

ISSN 2566-3364

DOI: 10.5281/zenodo.5656338



OPORPH 2021: Book of Abstracts

VII INTERNATIONAL
SCIENTIFIC-PROFESSIONAL SYMPOSIUM
»ENVIRONMENTAL RESOURCES,
SUSTAINABLE DEVELOPMENT
AND FOOD PRODUCTION«

OPORPH 2021

November 12th, 2021

Tuzla, Bosnia and Hercegovina



**Environmental resources, sustainable development
and food production – OPORPH 2021: Book of Abstracts**

The Symposium is the traditional meeting that takes place every second year, and this Book is a serial publication that accompanies it. The Book contains the abstracts of plenary lectures and oral presentations, along with the posters' abstracts, presented at VII International scientific-professional symposium "Environmental resources, sustainable development and food production" – OPORPH 2021, held on 12 November 2021 in Tuzla, Bosnia and Herzegovina, organized by Faculty of Technology, University of Tuzla in cooperation with Association of Chemist of Tuzla Canton.

ISSN 2566-3364

DOI 10.5281/zenodo.5656338

Publisher Faculty of Technology, University in Tuzla

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Graphical & Technical Editor Franc Andrejaš

Editorial Office Nermina Jahić (Technical Secretary)
Faculty of Technology, University in Tuzla
Urfeta Vejzagića 8, 75000 Tuzla, Bosnia and Herzegovina
Phone/fax: +387 35 320 740 / +387 35 320 741
E-mail: dekanat.tf@untz.ba

Circulation (CD edition) 100

Acknowledgements OPORPH 2021 was supported by: Global Ispat Koksna Industrija d.o.o. Lukavac, Fabrika cementa Lukavac d.d. Lukavac, Majevisa d.d. Srebrenik, Pivara d.d. Tuzla, Solana d.d. Tuzla, JP Elektroprivreda BiH d.d. Sarajevo - Podružnica Termoelektrana Tuzla, Sisecam soda Lukavac d.o.o. Lukavac, Voćar d.o.o. Brčko, DITA 1977 industrija deterdženata d.o.o. Tuzla, Subašić d.o.o. Tešanj, Noćko Komerc d.o.o. Živinice, Nihad Muminović, dipl.ing.-Gradačac, Menprom d.o.o. Gornja Tuzla, Kondisa d.o.o. Sarajevo, Perutnina Ptuj-BH d.o.o. Breza

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APPLICATION OF NATURAL BENTONITE IN WASTEWATER TREATMENT FROM PACKAGING
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Hana Alihodžić*¹, Abdel Đozić², Vahida Selimbašić³, Franc Andrejaš⁴, Vedran Stuhli⁵,
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APPLICATION OF NATURAL AND ACTIVATED BENTONITE IN WASTEWATER TREATMENT
FROM INITIAL EXPLOSIVES PRODUCTION PROCESS

Hana Alihodžić*¹, Abdel Đozić², Vahida Selimbašić³, Franc Andrejaš⁴, Nisad Avdić⁵ 24

MULTIFUNCTIONAL POLYMER ADDITIVES FOR LUBRICATING OILS

ANTE JUKIĆ*, ELVIRA VIDOVIĆ, FABIO FARAGUNA, LUCIJA REBROVIĆ,
MIHOVIL MEDIĆ

Faculty of Chemical Engineering and Technology, University of Zagreb
Trg Marka Marulića 19, Zagreb, Croatia

* ajukic@fkit.unizg.hr, evidov@fkit.unizg.hr, ffaragun@fkit.unizg.hr, lrebrov@fkit.unizg.hr,
mmedic@fkit.unizg.hr

Requirements regarding the less harmful emissions and increasing fuel efficiency of internal combustion engines govern the development of modern lubricating oils towards lower viscosity grade and multi-functional, highly efficient additives. Here, two additives, namely viscosity index improvers and friction modifiers play the most important role. Among the polymeric additives commonly used as viscosity index improvers, poly(alkyl methacrylates) (PAMA) provide the easiest way of changing the composition and structure that are necessary to comply with the new engine oil specifications. PAMA additives are manufactured by the free radical copolymerization of corresponding methacrylate monomers in solution of lubricating base oil. Therefore, they can relatively simply be chemically modified by the addition of different functional methacrylate comonomers because of similar copolymerization reactivity. This is their noteworthy advantage over the competing additives such as polyolefins or styrene/butadiene/isoprene copolymers that are prepared by metallocene or anionic polymerization where chemical modification is a much more complicated and demanding process. In addition to the viscosity index improving, the additives based on PAMA are well known and widely used pour point depressants of lubricating oils. They prevent gelation of the oil and deposition of n-paraffins from the base oil at low temperatures and enable oil to flow at much lower temperatures.

This paper will present the results of synthesis and properties of new dispersant PAMA additives of improved solubility, shear and thermal stability, while maintaining excellent properties of improving the viscosity index and lowering the pour point of lubricating oil.

Keywords: lubricating oil; polymer additives; viscosity index; pour point; dispersant

APPLICATION OF COCOA SHELL IN THE PRODUCTION OF CHOCOLATE AND CHOCOLATE-LIKE PRODUCTS

ĐURĐICA AČKAR*, VERONIKA BARIŠIĆ, IVANA FLANJAK, JURISLAV BABIĆ

Josip Juraj Strossmayer University of Osijek, Faculty of Food Technology Osijek, Franje Kuhača 18, 31000 Osijek, Croatia, * dackar@ptfos.hr

The aim of the research within the project of the same title is to make chocolate production more sustainable through usage of cocoa shell in chocolate, sweet spread and cocoa instant beverage. Namely, app. 12 – 15 % of cocoa bean is a shell, which is discarded before or after roasting the beans. To this day, it has not been efficiently utilized. It has been used as a fuel, in biogas production, for animal feed and as a mulch, but in all these applications it has large limitations. At the same time, cocoa shell is a valuable source of fiber and polyphenols, and as such has a high potential for use in food industry. Up to now, we have produced dark and milk chocolates, and sweet cocoa spread with the addition of cocoa shell. Although it has an impact on rheological properties of these products, cocoa shell does not influence significantly polyphenolic profile, and sensory acceptability is slightly decreased. The ongoing research will be focused on instant cocoa drinks.

Keywords: cocoa shell; chocolate; sweet spread; instant cocoa beverage; sustainable production

DETERGENTS IN WASTEWATERS

MARINA ŠČIBAN

University of Novi Sad, Faculty of Technology Novi Sad, Novi Sad, Serbia, msciban@uns.ac.rs

Increasing the number of people on the planet and increasing living standards, intensive agriculture and the rapid development of the industrial sector are leading to increased pressure on the natural environment. Among other things, in households, but also in many other sectors, the use of washing agents, ie detergents, is increasing. The remains of these agents get into the wastewater, and through them in water in nature. In addition to surfactants, modern detergents contain a large number of other ingredients such as: fillers, bleaches and bleach activators, agents for creating or preventing the formation of foam, then paints, odors, preservatives, disinfectants, etc. What is their fate when they reach the wastewater? Some of these substances are biodegradable and can be removed by standard wastewater treatment, but some undergo conventional treatment and reach the environment. Over time, the concentration of such substances, but also other micropollutants that do not originate from detergents and reach wastewater and are not removed by standard treatment, increases in water in nature and the question is what is their impact on living organisms, as well as whether they reach, and in what ways, to human. These topics are the subject of many researches and the results of some of them will be presented in this paper.

Keywords: wastewaters; detergents

UPOREDNE EKSTERIJERNE MJERE PRAMENKA OVACA GAJENIH NA TRI LOKALITETA U BOSNI I HERCEGOVINIHUSEIN VILIĆ*¹, AMIR HASIĆ², JELENA NIKITOVIĆ³, EMIR MUJIĆ¹, AMIR ZENUNOVIĆ², TONI BABIĆ⁴, REFIK ŠAHINOVIĆ¹

¹ Husein Vilić*: Biotehnički fakultet, Univerzitet u Bihaću, Bihać, e-mail: husein.btf@gmail.com,

² Amir Hasić: Tehnološki fakultet, Univerzitet u Tuzli, Tuzla, e-mail: a.hasic@gmail.com;

³ Jelena Nikitović: Institut za genetičke resurse, Univerzitet u Banjoj Luci, e-mail:

jelena.nikitovic@igr.unibl.org

¹ Emir Mujić: Biotehnički fakultet, Univerzitet u Bihaću, Bihać, e-mail: ebiofax@gmail.com

² Amir Zenunović: Tehnološki fakultet, Univerzitet u Tuzli, Tuzla, e-mail: amir.zenunovic@hotmail.com,

⁴ Toni Babić: Ministarstvo poljoprivrede, vodoprivrede i šumarstva Tuzlanskog kantona, Tuzla, e-mail:

babic.toni98@gmail.com

¹ Refik Šahinović: Biotehnički fakultet, Univerzitet u Bihaću, Bihać, e-mail: sahinovic.r@gmail.com

Cilj ovog rada je bio da se izvrši mjerenje osnovnih eksterijernih osobina ovaca Pramenka rase (visina grebena, od tla do najviše tačke grebena, visina krsta, od tla do najviše tačke na krstima, dužina trupa, širina grudi, dubina grudi, obim grudi, obim trupa, obim cjevanice i tjelesna masa), sa ciljem da se uporede izmjerene vrijednosti radi procjene uticaja područja gajenja na iste. Za istraživanja su korišteni domaći autohtoni sojevi Pramenke (kupreška, travnička). U grupi oglednih životinja bilo je po 36 ovaca, a isto toliko imala je i kontrolna grupa. Ogledi su izvedeni na dugogodišnjim čistokrvnim stadima Pramenke i to na tri privatne farme na području Unsko-Sanskog kantona, 2 općina Cazin i 1 općina Bihać, kao i na jednoj privatnoj farmi u području Srednje Bosne (područje općine Travnik), a jedna na području općine Kupres (Livanjski kanton). Na osnovu prikazanih prosječnih vrijednosti eksterijernih svojstava ovaca rase Pramenka i njihovih variranja za sve ispitivane lokalitete možemo zaključiti slijedeće: da su ovce duže u odnosu na njihovu visinu i da je Pramenka srednje tjelesne razvijenosti, da na razlike u tjelesnim mjerama u ispitivanim područjima veliki utjecaj imaju i porijeklo nastanka pojedinih pasmina-sojeva ovaca rase Pramenka (Kupreški soj, Vlašički soj), kao i kvalitet pašnjačkih površina i nejednak pristup ishrani. Komparacijom naših rezultata sa rezultatima drugih autora koji su ispitivali eksterijer drugih sojeva pramenke (Rapska, Lička, Paška, Istarska) u našem širem okruženju zaključujemo da je vlašička pramenka najkrupniji soj pramenke na ovim prostorima.

Ključne riječi: ovca; eksterijer; mjerenje

ELECTROCHEMICAL REMOVAL OF HEXAVALENT CHROMIUM BY ELECTROCOAGULATION

BORISLAV N. MALINOVIC¹, TIJANA DJURICIC¹, DAJANA DRAGIC¹, RADE MALESEVIC¹,
DRAZENKO BJELIC²

¹Faculty of Technology, University of Banja Luka, Stepe Stepanovica, 78000 Banja Luka, Bosnia and Herzegovina

²JP Dep-ot, Bulevar Zivojina Misica 23, 78000 Banja Luka, Bosnia and Herzegovina

Chromium in wastewater is discharged from tannery, electroplating, metal finishing, dying industry and many other industries. Presence of hexavalent chromium (Cr(VI)) in the environment considerable concern because it is non-biodegradable, highly toxic and carcinogen. There are several treatments for the removal of chromium from wastewater, but the most common method involves reduction to its less toxic trivalent state.

In this paper electrocoagulation was used as treatment for removing of hexavalent chromium from synthetic prepared wastewater initial concentration 50 mg/L, in presence of sodium chloride as supporting electrolyte (1 g/L). The treatment was performed in a batch electrochemical reactor 250 mL capacity and with possibility of constant stirring. It was examined the impact of electrode materials and current density (5, 10, 20 mA/cm²) on Cr(VI) removal efficiency. The examination showed that iron has higher removal efficiency compared to aluminium. Also, it was observed high efficiency at very begin of treatment and at low current density. For 20 minutes of treatment it was achieved almost complete Cr(VI) removal at current density of 5 mA/cm² by using iron electrodes ($E_r = 99.8\%$).

Keywords: removal efficiency, current density, iron anode.

FITOREMEDIJACIJSKI POTENCIJAL KUKURUZA (*ZEA MAYS*) ZA ZEMLJIŠTE KONTAMINIRANO TEŠKIM METALIMA

JASMINA IBRAHIMPASIĆ*, VILDANA JOGIĆ, AIDA DŽAFEROVIĆ, HALID MAKIĆ, MERIMA
TOROMANOVIĆ, SAMIRA DEDIĆ

Biotechnical Faculty, University of Bihać, Ul. Luke Marjanovića bb, Bihać

* jasmina.ibrahimpasic@unbi.ba

Zagađenje teškim metalima značajan je ekološki problem i ima negativan utjecaj na zdravlje ljudi i poljoprivredu.

Fitoremedijacija se u posljednje vrijeme javlja kao efikasna tehnologija remedijacije teških metala. Za ispitivanje fitoremedijacijskog potencijala, proveden je eksperiment, gdje je praćen utjecaj visoke i niske koncentracije teških metala, olova, kadmija i cinka (Pb, Cd i Zn) na fenološke karakteristike kukuruza (*Zea mays*), kao i akumulacija istih u podzemnom i nadzemnom dijelu. Eksperiment je proveden u vanjskim uvjetima u saksijama u kojima je zasađen kukuruz, a zemljište kontaminirano teškim metalima u koncentracijama ispod i iznad maksimalno dopuštene koncentracije propisane Pravilnikom. Ispitan je akumulacijski potencijal, rast biljke i sposobnost preživljavanja ovisno o različitim koncentracijama teških metala. Eksperiment je trajao 45 dana. Obradom rezultata utvrđene su statistički značajne razlike u razvijenosti biljke, kao i samoj masi biljke ovisno od primjenjene koncentracije, ali i apsorpciji teških metala u pojedinim dijelovima biljaka. Najviša koncentracija Zn zabilježena je u nadzemnom dijelu biljke, stabljika u količini od 24,443 mg/kg, a najniža koncentracija u listu 0,216 mg/kg. Najviše koncentracije Cd i Pb zabilježene su u korjenu, za olovo 26,610 mg/kg i u stabljici za kadmij 30,490 mg/kg, što je statistički značajno viša utvrđena vrijednost u odnosu na druge dijelove biljke.

Cljučne riječi: fitoremedijacija, Kukuruz (*Zea mays*), teški metali

BIOPOLIMERNE NANOČESTICE I JESTIVI BARIJERNI FILMOVI NA BAZI ZEINA

LJILJANA SPASOJEVIĆ*, JELENA ŠKRBIĆ, SANDRA BUČKO, JADRANKA FRAJ, JELENA MILINKOVIĆ BUDINČIĆ, LIDIJA PETROVIĆ, JAROSLAV KATONA

Univerzitet u Novom Sadu, Tehnološki fakultet Novi Sad, Bul. cara Lazara 1, 21000 Novi Sad, Srbija
lj.spasojevic@tf.uns.ac.rs*

Univerzitet u Novom Sadu, Tehnološki fakultet Novi Sad, Bul. cara Lazara 1, 21000 Novi Sad, Srbija
jelenaskrbic94@uns.ac.rs

Univerzitet u Novom Sadu, Tehnološki fakultet Novi Sad, Bul. cara Lazara 1, 21000 Novi Sad, Srbija
sandranj@uns.ac.rs

Univerzitet u Novom Sadu, Tehnološki fakultet Novi Sad, Bul. cara Lazara 1, 21000 Novi Sad, Srbija
jadrnkam@gmail.com

Univerzitet u Novom Sadu, Tehnološki fakultet Novi Sad, Bul. cara Lazara 1, 21000 Novi Sad, Srbija
jelenamilinkovic@uns.ac.rs

Univerzitet u Novom Sadu, Tehnološki fakultet Novi Sad, Bul. cara Lazara 1, 21000 Novi Sad, Srbija
lidijap@uns.ac.rs

Univerzitet u Novom Sadu, Tehnološki fakultet Novi Sad, Bul. cara Lazara 1, 21000 Novi Sad, Srbija
jaroslav.katona@uns.ac.rs

Zein je protein, koji se može naći u žitaricama, a osnovni izvor ovog proteina je kukuruz (*Zea mays*). Nije rastvoran u vodi, a za njegovo rastvaranje najčešće se koristi razblaženi etanol. Smanjenjem koncentracije etanola u rastvoru, zein može formirati različite koloidne strukture, koje pokazuju veliki potencijal za primenu u prehrambenoj industriji. Stoga, osnovni cilj istraživanja u okviru ovog rada bio je da se ispita mogućnost i uslovi formiranja nanočestica na bazi zeina, kao i mogućnost formiranja filmova zeina iz disperzija nanočestica. Nanočestice na bazi zeina pripremane su metodom precipitacije usled smanjenja rastvorljivosti. Ispitani su uslovi pripreme nanočestica na njihove koloidne osobine. Pripremani su filmovi iz disperzija sa nanočesticama različitog prosečnog prečnika, sa i bez plastifikatora. Ispitan je uticaj veličine čestica zeina i uticaj plastifikatora na morfologiju, barijerna i optička svojstva filmova. Utvrđeno je da se metodom precipitacije u nerastvaraču mogu dobiti nanočestice zeina, a da se na veličinu nanočestica može uticati koncentracijom osnovnog etanolnog rastvora. Takođe, pH vrednost disperzije nanočestica utiče na koloidne osobine nanočestica. Pokazano je da je moguće pripremiti kontinualne zeinske filmove iz disperzija nanočestica, sušenjem na vazduhu. Utvrđeno je da morfološka, barijerna i optička svojstva filmova zavise od veličine čestica u disperziji, kao i od prisustva plastifikatora.

Ključne riječi: zein; biopolimeri; nanočestice; barijerni filmovi.

INDUSTRIAL WASTE – AN ALTERNATIVE MATERIALS FOR SUSTAINABLE WATER AND WASTEWATER TREATMENT

MIRNA HABUDA-STANIĆ^{1*}, RAMZIJA CVRK², SABINA BEGIĆ²

¹Josip Juraj Strossmayer University of Osijek, Faculty of Food Technology Osijek, F. Kuhača 18, Osijek, Croatia

* habudastanic@gmail.com

²Faculty of Technology, University of Tuzla, Urfeta Vejzagića 8, Tuzla, Bosnia and Herzegovina

The worldwide waste generation by 2050 will increase up to 3.4 billion metric tons as the result of population and economic growth, urbanization, as well as consumer shopping demands and habits and this a major worldwide issue still waiting for right and efficient solutions.

Industrial waste presents the group of waste materials which has been produced during the various industrial processes and due to the scientist's estimations, a total worldwide generation of industrial waste per capita is about 1.74 tons per year. A special fast-growing trend of industrial waste is noted in developing countries.

Industrial waste can be generally divided as nonhazardous and hazardous, and recyclable and non-recyclable waste. Significant percentage of nonhazardous industrial generated waste can be used as alternative materials for production of adsorbents and chemicals that can be efficiently applied in water and wastewater treatments.

The aim of this study is to present the possibility of industrial waste reuse, especially in the purpose of water and wastewater treatment processes.

Keywords: industrial waste, reuse, water treatment, wastewater treatment

DEVELOPMENT AND ANALYSIS OF BIOFUEL BASED ON FAST-GROWING TREE AND THE POSSIBILITY OF ITS USE AS AN ALTERNATIVE FUEL IN THE CEMENT INDUSTRY

AMILA DUBRAVAC¹, KENAN HADŽIĆ², ZEHRUDIN OSMANOVIĆ³

¹University of Tuzla, Faculty of Technology, department of Chemical engineering, Urfeta Vejzagića 8, 75000 Tuzla, dubravac.amila@gmail.com

²University of Tuzla, Faculty of Technology, department of Chemical engineering, Urfeta Vejzagića 8, 75000 Tuzla, kenohadzic@live.com

³University of Tuzla, Faculty of Technology, department of Chemical engineering, Urfeta Vejzagića 8, 75000 Tuzla, zehrudin.osmanovic@untz.ba

The process of cement production involves the release of a lot of gases and some of them are CO₂ and NO₂. It is estimated that 5% of worldwide CO₂ emission come from the cement industry. The emission of greenhouse gases and air pollutants from the plant is a serious problem and it is expected to deteriorate in the future. In particular, CO₂ is the third largest air pollutant in the world (ECJRC & NEAA, 2011). The use of alternative fuels in the cement industry can reduce the price of the final product. 'Alternative fuels', in relation to directive 2014/94, represent fuels or energy sources that serve, at least in part, as a substitute for fossil fuel sources in the supply of energy to the industrial sector and contribute to decarbonisation and to improving the environmental efficiency of the industrial sector. Paulownia Elongata is specific for its extremely fast growth.. The application of Paulownia Elongata for decorative purposes represents only one of its possible uses. Extremely rapid growth, survival in soil that is basically contaminated with heavy metals, the possibility of absorbing CO₂ in an amount that is ten times higher than the basic one opens the field of its use for the purpose of biomass, which by burning as end results will give high-quality low-cost biofuel. By directly using this tree as a biofuel, great importance is also realized in the environmental segment by restoring the soil after the root of the plant absorbs a certain amount of heavy metals as well as reducing CO₂ emissions into the air. This paper presents an overview of alternative fuels in the cement industry and the use of them, with an emphasis on biomass and trees. Also, a direct comparison of the characteristics of the alternatives with fossil fuels is presented. Soil testing, which was contaminated with various pollutants, was carried out. An elementary analysis of seedlings growing on soil was carried out. After the resulting analysis, a calculation was made and it was based on the clerk's cement plant, where part of the primary fuel (coal) is replaced by Paulownia Elongata tree.

Keywords: biofuel, Paulownia Elongata, CO₂, cement industry, air pollution

THE POSSIBILITY OF RE-USE THE WASTE STREAM CONDENSATE FROM DRUMS FOR EXTINGUISHING LIME IN THE PROCESS OF SODA PRODUCTION

HANA ALIHODŽIĆ*¹, ABDEL ĐOZIĆ², NISAD AVDIĆ³

*¹TQM d.o.o Lukavac, Institute for quality, standardization and ecology, 75300 Lukavac, BiH, e-mail:

alihodzichana0@gmail.com

²University of Tuzla, Faculty of Technology, 75000 Tuzla, BiH

³Sisecam soda Lukavac, 75300 Lukavac, BiH

In the "Sisecam Soda Lukavac" factory, the production of soda is carried out according to the Solvay process using an aqueous solution of sodium chloride and calcium carbonate. As the sources of soda in the world are quite limited, efforts are being made to increase its production capacity. However, by increasing the production capacity, it is necessary to provide larger quantities of industrial water, which ultimately results in higher consumption of fresh water from the natural accumulation Modrac. The main goal of this paper is to show the possibility of reusing the waste stream condensate from the process unit of mixing the aqueous solution of calcium hydroxide (lime milk) by installing a barometric condenser that works on the direct contact principle between the refrigerant and the steam. By reusing this waste condensate significant operational and environmental improvements would be achieved, as well as economic savings, as well as return on investment after five years.

Keywords: soda production, waste stream, condensate, water, reuse

MIKROKAPSULACIJA U SISTEMU HITOZAN/NATRIJUM-DODECIL-SULFAT, UTICAJ METODE DOBIJANJA

JELENA MILINKOVIĆ BUDINČIĆ*, LIDIJA PETROVIĆ, MILIJANA ALEKSIĆ, JADRANKA FRAJ, SANDRA BUČKO, JAROSLAV KATONA, LJILJANA SPASOJEVIĆ, JELENA ŠKRBIĆ

Tehnološki fakultet Novi Sad, Univerzitet u Novom Sadu, Bulevar cara Lazara 1, 21000 Novi Sad, jelenamilinkovic@uns.ac.rs, lidijap@uns.ac.rs, maja.maki16@gmail.com, jadranka@uns.ac.rs, sandranj@uns.ac.rs, jaroslav.katona@uns.ac.rs, ljiljanas@uns.ac.rs, jelenaskrbic94@uns.ac.rs

Mikrokapsulacija je jedna od najvažnijih tehnika za očuvanje osjetljivih i nestabilnih supstanci i njihovo kontrolisano oslobađanje. Uspješnost inkorporiranja aktivne materije zavisi od mnogo faktora među kojima su najznačajniji pravilan izbor materijala omotača i metode mikrokapsulacije. Ukoliko se za stabilizaciju emulzionih sistema koriste prirodni, biorazgradivi polimeri ili njihove smeše sa površinski aktivnim supstancama, oni predstavljaju dobru osnovu za dobijanje mikrokapsula uljnog sadržaja. Hitozan, katjonski biopolimer koji zbog svojih izuzetnih fizičko-hemijskih osobina, izrazite biokompatibilnosti i mogućnosti dobijanja iz obnovljivih izvora poslednjih godina privlači sve veću pažnju. S obzirom na izrazitu netoksičnost, biodegradabilnost, antibakterijsko i antivirusno delovanje, hitozan se široko primenjuje u proizvodima kozmetičke, farmaceutske i prehrambene industrije. U ovoj studiji ispitivane su 20% U/V emulzije (veličina i raspodela veličina kapi, stabilnost tokom vremena). Emulzije su dobijene na dva načina. Prvi način pripreme odnosi se na emulgovanje triglicerida srednje dužine ugljovodoničnog lanca-kaprinske i kaprilne kiseline u vodenom rastvoru smeše hitozana i anjonske površinski aktivne supstance, natrijum-dodecil-sulfata (SDS), dok je drugi način zasnovan na naknadnom ukapavanju hitozana u već pripremljenu emulziju sa SDS. Mikrokapsule su dobijene metodom sušenja raspršivanjem. Na osnovu dobijenih rezultata, prva metoda je pokazivala veći prinos i može se primeniti u farmaceutskoj i prehrambenoj industriji za pripremu mikrokapsula uljnog sadržaja.

Ključne riječi: hitozan; natrijum-dodecil-sulfat; emulzije; mikrokapsule

THERMODYNAMICS OF METHYL ORANGE ADSORPTION FROM AQUEOUS SOLUTION USING Zn-BASED MIXED OXIDES

DJURDJICA KARANOVIC, MILICA HADNADJEV KOSTIC, ALEKSANDAR JOKIC AND TATJANA VULIC

University of Novi Sad, Faculty of Technology Novi Sad, bul. cara Lazara 1, Novi Sad, Serbia
djurdjicakaranovic@uns.ac.rs, hadnadjev@uns.ac.rs, jokic@uns.ac.rs, tvulic@uns.ac.rs

Organic dyes released in the water from various industries, represent a serious concern regarding environmental pollution. One of the most effective processes for the removal of dyes from aqueous solution is adsorption. Non-stoichiometric mixed oxides derived from layered double hydroxides (LDHs) have properties desirable for their application in the adsorption processes.

Thermodynamics of the Methyl Orange (MO) adsorption by mixed oxides (ZnAl-C and ZnCuAl-C) was studied. For material characterization structural (XRD) and Fourier-Transform Infrared Spectroscopy analyses were conducted. Mixed oxides were obtained by LDHs calcination at 500°C. Experiments were carried out in the dark using an open pyrex reaction vessel containing 100 ml of MO solution ($C_{MO} = 200-600$ mg/L) and 50 mg of adsorbents. After the equilibrium was reached, the MO concentrations were measured at different temperatures (20°C, 40°C, 60°C) using the UV-VIS spectrophotometer at 464 nm.

The structural analysis revealed typical mixed-oxides XRD reflections that were additionally confirmed by FTIR spectra. The thermodynamic parameters were determined by the best fit of the experimental data from the Langmuir isotherm model indicating that the adsorption process was exothermic ($\Delta_r H < 0$) and spontaneous ($\Delta_r S > 0$).

Keywords: wastewater treatment, Langmuir adsorption isotherm model, thermodynamic parameters, Gibbs free energy.

Acknowledgment: The financial support from the Provincial Secretariat for Higher Education and Scientific Research (Contract No. 142-451-2341/2021-01/02) is gratefully acknowledged.

QUALITY OF DOMESTIC COW'S CHEESES PRODUCED BY HEAT TREATMENT OF MILK

SUZANA JAHIĆ*, SEBILA REKANOVIĆ, SEMRA DURANOVIĆ

Biotechnical faculty, University of Bihać, Luke Marjanovića bb, 77 000 Bihać,

suzanajahic2002@gmail.com

Biotechnical faculty, University of Bihać, Luke Marjanovića bb, 77 000 Bihać,

sebilarekanovic@outlook.com

Biotechnical faculty, University of Bihać, Luke Marjanovića bb, 77 000 Bihać,

semra.duranovic23@gmail.com

Una - Sana Canton with geographical and climatic characteristics abounds in different types of cheese produced from cow 's milk. This paper presents the production process and the results of chemical and sensory analysis of three types of domestic cow's cheeses, where we used acetic acid (80%) and whey for milk coagulation, whit heating temperature of milk ranged from 90°C to 95°C, and for the third type of cheese, we coagulated the milk using our own microflora, where the heating temperature ranged from 50°C to 55°C. Cheeses obtained by coagulation of milk using their own microflora and whey could be classified as semi-soft soft cheeses, and cheese obtained by coagulation of milk with 80% acetic acid in the group of semi-hard cheeses. Sensory analysis of the cheeses showed that the cheese obtained by coagulation of milk with 80% acetic acid had the highest total score of 94.10; followed by cheese obtained by coagulation of milk by its own microflora with 84.16 points, and the lowest number of points 81.92 was obtained by cheese obtained by coagulation of milk by whey.

Keywords: domestic cow's cheeses, heat treatment, chemical and sensory analysis

Poster presentation

INFLUENCE OF PROCESS PARAMETERS ON THE PRODUCTION OF TRICHODERMA BIOCONTROL AGENT

IVANA MITROVIĆ*, SONJA TANČIĆ ŽIVANOV, BOŽANA PURAR, ZORANA TRIVUNOVIĆ,
BOJAN MITROVIĆ

Faculty of Technology Novi Sad, University of Novi Sad, Bulevar cara Lazara 1, Novi Sad 21000,

Serbia, * tadi@uns.ac.rs

ron@uns.ac.rs

Institute of Field and Vegetable Crops, Maksima Gorkog 30, Novi Sad 21000, Serbia,

sonja.tancic@nsseme.com

bozana.purar@gmail.com

bojan.mitrovic@ifvcns.ns.ac.rs

Maize is an agricultural crop that is susceptible to infections by various phytopathogenic fungi, producers of mycotoxins harmful to humans and animals. Since this agricultural crop has an important place in the human diet, its health safety is very important. *Trichoderma* genus has great potential in the biocontrol of various phytopathogens however, the medium composition as well as the cultivation conditions, have a significant impact on the efficiency of the produced *Trichoderma* bioagents. In this work, influence of medium pH, temperature and mixing speed on the productivity of *Trichoderma* bioagent effective against two maize pathogens, *Fusarium graminearum* and *Aspergillus flavus*, was investigated. The results obtained by statistical processing show that the best productivity of *Trichoderma harzianum* bioagent was achieved when the pH of the medium was 6, the temperature was 28°C and the mixing speed of the rotary shaker was 180 rpm. By applying these cultivation conditions, the largest inhibition zone diameters of *F. graminearum* and *A. flavus* mycelial growth were formed. Also, the results show that the maize pathogen, *F. graminearum*, was more sensitive to the produced *Trichoderma* biocontrol agent compared to the other maize pathogen, *A. flavus*.

Keywords: *Trichoderma harzianum*; Bioprocess; Process parameters; pH; Temperature; Mixing.

Acknowledgements. This work was supported by the Ministry of Education, Science and Technological development of the Republic of Serbia (451-03-9/2021-14/200134), and the Provincial Secretariat for Higher Education and Scientific Research, Autonomous Province of Vojvodina, Republic of Serbia. (142-451-3213/2020-03).

Poster presentation

STUDIJA ANTIBAKTERIJSKOG I ANTIOKSIDATIVNOG DJELOVANJA KOMERCIJALNIH ETERIČKIH ULJA

EMIR HOROZIĆ¹, ENIDA KARIĆ², MERIMA IMAMOVIĆ³, EDINA HUSEINOVIĆ⁴, DARJA HUSEJNAGIĆ⁴, EDITA BJELIĆ¹

¹ Tehnološki fakultet, Univerzitet u Tuzli, Urfeta Vejzagića 8, 75 000 Tuzla, Bosna i Hercegovina

² Farmaceutski fakultet, Univerzitet u Tuzli, Urfeta Vejzagića 8, 75 000 Tuzla, Bosna i Hercegovina

³ JZU Dom zdravlja Lukavac, Kulina bana, 75 300 Lukavac, Bosna i Hercegovina

⁴ Prirodno-matematički fakultet, Univerzitet u Tuzli, Urfeta Vejzagića 4, 75 000 Tuzla, Bosna i Hercegovina

emir.horozic@untz.ba

Eterična ulja su prirodni proizvodi koji sadrže mnoge biološki aktivne organske spojeve. Zbog toga se često ispituju kao potencijalni antioksidansi, antimikrobni i antitumorski preparati koji bi u određenoj mjeri mogli zamijeniti klasične sintetičke lijekove koji se koriste za liječenje različitih patoloških stanja. U ovom radu ispitivano je antioksidativno i antibakterijsko djelovanje eteričih ulja limuna, kedra, eukaliptusa, smilja, pelina i čajevca, dostupnih u marketima s područja grada Tuzle. Učinkovitost neutralizacije slobodnih radikala određena je spektrofotometrijskom metodom, dok je antibakterijski potencijal određen difuzijskom tehnikom na referentnim bakterijskim sojevima. Za eterična ulja koja su pokazala antibakterijsko djelovanje, određena je minimalna inhibitorna koncentracija (MIC). Rezultati su pokazali da komercijalna eterična ulja imaju visoku sposobnost neutraliziranja DPPH radikala u *in vitro* uslovima. Difuzijska tehnika potvrdila je visoku antibakterijsku aktivnost za eterična ulja čajevca, eukaliptusa, smilja i pelina, dok su eterična ulja limuna i kedra pokazala izrazito slabo antibakterijsko djelovanje.

Ključne riječi: eterična ulja; *in vitro* studija; DPPH, difuziona tehnika; MIC

DETERMINATION OF POLYPHENOLIC CONTENT AND ANTIOXIDANT ACTIVITY OF *CUCURBITA PEPO L.* LEAVES EXTRACTS OBTAINED BY ULTRASONIC EXTRACTION

LAMIJA KOLAREVIĆ*¹, EMIR HOROZIĆ², ZAHIDA ADEMOVIĆ²

¹ Faculty of Pharmacy, University of Tuzla, Urfeta Vejzagića 8, 75000 Tuzla, Bosnia and Herzegovina
lamijak@live.com

² Faculty of Technology, University of Tuzla, Urfeta Vejzagića 8, 75000 Tuzla, Bosnia and Herzegovina
emir.horozic@untz.ba, zahida.ademovic@untz.ba

Bioactive ingredients from plants can have an influence on physiological functions in humans. Pumpkin (*Cucurbita pepo L.*) is considered a medicinal plant, as its plant parts are rich in bioactive substances. Extraction is an important step during phytochemical treatment. The extraction yield and antioxidant capacity depend on the choice of solvent, the conditions under which the process is performed and the extraction method used. Methanol, ethanol, acetone, and water are the most commonly used solvents for phenol extraction.

The aim of this study was to determine the antioxidant activity and its correlation with the polyphenolic content in pumpkin leaf extracts (*Cucurbita pepo L.*). Dried and grounded pumpkin leaves were used as extraction material. Various solvents (water, methanol, ethanol and acetone) and their aqueous mixtures, in a ratio of 50:50 (v/v) were used for extraction. The influence of solvents on the phenolic extraction, as well as the effect of ultrasonic extraction was investigated. The total phenolic content was determined by the Folin-Ciocalteu method and the antioxidant activity of the extracts by FRAP and DPPH methods. Total phenolic content is expressed as gallic acid equivalent (GAE) in milligrams per gram of sample. The FRAP value was calculated from the calibration curve of iron (II) sulphate heptahydrate and expressed in $\mu\text{mol/g}$. The results of the DPPH method are expressed as a percentage inhibition of DPPH radicals.

The obtained results indicate the importance of choosing an adequate extraction solvent for the phenolic isolation from plant material. Mixtures of organic solvents and water, especially mixture of water and acetone, have been shown to be the most suitable for the extraction of phenolic compounds. At the same time, a positive correlation was established between the content of total phenols and the antioxidant activity of the extracts. This suggests that phenols significantly contribute to the antioxidant properties of pumpkin leaves. The results also showed the potential medicinal properties of pumpkin leaves, even though further studies are needed to identify, characterize and isolate different bioactive components, which could be used as a basis for obtaining new drugs to treat various diseases.

Keywords: pumpkin; extraction; UAE; phenolic compounds; antioxidant activity

THE EVALUATION OF ANTIOXIDANT ACTIVITY AND TOTAL PHENOLIC CONTENT OF *LYSIMACHIA VULGARIS* L. EXTRACTS

LEJLA MEKIĆ¹, EMIR HOROZIĆ², ERMINA CILOVIĆ KOZAREVIĆ³

¹ Faculty of Pharmacy, University of Tuzla, Urfeta Vejzagića 8, 75000 Tuzla, Bosnia and Herzegovina, mekic.lejla1998@gmail.com

² Faculty of Technology, University of Tuzla, Urfeta Vejzagića 8, 75000 Tuzla, Bosnia and Herzegovina, emir.horozic@untz.ba

³ Faculty of Pharmacy, University of Tuzla, Urfeta Vejzagića 8, 75000 Tuzla, Bosnia and Herzegovina, ermina.cilovic@untz.ba

Lysimachia vulgaris (Yellow loosestrife) is well-known for its anti-inflammatory, hemostatic and antidiarrhoeic activity. It is most widespread on territory of Euroasia, where its traditional medicinal use has been reported. Due to the plant invasiveness, it is undesirable plant in the other parts of the world. The aim of this study was to determine the influence of different solvents and extraction techniques on antioxidant activity and the total phenolic content of selected plant. The polyphenol content of plant extracts was examined using the Folin-Ciocalteou method, the results were expressed in mg GAE / g. Antioxidant activity of selected plant was also determined, using DPPH and FRAP methods. Extracts of different polarities were prepared using methanol and acetone. Extraction was performed by maceration and ultrasonic extraction. The results of the study show that Yellow loosestrife possesses antioxidant activity, where methanolic extracts showed the highest antioxidant potential. The different antioxidant activity of the prepared extracts confirms the influence of solvents and extraction methods on the utilization of the antioxidant potential of plants.

Keywords: *Lysimachia vulgaris* (Yellow loosestrife); antioxidative activity; DPPH; FRAP; total phenolic content

Poster presentation

EFFICIENCY OF DEGREASING BY DISHWASHING DETERGENTS

ALEKSANDRA BORKOVIĆ^{1*}, PERO DUGIĆ¹, TATJANA BOTIĆ¹, SANJA TATIĆ², DAJANA MARKULJEVIĆ³, DIJANA DRLJAČA¹, DAJANA DRAGIĆ¹

¹University of Banja Luka, Faculty of Technology, Stepe Stepanovića 73, 78 000 Banja Luka, BiH * aleksandra.sinik@tf.unibl.org, pero.dugic@tf.unibl.org, tatjana.botic@tf.unibl.org, dijana.drljaca@tf.unibl.org, dajana.dragic@tf.unibl.org

² EURO-INSPEKT d.o.o., Osječani bb, 74 225 Osječani, Dobož, BiH, sanjatatic@live.com

³ALCON/CIBA VISION GmbH, Industriering 1, 63 868 Großwallstadt, Deutschland, dajanamarkuljevic1994@yahoo.com

Consumption of agents for manual and machine washing of dishes is constantly increasing. Although the growth of the use of dishwashers is evident, hand dishwashing is still dominant in our region. A good dishwashing detergent must effectively remove food residues and degrease the surface of dishes, made of different materials, while the surfaces of washed dishes should remain smooth, shiny with a pleasant smell of freshness. The requirements of consumers-users of these funds are, in addition to the listed basic functions, also practicality of handling and dosing, pleasant smell and mild action on the hands and acceptable price. The aim of this paper is to examine the degreasing efficiency of commercial detergents from our market on four types of fats. In addition to commercial dishwashing detergents, whose composition is known only roughly indicated in the declaration producer, was tested a laboratory prepared sample with exactly known composition. All tests of the degreasing ability of dishes with different types of impurities were performed under the same conditions with a change in the concentration and type of detergent, and according to the method used by some industrial detergent manufacturers. It was found that in addition to the concentration of detergent in the washing solution, the degreasing efficiency is affected by the type and concentration of surfactants, as well as auxiliary components that are part of the product.

Keywords: degreasing; fat; dishwashing detergents; surfactant

Poster presentation

THE IMPACT OF KERAS OPTIMIZERS ON THE RUBBER CURING PREDICTION

JELENA LUBURA*, DARIO BALABAN, PREDRAG KOJIĆ, JELENA PAVLIČEVIĆ, BOJANA IKONIĆ, OSKAR BERA

Jelena Lubura*, University of Novi Sad, Faculty of Technology, Bul. cara Lazara 1, 21000 Novi Sad, Serbia, jelenalubura@uns.ac.rs

Dario Balaban, University of East Sarajevo, Faculty of Technology Zvornik, Karakaj 34A, 75400 Zvornik, Republic of Srpska, dario.balaban@tfzv.ues.rs.ba

Predrag Kojić, University of Novi Sad, Faculty of Technology, Bul. cara Lazara 1, 21000 Novi Sad, Serbia, kojicpredrag@uns.ac.rs

Jelena Pavličević, University of Novi Sad, Faculty of Technology, Bul. cara Lazara 1, 21000 Novi Sad, Serbia, jpavlicevic@uns.ac.rs

Bojana Ikonić, University of Novi Sad, Faculty of Technology, Bul. cara Lazara 1, 21000 Novi Sad, Serbia, bojana.ikonik@uns.ac.rs

Oskar Bera, University of Novi Sad, Faculty of Technology, Bul. cara Lazara 1, 21000 Novi Sad, Serbia, obera@uns.ac.rs

Efficient vulcanization process in rubber industry strongly depends on the successfully obtained rheological properties. Therefore, the aim of this study was developing and investigating Machine Learning (ML) model to predict samples' vulcanization of commercially available rubber. Oscillating disc rheometer was used to investigate experimental dependence of torque on time, at six temperatures. The model was developed using TensorFlow with Keras, in a Python framework, with two hidden layers containing 20 neurons, where the model and activation function were Sequential and Softplus, respectively. The optimizer was varied in order to investigate their impact on the curing prediction. The following optimizers were used: adadelta, adagrad, adam, adamax and nadam, where the model with adam optimizer showed the best results. The training of the network was conducted at 140, 160, 180 °C, and experimental data at 130 °C, 150, 170 °C were used for determining numerical error. Proposed ML model was used to predict torque dependence on time at two temperatures in the range (150, 170 °C) and one extrapolated temperature (130 °C). Obtained solutions were confirmed as accurate prediction using different numerical methods at all tested temperatures, where MAPE and MSE values were less than 1.99% (and 5.7% for extrapolated temperature).

Keywords: Vulcanization, Rubber, Keras, Machine learning

MICROBIOLOGICAL ACTIVITY OF JUNIPER BERRY ESSENTIAL OIL (*JUNIPERUS COMMUNIS L.*) EMULSIONS AND MICROCAPSULES

JELENA D. BAJAC^{1*}, BRANISLAVA G. NIKOLOVSKI¹, SUNČICA KOCIĆ-TANACKOV¹, EMILJA KOVAČEVIĆ¹, LIDIJA B. PETROVIĆ¹

¹University of Novi Sad, Faculty of Technology, Bulevar cara Lazara 1, 21000 Novi Sad, Serbia, ilicj@uns.ac.rs

Microencapsulation of juniper berry essential oil has been used for protection of essential oil volatiles, giving the possibility of their implementation as a food flavouring agent and preservative. The antioxidant, antimicrobial, antiseptic and antifungal properties of juniper berry essential oil makes it attractive ingredient for food protection from existing pathogens. In this work, the microbiological activity of juniper berry essential oil (JBEO), JBEO emulsions and microcapsules prepared with different wall materials (gum arabic, maltodextrin and whey protein) against three common food pathogens were investigated. Their activity on growth of *Listeria monocytogenes*, *Salmonella Typhimurium* and *Bacillus cereus* using disc-diffusion method and micro-dilution method were determined. The juniper berry essential oil showed inhibition zone of 8, 11 and 11 mm and minimal inhibitory concentration (MIC) of 56.82, 113.64 and 113.64 µl/ml for *Listeria monocytogenes*, *Salmonella Typhimurium* and *Bacillus cereus*, respectively. Applied JBEO emulsions with gum arabic as a carrier have shown the zone of inhibition between 8 and 10 mm (MIC was 454.54 and ≥ 454.54 µl/ml) for all of investigated bacteria. The antimicrobial activity of microcapsules was investigated in saline. Prepared JBEO microcapsules have reduced the number of microorganisms after 24h of incubation at 37 °C, but the used carrier type did not have a pronounced effect.

Keywords: juniper berry essential oil; emulsion; microencapsulation; antimicrobial activity.

UTICAJ BRZINE HLADNOG PREŠANJA SJEMENKI SIKAVICE (*SILYBUM MARIANUM*) NA KVALITET ULJA I STEPEN DJELOVANJA PREŠE

SEBILA REKANOVIĆ*, HALID MAKIĆ, ELVISA HODŽIĆ, SMIRA DEDIĆ, IFET ŠIŠIĆ

Biotehnički fakultet Univerziteta u Bihaću, Bihać, e-mail: sebilarekanovic@outlook.com

Sikavica (*Silybum Marianum*) je ljekovita biljka koja se od davnina koristi za pripremu biljnih ekstrakata za liječenje različitih bolesti poput poremećaja jetre i žučnog mjehura. Najveće količine aktivnih sastojaka se dobivaju iz sjemena biljke. Sjeme sadrži približno 70 do 80 % silimarina (biljni lijek na bazi sikavičnog ploda) i 20 do 30% hemijski nedefinirane frakcije sastavljene od polimernih i oksidiranih polifenola.

U procesu proizvodnje silimarina, ulje sikavice je nusprodukt, međutim zbog raznih sastojaka u ulju koji su korisni u prevenciji različitih oboljenja i promicanju zdravlja, hladno prešano ulje sikavice se sve češće proizvodi i upotrebljava.

Cilj ovog rada odnosio se na ispitivanje utjecaja procesnih parametara prešanja sikavice (*Silybum Marianum*) na iskorištenje i kvalitetu hladno prešanog ulja. Proces prešanja sjemenki sikavice (*Silybum marianum*) proveden je na kontinuiranoj pužnoj preši (poljoprivredno gazdinstvo Gerzić iz Bosanske Krupe). Prešanjem sikavice (*Silybum Marianum*) dobivena su tri proizvoda: sirovo ulje, uljni talog i pogača. Tokom prešanja mjenjani su procesni parametri: frekvencija elekromotora (brzina pužnice), temperatura glave preše i nastavak za izlazak pogače. Nakon procesa hladnog prešanja sjemenki, ispitivani su osnovni parametri kvalitete ulja: peroksidni broj, jodni broj, sadržaj slobodnih masnih kiselina, udio vlage i netopljivih nečistoća. Na temelju dobivenih rezultata istraživanja, možemo zaključiti da procesni parametri hladnog prešanja utječu na iskorištenje ulja.

Ključne riječi: sjemenke sikavice (*Silybum Marianum*), hladno prešano ulje, procesni parametri, kvaliteta ulja

Poster presentation

CURRENT APPROACHES OF BIOTECHNOLOGICAL PRODUCTION OF CAROTENOIDS

VANJA ŠEREGELJ, NEMANJA ŠPIRIĆ*, OLJA ŠOVLJANSKI, GORDANA ČETKOVIĆ, VESNA TUMBAS ŠAPONJAC, ANA TOMIĆ, ALEKSANDRA RANITOVIĆ, SINIŠA MARKOV

University of Novi Sad, Faculty of Technology Novi Sad, Novi Sad, Serbia

Nutritionally and energy-rich foods are directly related to stronger immunity, longevity and reduced risk of developing chronic diseases. However, modern life dictates the use of quickly prepared food, which satisfies only the basic needs. For these reasons, research is increasingly focused on the production and application of food with improved nutritional composition. Carotenoids are one of the most common classes of pigments with significant biological characteristics that occur in nature. They represent valuable molecules in chemical, pharmaceutical, and food industries. These pigments also have antioxidant properties. Carotenoid production through chemical synthesis or plant extraction is limited by low yields that result in high production costs. Additionally, toxic effects on the consumers are possible. All this leads to research in microbial production of carotenoids, as an alternative that has shown better yields than previously mentioned methods. In addition, the microbial production of carotenoids could be a better option in terms of cost and environment, due to the usage of low-cost substrates such as agro-industrial wastes. The focus of this study is carotenoid-producing microorganisms and the importance of their use in biotechnological production. Special emphasis is given to the genus *Rhodotorula* of great potential in industrial production.

Keywords: pigments; carotenoids; β -carotene; *Rhodotorula*; biotechnological production;

Poster presentation

IMPLEMENTATION OF TECHNOLOGICAL PROCESSES FOR PROCESSING BERRY FRUITS IN ORDER TO OBTAIN NEW PRODUCTS FOR INCREASED MARKET NEEDS

MILENA VUJANOVIĆ¹, GÖKHAN ZENGİN², IVANA BEARA³, VLADIMIR TOMOVIĆ¹,
MILICA STOŽINIĆ¹, SANJA MILOŠEVIĆ¹, MARIJA RADOJKOVIĆ¹

¹University of Novi Sad, Faculty of Technology, Bulevar cara Lazara 1, 21000 Novi Sad, Serbia

milnavujanovic@uns.ac.rs

²Selçuk Üniversitesi, Fen Fakültesi Biyoloji Bölümü, Kampüs/Konya, Turkey

³Faculty of Sciences, University of Novi Sad, Trg Dostiteja Obradovića 3, 21000 Novi Sad, Serbia

Elderberry (*Sambucus nigra* L.) is a common plant used for its medicinal and nutritional properties. In addition to elderberry, guarana is a very attractive plant raw material that is increasingly used as a source of nutritionally valuable molecules. Obtaining products with added value is in the focus of the public, but also of the scientific community. The aim of this study was to obtain new elderberry juice as a potential functional products, using elderberry fruits and powder of guarana. Cold squeezed juice was obtained using ripened elderberry fruits and guarana powder. Nutritional profile, antioxidant and enzyme inhibitor activity of obtained juice were determined. New potential functional product had carbohydrates (3.54 g/100 g), proteins (0.98 g/100 g), and fats (0.06 g/100 g). Content of minerals was high, specially K (4390.80 mg/L). The highest antioxidant activity was achieved by FRAP assay (63.19 mg TE/g). Analyzed juice had great antityrosinase activity (12.68 mg KAE/g), as well as neuroprotective activity (2.14 mg GALAE/g). On the basis of the obtained results that have shown rich nutritional profile, and strong antioxidative and inhibitory enzymatic activity, as well as a high content of total phenols and flavonoids, elderberry juice enriched with guarana powder could be used as food product for different kind of consumers.

Keywords: elderberry; *Sambucus nigra* L.; guarana; functional foods.

Acknowledgments:

The present work is financial supported by Autonomous Province of Vojvodina, project 142-451-2418/2021-01/02, and within the projects of the Serbian Ministry of Education, Science and Technological Development (Project No.451-03-9/2021-14/200134).

ESSENTIAL OIL OF *HELICHRYSUM ITALICUM* AS A POTENTIAL NEW PHYTOPHARM PRODUCT

VLADISLAVA NEBRIGIĆ¹, MILENA VUJANOVIĆ¹, GÖKHAN ZENGİN², SAŠA ĐUROVIĆ³,
MARIJA RADOJKOVIĆ¹

¹Faculty of Technology, University of Novi Sad, Novi Sad, Serbia

²Selçuk Üniversitesi, Fen Fakültesi Biyoloji Bölümü, Kampüs/Konya, Turkey

³Institute of General and Physical Chemistry, Belgrade, Serbia

In recent years, one of the goals in treatment the modern society disease, diabetes type 2, is to inhibit action of enzymes of the digestive system, such as α -amylase, by using natural products. The aim of this study was to determine chemical constituents of the essential oil of *H.italicum* aerial parts by gas chromatography-mass spectrometry and to evaluate its antihyperglycemic activity by inhibition of the α -amylase enzyme. Antioxidant potential was analyzed using *in vitro* antioxidant assays: FRAP, CUPRAC and phosphomolybdenum assay. Investigated oil was characterized by the dominance of sesquiterpenes hydrocarbons and monoterpenes hydrocarbons. The major constituent of the oil was α -pinene (20.37%) followed by α -muurolen (16.95%). Other components presented in significant percentage were trans-caryophyllene, β -himachalene, neryl acetate, β -pathoulene and α -curcumene. Antioxidant activity of the oil was very good in all performed tests. The analysed oil showed great inhibition activity against of α -amylase enzyme (2.07 mmol ACAE/g) which was researched for the first time in this paper. According to the obtained results this oil can be considered as a valuable source of natural antioxidants and indicator that this plant has potential as an additional drug in the treatment of diabetes type 2.

Keywords: essential oil; *H. italicum*; α -amylase;

Acknowledgments:

This research study was supported by the Serbian Ministry of Education, Science and Technological Development (Project No.451-03-9/2021-14/200134).

EFEKTI BISTRENJA DOMAĆEG KUPINOVOG VINA KOMERCIJALNIM BENTONITOM

*ZORAN PETROVIĆ¹, MILICA PETRONIĆ¹, SABINA BEGIĆ², TATJANA BOTIĆ³,
DRAGANA KEŠELJ¹

¹Tehnološki fakultet Univerziteta u Istočnom Sarajevu, Zvornik, zoran.petrovic@tfzv.ues.rs.ba

¹Tehnološki fakultet Univerziteta u Istočnom Sarajevu, Zvornik, milicapetronic5@gmail.com

²Tehnološki fakultet Univerziteta u Tuzli, Tuzla, sabina.begic@untz.ba

³Tehnološki fakultet Univerziteta u Banjoj Luci, Banja Luka, tatjana.botic@tf.unibl.org

¹Tehnološki fakultet Univerziteta u Istočnom Sarajevu, Zvornik, draganakeselj@yahoo.com (10 pt.)

Voćno vino je prehrambeni proizvod dobiven alkoholnim vrenjem voćnog soka ili masulja od svježeg i za to pogodnog koštičavog, jezgričavog, jagodičastog, bobičastog ili ostalog voća, sa minimalnim sadržajem prirodnog alkohola od 1,2 % vol. Pravilnikom o kvalitetu voćnih vina je propisan kvalitet voćnih vina koja se mogu komercijalizovati (organoleptičke karakteristike, sadržaj alkohola, ukupnih kiselina, isparljivih kiselina, ekstrakta, slobodnog i ukupnog sumpor dioksida, pepela itd.). U proizvodnji voćnih vina se mogu koristiti različita sredstva za bistenje, koja ne mijenjaju hemijski sastav, kao i njihov ukus i miris.

Cilj ovog rada je da se ispita uticaj domaćeg komercijalnog bentonita proizvođača „Bentoprodukt“ Šipovo za efikasno bistenje kupinog vina proizvedenog od domaće sorte kupine u jednom seoskom gazdinstvu. Izvršena je dodatna karakterizacija komercijalnog kombinovanog kalcijum-natrijum bentonita savremenim metodama ispitivanja (XRD BET, SEM, laserska metoda za određivanje raspodjele veličina čestica). U laboratorijskim uslovima izvedeno je bistenje domaćeg kupinog vina komercijalnim bentonitom. U cilju ispitivanja efikasnosti bistenja izvršena je uporedna karakterizacija ispitivanog domaćeg kupinog vina i komercijalnog kupinog vina sa domaćeg tržišta (relativna gustina, ukupna kiselost, sadržaj alkohola, ekstrakta, pepela i sumpor dioksida). Rezultati ispitivanja su pokazali da domaći komercijalni bentonit ima dobre adsorpcione osobine i može se koristiti za efikasno bistenje kupinog vina, kao i da su karakteristike ispitivanih vina u skladu sa odgovarajućim Pravilnikom o kvalitetu voćnih vina u BiH. Neke ispitivane karakteristike domaćeg kupinog vina su bolje od karakteristika komercijalnog vina.

Ključne riječi: domaće kupinovo vino, kombinovani kalcijum-natrijum bentonit, bistenje, komercijalno kupinovo vino, karakteristike kupinog vina, savremene metode ispitivanja,

UTICAJ KARAKTERISTIKA I TIPA SIROVE NAFTE NA PRINOS FRAKCIJE GASNOG ULJA

*ZORAN PETROVIĆ¹, BORINKA LISICA², SABINA BEGIĆ³, PERO DUGIĆ⁴, AMIR FAZLIĆ⁵

¹Tehnološki fakultet Univerziteta u Istočnom Sarajevu, Zvornik, zoran.petrovic@tfzv.ues.rs.ba

²Fakulteta za kemiju in kemijsko tehnologiju Ljubljana, Tehnička varnost, Ljubljana, biser.lisica@gmail.com

³Tehnološki fakultet Univerziteta u Tuzli, Tuzla, sabina.begic@untz.ba

⁴Tehnološki fakultet Univerziteta u Banjoj Luci, Banja Luka, pero.dugic@tf.unibl.org

⁵Prirodno-matematički fakultet Sarajevo, Sarajevo, fazlic.amir@smf.unsa.ba

Sirova nafta se razdvaja procesima atmosferske i vakuum destilacije na niz frakcija različitih tačaka ključanja. Prinos pojedinih frakcija zavisi od sastava i fizičko-hemijskih karakteristika nafte, kao i od savremenosti rafinerijske opreme i izbora adekvatnog režima rada. Potražnja proizvoda nafte, a prije svih motornih goriva (benzin, dizel gorivo) i različitih vrsta maziva stalno raste, a istovremeno rezerve kvalitetne nafte se stalno smanjuju. Rafinerije su prinudene da prerađuju naftu različitog kvaliteta ili njihove smješe da bi dobile proizvode adekvatnog kvaliteta. Za ocjenu kvaliteta sirove nafte, odnosno postavljanja odgovarajućeg režima rada rafinerije, provode se laboratorijska i poluindustrijska ispitivanja propisana različitim standardima.

U ovom radu ispitivan je uticaj različitih tipova sirove nafte (5) na prinos i karakteristike frakcije gasnog ulja. Osim različitog hemijskog sastava ove nafte sadrže i različite udjele sumpora, koji utiču i na troškove prerade istih. Određene su destilacione karakteristike sirovih nafti metodom ASTM D86 i TBP (stvarnih tački ključanja) metodom ASTM D2892, te niz fizičko-hemijskih karakteristika propisanih različitim standardima. Na osnovu provedenih istraživanja došlo se do zaključka da se destilacijom sirovih nafti dobija različiti prinos frakcije gasnog ulja. Ispitivan je uticaj režima rada rafinerije za različite mješavine ispitivanih sirovih nafti da bi se dobio najoptimalni prinos željene frakcije gasnog ulja i benzina. Utvrđeno je da kombinacijom različitih tipova nafti može se dobiti najveći prinos frakcije gasnog ulja, odnosno dizel goriva pri dobijena pri mazutskom režimu rada rafinerije.

Ključne riječi: uzorci sirovih nafti, ASTM i TBP destilacija, fizičko-hemijske karakteristike, mazutski režim rada, prinos frakcije gasnog ulja

PROCESS DEVELOPMENT FOR SYNTHESIS OF ADVANCED POLY(METHACRYLATE) ADDITIVES FOR LUBRICATING OILS

MIHOVIL MEDIĆ, LUCIJA REBROVIĆ, FABIO FARAGUNA, ELVIRA VIDOVIĆ, ANTE JUKIĆ*

University of Zagreb, Faculty of Chemical Engineering and Technology,
Trg Marka Marulića 19, Zagreb, Croatia

mmedic@fkit.unizg.hr, lrebrovic@fkit.unizg.hr, ffaragun@fkit.unizg.hr, evidov@fkit.unizg.hr,
ajukic@fkit.unizg.hr

Oil-soluble poly(methacrylate) based polymer additives play a significant role in lubricating base oil properties improvement, where increased viscosity at elevated temperatures ensures sufficient lubricity over a broad temperature range. Methacrylates with medium size lateral alkyl groups (C₁₀–C₁₄) enhance viscosity index and those with the long chain groups (C₁₆–C₁₈) mostly contribute to the lowering of the pour point of solutions, whereas the methyl group contributes to the stiffness of the polymer chain.

To simulate industrial process, polymerizations were conducted in batch reactor directly in base oil. Mixture of monomers (different methacrylates: methyl methacrylate, *N,N*-dimethylaminoethyl methacrylate, dodecyl methacrylate, octadecyl methacrylate and styrene) was added to mineral or synthetic polyalphaolefin base oil and in this way, after the polymerization, product is ready for dilution and packaging.

Chain transfer agent and different initiator types were used to tailor the product toward more shear stable additive with lower molar mass. To confirm the molar mass of polymers gel permeation chromatography was used. We developed an industry ready process that can be used to synthesize wide range of polymer additives having different molar masses.

Keywords: polymer additives; lubricating oil; polymethacrylates; gel permeation chromatography

Poster presentation

PRIMENA POVRŠINSKI MODIFIKOVANIH UGLJENIČNIH NANOCEVI KAO NOSAČA ZA IMOBILIZACIJU PEROKSIDAZE IZ RENA

MIRJANA PETRONIJEVIĆ*, SANJA PANIĆ, IGOR ANTIĆ, NATAŠA ĐURIŠIĆ-MLADENOVIĆ

*Univerzitet u Novom Sadu Tehnološki fakultet, Novi Sad, mirjana.petronijevic@uns.ac.rs

Univerzitet u Novom Sadu Tehnološki fakultet, Novi Sad, sanjar@tf.uns.ac.rs

Univerzitet u Novom Sadu Tehnološki fakultet, Novi Sad, antic@tf.uns.ac.rs

Univerzitet u Novom Sadu Tehnološki fakultet, Novi Sad, natasadjm@tf.uns.ac.rs

Peroksidaze predstavljaju veliku grupu enzima koji su našli svoju primenu u različitim procesima zaštite životne sredine. Slobodni oblici ovih enzima karakterišu se kratkim vremenom operativne stabilnosti, ali se njihove performanse mogu značajno poboljšati postupkom imobilizacije na adekvatnom čvrstom nosaču. Cilj ovog rada bio je ispitivanje mogućnosti primene ugljeničnih nanocevi kao nosača za imobilizaciju enzima peroksidaze dobijenog ekstrakcijom iz rena. Ispitana je aktivnost imobilisanog enzima pri različitim vrednostima temperature (10–80°C) i pH (4–10), mogućnost njegove ponovne upotrebe, kao i stabilnost u vremenskom periodu od mesec dana. Ugljenične nanocevi sintetisane su postupkom katalitičke hemijske depozicije iz smeše gasova etilen/azot na 700°C, funkcionalizovane 85% azotnom kiselinom i dodatno modifikovane sa 5% tionil-hloridom. Za na ovaj način modifikovane nanocevi kovalentno je vezan enzim preko glutaraldehida kao vezivnog agensa. Nakon imobilizacije, peroksidaza je pokazala visoku aktivnost (32±1 U/g). Takođe, enzim zadržava preko 80% svoje aktivnosti u temperaturnom opsegu 10–60°C i aktivniji je u baznoj sredini (pH 8–10). Nakon mesec dana skladištenja imobilisanog enzima (10°C) njegova aktivnost iznosi 70% u odnosu na početnu vrednost, dok posle šest uzastopnih ispiranja enzim zadržava oko 50% svoje aktivnosti, što ukazuje na mogućnost njegove ponovne upotrebe.

Glavne riječi: peroksidaza iz rena; ugljenične nanocevi; imobilizacija enzima; enzimska aktivnost; stabilnost imobilisanog enzima

Zahvalnica: Autori se zahvaljuju Ministarstvu prosvete, nauke i tehnološkog razvoja Republike Srbije za finansijsku podršku (grant No. 451-03-9/2021-14/200134).

Poster presentation

PRIPREMA I KARAKTERIZACIJA VODENOG RASTVORA FIBROINA SVILE

JELENA ŠKRBIĆ*, LJILJANA SPASOJEVIĆ, LIDIJA PETROVIĆ, JELENA MILINKOVIĆ
BUDINČIĆ, JADRANKA FRAJ, JAROSLAV KATONA

Univerzitet u Novom Sadu, Tehnološki fakultet Novi Sad, Bulevar cara Lazara 1, 21000 Novi Sad, Srbija jelenaskrbic94@uns.ac.rs
Univerzitet u Novom Sadu, Tehnološki fakultet Novi Sad, Bulevar cara Lazara 1, 21000 Novi Sad, Srbija ljiljanas@uns.ac.rs
Univerzitet u Novom Sadu, Tehnološki fakultet Novi Sad, Bulevar cara Lazara 1, 21000 Novi Sad, Srbija lidijap@uns.ac.rs
Univerzitet u Novom Sadu, Tehnološki fakultet Novi Sad, Bulevar cara Lazara 1, 21000 Novi Sad, Srbija jelenamilinkovic@uns.ac.rs
Univerzitet u Novom Sadu, Tehnološki fakultet Novi Sad, Bulevar cara Lazara 1, 21000 Novi Sad, Srbija jadranka@uns.ac.rs
Univerzitet u Novom Sadu, Tehnološki fakultet Novi Sad, Bulevar cara Lazara 1, 21000 Novi Sad, Srbija jkatona@uns.ac.rs

Svilena vlakna izolovana iz čaura svilenih buba Bombyx mori sastoje se od dva proteina, fibroina i sericina. Udeo fibroina se kreće u intervalu 66,5-73,5%, a udeo sericina je najčešće 26,5-33,5%. Fibroin svile se sastoji od dva proteinska lanca, koji su međusobno povezani disulfidnim vezama, i glikoproteina P25 koji je nekovalentnim vezama povezan sa proteinskim lancima. Zbog prisustva velikog broja intra- i intermolekulskih vodoničnih veza i specifičnih fizičko-hemijskih osobina, prirodni fibroin je rastvorljiv u određenom broju rastvarača, a nerastvoran u vodi. Disocijacijom intermolekulskih veza, ali bez raskidanja polipeptidnih lanaca, mogu se dobiti vodeni rastvori fibroina. Vodeni rastvor fibroina može da se koristi za pripremu filmova, hidrogelova ili praškastih formi. Cilj rada je priprema vodenog rastvora fibroina i njegova karakterizacija. Vodeni rastvor fibroina pripremljen je od čaura svilene bube, koje su prethodno tretirane radi uklanjanja sericina. Fibroin je rastvoren u 9,3 M LiBr i podvrgnut procesu dijalize. Određena je izoelektrična tačka fibroina podešavanjem pH vrednosti rastvora. Unutrašnji viskozitet pripremljenog rastvora određen je merenjem vremena proticanja rastvora na kapilarnom viskozimetru u opsegu temperatura od 10 do 70°C. Dodatno, merenjem na kapilarnom viskozimetru utvrđeno je da je rastvor fibroina stabilan do tri nedelje, ako se čuva u frižideru.

Ključne reči: fibroin; proteini svile; izoelektrična tačka; viskozitet.

INVESTIGATION OF PLASTICIZER TYPE AND CONCENTRATION INFLUENCE ON PROPERTIES OF GELATIN AND SODIUM CASEINATE BASED EDIBLE FILMS

JADRANKA FRAJ*, LIDIJA PEROVIĆ, JELENA MILINKOVIĆ BUDINČIĆ, SANDRA BUČKO,
LJILJANA SPASOJEVIĆ, JELENA ŠKRBIĆ, JAROSLAV KATONA

Faculty of Technology Novi Sad, jadranka@uns.ac.rs
Faculty of Technology Novi Sad, lidijap@uns.ac.rs
Faculty of Technology Novi Sad, jelenamilinkovic@uns.ac.rs
Faculty of Technology Novi Sad, sandranj@uns.ac.rs
Faculty of Technology Novi Sad, lj.spasojevic@tf.uns.ac.rs
Faculty of Technology Novi Sad, jelenaskrbic94@uns.ac.rs
Faculty of Technology Novi Sad, jaroslav.katona@uns.ac.rs

In order of environment protection, there is increasing use of ecological materials for packaging production, primarily for food industry. The use of natural compounds, like proteins, polysaccharides and lipids, as well as their combinations, for the edible films and coatings production, is becoming more frequent. Edible films are defined as thin layers of biopolymers, used to cover, package or wrap the food. Interactions in the solutions of various biopolymers can be used for film properties modifications. As a result of the interaction in the solution of charged macromolecules phase separation may occur, ie coacervation appearance. Coacervate is an insoluble complex, which arises as a consequence of a strong electrostatic interaction between charged groups of macromolecules, resulting in complexes of reduced solubility formation. These complexes stand out as a separate phase. The phenomenon of coacervation in the system has application in various areas, including films formation.

The aim of this study was to investigate the influence of plasticizer addition (glycerin, propylene glycol and sorbitol) on barrier, optical and mechanical properties of films based on coacervate, formed in gelatin/sodium caseinate system. The obtained results showed that both, type and concentration of plasticizer, affect the mentioned films properties.

Keywords: edible films, gelatin, sodium caseinate, coacervation, plasticizers

EFFECT OF PHOSPHORUS SOURCE CONCENTRATION IN WASTE GLYCEROL-BASED MEDIUM ON XANTHAN PRODUCTION

IDA ZAHOVIĆ*, JELENA DODIĆ, ZORANA TRIVUNOVIĆ

University of Novi Sad, Faculty of Technology Novi Sad, Department of Biotechnology and Pharmaceutical Engineering, Novi Sad, ida.zahovic@uns.ac.rs
 University of Novi Sad, Faculty of Technology Novi Sad, Department of Biotechnology and Pharmaceutical Engineering, Novi Sad, klik@uns.ac.rs
 University of Novi Sad, Faculty of Technology Novi Sad, Department of Biotechnology and Pharmaceutical Engineering, Novi Sad, ron@uns.ac.rs

Phosphorus nutrition appears to be very important in the xanthan production, next to carbon and nitrogen. Various studies indicated that xanthan production is controlled by phosphorus concentration in cultivation medium and that phosphorus is generally added in the form of K_2HPO_4 . This paper presents an analysis of the effect of various K_2HPO_4 concentrations (0-3 g/L) in waste glycerol-based medium on xanthan production using *Xanthomonas* strain PL 4 isolated from pepper leaves. The bioprocess success was assessed by analysis of medium at the end of cultivation in terms of xanthan concentration, molecular weight of separated xanthan and degree of phosphorus conversion. The obtained results show that the increase of K_2HPO_4 concentration in medium from 0 g/L to 2.5 g/L significantly contributes to the rise in separated xanthan amount and its molecular weight, while further increase of phosphorus source concentration has a statistically insignificant effect on the values of these parameters. The greatest bioprocess success is achieved when the concentration of K_2HPO_4 in medium was 2.5 g/L. Cultivation of producing strain on medium with optimal K_2HPO_4 concentration resulted in high production of xanthan (13.26 ± 0.20 g/L) of good quality ($3.38 \pm 0.14 \cdot 10^5$ g/mol) along with a relatively high degree of phosphorus conversion ($73.62 \pm 0.02\%$).

Keywords: biotechnological production; xanthan; *Xanthomonas* isolate; cultivation media; phosphorus source; waste glycerol;

Poster presentation

XANTHAN BIOSYNTHESIS ON WASTEWATERS FROM ROSE WINE PRODUCTION: THE EFFECT OF CULTIVATION TIME

ZORANA TRIVUNOVIĆ, ALEKSANDRA KATANSKI*, VLADIMIR PUŠKAŠ, IVANA MITROVIĆ, JELENA DODIĆ

University of Novi Sad, Faculty of Technology Novi Sad, Department of Biotechnology and Pharmaceutical Engineering, Novi Sad, Serbia, ron@uns.ac.rs
 University of Novi Sad, Faculty of Technology Novi Sad, Department of Biotechnology and Pharmaceutical Engineering, Novi Sad, Serbia, aleksandra.katanski@gmail.com
 University of Novi Sad, Faculty of Technology Novi Sad, Department of Biotechnology and Pharmaceutical Engineering, Novi Sad, Serbia, puskasv@uns.ac.rs
 University of Novi Sad, Faculty of Technology Novi Sad, Department of Biotechnology and Pharmaceutical Engineering, Novi Sad, Serbia, tadi@uns.ac.rs
 University of Novi Sad, Faculty of Technology Novi Sad, Department of Biotechnology and Pharmaceutical Engineering, Novi Sad, Serbia, klik@uns.ac.rs

The agro-industrial effluents, including winery wastewaters, due to their biodegradable character, represent interesting substrates for biotechnological production of xanthan, commercially the most important microbial biopolymer. The winery wastewaters utilization for xanthan biosynthesis reduces the biopolymer's production costs and the ecological problems caused by their accumulation in the environment. In this study, the effect of cultivation time on xanthan biosynthesis in laboratory bioreactor by *Xanthomonas campestris* ATCC 13951 on wastewaters generated separately in different stages of rose wine production was examined. Bioprocess was monitored by analysis of winery wastewaters-based medium samples, taken in predetermined time intervals, in terms of the most important nutrients quantity and rheological behaviour. The obtained results indicate that after 96 h of cultivation there is no significant consumption of sugars in all examined winery wastewater-based media, and consequently there is no significant xanthan biosynthesis. Accordingly, the reduction of cultivation time for 24 h is possible without negative effect on the bioprocess efficacy. Additionally, it has been found that the consumption of total nitrogen was considerably higher in comparison with the consumption of ammonia and amino compounds, suggesting that the wastewaters from rose wine production contain other nitrogen components that applied producing strain can successfully metabolize.

Keywords: biotechnological production; xanthan; winery wastewaters; bioprocess monitoring; cultivation time

Acknowledgment: This research is part of the project (451-03-9/2021-14/200134) funded by the Ministry of Education, Science and Technological Development of the Republic of Serbia.

Poster presentation

SYNTHESIS OF FUEL BIOLUBRICANTS BASED ON PENTAERYTHRITOLIVAN PUCKO¹, MIA GOTOVUŠA¹, KRISTINA CRNJAC¹, MARIJA TIRIĆ UNETIĆ², LUCIJA KONJEVIĆ², FABIO FARAGUNA¹, MARKO RACAR¹¹ University of Zagreb, Faculty of Chemical Engineering and Technology, Trg Marka Marulića 19, Zagreb, Croatia² INA – Industrija nafte d. d., Refining and Marketing, Central Testing Laboratory, Lovinčićeva ul. 4, 10 000 Zagreb, Croatiaipucko@fkit.unizg.hr, mgotovusa@fkit.unizg.hr, kcrnjac@fkit.unizg.hr, marija.tiric-unetic@ina.hr, Lucija.Konjevic@ina.hr, ffaragun@fkit.unizg.hr, mracar@fkit.unizg.hr

Additives are necessary for the use of diesel fuel and due to the growing concerns of the scientific community regarding environmental protection, it is desirable to consider the possibility of using materials of natural origin in their synthesis. In the past period, the proportion of sulfur that may be present in diesel fuel has been significantly reduced, which has negatively affected its lubricity, so it is necessary to focus the research on the synthesis of bio-additives that would improve it. In this work, bio-additives were synthesized from lauric acid and a branched polyol, pentaerythritol. The used lauric acid is a saturated acid containing twelve carbon atoms and it can be obtained from renewable sources such as coconut and palm oil. On the other hand, pentaerythritol is a polyol, an alcohol containing more than one hydroxyl group in the structure, obtained by an aldol reaction from formaldehyde, a product of metabolism, and acetaldehyde. Preliminary tests have shown an improved lubricity of diesel fuel additivated with 2000 ppm of the synthesized bio-additive by up to 40 %. In the standard test EN 12156-1 the wear scar diameter was reduced from 571 μm to 360 μm which satisfies the values for use in motor vehicles according to EN 590.

Keywords: bioadditives; lubricity; diesel fuel

Poster presentation

MONITORING THE STABILITY OF EMULSIONS BY OPTICAL MICROSCOPY

MARKO BABIĆ, PETRA AČKAR*, FABIO FARAGUNA, ANTE JUKIĆ, ELVIRA VIDOVIĆ

University of Zagreb, Faculty of Chemical Engineering and Technology, Trg Marka Marulića 19, Zagreb, Croatia

mbabic@fkit.unizg.hr, *packar@fkit.unizg.hr, ffaragun@fkit.unizg.hr, ajukic@fkit.unizg.hr, evidov@fkit.unizg.hr

Emulsions are defined as thermodynamically unstable systems of two or more immiscible liquids in which one phase is dispersed in another. Stability of emulsion refers to the ability of emulsions to resist changes in physicochemical properties over a period of time. Destabilization of emulsions can occur as gravitational separation (creaming / sedimentation), flocculation, coalescence, phase inversion and Ostwald ripening. Factors affecting the stability of emulsions are preparation conditions, the composition of the emulsion and the properties of the dispersed phase (concentration and size of droplets, droplet charge, interactions). The fastest and cheapest method of stability monitoring is visual monitoring of the separation of the emulsion's phases. However, the stability of emulsions containing droplets smaller than 100 μm can't be detected visually. Optical microscopy is widely used as a simple technique that allows monitoring of the stability of emulsions, size and distribution of droplets in the emulsion over a long period of time. In this way the destabilization can be monitored by visual observation of the size of droplet and phase separation. In this work, the stability of prepared emulsions was monitored using optical microscopy by taking samples from the top, middle and bottom of the container and observing the stability at 10x and 20x magnification over some period of time.

Keywords: emulsions; stability monitoring; optical microscopy

Poster presentation

INFLUENCE OF THE REACTION PARAMETERS ON THE SYNTHESIS OF FATTY ACID ISOPENTYL ESTERS

MIA GOTOVUŠA^{1,*}, IVA ŽUVIĆ¹, JELENA PARLOV-VUKOVIĆ², LUCIJA KONJEVIĆ²,
FABIO FARAGUNA¹

¹University of Zagreb, Faculty of Chemical Engineering and Technology, Marulićev trg 19, Zagreb, Croatia

²Industrija nafte d. d., Refining and Marketing, Central Testing Laboratory, Lovinčićeva ul. 4, 10 000 Zagreb, Croatia

mgotovusa@fkit.hr, izuvic@fkit.hr, Jelena.Parlov-Vukovic@ina.hr, Lucija.Konjevic@ina.hr, ffaragun@fkit.hr

Nowadays, due to the increasing environmental concerns, more and more emphasis is put on the research of renewable energy. Here, fatty acid isopentyl esters, also known as type of biodiesel, were synthesized and the influence of the reaction parameters on biodiesel conversion was investigated. The synthesis required a source of triglycerides (here, sunflower oil) and an alcohol (here, isopentanol) as reactants, as well as a catalyst, specifically potassium hydroxide. Isopentanol was chosen as an alcohol since the presence of molecular branching could improve the biodiesel low-temperature properties, therefore excluding the need for corresponding fuel additives. The monitored reaction parameters were the reaction temperature, time, molar ratio of the reactants and the mass fraction of the catalyst. The obtained results suggested that the most significant reaction parameters are the molar ratio of the reactants and the mass fraction of the catalyst. According to the experimental plan, the highest conversion of 89.7 % was achieved when the reaction temperature was held at 40 °C, throughout 2.5 hours, with the molar ratio of the reactants of 7:1 and the mass fraction of the catalyst of 2 %.

Keywords: biodiesel, transesterification, isopentanol

Poster presentation

INFLUENCE OF CARBON FILLER TYPE ON THERMAL CONDUCTIVITY AND STABILITY OF ESTER RESIN

KRISTINA SUŠAČ*, MARKO BABIĆ, FABIO FARAGUNA, MARKO RACAR, ELVIRA
VIDOVIĆ, ANTE JUKIĆ

University of Zagreb, Faculty of Chemical Engineering and Technology,
Trg Marka Marulića 19, Zagreb, Croatia

ksusac@fkit.unizg.hr, mbabic@fkit.unizg.hr, ffaragun@fkit.unizg.hr, mracar@fkit.unizg.hr,
evidov@fkit.unizg.hr, ajukic@fkit.unizg.hr

Ester resin has electrical insulating properties and low thermal conductivity. With the addition of nano-sized carbon fillers, a polymer nanocomposite with higher thermal and electrical conductivity can be produced. The interface and adhesive interactions between polymer matrix and filler have a significant impact on the properties of polymer nanocomposites. Five types of carbon fillers were used in this paper: carbon black nanoparticles (CB), long multi-walled (L-MWCNT), short multi-walled (S-MWCNT), long multi-walled functionalized with carboxyl group (L-MWCNT-COOH) and short multi-walled carbon nanotubes with carboxyl group (S-MWCNT-COOH) with mass fractions of 0.5, 1 and 5 wt %. Thermal properties were determined by measuring thermal conductivity by the "hot bridge" method and the thermal stability of prepared nanocomposites were observed by thermogravimetric method (TGA). The addition of 1 and 5 wt % of carbon nanoparticles increases the thermal conductivity and did not affect the thermal stability.

Keywords: nanocomposite, carbon filler, thermal stability, thermal conductivity

Poster presentation

HELJDA U ISHRANI KOKA NOSILJA KAO FAKTOR KVALITETA JAJA

AMIR HASIĆ¹, AMIR. ZENUNOVIC¹, JELENA NIKITOVIĆ², TONI BABIĆ³, EMIR MUJIĆ⁴,
HUSEIN. VILIĆ⁴, REFIK. ŠAHINOVIĆ⁴

¹Amir Hasić, Tehnološki fakultet, Univerzitet u Tuzli, Tuzla, e-mail: a.hasic@gmail.com;

¹Amir Zenunović, Tehnološki fakultet, Univerzitet u Tuzli, Tuzla, e-mail: amir.zenunovic@hotmail.com

²Jelena Nikitović, Institut za genetičke resurse, Univerzitet u Banjoj Luci, e-mail:

jelena.nikitovic@jgr.unibl.org

³Toni Babić, Ministarstvo poljoprivrede, vodoprivrede i šumarstva Tuzlanskog kantona, Tuzla, e-mail:

babic.toni98@gmail.com

⁴Emir Mujić, Biotehnički fakultet, Univerzitet u Bihaću, Bihać, e-mail: ebiofax@gmail.com

⁴Husein Vilić, Biotehnički fakultet, Univerzitet u Bihaću, Bihać, e-mail: Husein.btf@gmail.com,

⁴Refik Šahinović, Biotehnički fakultet, Univerzitet u Bihaću, Bihać, e-mail: sahinovic.r@gmail.com

Cilj ovog rada je istraživanje utjecaja različitih omjera heljde, u koncentriranoj hrani za koke nosilje, na kvalitativne i kvantitativne vrijednosti jaja koka nosilja. Istraživanje je sprovedeno u četiri grupe nosilja: jedna kontrolna i tri ogledne. Ogledne grupe su određene prema procentu heljde u obrocima. Prva grupa je dobijala obroke sa 10% heljde, druga grupa je dobijala obroke sa 20% heljde, a treća grupa obroke sa 30% heljde, dok je kontrolna grupa dobijala standardna koncentrirana hraniva. Na osnovu sprovedenog istraživanja može se zaključiti da heljda u obroku koka nosilja ima pozitivan uticaj na kvalitativne i kvantitativne osobine jaja, kao i na učestalost nošenja. Pokazalo se da postoje statistički značajne razlike u srednjim vrijednostima za sljedeće osobine: sadržaj proteina u bjelancetu, sadržaj bjelancevina u žumancetu (%), sadržaj masti u žumancetu (%), pri čemu je najveća vrijednost zabilježena u trećoj oglednoj grupi koka nosilja. Također, utvrđene su statistički značajne razlike u pogledu težine ljuske jaja (g), debljine ljuske (mm), prečnika žumanca (mm) i pH bjelanceta. Najveća prosječna učestalost nošenja jaja utvrđena je u prvoj oglednoj grupi, a najniža prosječna učestalost nošenja jaja u kontrolnoj grupi. Opšti zaključak je da se heljda može koristiti u ishrani koka nosilja, jer ima mnogo više pozitivnih nego negativnih uticaja na proizvodnju i osobine konzumnih jaja.

Ključne riječi: koke nosilje; heljda; kvalitet jaja

DETERMINATION OF HEAVY METAL CONTENT IN *MENTHA LONGIFOLIA* L. FROM BOSNIA AND HERZEGOVINA

ŠAĆIRA MANDAL

University of Sarajevo, Faculty of Pharmacy, Sarajevo, sacira.mandal@ffsa.unsa.ba

Heavy metals have important biochemical functions in the body and thus can affect human health. The aim of this study was to determine the concentrations of heavy metals Cu, Cr, Mn, Ni, Fe, Pb, Zn and Cd in the leaves of *Mentha × longifolia* L. Samples of plant material were collected from three different locations in Bosnia and Herzegovina (BH), at recommended distances from sources of heavy metal pollution. Wet digestion was used to dissolve the samples, and concentrations of essential and heavy metals were analyzed by flame atomic absorption spectrometry (PAAS). The results of the analysis (expressed in mg g⁻¹) were obtained as follows: Cu 0.01 - 0.05; Cr 0.0007 - 0.0009; Mn 0.02 - 0.09; Ni 0.0007 - 0.0066; Fe 0.06 - 1.11; Pb 0.0001 - 0.0009; Zn 0.01 - 0.04. The cadmium concentration of 0.002 mg L⁻¹ was below the detection limit of PAAS. Therefore, *Mentha × longifolia* L. can be used in daily consumption due to the high content of Fe, Cu, and Zn and their beneficial effects on the normal functioning of the organism and there is no risk of heavy metals to human health after consuming these samples due to low concentration of elements.

Keywords: heavy metals; Mentha; AAS

SELECTIVE SEPARATION AND REMOVAL OF LEAD (II) IONS FROM MULTICOMPONENT SYSTEM THROUGH BLMs SUPPORTED BY FATTY ACIDS

JASMIN SULJAGIĆ^{1*}, MERSIHA SULJKANOVIĆ², EDITA BJELIĆ¹, AZRA KOVAČEVIĆ¹

¹Faculty of Technology, University of Tuzla, Urfeta Vejzagića 8, 75000 Tuzla
Bosnia and Herzegovina

²Faculty of Natural Sciences and Mathematics, University of Tuzla, Urfeta Vejzagića 4, 75000 Tuzla
Bosnia and Herzegovina

Selective separation and removal of a metal species from complex matrices of other species is of critical importance in analytical chemistry, separation sciences and especially in industrial processes. The selectivity and efficiency of Pb(II) removal from an aqueous solution in the presence of Ni(II), Zn(II), Co(II), Cu(II), and Cd(II) ions as competing ions in a multi-component aqueous source phase through bulk liquid membrane system were investigated. The influence of the palmitic and oleic acid as supporting surfactants in the membrane phase on the removal of Pb(II) ions was also analyzed. Dicyclohexano-18-crown-6 dissolved in chloroform, proved to be a selective and efficient carrier for Pb(II) ions. In the optimized procedure, 3 hours of equilibrium time was required to achieve the maximum removal efficiency. It was found that removal of Pb(II) ions was achieved without significant reduction in the efficiency compared to the liquid membrane transport of a single-component system. None of these cations interfered with Pb(II) removal. The presence of the oleic and palmitic acid in the membrane phase increase the content of Pb(II) removed to the receiving phase. In optimal transport conditions, more than 97% efficiencies for the removal of Pb(II) were obtained for a system supported by oleic acid. The excellent efficiency and high degree of selectivity for the Pb(II) ion removal by the proposed BLM system, reveals its potential application for the selective removal, concentration, and purification of lead ions from its different mixtures.

Keywords: liquid membrane transport; Pb(II) ion removal; dicyclohexano-18-crown-6; oleic acid; palmitic acid

ELEMENTI UGRADNJE ULTRAZVUČNOG MJERAČA PROTOKA, MODEL OMNI TDI 200H, SA REZULTATIMA PROBNOG RADA MERIMA TOROMANOVIĆ*, JASMINA IBRAHIMPAŠIĆ, IFET ŠIŠIĆ

*Univerzitet u Bihaću, Biotehnički fakultet, Bihać, merima.toromanovic@unbi.ba
Univerzitet u Bihaću, Biotehnički fakultet, Bihać, jasmina.ibrahimpasic@unbi.ba
Univerzitet u Bihaću, Biotehnički fakultet, Bihać, sisic_btf@yahoo.com

Ultrazvučni mjerači protoka (eng. *Ultrasonic flowmeter*) rade na principu odašiljanja i povrata ultrazvučnih valova koji prolaze kroz tekućinu, a služe za mjerenje brzine kretanja tekućine. Poznavanjem brzine kretanja tekućine i površine poprečnog presjeka cjevovoda ili drugog sistema, može se matematičkim putem izračunati volumetrijski protok. Za razliku od većine mjerača protoka, ultrazvučni mjerni uređaji ne uključuju pokretne dijelove, čime se omogućuje fleksibilniji rad i rad bez održavanja, što je i slučaj sa modelom OMNI TDI 200H. S obzirom na tehničke sposobnosti, ovaj ultrazvučni mjerač protoka tečnih medija može se koristiti i za tekućine u kojima se nalaze čestice čvrstog materijala, što je slučaj sa tzv. laboratorijskim i sanitarnim vodama nastavnog centra „Grmeč“. U radu će se opisati postupak ugradnje i predstaviti rezultati probnog rada ultrazvučnog mjerača protoka, model OMNI TDI 200H, *in situ* na biljnom uređaju koji se nalazi u sklopu nastavnog centra „Grmeč“ Biotehničkog fakulteta.

Ključne riječi: ultrazvučni mjerač, elementi ugradnje, rezultati mjerenja

RETENTION BEHAVIOR OF TRIAZINES WITH ACYCLIC AND CYCLIC SUBSTITUENTS IN REVERSED-PHASE ULTRA-HIGH PERFORMANCE LIQUID CHROMATOGRAPHY SYSTEM WITH PHENYL COLUMN AND APROTIC MODIFIER

BENJAMIN SALAKOVIĆ^{1,*}, STRAHINJA KOVAČEVIĆ¹, MILICA KARADŽIĆ BANJAC¹, JASMINA ANOJČIĆ², LIDIJA JEVRIC¹, SANJA PODUNAVAC-KUZMANOVIĆ¹, SLOBODAN GADŽURIĆ², DUŠAN ANTONOVIĆ³

¹University of Novi Sad, Faculty of Technology Novi Sad, Department of Applied and Engineering Chemistry, Bulevar cara Lazara 1, 21000 Novi Sad, Serbia (benjamin.salakovic@uns.ac.rs; strahko@uns.ac.rs; mkaradza@uns.ac.rs; lydija@uns.ac.rs; sanja.podunavac@uns.ac.rs)

²University of Novi Sad, Faculty of Sciences, Department of Chemistry, Biochemistry and Environmental Protection, Trg Dositeja Obradovića 3, 21000 Novi Sad, Serbia (jasmina.anojic@dh.uns.ac.rs; slobodan.gadzuric@dh.uns.ac.rs)

³University of Belgrade, Faculty of Technology and Metallurgy, Karnegijeva 4, 11120 Belgrade, Serbia (ducun@tmf.bg.ac.rs)

The retention behavior of two series of *s*-triazine derivatives were analyzed by using reversed-phase ultra-high performance liquid chromatography system (RP-UHPLC). The first series contains four triazine derivatives with acyclic substituents (propyl, isopropyl, butyl and isobutyl) while in the second series there are four triazine derivatives with cyclic substituents (cyclopentyl, cyclohexyl, cycloheptyl and cyclooctyl). The isocratic chromatographic analysis was carried out in triplicates by using phenyl column and acetonitrile/water mixtures as mobile phases. The portion of acetonitrile in the mobile phase varied from 67.5 to 80 v/v. The capacity factor ($\log k$) for each compound was determined and correlated with the portion of acetonitrile in the mobile phase so the parameter $\log k_0$ (the retention in pure water) can be determined based on the interpolation. Both $\log k$ and $\log k_0$ parameters were further correlated with *in silico* lipophilicity parameters and outstanding correlations were determined. These relationships indicate the strong influence of molecular polarity on the retention behavior of the studied compounds in the applied chromatographic system. Due to the potential acetonitrile blockage of π - π interactions between analytes and the phenyl groups of the stationary phase, the separation of the compounds (particularly isomers) from the mixture may be difficult however further investigations with various modifiers are needed.

Keywords: chemometrics, chromatography, lipophilicity, molecular modeling, pesticides, triazines.

OPERATOR EXPOSURE TO HEAVY METALS FROM ASHES OF WOOD PELLETS AND HEALTH RISK ASSESSMENT

MIRHA PAZALJA^{1*}, MIRSADA SALIHOVIĆ¹, ALISA SMAJOVIĆ¹, JASMINA SULEJMANOVIĆ²

¹University of Sarajevo, Faculty of Pharmacy, Zmaja od Bosne 8, 71 000 Sarajevo, Bosnia and Herzegovina, mirha.pazalja@ffsa.unsa.ba, mirsada.salihovic@ffsa.unsa.ba, alisa.smajovic@ffsa.unsa.ba

²University of Sarajevo, Faculty of Science, Department of Chemistry, Zmaja od Bosne 33-35, 71000 Sarajevo, Bosnia and Herzegovina, jasmina.sulejmanovic@yahoo.com

Most ash of wood biomass contains a significant amount of heavy metals. Metals, such as As, Cd, Hg, Cr, Ni, and Pb present in very low concentrations in wood pellets, may cause harmful effects on the body. They can generate acute and chronic toxicity in humans and in particular in operators who are exposed to heavy metals via many pathways. The goal of this study was to estimate the risk to operators health based on the exposure to heavy metals from ash produced by combustion wood pellets. After analysis of the measured content of heavy metals: Fe, Mn, Ni, Co, Cd, Pb, Zn, Cu, and Cr, the assessment of potential health risk was calculated for exposure (ingestion, inhalation, and dermal) based on the USEPA model, and is determined as cumulative non-carcinogenic and carcinogenic risk for operators.

Considering all the analyzed metals in wood pellet ashes, our results indicate that there is a very low non-carcinogenic and carcinogenic risk for operators during the cleaning of pellet stoves in confined environments.

Keywords: heavy metals, ashes, health risk assessment.

FLAME ATOMIC ABSORPTION SPECTROPHOTOMETRIC DETERMINATION OF HEAVY METALS IN WOOD BIOMASS

MIRHA PAZALJA^{1*}, MIRSADA SALIHOVIĆ¹, JASMINA SULEJMANOVIĆ², ALISA SMAJOVIĆ¹

¹University of Sarajevo, Faculty of Pharmacy, Zmaja od Bosne 8, 71 000 Sarajevo, Bosnia and Herzegovina, mirha.pazalja@ffsa.unsa.ba, mirsada.salihovic@ffsa.unsa.ba, alisa.smajovic@ffsa.unsa.ba

²University of Sarajevo, Faculty of Science, Department of Chemistry, Zmaja od Bosne 33-35, 71000 Sarajevo, Bosnia and Herzegovina, jasmina.sulejmanovic@yahoo.com

The use of wood biomass is one of the most efficient and practicable methods of thermal energy generation and its sustainable use brings numerous general, ecological, economic, and social benefits. An important characteristic of wood biomass is its chemical composition. Heavy metals such as Cd, Hg, Pb, Cr, Ni, and As present even at very low concentrations have a harmful effect on humans and other biological systems.

Therefore, this study aimed to determine the content of heavy metals in wood biomass by the flame atomic absorption spectrometry (FAAS) technique. The content of Cu, Zn, Cr, Cd, Co, Mn, Ni, Pb, Fe, and As was determined in the wood pellet and briquette samples. Samples were prepared by wet digestion using HNO₃, and heavy metals were determined by FAAS (SpectraAA-10, AA240FS, Varian). The obtained results showed that the heavy metal concentrations in the analyzed wood biomass range from 0.50 to 2.50 mg/kg for Cu, from 24.85 to 54.95 mg/kg for Mn, from 66.50 to 152 mg/kg for Fe, from 0.35 to 2.30 mg/kg for Co, from 0.010 to 0.03 mg/kg for Pb, from 8 to 44.50 mg/kg for Zn, from 0.75 to 2.40 mg/kg for Ni, from 0.008 to 0.264 mg/kg for As, and Cr was a lover from limit detection. Based on the obtained results, it can be concluded that monitoring of heavy metals in wood biomass is necessary for environmental protection because combustion of contaminated wood biomass carries risks of higher heavy metal emissions.

Keywords: heavy metals, FAAS, wood biomass.

MORFOLOŠKO - HEMIJSKA ANALIZA DRIJENA (*CORNUS MAS L.*)

*SAMIRA HUSEINOVIĆ¹, SANIDA BEKTIĆ¹, INDIRA ŠESTAN², LARISA SINANOVIĆ²

¹Prirodno- matematički fakultet Univerzitet u Tuzli, samira.huseinovic@untz.ba

¹Prirodno- matematički fakultet Univerzitet u Tuzli, sanida.osmanovic@untz.ba

²Tehnološki fakultet Univerzitet u Tuzli, indira.sestan@untz.ba

²Tehnološki fakultet Univerzitet u Tuzli, lara.la97@hotmail.com

Drijen (*Cornus mas L.*) je grm ili maleno drvo obično visine od 2-5m, koje raste kao samonikla voćka. Osim što ovo listopadno drvo ili grm ima dekorativnu ulogu, skoro svi dijelovi (*Cornus mas L.*) koristi se u modernoj i narodnoj medicini, nutritivnog i ljekovitog su potencijala. Plodovi drijena pogodni su za različite oblike prerade. Danas, sve više zauzimaju mjesto u proizvodnji zdravstveno bezbjedne hrane. Koristi se za liječenje stomačnih oboljenja, reumatskih bolesti i sl. Uglavnom u obliku čajeva od korijena, debla, lista cvijeta i ploda. Opisi drijena uglavnom se nalaze u literaturi o divljoj flori kao i ljekovitom bilju. Drijen je jedna od rijetkih biljnih vrsta modernog doba koja se održava u svom prirodnom obliku bez primjene hemijskih preparata. Plodovi drijena, najčešće su proizvedeni u uslovima nenarušenih prirodnih zakona, bez ikakvih pesticida i zato zadovoljavaju standarde visoko bezbjedne hrane. Cilj ovog rada jeste da se prikaže dio populacije drijena u gradu Srebreniku, kako bi se ukazalo na bioraznolikost tj.na varijabilnost same populacije. Parametri koji su praćeni jesu parametri ploda, te je urađena hemijska analiza ploda kako bi se odredila suha tvar, ukupni šećeri u plodu, sadržaj vode, sadržaj proteina, vitamin C i sirova vlakna.

Na osnovu mjerenja morfoloških i pomoloških osobina utvrđen je određeni stepen varijabilnosti promatranih karaktera (dužine ploda, širine ploda, masa cijelog ploda, masa koštunice te masa ploda bez koštunice (masa mezokarpa). Hemijskom analizom je ustanovljen visok sadržaj vitamina C.

Ključne riječi: morfološke, hemijske, plod, drijen, analiza

IMPACT OF THERMAL DECOMPOSITION OF SLUDGE FROM AMMONIA-PHENOLIC WASTEWATER TREATMENT PLANT ON FLUE GAS COMPOSITION

ABDEL ĐOZIĆ*¹, HANA ALIHODŽIĆ² VAHIDA SELIMBAŠIĆ³, FRANC ANDREJAŠ³,
VEDRAN STUHLI³, MIRNESA ZOHOROVIĆ³

¹University of Tuzla, Faculty of Technology, St. Urfeta Vejzagića 8, 75000 Tuzla, abdel.dozic@untz.ba

²TQM d.o.o Lukavac, Institute for quality, standardisation and ecology, 75300 Lukavac, alihodzichana0@gmail.com

³University of Tuzla, Faculty of Technology, St. Urfeta Vejzagića 8, 75000 Tuzla, vahida.selimbasic@untz.ba

³University of Tuzla, Faculty of Technology, St. Urfeta Vejzagića 8, 75000 Tuzla, franc.andrejas@untz.ba

³University of Tuzla, Faculty of Technology, St. Urfeta Vejzagića 8, 75000 Tuzla, vedran.stuhli@untz.ba,

³University of Tuzla, Faculty of Technology, St. Urfeta Vejzagića 8, 75000 Tuzla, mimesa.zohorovic@hotmail.com

In this paper, the impact of the addition of excess activated sludge to the coal mixture on the increase of emission concentrations of certain pollutants in flue gases is investigated. Before adding the sludge, its physical-chemical analysis was performed, which determined that the sludge does not contain heavy metals. The sludge consists of liquid (water 92-95%) and solid phase, which consists of carbon (about 35%) and the rest is mostly N, in a smaller amount is present P and K. The amount of sludge in terms of dry matter added to coal mixture does not affect the material and thermal balance of coking. Taking into account the dry matter content of 8% in 100 m³ of sludge, 8t of dry matter can be decomposed pyrolytically, which is 0.37% for the required 2125 tons of coal. This process takes place in coke ovens at temperatures from 1100 °C to 1300 °C in an average time interval of 16 h. Emission values on the chimney V of the coke oven battery were: CO₂=130.92 Nm³/h; SO₂=611.9 Nm³/h; NO_x=321.09 Nm³/h; particulate matter=39.86 Nm³/h; H₂S=54.07 Nm³/h and NH₃=38.58 Nm³/h. In relation to the emission values before the addition of sludge, it can be concluded that there is no change or increase in emissions of individual gaseous pollutants.

Keywords: sludge, thermal decomposition, flue gas, coke oven

REMEDIATION OF AGRICULTURAL SOIL AFTER ACCIDENT ON „WHITE SEA“ SEDIMENTATION POND

ABDEL ĐOZIĆ*¹, HANA ALIHODŽIĆ² VAHIDA SELIMBAŠIĆ³, FRANC ANDREJAŠ³,
VEDRAN STUHLI³, MIRNESA ZOHOROVIĆ³

¹University of Tuzla, Faculty of Technology, St. Urfeta Vejzagića 8, 75000 Tuzla, abdel.dozic@untz.ba

²TQM d.o.o Lukavac, Institute for quality, standardisation and ecology, 75300 Lukavac, alihodzichana0@gmail.com

³University of Tuzla, Faculty of Technology, St. Urfeta Vejzagića 8, 75000 Tuzla, vahida.selimbasic@untz.ba

³University of Tuzla, Faculty of Technology, St. Urfeta Vejzagića 8, 75000 Tuzla, franc.andrejas@untz.ba

³University of Tuzla, Faculty of Technology, St. Urfeta Vejzagića 8, 75000 Tuzla, vedran.stuhli@untz.ba,

³University of Tuzla, Faculty of Technology, St. Urfeta Vejzagića 8, 75000 Tuzla, mimesa.zohorovic@hotmail.com

Dam failure in the sedimentation pond released a waste sludge flow that advanced agricultural soil caused pollution of agricultural soil in the immediate vicinity of the pond. The waste sludge is white in color, consists mainly of CaCO₃ and CaCl₂, is alkaline with a pH value of 10.75 and does not contain heavy metals. The analysis showed that the soil was contaminated with chlorides (8000.0 mg / kg) and sulfates (210.0 mg / kg) to a maximum depth of 30 cm. High values of chloride and sulfate cause salinization which slows the growth of crops due to the inability to absorb water and reduce microbiological activity. Remediation of such contaminated soil is performed by removing the surface layer to a depth of 30 cm and applying a previously prepared mixture of soil that is not contaminated with the addition of bentonite and peat. Bentonite is used for soil conditioning due to its high ion exchange capacity. Peat is used to improve soil fertility due to its high humus content of up to 60% and water retention capacity. During the remediation process it is necessary to provide periodic monitoring of soil quality in order to determine the degree of remediation efficiency and to achieve the quality of land that can be used for agricultural purposes.

Keywords: remediation, soil, accident, pollution

APPLICATION OF NATURAL BENTONITE IN WASTEWATER TREATMENT FROM PACKAGING TAPE PRODUCTION PROCESS

HANA ALIHODŽIĆ*¹, ABDEL ĐOZIĆ², VAHIDA SELIMBAŠIĆ³, FRANC ANDREJAŠ⁴,
VEDRAN STUHLI⁵, MIRNESA ZOHOROVIĆ⁶

*¹TQM d.o.o Lukavac, Institute for quality, standardization and ecology, 75300 Lukavac, BiH, e-mail: alihodzichana0@gmail.com

^{2,3,4,5,6}University of Tuzla, Faculty of technology, 75000 Tuzla, BiH

One of the basic indicators of water pollution is coloration depending on the structure and origin can be very toxic for aquatic ecosystem. The presence of dye in high concentrations in wastewater interferes with the penetration of light that disrupts the biological activity of aquatic organisms as well as photosynthesis of aquatic plants and algae, and also reduces the ability to reoxygenate the receiving water. Due to such a negative impact, dyed wastewater should be treated before discharge into the recipient and to brought its quality to the level prescribed by applicable legislation. Since the treatment of such wastewater is not simple and involves the use of various chemical agents, which further pollutes, more and more efforts are being made to find an alternative solution. Accordingly, the aim of this paper is to investigate the efficiency of treatment of dyed wastewater using natural bentonite as an adsorbent. For this purpose, a simulation of a reactor with a mixer was performed in a laboratory conditions where a real sample of wastewater from the packaging tape production process was treated. In order to determine the degree of efficiency, the analysis of wastewater was performed before and after treatment with bentonite on the following parameters: HPK, pH, eV, dye, dissolved O₂. Based on the obtained results, the efficiency of dye removal was 99.09% which indicates that there is a great potential for the use of bentonite as an adsorbent in the treatment of colored wastewater.

Keywords: paint, wastewater, bentonite, treatment, degree of efficiency

APPLICATION OF NATURAL AND ACTIVATED BENTONITE IN WASTEWATER TREATMENT FROM INITIAL EXPLOSIVES PRODUCTION PROCESS

HANA ALIHODŽIĆ*¹, ABDEL ĐOZIĆ², VAHIDA SELIMBAŠIĆ³, FRANC ANDREJAŠ⁴, NISAD
AVDIĆ⁵

*¹TQM d.o.o Lukavac, Institute for quality, standardization and ecology, 75300 Lukavac, BiH, e-mail: alihodzichana0@gmail.com

^{2,3,4}University of Tuzla, Faculty of technology, 75000 Tuzla, BiH

⁵Sisecam soda Lukavac, 75300 Lukavac, BiH

The rapid population growth and their needs contribute to the generation of enormous amounts of waste streams resulting in excessive environmental pollution, which is why the protection of the environment is increasingly emphasized. The natural resource that life on Earth would be impossible without is water and as the shortage of drinking water is more and more pronounced today, more emphasis is placed on its preservation. In view of the above, special attention is paid to the treatment of wastewater as a product of daily activities such as industrial production. Industrial wastewater containing heavy metals has a negative impact on flora and fauna as well as on human health that is why it is necessary to find an appropriate technique for their removal. One of the most efficient methods for removing heavy metals from wastewater is adsorption based on the principle of using an appropriate adsorbent. Due to the high costs associated with the application of activated carbon, recent researches have focused on the exploring for alternative adsorbents. Therefore, in this paper, the efficiency of lead removal using natural and activated bentonite was investigated. In addition to lead, other heavy metals were tested, as well as parameters such as: pH, HPK, etc. The experiment was performed on a real sample of wastewater from the process of production of initial explosives in laboratory conditions. The results of the research showed that the highest efficiency of lead removal was achieved by applying natural bentonite.

Keywords: wastewater, bentonite, treatment, adsorption, lead