electrodes

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electrode material,
phosphate removal,
electrolysis duration.

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**Abstract:** Effects of electrolysis duration, initial phosphate concentrations and supporting electrolyte concentrations on the phosphate removal efficiency by electrocoagulation using either aluminum or iron electrodes were investigated in this study. All experiments were performed in a batch electrochemical reactor on synthetically prepared wastewater of the initial volume 0.2 L. The results indicate that increase of initial phosphate concentration has reduced removal rate, and by increasing the electrolysis duration removal efficiency increases. It was found that the aluminum electrode has higher removal efficiency (98.9%) compared to the iron electrode (93.5%) for 40 minutes of treatment (pH = 3, $j$ = 1 mA/cm$^2$, $\gamma_0$ = 50 mg/L P–$PO_4$). The addition of supporting electrolyte ($\gamma_{NaCl}$ = 0.25 g/L) is achieved removal efficiency of 50.2% for Fe and 52.1% for Al electrode in only 10 minutes of treatment, respectively.

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Abstract

PP-CE-02

# Biodegradable Lubricants

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biodegradable,
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renewable raw materials

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**Abstract:** In recent years significantly increases environmental awareness in the lubricant industry. Lubricants based on synthetic and mineral base oils arrive to environment in significant quantities, leading to environmental pollution. This led to active research of renewable raw materials for the production of lubricants, ie. Biolubricants. Their preference in comparison to conventional lubricant reflects in biodegradability, renewability and without adverse effects on the environment. Biodegradable lubricants are produces by the high quality natural and synthetics oils and fats. However, a competitor in the market are lubricants produced from waste natural oils and fats, because a price is lower. This paper will describe the development and design of biodegradable final lubricants, their characteristics, raw materials, as well as advantages and disadvantages.

# POSTER PRESENTATIONS

Education in Chemistry

(EC)

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*Abstract*

PP-EC-01

# Assessment of Primary School Students' Achievements in General Chemistry

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tests of knowledge,
general chemistry,
primary school students.

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**Abstract:** When learning chemistry, the permanent and creative knowledge is expected from learners, as well as its application when solving different assignments and problem oriented tasks in their further education and in everyday life. To establish and assess the level of students' knowledge and to evaluate the efficacy of teaching methods used by teacher, students' knowledge assessment is conducted in teaching practice, using both oral exams and written tests of knowledge. Written tests are considered as more objective than oral exams. Tests of knowledge ensure that the results of a teaching process are more objective, complete and reliable. This study is conducted in one primary school in Middle Bosnia Canton in 2014/2015 school year, using two different models of tests of knowledge in chemistry designed for the purpose of this study. Both models included the same part of general chemistry teaching content: they differed in the type of the tasks. The participants in this study were 7$^{th}$ grade primary school students (N=70). The purpose of this study was to design different models of the test of knowledge and to assess students' knowledge based on students' achievements. The accent is set on Bloom's taxonomy of educational objectives and on expected learning outcomes.

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Abstract

PP-EC-02

# An Example of Multimedia Application in Teaching Chemistry at Primary School Level

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**Keywords:**

multimedia,
teaching chemistry,
primary school

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**Abstract:** Modern educational technologies have become an integral part of teaching process with tendency not just to improve it but to change its basics. Considering the fact that teaching process is already centered on student instead to a teacher, multimedia can contribute in modernizing traditional teaching. Since multimedia can also improve communication between student and teacher, and to ensure effective learning, it has preoccupied teachers for some time. There are many definitions of multimedia – we can consider it as combination of hardware and software in order to integrate videos, animations, audios, pictures, text etc. in order to effectively present information. Within this study we tried to assess the effectiveness of multimedia compared to traditional teaching process (teacher centered approach). This study was conducted in the second semester in the school year 2014/2015 in three primary schools with 8$^{th}$ grade students (N=69) in both eight- and nine-year long primary education Results showed that multimedia is effective when applied in teaching chemistry, but we had limitations such as resources and available time for research. Therefore, study should be taken with more participants and for a longer period of time.

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Abstract

PP-EC-03

# Incorporation of Astronomy Topics in the Chemistry Curriculum at Gymnasiums in Canton Sarajevo

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education in chemistry,
curriculum of chemistry.

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**Abstract:** Astronomy like no other scientific discipline combines elements from almost the whole spectrum of research, from high energy physics to philosophy and psychology. It is expected that, chemistry as one of the fundamental sciences, finds significant place in this ever increasing field of frontier research. Astronomy topics in gymnasiums in Canton Sarajevo are, at present time, part of physics and geography programs. This paper explains how study of astronomy can be progressed by its incorporation in gymnasium subject such as chemistry. Topics can be chemical composition of celestial bodies, organic molecules present in gas clouds and exotic types of matter not found on Earth. The benefit of this incorporation does not hold only at purely educational level but expands on the goal of bringing somewhat abstract and fascinating ideas of reality beyond the tangible borders of Earth with the aim of increasing the interest of students in the subject of chemistry.

# POSTER PRESENTATIONS

Topics related to Chemistry

(TRC)

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Abstract

PP-TRC-01

# Installation of Solar Power Generation System on Building of Faculty of Science in Sarajevo

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power generation,
renewable energy sources

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**Abstract:** In the modern world of ever-increasing energy requirements and prices as well as unstable political scene many natural resources remain untapped, one of them being the Sun itself. Solar energy, considered by many to be the future of power generation, represents clean, sustainable, practically zero carbon emission source of producing electricity whose system can be implemented basically anywhere with adequate weather conditions with practically no pollution or hazard for the environment. This paper covers the basics of solar power generation system in urban areas, the example in question being the building of Faculty of Science in Sarajevo that includes the installation of solar panels, required auxiliary systems and connection to the local power grid, as well as basic calculation of project feasibility, justification and financing opportunities. The project would include mounting of photovoltaic solar panels on the rooftop of Faculty building, preeminently on the southern side with the aim of largest exposure to the Sun. Other that panels the system would require additional facilities such as cabling, substation and earthing and surge protection. With the solar irradiance of about 1350 kWh/m$^2$ and 1900 insolation hours per year the power plant of could provide in excess of 6,5 MWh yearly by placing 20 panels of total peak power 6,5 kW assuming the system performance ratio of 75 %. While this amount may not be very significant it would make utilize now unused parts of the building rooftops.

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PP-TRC-02

# Nanosensors Applications in Agriculture and Food Industry

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agriculture,
food,
food industry.

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**Abstract:** Food safety is very important issue in food industry and agriculture because it is directly related to the influence of food on the human health. Recent food safety incidents (such as the melamine affair in 2007 and 2008) and public health concerns about synthetic food additives and chemical residues in food have driven the need to develop rapid, sensitive, and reliable methods to detect those food hazards. An alternative is given in the rapid development of nanosensors which have advantage to detect food components in an easy and quick manner. Linking nanosensors with modern Information and Communication Technologies (ICTs) enables novel and online ways for different components detection accompanied with high accuracy. Various types of nanosensors are being developed to meet the different requirements in food inspection (nanosensors for detection of external and internal conditions in food packaging, carbon nanotubes based electrochemical sensors for detection of cations, anions and organic compounds in food, various aptamers for detection of pesticides, antibiotics, heavy metals, microbial cells and toxins).

The work reviews development and application of the most present nanosensors in agriculture and food industry.

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Abstract

PP-TRC-03

# Pollen Analysis of Honey from Three Sites in the Bosnia and Herzegovina and Montenegro

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pollen class and type,
honey,
melissopalynology.

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**Abstract:** The present study represents results of qualitative melissopalynological analyses of three honey samples in Bosnia and Herzegovina (Sarajevo-Pofalići and Tarčin) and Montenegro (Bukovica). The twenty three plant species from 14 families were identified according to the analyzed micromorphological characteristics of pollen grains by bright field optical microscopy. For all distinguished plant species basic pollen classes were detected. Only, *Calluna vulgaris* pollen had compound grain in tetrad form, while in all other species pollen grains appeared in monads. The most frequent shape classes were spheroidal, oblate and prolate. According to the size all pollen grain samples are sorted to the category of small, medium, large or very large. The most detected plants had triaperturate pollen grains, but also pantoporate and stephanoporate were detected. The three basic aperture types: colpus, pore and colporus, were the most common. In three analysed samples of nectar honey more than 300 counted pollen grains were detected. According to standards of honey type classification samples are sorted into flower or multifloral honey types. In sample from population Pofalići (BH) 897 pollen grains were counted and classified, according to their micromorphological features, into 16 plant species; in population Tarčin (BH) 963 pollen grains were from 15 plant species and in population Bukovica (MNE) 427 pollen grains were from 20 plant species. The absolute pollen count showed that the biggest percentage of pollen grains in the locality Pofalići belonged to the species *Prunus avium*, and in the localities Tarčin and Bukovica to the species *Brassica napus*.

# POSTER PRESENTATIONS

Project review

(PR)

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PP-PR-01

# PROJECT REVIEW

# Joint Research Project for the Production of Certified Matrix Reference Materials for Environmental Analysis

**İsleyen, A.[a], Vogl, J.[b], Nikolic, D.[c], Jotanovic, A.[d], Näykki, T.[e], Perkola, N.[e], Horvat, M.[f], Zoń, A.[g], Bulska, E.[h], Ochsenkuhn-Petropoulou, M.[i], Zühtü Can, S.[a], Bilsel, M.[a], Hafner, K.[d], Jacimovic, R.[f], Gažević, L.[c],**

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[b]*BAM-Federal Institute for Materials Research and Testing-GERMANY*
[c]*MoE-DMDM- Ministry of Economy, Directorate of Measures and Precious Metals-SERBIA*
[d]*IMBIH- Institute of Metrology-BOSNIA and HERZEGOVINA*
[e]*SYKE-Finnish Environment Institute-FINLAND*
[f]*IJS-Institute Jozef Stefan-SLOVENIA*
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Quality system;
CRM producers.

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**Abstract:** Reliable analysis of chemical indicators in water, sediment and soil samples for the purpose of environmental pollution assessment poses one of the greatest analytical challenges, having in mind the complexity of sample matrix and low concentrations of pollutants. Organics (pesticides, PAHs, PFOS, etc.) and heavy metals (Hg, Cd, Ni, Pb and As) represent target parameters. Laboratories performing sampling and tests in this field regulated by respective EU directives, need strong support in order to establish a quality system. It is necessary to provide appropriate calibrators i.e. matrix CRMs relates to the unique sample matrices representing typical samples in the geomorphological and anthropological sense. In addition to that, bearing in mind the complexity and instability of environmental samples, it is very difficult to obtain appropriate referents materials with no local providers.

Our project is aiming to develop capacity to produce CRMs for environmental analysis by transferring the theoretical and practical know-how between the partners and combining their skills to focus on environmental CRM production in accordance with ISO Guide 34. Our project will have an impact on environmental monitoring in the partnering countries and on the scientific community, who will use the newly developed reference materials. Furthermore, partners will develop strategies for producing new CRMs either on their own or in cooperation. This will lead to regional CRM producers serving scientific and official laboratories.

# POSTER PRESENTATIONS

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Abstract

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# The Effect of Aluminium on Antioxidant Activity and Production of Secondary Metabolites in *Ocimum basilicum* L.

**Džubur, N., Đogić, S., Karalija, E.*, Parić, A.**

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**Abstract:** *Ocimum basilicum* L. belongs to the family Lamiaceae and is considered as one of the most widespread and most commonly cultivated plants worldwide. The toxicity of heavy metals leads to the changes in life of plant, so the aim of this study was to investigate the effect of different concentrations of aluminium (50, 100 and 200 mg(Al)/kg soil) on antioxidant activity and production of secondary metabolites. The results indicated that application of 100 mg/kg aluminium induced an increase of secondary metabolites production, which is an excellent indicator of stress resulting from the action of heavy metals. Inhibitory effect of aluminium on the synthesis of secondary metabolites occurs at concentration of 200 mg(Al)/kg soil, where the lowest concentration of produced secondary metabolites is registered. The antioxidant activity of basil extracts was determined by the DPPH method, and application of aluminium increased antioxidative capacity of basil extracts due to the activation of antioxidative system in plant cells under heavy metal stress. The $IC_{50}$ value was determined for all tested samples, and the highest $IC_{50}$ value was registered in the control plants, indicating the lowest antioxidative potential which is in concordance with stress level.

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Abstract

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# Phenolic Acid Composition of *Knautia arvensis* Dependent upon Plant Organ

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**Abstract:** Genus *Knautia* L. is mostly represented with biannual plants with opposite leaves, and fruits with white elaiosomes. In Bosnia and Herzegovina this genus includes endemic and also several widely distributed species (e.g. *K. arvensis*). *Knautia arvensis* is listed as one of the plants that can be used as an alternative for antibiotic growth promotion in animal feed with potential anti-proteolytic activity but the chemical composition of this species is relatively unknown. Aim of this study was to evaluate differences between phenolic acid compositions of different plant organs of *K. arvensis*. The content of 14 different phenolic acids was evaluated using UPLC-MS/MS in stems, leaves, flowers, fruits and roots. Analytes were analysed in four different forms, i.e. free phenolic acids, phenolic esters, phenolic glycosides, and non-soluble phenolic acids. Variation of phenolic acids between different plant organs was evident. Gallic acid was identified only in stems and fruits, while the highest content was recorded for chlorogenic, caffeic and vanillic acid.

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