

## **Chair of Analytical and Physical Chemistry**

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### **ABSTRACT**

The Chair for Analytical and Physical Chemistry currently consists of ten professors and two associates. A number of researchers and other associates also contribute to the work carried out within the Chair. Throughout every level of the studies (Undergraduate Academic Studies, Master Academic Studies, and Doctoral Academic Studies), the students attend a great number of courses within these scientific fields. The members of the Chair are the authors of 14 university coursebooks, workbooks, as well as practicums. The professors, associates and researchers of the Chair deal with the following fields of scientific research: the GC-MS analysis of PAHs with the optimization of the method of samples preparation, the development and validation of the ICP- $\Theta$ AES methods, the development and validation of kinetic spectrophotometric methods, the HPLC determination of total polyphenols, flavonoids and anthocyanins with the examination of the kinetics of their degradation, the spectrophotometric and the cyclic voltammetry determination of antioxidant activity. A large number of papers has been published in international and national journals. The research laboratories are equipped with ICP-AES, HPLC, spectrophotometers, automatic titrator, analytical balances, high purity water system, vacuum evaporator, pH-meters, conductometers, and other minor laboratory equipment. The researchers of the Chair have participated in many national scientific-research projects, as well as international projects such as Erasmus, Tempus, FP7, The Researchers' Night, and they have also attended the postdoctoral specializations and study visits abroad, which contribute to the good cooperation between the Chair and other universities in the world.

## Staff of the Chair

The Chair for Analytical and Physical Chemistry includes the following professors and associates: Snežana Mitić (*Head of the Chair*), Vesna Stankov-Jovanović (*Head of the Division of Chemistry at the Center for Scientific and Professional Activities in Natural and Mathematical Sciences*), Snežana Tošić, Violeta Mitić (*Head of the Department of Chemistry*) and Aleksandra Pavlović as full professors; Sofija Rančić, Emilija Pecev-Marinković, Ivana Rašić Mišić, Milan Mitić as associate professors; Milan Stojković as an assistant professor and Jelena Cvetković and Jelena Mrmošanin as teaching assistants. Marija Ilić as a scientific associate, Marija Dimitrijević, and Ana Miletić as research associates, Slobodan Ćirić as a research assistant, professional associates and other associates in the laboratories also participate in teaching and research activities.



**Figure 1.** The Staff of the Chair for Analytical and Physical Chemistry

## **Studies**

At the first level of studies (three-year undergraduate academic studies-Chemistry) students are introduced to the following courses in the field of analytical and physical chemistry: Analytical Chemistry 1, Analytical Chemistry 2, Physical Chemistry 1, Structure of Atoms and Molecules, Analytical Chemistry 3, Physical Chemistry 2, Instrumental Analytical Chemistry as obligatory courses and Statistical Data Analysis, Selected Topics in Volumetric Analysis, Complex Samples Preparation, Principles of Quality Control in Analytical Laboratory and Molecular Spectra as elective courses. At the two-year second level of master academic studies-Chemistry (modules: Research and Development, and Teacher of Chemistry) and Applied Chemistry (modules: Applied Chemistry, and Environmental Chemistry) students are introduced to the following courses: Electrochemistry, Modern Optical Methods of Analysis, Modern Electroanalytical Methods, Chemometrics, Selected Topics in Instrumental Analysis, Kinetics and Catalysis, Environmental Analytical Chemistry, Methodology of Chemistry Teaching 2 and School Practice 2 as obligatory courses, and Physico-Chemical Bases of Separation Methods in Chemistry, Selected Topics in Physical Chemistry, Physical Chemistry of Solids, Scientific Research Methodology, Working with Talented Students, Food Chemistry Analysis, Bioanalytical Chemistry, Kinetic Methods of Analysis, Analysis of Toxic Substances, and Environmental Electroanalytical Methods as elective courses. Doctoral academic studies-Chemistry in duration of three years include the following elective courses: Equilibria in Chemistry, Selected Topics in Optical and Related Methods of Chemical Analysis, Selected Topics in Electrochemical Methods of Analysis, Atomic Spectroscopy, Molecular Spectroscopy, Instrumental Analysis 1, Instrumental Analysis 2, Physical and Chemical Methods for Equilibrium Determination in Complex Media, Separation Methods, Kinetic Methods of Analysis, Selected Topics in Physical Chemistry, Selected Topics in the Applications of Organic Reagents in Chemical Analysis.

## **Laboratory equipment**

The laboratory equipment of the Chair for Analytical and Physical Chemistry (Fig. 2) includes:



## Research Projects

Since 2000, researchers, members of the Chair for Analytical and Physical Chemistry, have been included in the following national projects:

- Ethnopharmacological study of the region of South-Eastern Serbia (2017-);
- 172047: Natural products of plants and lichens: isolation, identification, biological activity and application (2011-);
- 172051: Development of new and improvement of existing electrochemical, spectroscopic and flow injection (FIA) methods on environmental quality monitoring (2011-);
- 172061: Combinatorial libraries of heterogeneous catalysts, natural products, modified natural products, and analogs: The approach to new biologically active agents (2011-);
- 142015: Development and application of methods for industrial products and environment quality monitoring (2006-2010);
- 142054: Secondary metabolites: Biological and antioxidant activity (2006-2010);
- 1211: Development of new and improvement of existing analytical methods for industrial products and environment quality monitoring (2001-2005);
- 2812: Investigation of chemical composition and bioactivity of secondary metabolites of plants species from genera *Achillea*, *Acinos*, *Artemisia* and *Calamintha* (2001-2005);
- 02M14: Development of new analytical methods for the analysis of elements in the samples of natural and artificial origin in aquatic and non-aquatic environments (1995-2000).

They have taken part in following international projects as well:

- ERASMUS+ (Capacity building in higher education), 573806-EPP-1-2016-1-RS-EPPKA2-CBHE-JP, Development of master curricula for natural disasters risk management in Western Balkan countries (NatRisk) (2016-);
- TEMPUS,544006-TEMPUS-1-2013-1-RS-TEMPUS-SMGR, FUSE-FosteringUniversity Support Services and Procedures for Full Participation in the European Higher Education Area (2013-2016);

- "RESEARCHERS' NIGHT 2018-2019", Road to Friday of Science 2.0 - "ReFocuS 2.0", 818325-ReFocuS 2.0, H2020-MSCA-NIGHT-2018;
- "RESEARCHERS' NIGHT 2016-2017", Road to Friday of Science - "ReFocuS", 722341-ReFocuS, H2020-MSCA-NIGHT-2016;
- "RESEARCHERS' NIGHT 2014-2015", 633376-SCIMFONICOM, H2020-MSCA-NIGHT-2014;
- TEMPUS, 511044-TEMPUS-1-2010-1-UK-TEMPUS-JPCR UoG "Modernisation of Post-Graduate Studies in Chemistry and Chemistry Related Programmes", MCHM, 2011-2013;
- FP7, FP7- REG-POT-2007-3-01 "CHROMLAB-ANTIOXIDANT" (2008-2010).

## **Postdoctoral research and study visits**

Several researchers, members of the Group for Analytical and Physical Chemistry, were on postdoctoral stays abroad supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia within the program of postdoctoral fellowships for young scientists. In 2013, Milan Mitić was on a five-month postdoctoral stay at the Laboratory of Food Science and Technology, School of Chemistry, The Aristotle University of Thessaloniki (under the supervision of Prof. Dr. Maria Tsimidou and the collaboration of Dr. Eleni Naziri). In 2008, Milan Mitić was on a three-month study visit at the National Institute for Agricultural Research Laboratory, Montpellier, INRA, France. The training was carried out under the supervision of Jean-Marc Souquet (INRA, France). Vesna Stankov Jovanović was on a six-month postdoctoral stay at University Pierre and Marie Curie (Paris, France) under the program "Research in Paris 2011" (2011-2012). In 2018, she was also on a one-month study visit at University of Natural Resources and Life Sciences (BOKU, Vienna, Austria) and in 2010 she was a visiting researcher at the Institute for Water Education at Delft University (UNESCO-IHE). Since 1986, Vesna Stankov-Jovanović has collaborated with the Department of Chemistry and Hydrogeology of the Petnica Research Center and since 2006, she has lectured various courses to school pupils.

## **Collaboration**

Researchers at the Group for Analytical and Physical Chemistry cooperate with the following institutions: Middlesex University, London, UK; Technical University Crete, Greece; Obuda University, Budapest, Hungary; University of Messina, Messina, Italy; University "Otto Friedrich", Bamberg, Germany; Jagiellonian University, Krakow, Poland; University of Malaga, Malaga, Spain; Masaryk University, Brno, Czech Republic; University of Marseille, France; University of Poitiers, France; University of Ljubljana, Slovenia; Ondokuz Mais University, Samsun, Turkey; University of Tirana, Albania; University Alexandar Moisiu, Durres, Albania; University of Sarajevo, Bosnia and Herzegovina, and University of East Sarajevo, Bosnia and Herzegovina.

## **Research work**

Research work includes:

- investigation of a novel sorbent to the quick, easy, cheap, effective, rugged, and safe technique for soil sample preparation for the determination of polycyclic aromatic hydrocarbons (PAHs) by GC-MS analysis;
- optimization the QuEChERS (Quick, Easy, Cheap, Effective, Rugged and Safe) technique, in order to establish an efficient method for the extraction of PAHs from the soil, using various sorbent and solvent system combinations, followed by GC-MS analysis;
- development and validation of the ICP-AES method for determination of elements in soil, water, plants, foods, *etc.*;
- development and validation of kinetic spectrophotometric methods for the determination of metals, amino acids, the residue of pesticides and pharmaceuticals in the soil, water, foods, and pharmaceutical preparations;
- identification and quantification of polyphenolic compounds in food and plants by HPLC chromatography;



- determination of total polyphenols, flavonoids and anthocyanins in food and plants using spectrophotometric methods;
- evaluation of food and plant antioxidant activity by spectrophotometric techniques such as 1) radical scavenging activity (2,2-diphenyl-1-picrylhydrazyl, DPPH), 2) cation decolorization activity (2,2'-azino-bis (3-ethylbenzothiazoline-6-sulphonic acid, ABTS), 3) ferric reducing antioxidant power (FRAP), 4) cupric reducing antioxidant capacity (CUPRAC), and 5) total reducing power (TRP);
- evaluation of food and plant antioxidant activity by electrochemical technique-cyclic voltammetry;
- chemometric characterization of food and plants according to their antioxidant activities, polyphenolic and metal contents;
- investigation of the kinetics of the degradation of catechins and procyanidins during food storage and preparation.

### **Selected research papers**

- Mitic, V., Dimitrijevic, M., Pavlovic, J., Nikolic, J. J., Simonovic, S., Stankov Jovanovic, V., & Stojanovic, G. (2018). Comprehensive evaluation of antioxidant activity of *Ribes berry* fruit species: A Chemometric Approach. *Analytical Letters*, 51(6), 908-920.
- Mrmošanin, J. M., Pavlović, A. N., Krstić, J. N., Mitić, S. S., Tošić, S. B., Stojković, M. B., Micić, R. J., & Đorđević M. S. (2018). Multielemental quantification in dark chocolate by ICP OES. *Journal of Food Composition and Analysis*, 67, 163-171.
- Pavlović, J. Lj., Mitić, S. S., Mitić, M. N., Pavlović, A. N., Micić, R. J., & Stojković, M. B. (2018). Multielement analysis of south Serbian strawberry cultivars by inductively coupled plasma-optical emission spectrometry. *Analytical Letters*, 51(9), 1417-1432.
- Nikolić, J. S., Mitić, V. D., Stankov Jovanović, V. P., Dimitrijević, M. V., Ilić, M. D., Simonović, S. R., & Stojanović, G. S. (2018). Novel sorbent and solvent combination for QuEChERS soil sample preparation for the determination of polycyclic aromatic hydrocarbons by gas chromatography–mass spectrometry. *Analytical Letters*, 51(7), 1087–1107.



- Mitic, V. D., Ilic, M. D., Stankov-Jovanovic, V. P., Stojanovic, G. S., & Dimitrijevic, M. V. (2018). Essential oil composition of *Erica spiculifolia* Salisb - first report. *Natural Product Research*, 32(2), 222-224.
- Stojanović, B. T, Mitić, S. S., Stojanović, G. S., Mitić, M. N., Kostić, D. A., Paunović, D. Đ., Arsić, B. B., & Pavlović, A. N. (2017). Phenolic profiles and metal ions analyses of pulp and peel of fruits and seeds of quince (*Cydonia oblonga* Mill.). *Food Chemistry*, 232, 466-475.
- Kostic, D., Randjelovic, S., Arsic, B., Mitic, S., Mitic, M., Totic, S., & Stojanovic, G., (2017). Chemometric comparison of mineral content in different grape fruits growing in Serbia. *Journal of Food Safety and Food Quality*, 68(6), 140-145.
- Pavlović, A. N., Mrmošanin, J. M., Krstić, J. N., Mitić, S. S., Tošić, S. B., Mitić, M. N., Arsić, B. B., & Micić, R. J., (2017). Effect of storage temperature on the decay of catechins and procyanidins in dark chocolate. *Czech Journal of Food Science*, 35(4), 360-366.
- Totic, S., Stojanovic, G., Mitic, S., Pavlovic, A., & Alagic, S., (2017). Mineral composition of selected Serbian propolis samples. *Journal of Apicultural Science*, 61(1), 5-15.
- Dimitrijević, M., Stankov Jovanović, V., Cvetković, J., Mitić, M., Petrović, G., Đorđević, A., & Mitić, M. (2017). Phenolics, antioxidant potentials, and antimicrobial activities of six wild *Boletaceae* mushrooms. *Analytical Letters*, 50(10), 1691-1709.
- Tošić, S., Alagić, S., Dimitrijević, M., Pavlović, A., & Nujkić M., (2016). Plant parts of the apple tree (*Malus* spp.) as possible indicators of heavy metal pollution. *AMBIO: A Journal of the Human Environment*, 45(4), 501-512.
- Cvetkovic, J. S., Mitic, V. D., Stankov Jovanovic, V. P., Dimitrijevic, M. V., Petrovic, G. M., Nikolic-Mandic, S. D., & Stojanovic G. S., (2016). Optimization of the QuEChERS extraction procedure for the determination of polycyclic aromatic hydrocarbons in soil by gas chromatography-mass spectrometry. *Analytical Methods*, 8, 1711-1720.
- Nikolić, M., Pavlović, A., Mitić, S., Tošić, S., Pecev Marinković, E., Đorđević, M., Micić, R., (2016). Optimization and validation of inductively coupled atomic emission

spectrometry method for macro and trace element determination in berry fruit samples. *Analytical Methods*, 8, 4844-4852.

- Mitić, V., Stankov Jovanović, V., Ilić, M., Jovanović, O, Djordjević, A, & Stojanović, G. (2016). *Dittrichia graveolens* (L.) Greuter essential oil: Chemical composition, multivariate analysis and antimicrobial activity. *Chemistry and Biodiversity*, 13(1), 85-90.
- Veljković, J. N, Pavlović, A. N., Brčanović, J. M, Mitić, S. S., Tošić, S. B., Pecev-Marinković, E. T., & Mitić, M. N. (2016). Differentiation of black, green, herbal and fruit bagged teas based on multi-element analysis using inductively-coupled plasma atomic emission spectrometry. *Chemical Papers*, 70(4), 488-494.
- Alagić, S. Č., Stankov Jovanović, V. P., Mitić, V. D., Cvetković, J. S., Petrović, G. M., & Stojanović G. S., (2016). Bioaccumulation of HMW PAHs in the roots of wild blackberry from the Bor region (Serbia): Phytoremediation and biomonitoring aspects. *Science of The Total Environment*, 562, 561-570.
- Pavlović, A. N., Brčanović, J. M., Veljković, J. N., Mitić, S. S., Tošić, S. B., Kaličanin, B. M., Kostić, D. A., Đorđević, M. S., & Velimirović, D. S., (2015). Characterization of commercially available products of aronia according to their metal content. *Fruits*, 70(6), 385-393.
- Mitić, V. D., Ilić, M. D., Dimitrijević, M. V., Cvetković, J. S., Ćirić, S., Stankov Jovanović, V., (2015). Chemometric characterization of peach, nectarine and plum cultivars according to fruit phenolic content and antioxidant activity. *Fruits*, 71(1), 57-66.
- Tošić, S. B., Mitić, S. S., Velimirović, D. S., Pavlović, A. N., & Pecev-Marinković, E. T., (2015). Elemental composition of edible nuts: fast optimization and validation procedure of an ICP-OES method. *Journal of the Science of Food and Agriculture*, 95(11), 2271-2278.
- Rašić Mišić, I. D., Miletić, G. Ž., Mitić, S. S., Kostić, D. A., & Djordjević, A. S., (2015). Kinetic-spectrophotometric determination of neomycin. *Journal of Analytical Chemistry*, 70(2), 234-239.

- Alagić, S., Tošić, S., & Pavlović, A. (2014). Nickel content in deciduous trees near copper mining and smelting complex Bor (East Serbia). *Carpathian Journal of Earth and Environmental Sciences*, 9(4), 191–199.
- Pecev-Marinković, E. T., Grahovac, Z. M., Mitić, S. S., Pavlović, A. N., Rašić Mišić, I. D., & Mitić, M. N., (2014). Determination of herbicide difenzoquat methyl sulfate in citrus and baby juices by kinetic-spectrophotometric method and HPLC method. *Journal of the Chinese Chemical Society*, 61(6), 671-678.
- Rašić Mišić, I. D., Miletić, G. Ž., Mitić, S. S., Mitić, M., & Pecev-Marinković, E., (2013). A simple method for the ampicillin determination in pharmaceuticals and human urine. *Chemical and Pharmaceutical Bulletin*, 61(9), 913-919.
- Brčanović, J. M., Pavlović, A. N., Mitić, S. S., Stojanović, G. S., Manojlović, D. D., Kaličanin, B. M., & Veljković, J. N. (2013). Cyclic voltammetry determination of antioxidant capacity of cocoa powder, dark chocolate and milk chocolate samples: Correlation with spectrophotometric assays and individual phenolic compounds. *Food Technology and Biotechnology*, 51(4), 460-470.
- Alagić, S. Č., Šerbula, S. S., Tošić, S. B., Pavlović, A. N., & Petrović, J. V., (2013). Bioaccumulation of Arsenic and Cadmium in Birch and Lime from the Bor Region. *Archives of Environmental Contamination and Toxicology*, 65(4), 671-682.
- Mitić, S. S., Obradović, M. V., Mitić, M. N., Kostić, D. A., Pavlović, A. N., Tošić, S. B., & Stojković, M. B. (2012). Elemental Composition of Various Sour Cherry and Table Grape Cultivars Using Inductively Coupled Plasma Atomic Emission Spectrometry Method (ICP-OES). *Food Analytical Methods*, 5, 279-286.
- Mitić, S. S., Milan, M. B., Pavlović, A. N., Tošić, S. B., Mitić, M. N., (2012). Heavy Metal Content in Different Types of Smoked meat in Serbia. *Food Additives and Contaminants – Part B*, 5(4), 241-245.
- Micic, R., Mitic, S, Pavlovic, A., Tosic, S., & Mitic, M., (2011). Kinetic determination of traces of Th(IV) on the basis of its catalytic effect in environmental water samples. *Journal of Radioanalytical and Nuclear Chemistry*, 288(3), 845-850.

- Mitić, M. N., Obradović, M. V., Grahovac, Z. B., & Pavlović, A. N., (2010). Antioxidant capacities and phenolic levels of different varieties of Serbian white wines. *Molecules*, 15(3), 2016-2027.
- Grahovac, Z. M., Mitić, S. S., Pecev, E. T., & Pavlović, A. N. (2010). Determination of the insecticide diflubenzuron in mushrooms by kinetic method and high-performance liquid chromatographic method. *Journal of Environmental Science and Health Part B- Pesticides Food Contaminants and Agricultural Wastes*, 45(8), 783-789.
- Rančić, S. M., Nikolić Mandić, S. D., (2009). Kinetic spectrophotometric determination of Bi(III) based on its catalytic effect on the oxidation of phenylfluorone by hydrogen peroxide. *Journal of the Serbian Chemical Society*, 74(8-9), 977-984.
- Rančić, S. M, Nikolić Mandić, S. D., Mandić, Lj. M., (2005). Kinetic spectrophotometric method for gold(III) determination. *Analytica Chimica Acta*, 547, 144-149.

### **Published books in Serbian and chapters in edited books**

- Mitić, S., Rašić Mišić, I., Micić, R., & Dimitrijević, M., (2017). *Semimikro kvalitativna hemijska analiza*. Niš.
- Stojković M., (2017). *Ravnoteže u analitičkoj hemiji – zbirka zadataka*. Niš.
- Pecev-Marinković, E., (2017). *Praktikum iz strukture atoma i molekula*. Niš.
- Mitić M., (2017). *Hromatografske metode*. Niš.
- Pavlović, A., & Rašić Mišić, I., (2016). *Odabrana poglavlja optičkih metoda analize*. Niš.
- Stankov Jovanović, V., Mitić, V., Nikolić Mandić, S., Ilić, M., & Simonović, S., (2015). *Heavy Metals in the Post-catastrophic Soils, a chapter in the Heavy Metal Contamination of Soils: Monitoring and Remediation book*. Springer International Publishing Switzerland.
- Kaličanin, B. M., Velimirović, D. S., & Pavlović, A. N., (2015). *Teeth–Saliva Migration of Fluoride Ions and Health Implications*. In *Fluorine: Chemistry, Analysis, Function and Effects*. Cambridge: The Royal Society of Chemistry.
- Mitić, V., & Stankov-Jovanović, V., (2015). *Analitika prehrambenih proizvoda*. Niš.

- Mitić, S., Pavlović, A., & Živanović, V., (2012). Zbirka zadataka iz instrumentalne analitičke hemije. Niš.
- Rančić, S., Anđelković, T., (2010). Analitička hemija životne sredine. Niš.
- Mitić, S., (2008). Elektroanalitička hemija. Niš.
- Rančić, S., & Anđelković, T., (2007). Metodika nastave hemije sa metodologijom. Niš.
- Pecev, T., Perović, J., Miljković, M., Simonović, R., Stankov Jovanović, V., & Mitić, V., (2002). Kvantitativna analitička hemija - zbirka zadataka. Niš.
- Veselinović, D., Obradović, M., Mitić, S., Grahovac, Z., Đorđević, S., (1995). Zbirka zadataka iz fizičke hemije. Niš.