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SUSTAINABLE DEVELOPMENT
AND FOOD PRODUCTION «
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**Environmental resources, sustainable development
and food production – OPORPH 2019: Book of Abstracts**

The Symposium is the traditional meeting that takes place every second year, and this Book is a serial publications that accompanies it. The Book contains the abstracts of plenary lectures and oral presentations, along with the poster abstracts, presented at VI International scientific-professional symposium "Environmental resources, sustainable development and food production" – OPORPH 2019, held on 14-15 November 2019 in Tuzla, Bosnia and Herzegovina, organized by Faculty of Technology, University of Tuzla in cooperation with Association of Chemist of Tuzla Canton.

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TABLE OF CONTENTS

SOLUBILITY OF BIOACTIVE COMPONENTS IN SUPERCRITICAL CO ₂ . ARTIFICIAL NEURAL NETWORK MODELING Kiril Lisichkov, Stefan Kuvendziev, Mirko Marinkovski	1
TODAY'S INNOVABILITY CHALLENGES IN CORROSION ENGINEERING Sanja Martinez	2
DANAŠNJI IZAZOVI INOVABILNOSTI U KOROZIJSKOM INŽENJERSTVU Sanja Martinez	2
TRENDS IN DESIGN AND DEVELOPMENT OF CATALYSTS Ante Jukić	3
TRENDovi U DIZAJNU I RAZVITKU KATALIZATORA Ante Jukić	3
MODERNIZATION OF FOOD SAFETY SYSTEM AS A PREREQUISITE FOR PROTECTION OF CONSUMERS' HEALTH AND FREE TRADE IN FOOD Boris Antunović	4
MODERNIZACIJA SUSTAVA SIGURNOSTI HRANE KAO PREDUVJET ZAŠTITE ZDRAVLJA POTROŠAČA I SLOBODNE TRGOVINE HRANOM Boris Antunović	4
BIOMASS FRACTIONATION AND CATALYTIC FUNCTIONALISATION: A CONCEPT OF BIOREFINERY Miha Grilc, Matej Huš, Ana Bjelić, Brigita Hočevar, Rok Šivec, Aleksa Kojčinović, Brett Pomeroy, Gorica Ivaniš, Edita Jasiukaityte Grojzdek, Blaž Likozar	5
SUSTAINABLE PROCESS SYSTEMS ENGINEERING – ACCOMPLISHMENTS AND FUTURE CHALLENGES Zdravko Kravanja, Andreja Nemet, Lidija Čuček, Žan Zore, Zorka Novak Pintarič	6
ODRŽIVO PROCESNO SISTEMSKO INŽENJERSTVO – DOSTIGNUĆA I BUDUĆI IZAZOVI Zdravko Kravanja, Andreja Nemet, Lidija Čuček, Žan Zore, Zorka Novak Pintarič	6
EFFECT OF QUALITY OF PURIFIED BRINE AND MOTHER LIQUOR ON THE YIELD OF NaCl IN SALT PRODUCTION <u>Abdulah Ahmetović</u> , Amira Brkić	7
UTICAJ KVALITETA PREČIŠĆENE SLANE VODE I MATIČNE LUŽINE NA PRINOS NaCl U PROIZVODNJI SOLI <u>Abdulah Ahmetović</u> , Amira Brkić	7

BIOSORPTION OF HEAVY METAL IONS AND SYNTHETIC DYES FROM AQUAEOUS SOLUTIONS USING LIGNOCELLULOSIC MATERIALS Amila Dubravac, Joskić Monika	8	PRIMJENA ASPEN PLUS SOFTVERA U RJEŠAVANJU HEMIJSKO-INŽENJERSKIH PROBLEMA Aida Skejić, Elvis Ahmetović	14
BIOSORPCIJA JONA TEŠKIH METALA I SINTETSKIH BOJA IZ VODENIH RASTVORA KORIŠTENJEM LIGNOCELULOZNIH MATERIJALA Amila Dubravac, Joskić Monika	8	IMPACT OF RAW MATERIALS AND ALTERNATIVE FUELS ON THE MOVEMENT OF ALKALI AND SULPHATES IN THE PRODUCTION OF CEMENT Adisa Hasanbašić, Emina Tučić	15
A REVIEW: CHARACTERIZATION OF NATURAL FIBER REINFORCED POLYMER COMPOSITES Emina Tučić, Adisa Hasanbašić	9	UTICAJ POLAZNIH SIROVINA I ALTERNATIVNIH GORIVA NA KRETANJE ALKALIJA I SULFATA U PROIZVODNJI CEMENTA Adisa Hasanbašić, Emina Tučić	15
PREGLED: KARAKTERIZACIJA POLIMERNIH KOMPOZITA OJAČANIH PRIRODNIM VLAKNIMA Emina Tučić, Adisa Hasanbašić	9	EFFICIENT AND GREEN EXTRACTION OF PHENOLIC COMPOUNDS FROM DRIED ARONIA USING NATURAL DEEP EUTECTIC SOLVENTS Milena Ivanović, Mitja Kolar, Peter Krajnc, Maša Islamčević Razboršek	16
COPPER (II) SULFATE PENTAHYDRATE AS AGROCHEMICAL Irma Vilić, Mirza Muratović	10	EFIKASNA I ZELENA EKSTRAKCIJA FENOLNIH SPOJEVA IZ SUHE ARONIJE UZ UPOTREBU PRIRODNIH DUBOKO EUTEKTIČKIH RASTVARAČA Milena Ivanović, Mitja Kolar, Peter Krajnc, Maša Islamčević Razboršek	16
BAKAR (II) SULFAT PENTAHIDRAT KAO AGROHEMIKALIJA Irma Vilić, Mirza Muratović	10	COARSENING KINETICS ANALYSIS OF NANOCRYSTALLINE COPPER DOPED CERIA Katarina Mužina, Aleksandar Bajrović, Martina Župančić, Stanislav Kurajica	17
COMMINUTION KINETICS OF DOLOMITE IN A LABORATORY BALL MILL Samira Hotić, Gordana Matijašić, Osman Perviz	11	KINETIKA OKRUPNJAVANJA ZRNA NANOKRISTALNOG CERJEVA (IV) OKSIDA DOPIRANOG BAKROM Katarina Mužina, Aleksandar Bajrović, Martina Župančić, Stanislav Kurajica	17
KINETIKA MLJEVENJA DOLOMITA U LABORATORIJSKOM KUGLIČNOM MLINU Samira Hotić, Gordana Matijašić, Osman Perviz	11	HYDRODYNAMIC FRACTIONATION OF CELLULOSE FIBERS USING A MINI-CHANNEL Thomas Schmid, Stefan Radl	18
CORROSION COUPON TESTING OF COMMERCIAL INHIBITOR IN SIMULATED COOLING WATER Borislav N. Malinovic, Dusko Zoric, Tijana Djuricic	12	DETERMINATION OF CAFFEINE AND SUGAR CONTENT IN ENERGY DRINKS Sulejman Halilović, Martina Andrejaš	18
ISPITIVANJE KOMERCIJALNOG INHIBITORA KOROZIJE METODOM KOROZIONIH KUPONA U SIMULIRANOJ RASHLADNOJ VODI Borislav N. Malinovic, Dusko Zoric, Tijana Djuricic	12	ODREĐIVANJE KOLIČINE KOFEINA I ŠEĆERA U ENERGETSKIM NAPITCIMA Sulejman Halilović, Martina Andrejaš	18
MODELING OF SUSPENSION FLOWS IN THE CONTEXT OF SUSTAINABLE TECHNOLOGIES Stefan Radl	13	QUALITY EVALUATION OF BREAD WITH ADDITIONS Aldin Karić, Amela Kusur, Hurija Alibašić, Martina Andrejaš	19
APPLICATION OF ASPEN ENERGY ANALYZER SOFTWARE IN SOLVING HEAT INTEGRATION PROBLEMS Amra Rizvanović, Nidret Ibrić, Elvis Ahmetović	13	OCJENA KVALITETA KRUHA SA DODACIMA Aldin Karić, Amela Kusur, Hurija Alibašić, Martina Andrejaš	19
PRIMJENA ASPEN ENERGY ANALYZER SOFTVERA U RJEŠAVANJU PROBLEMA TOPLINSKE INTEGRACIJE Amra Rizvanović, Nidret Ibrić, Elvis Ahmetović	13	WASTE GYPSUM RECYCLING Filip Brleković, Biljana Šandor, Kristina Jazvo, Kata Šipić, Juraj Šipušić, Nevenka Vrbos	20
APPLICATION OF ASPEN PLUS SOFTWARE FOR SOLVING CHEMICAL ENGINEERING PROBLEMS Aida Skejić, Elvis Ahmetović	14	RECIKLIRANJE OTPADNOG GIPSA Filip Brleković, Biljana Šandor, Kristina Jazvo, Kata Šipić, Juraj Šipušić, Nevenka Vrbos	20

PRESENCE OF HEAVY METALS IN THE SOIL OF URBAN AREA OF LUKAVAC AND KALESIJA AND DISEASES PREVALENCE Abdel Đozić, Sanja Brekalo – Lazarević, Vedran Stuhli, Hana Alihodžić	21	Besim Salkic, Ahmed Salkić, Azra Salkić, Ensar Salkić, Ramzija Cvrk, Emir Imširović, Sead Noćajević	26
ENGINEERING'S ETHICS Azra Jaganjac	21	STUDY OF INTERACTION AND IN VITRO BIOLOGICAL ACTIVITY OF THE PRODUCT COPPER(II) AND NICKEL(II) WITH THENOYLTRIFLUOROACETONE Demir Bjelošević, Amila Zukić, Lamija Kolarević, Emir Horozić	27
INŽENJERSKA ETIKA Azra Jaganjac	21	STUDIJA INTERAKCIJE I IN VITRO BIOLOŠKA AKTIVNOST PRODUKATA KOBALT(II) I NIKL(II) SA TENOILTRIFLUOROACETONOM Demir Bjelošević, Amila Zukić, Lamija Kolarević, Emir Horozić	27
CONCEPTUAL DESIGN OF A GREEN POWER-TO-JET PROCESS UNDER VARYING ENERGY INPUTS Mahmoud Mostafa, Christopher Varela, Edwin Zondervan	22	KEMIJSKE I BIOLOŠKE ANALIZE MEDA Stipe Čelan, Zora Pilić, Josipa Karačić, Aldina Kesić, Nadira Ibrišimović Mehmedinović, Anamarija Jurkić	28
ESTIMATING BIOMASS RESOURCES AND BIOENERGY POTENTIAL: A REVIEW OF METHODOLOGIES AND CHALLENGES Ahmet Alp Şenocak, Hacer Güner Gören	22	DETECTION OF OXIDATION IN EXTRA VIRGIN OLIVE, HEMP OIL AND PUMPKIN OIL BY DSC, TGA AND FTIR TECHNIQUES Fabio Faraguna, Matea Lilić, Lucija Konjević, Dijana Blažek, Roko Blažic, Elvira Vidović, Ante Jukić	28
ISOLATION OF BACTERIAL CULTURES FOR EFFECTIVE COMPOSTING OF BIOWASTE Monika Šabić Runjavac, Vedran Vučić, Dajana Kučić Grgić, Marijana Vidaković, Anita Šalić, Bruno Zelić, Marija Vuković Domanovac	23	DEVELOPMENT OF CALIBRATION MODEL FOR REAL-TIME MEASUREMENT OF PARTICLE SIZE DISTRIBUTION IN CRYSTALLIZATION PROCESS Hrvoje Dorić, Ivan Vrban, Nenad Bolf	29
IZOLACIJA BAKTERIJSKIH KULTURA ZA UČINKOVITO KOMPOSTIRANJE BIOOPADA Monika Šabić Runjavac, Vedran Vučić, Dajana Kučić Grgić, Marijana Vidaković, Anita Šalić, Bruno Zelić, Marija Vuković Domanovac	23	RAZVOJ KALIBRACIJSKOG MODELA ZA KONTINUIRANO PRAĆENJE RASPODJELE VELIČINA ČESTICA U PROCESU KRISTALIZACIJE Hrvoje Dorić, Ivan Vrban, Nenad Bolf	29
REPRODUCTIVE INCOMPATIBILITY OF CHERRY Zlatko Čmelik, Besim Salkic, Ahmed Salkić, Ensar Salkić, Emir Imširović	24	EFFECT OF CONTACT TIME IN REMOVING Cr(IV) IONS FROM WATER USING LEMON PEEL AS LOW-COST BIOSORBENT Amila Dubravac, Meldina Omerčević, Mirnesa Zohorović, Emir Horozić	30
REPRODUKTIVNA INKOMPATIBILNOST TREŠNJE Zlatko Čmelik, Besim Salkic, Ahmed Salkić, Ensar Salkić, Emir Imširović	24	EFEKAT KONTAKTNOG VREMENA NA UKLANJANJE Cr(VI) JONA IZ VODE PRIMJENOM KORE OD LIMUNA KAO NISKOTROŠKOVNOG ADSORBENSA Amila Dubravac, Meldina Omerčević, Mirnesa Zohorović, Emir Horozić	30
THE LINEAR MODEL FOR PREDICTING ZINC AVAILABILITY IN SOILS OF EASTERN CROATIA Hrvoje Heffer, Domagoj Rastija, Krunoslav Dugalić, Ivana Rukavina, Milena Andrišić, Daniel Rašić, Katarina Perić, Zdenko Lončarić	25	SYNTHESIS, CHARACTERIZATION AND ANTIMICROBIAL ACTIVITY OF THE IMINE Co(II) COMPLEX DERIVED FROM NINHYDRIN AND GLYCINE Emir Horozić, Jasmin Suljagić, Adna Šerifović, Darja Husejnagić, Snježana Hodžić	31
LINEARNI MODEL PROCJENE RASPOLOŽIVOSTI ZN U TLIMA ISTOČNE HRVATSKE Hrvoje Heffer, Domagoj Rastija, Krunoslav Dugalić, Ivana Rukavina, Milena Andrišić, Daniel Rašić, Katarina Perić, Zdenko Lončarić	25	SINTEZA, KARAKTERIZACIJA I ANTIMIKROBNA AKTIVNOST IMINSKOG Co(II) KOMPLEKSA IZVEDENOG IZ NINHIDRINA I GLICINA Emir Horozić, Jasmin Suljagić, Adna Šerifović, Darja Husejnagić, Snježana Hodžić	31
PHYSICAL-CHEMICAL ANALYZES THE FRUITS OF STANDARD PEAR CULTIVARS GROWN IN TURKEY WITH VARIETIES THAT WERE DOMESTICATED IN OUR COUNTRY BUT THEY ARE ORIGIN FROM TURKEY Besim Salkic, Ahmed Salkić, Azra Salkić, Ensar Salkić, Ramzija Cvrk, Emir Imširović, Sead Noćajević	26	REMOVAL OF M (II) IONS FROM REAL SAMPLES OF INDUSTRIAL WASTE WATER BY CHEMICAL PRECIPITATION Halid Junuzović, Amra Selimović, Sabina Begić, Abdel Đozić, Melisa Ahmetović	32
MORFOLOŠKO-HEMIJSKA ANALIZA PLODOVA STANDARDNIH SORATA KRUŠKE GAJENIH U TURSKOJ SA SORTAMA KOJE SU SE ODOMAČILE KOD NAS A VODE PORIJEKLO IZ TURSKE			

UKLANJANJE M (II) JONA IZ REALNIH UZORAKA INDUSTRIJSKE OTPADNE VODE HEMIJSKOM PRECIPITACIJOM Halid Junuzović, Amra Selimović, Sabina Begić, Abdel Đozić, Melisa Ahmetović	32	POREĐENJE KOROZIONE STABILNOSTI ORTOPEDSKIH IMPLANTATA NA BAZI LEGIRANIH MATERIJALA Fehim Korać, Selma Burović, Selma Korać	38
REMOVAL OF CHROMIUM (VI) FROM AQUEOUS SOLUTION USING ORANGE PEEL Merisa Ljevaković, Almasa Djedović, Amila Dubravac, Mirnesa Zohorović, Emir Horozić	33	DISSOLUTION RATE ENHANCEMENT OF AN ACTIVE PHARMACEUTICAL INGREDIENT VIA SOLID DISPERSION Joško Barbarić, Krunoslav Žižek	39
UKLANJANJE HROMA (VI) IZ VODENOG RASTVORA POMOĆU KORE NARANDŽE Merisa Ljevaković, Almasa Djedović, Amila Dubravac, Mirnesa Zohorović, Emir Horozić	33	POVEĆANJE BRZINE OSLOBAĐANJA DJELATNE TVARI PRIPRAVOM ČVRSTIH DISPERZIJA Joško Barbarić, Krunoslav Žižek	39
TESTING THE EFFICIENCY OF REMOVING CHROMIUM (VI) IONS FROM WATER USING GRAPEFRUIT PEEL Meldina Omerčević, Haris Begović, Mirnesa Zohorović, Kanita Hukić	34	CELULOZA-G-DIMETILAMINOETIL METAKRILATNI HIDROGELOVI SA SREBROVIM NANOČESTICAMA Roko Blažić, Katarina Lenac, Elvira Vidović	40
ISPITIVANJE EFIKASNOSTI UKLANJANJA HROM (VI) JONA IZ VODE PRIMJENOM KORE OD GREJPFURTA Meldina Omerčević, Haris Begović, Mirnesa Zohorović, Kanita Hukić	34	AN EXAMPLE OF BLENDING COMMERCIAL MOTOR GASOLINE Tatjana Botić, Pero Dugić, Aleksandra Sinik	41
DETERMINATION OF THE CONTENT OF HEAVY METALS IN PELLET AND PELLET ASH BY FAAS TECHNIQUE Mirha Pazalja, Mirsada Salihović, Jasmina Sulejmanović, Mustafa Memić, Sabina Begić	35	PRIMJER NAMJEŠAVANJA KOMERCIJALNOG MOTORNOG BENZINA Tatjana Botić, Pero Dugić, Aleksandra Sinik	41
ODREĐIVANJE SADRŽAJA TEŠKIH METALA U PELETU I NJEGOVOJ PEPELU FAAS TEHNIKOM Mirha Pazalja, Mirsada Salihović, Jasmina Sulejmanović, Mustafa Memić, Sabina Begić	35	STUDYING THE HEAT EXCHANGE PROCESS IN A TUBULAR EXCHANGER Suad Grapkić, Nidret Ibrić, Elvis Ahmetović	41
DENSITY FUNCTIONAL THEORY: ¹ H-NMR and ¹³ C-NMR SPECTRA OF SOME SCHIFF BASES Salihović Mirsada, Pazalja Mirha, Roca Sunčica; Špirtović-Halilović Selma, Veljović Elma, Šapčanin Aida, Begić Sabina	36	STUDIRANJE PROCESA IZMJENE TOPLINE U CIJEVNOM IZMJENJIVAČU Suad Grapkić, Nidret Ibrić, Elvis Ahmetović	41
TEORIJA FUNKCIONALNA GUSTOĆE: ¹ H-NMR i ¹³ C-NMR SPEKTRI NEKIH SCHIFF-OVIH BAZA Salihović Mirsada, Pazalja Mirha, Roca Sunčica, Špirtović-Halilović Selma, Veljović Elma, Šapčanin Aida, Begić Sabina	36	SYNTHESIS OF GEL AIR FRESHENER AND ITS STABILITY Amra Bratovčić	42
DETERMINATION OF α -SOLANINE CONTENT IN TWO VARIETIES OF POTATOES BY THE DENSITOMETRIC METHOD Ismet Tahirović, Maja Radić, Lejla Klepo, Lutvija Karić, Hurija Džudžević-Čančar, Atifa Ajanović, Alija Uzunović	37	SINTEZA GELSKOG OSVJEŽIVAČA ZRAKA I NJEGOVA STABILNOST Amra Bratovčić	42
ODREĐIVANJE SADRŽAJA α -SOLANINA U DVIJE SORTE KROMPIRA DENZITOMETRIJSKOM METODOM Ismet Tahirović, Maja Radić, Lejla Klepo, Lutvija Karić, Hurija Džudžević-Čančar, Atifa Ajanović, Alija Uzunović	37	MICROENCAPSULATION OF ACTIVE INGREDIENT Matija Gretić, Gordana Matijašić, Juraj Petanjek	43
COMPARISON OF CORROSION STABILITY OF ALLOYED MATERIALS BASED ORTHOPEDIC IMPLANTS Fehim Korać, Selma Burović, Selma Korać	38	MIKROKAPSULIRANJE DJELATNE TVARI Matija Gretić, Gordana Matijašić, Juraj Petanjek	43
		MEASUREMENT AND MODELLING OF HYDROGEN SOLUBILITY IN FURFURAL Gorica Ivaniš, Ljudmila Fele Žilnik, Blaž Likozar, Miha Grilc	44
		MJERENJE I MODELOVANJE RASTVORLJIVOSTI VODONIKA U FURFURALU Gorica Ivaniš, Ljudmila Fele Žilnik, Blaž Likozar, Miha Grilc	44
		SIMULATION OF DISTILLATION PROCESS USING ChemSep SIMULATOR Aldin Karić, Muhamed Šišić, Nidret Ibrić, Elvis Ahmetović	45
		SIMULACIJA PROCESA DESTILACIJE UPOTREBOM ChemSep SIMULATORA Aldin Karić, Muhamed Šišić, Nidret Ibrić, Elvis Ahmetović	45

FORWARD OSMOSIS IN WATER TREATMENT PROCESSES – CASE STUDIES I. Petrinić, H. Bukšek, M. S. Sheldon, Amra Bratovic, C. Helix-Nielsen	45	THE DETERMINATION OF THE CONTENT OF POLYPHENOLS, ASCORBIC ACID, PECTIN AND ANTIOXIDANT CAPACITY IN APPLES AND CITRUS FRUITS Jasmina Alibašić, Almedina Alibašić, Suad Djedović	51
DEEP EUTECTIC SOLVENTS FOR PURIFICATION OF WASTE COOKING OIL AND CRUDE BIODIESEL Ana Petračić, Matea Gavran, Ana Škunca, Lucija Štajduhar, Aleksandra Sander	46	ODREĐIVANJE KOLIČINE POLIFENOLA, ASKORBINSKE KISELINE, PEKTINA I ANTIOKSIDATIVNOG KAPACITETA U JABUKAMA I CITRUSIMA Jasmina Alibašić, Almedina Alibašić, Suad Djedović	51
PRIMJENA NISKOTEMPERATURNIH EUTEKTIČKIH OTAPALA U PROČIŠĆAVANJU OTPADNOG JESTIVOG ULJA I BIODIZELA Ana Petračić, Matea Gavran, Ana Škunca, Lucija Štajduhar, Aleksandra Sander	46	COMPARISON OF QUALITY PARAMETERS OF SELECTED APPLE VARIETIES DURING STORAGE Hatidža Nurkić, Ramzija Cvrk, Besim Salkić, Amel Selimović, Tijana Brčina	52
INFLUENCE OF PROCESS PARAMETERS ON AROMATIC FIVE-MEMBERED HETEROCYCLES CATALYTIC CONVERSION IN A THREE PHASE BATCH REACTOR Rok Šivec, Nika Marinč, Miha Grilc, Blaž Likozar	47	USPOREDBA PARAMETARA KVALITETA ODABRANIH SORTI JABUKA TOKOM SKLADIŠTENJA Hatidža Nurkić, Ramzija Cvrk, Besim Salkić, Amel Selimović, Tijana Brčina	52
ISTRAŽIVANJE MOGUĆNOSTI RECIKLIRANJA MIJEŠANOG PLASTIČNOG OTPADA TERMIČKIM PROCESIMA Azra Kovačević, Stanko Blatnik, Zoran Iličković, Jasmin Suljagić	47	ASSESSMENT OF WATER SOURCES QUALITY IN DOBOJ EAST AREA Muhamed Šišić, Ramzija Cvrk, Sabina Begić, Amra Selimović	53
ENVIRONMENT, ENERGY, MATERIALS AND BIOGAS PRODUCTION Vladan Mičić, Ayse Aroguz, Jaroslava Budinski Simendić, Sabina Begić, Ljiljana Tanasić, Milica Mijatović, Jelena Pavličević,	48	PROCJENA KVALITETA IZVORIŠTA VODE NA PODRUČJU DOBOJ ISTOKA Muhamed Šišić, Ramzija Cvrk, Sabina Begić, Amra Selimović	53
OKOLINA, ENERGIJA, MATERIJALI I PROIZVODNJA BIOGASA Vladan Mičić, Ayse Aroguz, Jaroslava Budinski Simendić, Sabina Begić, Ljiljana Tanasić, Milica Mijatović, Jelena Pavličević,	48	THE DETERMINATION OF ANTIOXIDANT CAPACITY AND THE CONTENT OF POLYPHENOLS IN DIFFERENT TYPES OF TEA Suad Djedović, Jasmina Alibašić, Almedina Alibašić	54
COMBUSTION SYNTHESIS OF Al ₂ O ₃ WITH ASPARAGINE AS FUEL Ivana Katarina Munda, Ivona Matančević, Vilko Mandić, Gordana Matijašić, Stanislav Kurajica	49	ODREĐIVANJE ANTIOKSIDATIVNOG KAPACITETA I KOLIČINE UKUPNIH POLIFENOLA U RAZLIČITIM VRSTAMA ČAJA Suad Djedović, Jasmina Alibašić, Almedina Alibašić	54
SINTEZA Al ₂ O ₃ SAGORIJEVANJEM UZ ASPARAGIN KAO GORIVO Ivana Katarina Munda, Ivona Matančević, Vilko Mandić, Gordana Matijašić, Stanislav Kurajica	49	POBOLJŠANJE ORGANOLEPTIČKIH I SENZORSKIH OSOBINA GOTOVOG PROIZVODA - SO I BILJNI ZAČINI Ema Obralić, Amira Brkić, Enver Zulić	54
INFLUENCE OF ACTIVATED CARBON ADDITION ON SOME TEXTURAL CHARACTERISTICS OF ACID-ACTIVATED BENTONITE Zoran Petrović, Sabina Begić, Milomirka Škrba, Sanja Panić, Dragana Kešelj	50	BACTERIOLOGICAL ANALYSIS OF WELL WATER IN THE AREA OF BRČKO DISTRICT Snježana Hodžić, Amela Hercegovac, Suad Širanović, Aldijana Avdić, Darja Husejnagić, Edina Hajdarević	55
UTICAJ DODATKA AKTIVNOG UGLJA NA NEKE TEKSTURALNE KARAKTERISTIKE KISELINOM AKTIVIRANOG BENTONITA Zoran Petrović, Sabina Begić, Milomirka Škrba, Sanja Panić, Dragana Kešelj	50	BAKTERIOLOŠKA ANALIZA BUNARSKIH VODA NA PODRUČJU BRČKO DISTRIKTA Snježana Hodžić, Amela Hercegovac, Suad Širanović, Aldijana Avdić, Darja Husejnagić, Edina Hajdarević	55
THE DETERMINATION CARBONATED AND NATURAL JUICES COMPOSITION Almedina Alibašić, Jasmina Alibašić, Suad Djedović	51	CHANGE IN THE QUANTITY OF ASCORBIC ACID AFTER THERMAL PROCESSING OF POTATO Amela Kusur, Aldin Karić, Martina Andrejaš, Huriya Alibašić	56
ODREĐIVANJE SASTAVA GAZIRANIH I PRIRODNIH VOĆNIH SOKOVA Almedina Alibašić, Jasmina Alibašić, Suad Djedović	51	PROMJENA KOLIČINE ASKORBINSKE KISELINE NAKON TERMIČKE OBRADNE KROMPIRA Amela Kusur, Aldin Karić, Martina Andrejaš, Huriya Alibašić	56

THE INFLUENCE OF RECIPE MODIFICATION ON SENSORY PROPERTIES OF A MIXTURE OF SPICES – A COMPLEMENT OF DISHES Milica Vilušić, Amila Mehanović, Tijana Brčina, Midhat Jašić, Sabina Begić	57	OPTIMIZATION OF REACTION PARAMETERS OF BIODIESEL PRODUCTION BY USING WASTE COOKING OIL Alime Šenocak, Ezgi Zekiye Yiğit, Nazan Karapinar	61
UTJECAJ MODIFIKACIJE RECEPTURE NA SENZORSKA SVOJSTVA MJEŠAVINE ZAČINA – DODATKA JELIMA Milica Vilušić, Amila Mehanović, Tijana Brčina, Midhat Jašić, Sabina Begić	57	BIODIESEL PRODUCTION FROM WASTE COOKING OIL BY USING WASTE CHICKEN EGG SHELL CATALYSIS Ezgi Zekiye Yiğit, Alime Šenocak, Nazan Karapinar	62
ENVIRONMENTAL IMPACT ASSESSMENT OF FACTORY CEMENT LUKAVAC USING H1 METHODOLOGY Hana Alihodžić, Abdel Đozić, Damir Mulamehmedović, Emir Ćilimković, Azra Kovačević	58	ENVIRONMENTAL SUSTAINABILITY OF AEROBIC TREATMENT OF BIOWASTE Monika Šabić Runjavec, Dajana Kučić Grgić, Tomislav Domanovac, Dominik Knapić, Marija Vuković Domanovac	62
IMPACT OF ALTERNATIVE FUELS ON REDUCING THE EMISSION CONCENTRATION OF GASEOUS POLLUTANTS IN CEMENT FACTORY LUKAVAC Hana Alihodžić, Abdel Đozić, Damir Mulamehmedović, Emir Ćilimković	58	OKOLIŠNA ODRŽIVOST AEROBNE OBRADNE BIOOTPADNA Monika Šabić Runjavec, Dajana Kučić Grgić, Tomislav Domanovac, Dominik Knapić, Marija Vuković Domanovac	62
AN INVESTIGATION ON THE EFFECT OF WATER-SOLUBLE POLYMERS ON THE PROPERTIES OF CEMENT AND CONCRETE Anıl Utku ÇETİNKAYA, Mustafa İNCİ, Necip ATAR	59	CALIBRATION AND VALIDATION OF LINEAR MODELS FOR PREDICTING SOIL HYDROLYTIC ACIDITY Zdenko Lončarić, Hrvoje Heffer, Ivana Rukavina, Krunoslav Dugalić, Daniel Rašić, Milena Andrišić, Mario Mitrović, Domagoj Rastija	63
THE IMPACT OF WHEY VALORIZATION ON THE QUALITY OF THE WASTEWATER IN THE DAIRY INDUSTRY Aleksandar Chadikovski, Jana Simonovska, Dalibor Mladenovski, Vesna Rafajlovska	59	KALIBRACIJA I VALIDACIJA LINERANIH MODELA PROCJENE HIDROLITIČKE KISELOSTI TLA Zdenko Lončarić, Hrvoje Heffer, Ivana Rukavina, Krunoslav Dugalić, Daniel Rašić, Milena Andrišić, Mario Mitrović, Domagoj Rastija	63
DEGREE OF POLLUTION OF AGRICULTURAL SOIL AFTER ACCIDENT ON DISPOSAL SITE IV "WHITE SEA" Abdel Đozić, Vedran Stuhli, Mirnesa Zohorović, Hana Alihodžić	60	BIODYNAMIC AGRICULTURE AS A SYSTEM OF SUSTAINABILITY AND A WAY OF PRESERVING SOIL FERTILITY Emina Mešinović, Adela Mujić, Alisa Frkić, Ernad Kucalović, Ahmed Salkić, Besima Buljubašić	64
REMOVAL OF TEXTILE DYE FROM AQUEOUS SOLUTIONS BY USING HYDROXYAPATITE-MAGNETITE NANOCOMPOSITE MATERIALS Ramazan Koca, Ayşenur Öztürk, Arzu Yakar	60	BIODINAMIČKA POLJOPRIVREDA KAO SISTEM ODRŽIVOSTI I NAČIN OČUVANJA PLODNOSTI TLA Emina Mešinović, Adela Mujić, Alisa Frkić, Ernad Kucalović, Ahmed Salkić, Besima Buljubašić	64
COMPOSTING OF A MIXTURE OF ACTIVATED SLUDGE AND BIOWASTE IN A CLOSED REACTOR Dajana Kučić Grgić, Marija Vuković Domanovac, Martina Miloloža, Monika Šabić Runjavec, Tomislav Domanovac	61		

SOLUBILITY OF BIOACTIVE COMPONENTS IN SUPERCRITICAL CO₂. ARTIFICIAL NEURAL NETWORK MODELING

KIRIL LISICHKOV✉, STEFAN KUVENDZIEV, MIRKO MARINKOVSKI

Faculty of Technology and Metallurgy, University "Ss. Cyril and Methodius" in Skopje, N. Macedonia
✉ klisickov@yahoo.com

Supercritical fluid CO₂ extraction (SFE-CO₂) is a contemporary precise process eco-separation technique that produces a minimal impact on the environment. Furthermore, this extraction procedure is conducted at relatively low operating temperatures and produces solvent-free extracts and proved to be more selective towards polyunsaturated fatty acids compared to conventional separation techniques. Several studies have confirmed the supercritical carbon dioxide as an adequate solvent for the non-polar bioactive components.

The supercritical fluid extraction has several practical and ecological advantages over the classical separation processes. This non-conventional extraction technique is performed under moderate operating conditions, regarding the operating temperature, and requires no additional energy consumption for solvent removal. Supercritical carbon dioxide has been widely used within the supercritical fluid extraction processes as it represents a non-toxic, relatively cheap and inflammable "green" solvent with relatively mild critical values for the operating parameters - critical temperature of 304.15 K and critical pressure of 7.38 MPa. These properties ensure successful extraction of thermally unstable bioactive components such as ω -3 and ω -6 polyunsaturated fatty acids (PUFA)

Artificial neural network (ANN) represents a modern data processing system, whose design, structure and functioning principles are based on the principles of biological neural system. The fundamental processing element of ANN is an artificial neuron that receives inputs such as values of operating parameters and outputs the desired result, such as extraction yield. Designed neural architecture includes multiple interconnected process elements (neurons) that simultaneously process data. Basic characteristics of a neural network are adaptive learning (training), data self-organization capability and parallel processing ability. These advantages exclude the need of conventional mathematical modeling. Response surface-3D optimization method was employed in order to mathematically describe the ANN model through the functional dependence of ANN outputs from the input vectors and their interactions.

The aim of this work is the application of artificial neural network modeling in prediction of the solubility of polyunsaturated fatty acids isolated from lyophilized common carp viscera(ω -3 and ω -6) in SFE-CO₂ in correlation to the operating conditions: pressure, temperature, CO₂ mass flow and extraction time, as well as their interactions.

Keywords: bioactive components, solubility, SFE-CO₂, ANN modeling

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TODAY'S INNOVABILITY CHALLENGES IN CORROSION ENGINEERING

SANJA MARTINEZ✉

Faculty of Chemical Engineering and Technology, University of Zagreb, Marulićev trg 19, HR-10000 Zagreb, Croatia

✉ sanja.martinez@fkit.hr

Corrosion engineering is facing new innovability (innovation+sustainability) challenges in order to develop more corrosion resistant and/or environmentally friendly materials and processes, improve corrosion control and implement advanced inspection techniques and corrosion management strategies that would aid attainment of sustainable industrial society. In this paper, the two specific challenges faced by the ReCorr Laboratory at the Faculty of Chemical Engineering and Technology of the University of Zagreb will be discussed.

The first challenge refers to the development of a novel quality assurance and control testing device for rating variable-performance protective coating solutions with the aim of avoiding expensive maintenance, negative environmental impact and the loss of revenue. The QCQ (Quantitative Coating Quality) test uses a hand-held potentiostat, flexible conductive-polymer electrodes and a paste electrolyte for laboratory and field use have been developed along with the matching Windows, Android and IOS based software. Examples of application are given that expose a prospect of the wide-spread use of the method.

The second challenge refers to the development of a measurement device and software for automated correlation, in the wavelet space, of multiparametric measurements of non-stationary nature obtained on underground pipelines and rails experiencing stray currents originating from DC traction. The wavelet space analysis pinpoints time intervals with harmful stray current periods within them and resolves between the dominant potential positive and negative shifts and those due to the nearby passing trams/trains and distant trams/trains in the transport network. Examples of application in a congested urban area and on a cross-country pipeline are given.

Keywords: corrosion, protective coating, coating impedance, stray current, wavelet analysis

Plenary Lecture

DANAŠNJI IZAZOVI INOVABILNOSTI U KOROZIJSKOM INŽENJERSTVU

SANJA MARTINEZ✉

Fakultet kemijskog inženjerstva i tehnologije, Sveučilište u Zagrebu, Marulićev rg 19, HR-10000 Zagreb, Croatia

✉ sanja.martinez@fkit.hr

Korozijsko inženjerstvo suočava se s novim izazovima inovabilnosti (inovacije+održivosti) u razvoju korozijski otpornijih i/ili ekološki prihvatljivijih materijala i procesa, u poboljšanju korozijske kontrole i primijeni naprednih tehnika inspekcije i strategija upravljanja korozijom, koji pomažu postizanje održivog industrijskog društva. U ovom radu raspravljat će se o dva specifična izazova s kojima se suočava Laboratorij ReCorr na Fakultetu kemijskog inženjerstva i tehnologije Sveučilišta u Zagrebu.

Prvi izazov odnosi se na razvoj novog uređaja za osiguranje i kontrolu kvalitete, odnosno ocjenjivanje zaštitnih premaza različite učinkovitosti s ciljem izbjegavanja skupog održavanja, negativnog utjecaja na okoliš i gubitka prihoda. QCQ (engl. Quantitative Coating Quality) test koristi ručni potenciostat, fleksibilne provodljive polimerne elektrode i elektrolitsku pastu za laboratorijsku i terensku primjenu zajedno s odgovarajućim Windows, Android i IOS softverom. Navedeni su primjeri primjene koji otkrivaju mogućnost široke rasprostranjenosti ove metode.

Drugi izazov odnosi se na razvoj mjernog uređaja i softvera za automatiziranu korelaciju, u "wavelet" prostoru, multiparametarskih mjerenja nestacionarne prirode dobivenih na podzemnim cjevovodima i tračnicama pod utjecajem lutajućih struja koje potječu od istosmjerne vuče. Analizom u "wavelet" prostoru vidljivi su vremenski intervali sa štetnim razdobljima djelovanja lutajućih struja unutar njih. Također je moguće razlučiti između dominantnih pozitivnih i negativnih pomaka potencijala i onih koji su posljedica obližnjih tramvaja/vlakova i udaljenih tramvaja/vlakova u prometnoj mreži. Navedeni su primjeri primjene u gradskom području i na cjevovodu koji prolazi van grada.

Ključne riječi: korozija, zaštitni premaz, impedancija premaza, lutajuća struja, "wavelet" analiza

Plenary Lecture

TRENDS IN DESIGN AND DEVELOPMENT OF CATALYSTS

ANTE JUKIĆ✉

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

✉ ajukic@fkit.hr

Nowadays, most chemical conversion processes are catalytic. Therefore, it is obvious that the development of catalysts will greatly influence the development of associated processes, which is particularly pronounced in environmental protection and in the petroleum refining and petrochemical industry. Catalyst development is usually evaluated in terms of activity, selectivity and stability, bearing in mind that these properties are often interrelated. An increase in catalyst activity is achieved by new and improved chemical formulations, but also by an increase in the active surface, thereby entering the field of nanotechnology. However, dispersion of the active substance at the nano-level can result in poorer catalyst stability and an increased tendency for poisoning. Improvements to the catalyst carrier, most commonly inorganic, can also be crucial. Changing the chemical and phase composition of the oxide can result in significantly better mechanical stability of the catalyst.

The methods used to improve the catalyst properties are often based on calculations by using electron density of states theory and by structuring at nano-level. In this paper, examples of the application of nanotechnology in the development of catalysts for the process of hydrodesulfurization in oil refineries and the relationship of the electronic structure of Ni-Zr metal alloys in the process of electrocatalytic hydrogen production will be given.

Keywords: catalyst; development; hydrodesulfurization; hydrogen evolution reaction

Plenary Lecture

TRENDovi U DIZAJNU I RAZVITKU KATALIZATORA

ANTE JUKIĆ✉

Fakultet kemijskog inženjerstva i tehnologije, Sveučilište u Zagrebu, Marulićev trg 19, Zagreb, Hrvatska

✉ ajukic@fkit.hr

U današnje vrijeme većina kemijskih konverzijskih procesa je katalitička. Stoga je jasno da će razvitak katalizatora u velikoj mjeri utjecati i na razvitak pripadajućih procesa, što je osobito izraženo u zaštiti okoliša i naftno-petrokemijskoj industriji. Razvitak katalizatora obično se ocjenjuje s gledišta aktivnosti, selektivnosti i stabilnosti, pri čemu treba imati na umu da su ova svojstva često međusobno povezana. Povećanje aktivnosti katalizatora postiže se novim i poboljšanim kemijskim formulacijama, ali također i povećanjem aktivne površine, čime se sve više ulazi u područje nanotehnologije. Ipak, raspršenje aktivne tvari na nano razini može imati kao posljedicu slabiju stabilnost katalizatora i povećanu sklonost trovanju. Od presudnog značenja znaju biti i poboljšanja nosioca katalizatora, najčešće anorganskog. Promjena kemijskog i faznog sastava oksida može rezultirati znatno boljom mehaničkom postojanošću katalizatora. Metode koje se koriste pri unaprjeđenju svojstava katalizatora često se temelje na kvantnom računu primjenom izračuna gustoće elektronskih stanja, te nanostrukturiranjem. U ovom radu, biti će dani primjeri primjene nanotehnologije u razvitku katalizatora za proces hidrodesulfurizacije u rafinerijama nafte, te povezanosti elektronske strukture Ni-Zr metalnih slitina u procesu elektrokatalitičkog dobivanja vodika.

Ključne riječi: katalizator; razvoj; hidrodesulfurizacija; reakcija razvijanja vodika

Plenary Lecture

MODERNIZATION OF FOOD SAFETY SYSTEM AS A PREREQUISITE FOR PROTECTION OF CONSUMERS' HEALTH AND FREE TRADE IN FOOD

BORIS ANTUNOVIĆ✉

Faculty of Agrobiotechnical Sciences, University of J.J. Strossmayer, V. Preloga 1, 31000 Osijek, Croatia

✉ boris.antunovic@fazos.hr

Production and marketing of safe, healthy food is one of the imperatives of today's society. In the past, scandals related to the occurrence of mass diseases related to the consumption of contaminated foods (mad cow disease, dioxins, *E. coli*) have led to the need for a review of the food control system. In this regard, one of the most significant steps was the introduction of the HACCP system, the shift of responsibility to food producers and strengthening of the self-control system during production, before the food product has been found on the market.

At the European level, the European Food Safety Authority was established, and national agencies were set up according to different models, with the role of protecting consumer health. In Bosnia and Herzegovina, this role is being successfully performed by the Food Safety Agency of B&H. Risk assessment has become a tool in international food trade, defined by World Trade Organization (WTO) rules.

With a view to further modernizing the food safety system, the EU is currently in the phase of revising the general Food Law (2002), which at the time brought major changes. A good introduction to this process is Regulation 2017/625, which enters into force in December 2019. The focus is on strengthening the system of self-control, traceability, transparency, and consumer information and fight against food fraud, which should restore consumer confidence in the integrity of the food chain. Some of the new elements are: stronger involvement of agriculture in the food safety system ("from field to table"); greater transparency of controls, especially regarding the publication of results; combating food fraud; conducting controls on a regular, unannounced and risk-oriented basis; the establishment of EU reference centers for animal welfare and for the audit of the authenticity and integrity of the food chain; stronger cooperation in international trade (border crossings); establishing new more transparent systems for assessing compliance with food law requirements for manufacturers, food retailers and restaurants.

Keywords: food safety, modernization, health, food trade, EU

MODERNIZACIJA SUSTAVA SIGURNOSTI HRANE KAO PREDUVJET ZAŠTITE ZDRAVLJA POTROŠAČA I SLOBODNE TRGOVINE HRANOM

BORIS ANTUNOVIĆ✉

Fakultet Agrobiotehničkih znanosti, Sveučilište J.J. Strossmayer, V. Preloga 1, 31000 Osijek, Hrvatska

✉ boris.antunovic@fazos.hr

Proizvodnja i stavljanje na tržište sigurne, zdravstveno ispravne hrane, jedan je od imperativa današnjeg društva. Skandali u prošlosti povezani s pojavama masovnih oboljenja vezanih uz konzumaciju zdravstveno neispravne hrane (kravlje ludilo, dioksini, *E. coli*) doveli su do potrebe revizije sustava kontrole hrane. U tome smislu, jedan od najznačajnijih koraka bilo je uvođenje HACCP sustava, prebacivanje odgovornosti na proizvođače hrane i jačanje sustava samokontrole tijekom proizvodnje, prije no što se prehrambeni proizvod nađe na tržištu.

Na europskoj razini osnovana je Europska agencija za sigurnost hrane, a po različitim modelima osnivane su i nacionalne agencije čija je uloga zaštita zdravlja potrošača. U Bosni i Hercegovini, ovu ulogu uspješno obavlja Agencija za sigurnost hrane BiH. Procjena rizika postala je alatom u međunarodnoj trgovini hranom, određenom pravilima Svjetske trgovinske organizacije (WTO).

U svrhu daljnje modernizacije sustava sigurnosti hrane, EU je trenutno u fazi revizije Zakona o hrani iz 2002. godine, koji je tada donio temeljite promjene. Dobar uvod u ovaj proces predstavlja Regulativa 2017/625, koja stupa na snagu u decembru 2019. godine. Fokus je stavljen na jačanje sustava samokontrole, sljedivosti, transparentnosti, te informiranja potrošača i borbu protiv prijevara s hranom, čime bi se trebalo obnoviti povjerenje potrošača u integritet prehrambenog lanca. Neki od novih elemenata su jače uključivanje poljoprivrede u sustav sigurnosti hrane („od polja do stola“); veća transparentnost kontrola, posebno u vezi s objavljivanjem rezultata; suzbijanje prevara s hranom; provođenje kontrola redovito, nenajavljeno i orijentirano na rizik; uspostavljanje EU referentnih centara za dobrobit životinja, te za reviziju autentičnosti i integriteta prehrambenog lanca; jača suradnja pri međunarodnoj trgovini (granični prijelazi); uspostavljanje novih transparentnijih sustava procjene ispunjavanja zahtjeva zakona o hrani za proizvođače, trgovce hranom i restorane.

Ključne riječi: sigurnost hrane, modernizacija, zdravlje, trgovina hranom, EU

BIOMASS FRACTIONATION AND CATALYTIC FUNCTIONALISATION: A CONCEPT OF BIOREFINERY

MIHA GRILC,^{1,2} ✉, MATEJ HUŠ,¹ ANA BJELIĆ,¹ BRIGITA HOČEVAR,¹ ROK ŠIVEC,¹
ALEKSA KOJČINOVIĆ,¹ BRETT POMEROY,¹ GORICA IVANIŠ,¹ EDITA JASIUKAITYTE
GROJZDEK,¹ BLAŽ LIKOZAR¹

¹ Department of Catalysis and Chemical Reaction Engineering, National Institute of Chemistry, Hajdrihova 19, 1000 Ljubljana, Slovenia

² Univerza v Novi Gorici, Vipavska 13, 5000 Nova Gorica, Slovenia

✉ miha.grilc@ki.si

Depleting oil reserves, as well as a negative impact of its processing on the environment, have promoted search for new, renewable and green sources of fuels and chemicals. Lignocellulosic biomass has proven to be a promising alternative feedstock, not only in its natural form, but also as a waste. Agriculture, forestry, food and paper industries generate large waste streams that are still energy-rich or can be converted into value added chemicals.

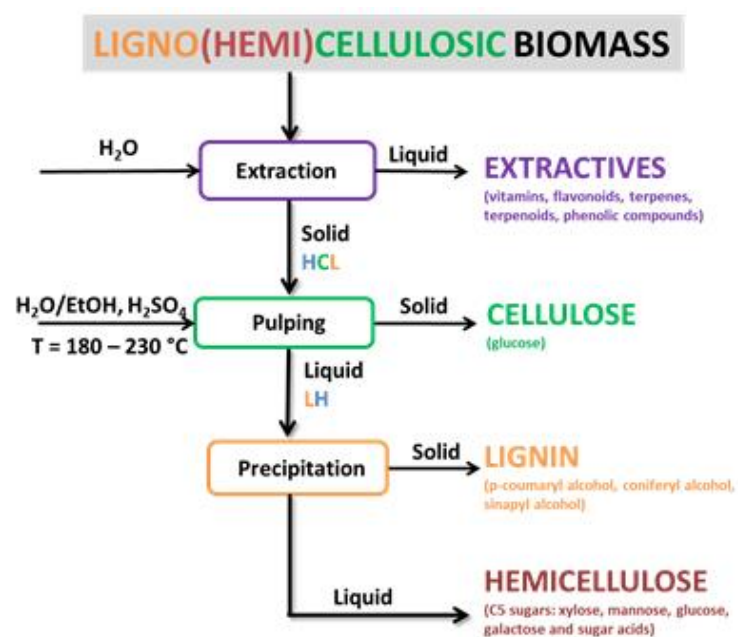


Figure 1: Schematic depiction of fractionation step in a biorefinery with eventual products in brackets.

At this invited lecture technologies for isolation of biopolymers from LC biomass (the so called fractionation) will be presented, as well as their further depolymerisation and final catalytic conversion into final value-added product. Case studies for production of bio-based adipic acid, GVL, levulinates and dihydroxyl furanes from cellulose and hemicellulose will be presented, as well as phenolics from depolymerized lignin. Bio-based technologies developed at the National Institute of Chemistry are of various technology readiness levels (TRLs), from proof-of-concept to commercialized multi-ton industrial production capacities. Main focus of the presented study will be on the catalytic functionalization of platform chemicals obtained from (hemi)cellulose and lignin by heterogeneous catalytic hydrotreatment over noble and transition metals over various supports.

Keywords: Lignocellulosic Biomass; Biorefinery; Catalysis; Bio-based Chemicals;

SUSTAINABLE PROCESS SYSTEMS ENGINEERING – ACCOMPLISHMENTS AND FUTURE CHALLENGES

ZDRAVKO KRAVANJA✉, ANDREJA NEMET, LIDIJA ČUČEK,
ŽAN ZORE, ZORKA NOVAK PINTARIČ

Faculty of Chemistry and Chemical Engineering, University of Maribor, Smetanova ulica 17, 2000 Maribor, Slovenia

✉ zdravko.kravanja@um.si

The presentation will start by discussing main incentives for sustainable development. Different greenhouse gas (GHG) mitigation options and possible contributions of Process Systems Engineering community to GHG emission reduction will be discussed. Thermodynamic analysis of European Union (EU) energy sectors based on Pinch Technology will be presented. It will be shown that European anthropogenic energy system is pinched with the Pinch temperature around 65 °C. Possible measures for huge energy saving and significant reduction of related GHG emissions will be discussed. Also, the importance of using holistic synthesis approach based on mathematical programming will be stressed out. Different case studies will be shown to illustrate the effectiveness of using the mathematical programming approach in regard to the synthesis of more sustainable systems, including the one of continental renewable-based supply networks for producing food, biofuels and electricity, applied to EU. The results indicate that the necessary transition away from fossil-based production could be carried out in a sustainable way, the implementation of which could be regarded as one of the most important challenges for fruitful sustainable development of our society.

Keywords: sustainable process systems engineering, holistic approach, mathematical programming.

ODRŽIVO PROCESNO SISTEMSKO INŽENJERSTVO – DOSTIGNUĆA I BUDUĆI IZAZOVI

ZDRAVKO KRAVANJA✉, ANDREJA NEMET, LIDIJA ČUČEK,
ŽAN ZORE, ZORKA NOVAK PINTARIČ

Fakultet za hemiju i hemijsku tehnologiju, Univerzitet u Mariboru, Smetanova ulica 17, 2000 Maribor, Slovenija

✉ zdravko.kravanja@um.si

Prezentacija će započeti sa diskutiranjem glavnih motiva za održivi razvoj, različitih opcija za smanjenje stakleničkih plinova i mogućih doprinosa zajednice procesnog sistemskog inženjerstva s ciljem smanjenja emisija stakleničkih plinova. Termodinamska analiza energetske sektora Evropske unije (EU) baziranih na Pinch tehnologiji će biti predstavljena i biće pokazano da Evropski antropogeni energetski sistem ima pinch temperaturu oko 65 °C. Diskutirati će se moguće mjere za ogromnu uštedu energije i značajno smanjenje emisija stakleničkih plinova. Također će se naglasiti važnost korištenja holističkog sinteznog pristupa baziranog na matematičkom programiranju. Biće prikazane različite studije slučaja koje ilustruju efikasnost upotrebe pristupa matematičkog programiranja za sintezu održivih sistema, uključujući i kontinentalne mreže opskrbe obnovljivim izvorima energije u proizvodnji hrane, biogoriva i električne energije koje se primjenjuju u EU. Rezultati pokazuju da bi se potreban prelaz sa proizvodnje bazirane na fosilnim gorivima mogao provesti na održiv način a ta implementacija se može smatrati jednim od najvažnijih izazova za plodonosni održivi razvoj našeg društva.

Ključne riječi: održivo procesno sistemsko inženjerstvo, holistički pristup, matematičko programiranje.

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Moja priča.



EFFECT OF QUALITY OF PURIFIED BRINE AND MOTHER LIQUOR ON THE YIELD OF NaCl IN SALT PRODUCTION

ABDULAH AHMETOVIĆ¹, AMIRA BRKIĆ²,✉

¹Faculty of Technology, University of Tuzla, Tuzla, Bosnia and Herzegovina

²Solana d.d. Tuzla, Bosnia and Herzegovina

✉ amira.brkic@solana.ba

The salt water from Tetima salt mine, which is the basic salt source for salt production, is the system of: Na^+ ; Ca^{2+} ; Mg^{2+} / Cl^- ; HCO_3^- ; SO_4^{2-} / H_2O . It is commonly believed that the basic factor of higher salt yield is the concentration of NaCl in the purified brine, which is introduced into the evaporator. This paper analyzes the influence of brine quality which supplies evaporator as well as the influence of the mother liquor quality that must be performed from the vaporizing station on salt yield in the production process

Keywords: Purified brine (PSV), mother liquor (ML), concentration (C_{1-n}).

UTICAJ KVALITETA PREČIŠĆENE SLANE VODE I MATIČNE LUŽINE NA PRINOS NaCl U PROIZVODNJI SOLI

ABDULAH AHMETOVIĆ¹, AMIRA BRKIĆ²,✉

¹Tehnološki fakultet, Univerzitet u Tuzli, Univerzitetska 8, 75000 Tuzla, Bosna i Hercegovina,

¹ Solana d.d. Tuzla, Ul. Soli 3, 75000 Tuzla, Bosna i Hercegovina

✉ amira.brkic@solana.ba

Slana voda ležišta Tetima, koja je osnovna sirovina za proizvodnju soli je sistem: Na^+ ; Ca^{2+} ; Mg^{2+} / Cl^- ; HCO_3^- ; SO_4^{2-} / H_2O . Uobičajeno je mišljenje da je osnovni faktor većeg prinosa soli koncentracija NaCl u prečišćenoj slanoj vodi, koja se uvodi u isparivačku stanicu.

U radu je analiziran uticaj kvaliteta slane vode kojom se napaja isparivačka stanica, kao i uticaj kvaliteta matične lužine koja se mora izvoditi iz isparivačke stanice na prinos soli u procesu proizvodnje.

Ključne riječi: Prečišćena slana voda (PSV), matična lužina (ML), koncentracija (C_{1-n}).

BIOSORPTION OF HEAVY METAL IONS AND SYNTHETIC DYES FROM AQUEOUS SOLUTIONS USING LIGNOCELLULOSIC MATERIALS

AMILA DUBRAVAC✉, JOSKIĆ MONIKA

Faculty of Technology, University of Tuzla, Univerzitetska 8, 75000 Tuzla, Bosnia and Herzegovina
✉ dubravac.amila@gmail.com

Biosorption can be defined as an ability of certain biomolecules to bind by their functional groups or to concentrate ions from aqueous solutions. Nowadays, biosorption is often an alternative method to existing conventional methods for purification wastewaters. The main advantage of biosorption in relation to conventional purification methods, in addition to its efficiency in removing metal ions from aqueous solutions, is the availability, cost-effectiveness and ecological acceptability of adsorbents, which are most often the waste product of the agricultural, food or wood industry. In the literature they are called "cheap" adsorbents, and most often they are lignocellulosic materials. A review of the literature of selected materials as biosorbents for removal of synthetic dyes and heavy metals (sawdust of poplar, poplar and beech, beer tropics, apple tropes, rapeseed oil, orange peel) is presented. For removal of small hits of green and methylene blue, the efficiency of papilla and beech as a biosorbent was over 90%. The removal of the Br (II) bifurcons with the black boron blackberry biomass was over 80%, while the biosorbent sawdust of oak was used for Cd (II) ions and Pb (II) ions. The percentage of Cd (II) was 58%, while Pb (II) was 87%. The maximum orange adsorption capacity as biosorbent for the removal of heavy metals was for Cu²⁺ (60 mg / ml), Cd²⁺ (126 mg / ml), Pb²⁺ (142 mg / ml), Zn²⁺ (45 mg / ml) and Ni²⁺ (49 mg / ml). As the overall result of the analysis, we can conclude that lignocellulosic materials, especially materials with high cellulose content, have proved to be very effective as biosorbents.

Keywords: heavy metals, biosorption, synthetic colors

"Chemical analysis control and monitoring"
Oral presentation. Section:

BIOSORPCIJA JONA TEŠKIH METALA I SINTETSKIH BOJA IZ VODENIH RASTVORA KORIŠTENJEM LIGNOCELULOZNIH MATERIJALA

AMILA DUBRAVAC✉, JOSKIĆ MONIKA

Tehnološki fakultet Univerziteta u Tuzli, Univerzitetska 8, 75000 Tuzla, Bosna i Hercegovina
✉ dubravac.amila@gmail.com

Biosorpcija se može definisati kao sposobnost određenih biomolekula da svojim funkcionalnim grupama vezuju ili iz vodenih rastvora koncentrišu jone metala. Biosorpcija je danas često alternativa postojećim konvencionalnim metodama za prečišćavanje otpadnih voda. Glavna prednost biosorpcije u odnosu na konvencionalne metode prečišćavanja, pored njene efikasnosti u uklanjanju jona metala iz vodenih rastvora je dostupnost, ekonomičnost i ekološka prihvatljivost adsorbensa, koji su najčešće otpadni proizvod poljoprivredne, prehrambene ili drvne industrije. U literaturi se nazivaju „low-cost“ adsorbensi, a najčešće su to lignocelulozni materijali. Dat je literaturni pregled odabranih materijala kao biosorbena za uklanjanje sintetskih bojila i teških metala (piljevina hrasta, topole i bukve, pivski trop, trop jabuke, repini rezanci, šišarice borai kora narandže). Za uklanjanje malahitnog zelenila i metilenskog modrila efikasnost piljevine topole i bukve kao biosorbenta iznosila je preko 90%. Uklanjanje Br(II)jona sa biomasom šišarice crnog bora iznosilo je preko 80%, dok je za jone Cd(II) i jone Pb(II) kao biosorbent korištena piljevina hrasta. Postotak za Cd(II) iznosio je 58%, dok je za Pb(II) iznosio 87%. Maksimalni adsorpcijski kapacitet kore narandže kao biosorbenta za uklanjanje teških metala iznosio je za Cu²⁺ (60 mg/ml), Cd²⁺ (126 mg/ml), Pb²⁺ (142 mg/ml), Zn²⁺ (45 mg/ml) i za Ni²⁺ (49 mg/ml). Kao sveukupni rezultat analize možemo zaključiti da su se lignocelulozni materijali, posebno materijali sa visokim sadržajem celuloze pokazali vrlo efikasnim kao biosorbenti.

Ključne riječi: Teški metali, biosorpcija, sinteske boje

"Chemical analysis control and monitoring"
Oral presentation. Section:

A REVIEW: CHARACTERIZATION OF NATURAL FIBER REINFORCED POLYMER COMPOSITES

EMINA TUČIĆ✉, ADISA HASANBAŠIĆ

Faculty of Technology, University of Tuzla, Univerzitetska 8, 75000 Tuzla, Bosnia and Herzegovina
✉ eminatucic12@gmail.com

The aim of this work is to review characterization of natural fiber reinforced polymer composites. Natural fiber-reinforced polymer composites (NFPCs) have attracted attention due to their biodegradable, lightweight, nontoxic and low cost properties. The wide use of NFPCs are rapidly increasing in many areas of the technique. The chemical composition and properties of natural fibers depends on the type of fiber itself. Natural fibers are an alternative for replacing traditional synthetic fibers. Natural fibers are low cost and require low production energy then synthetic fibers .

Polymer matrix composites have several advantages, such as low cost, low density and they are easy to handle. In recent years, composite materials replace already existing materials and occupy an important place in the industry.

In this paper will be explained several methods that can be used for the characterization of composite materials. Thermal methods, like DSC and TG, which can be used for characterization of NFPCs are explanation. An overview of microscopic analysis and mechanical properties of various natural fiber reinforced polymers is also presented.

Keywords: natural fiber, polymer matrix composites, characterization

PREGLED: KARAKTERIZACIJA POLIMERNIH KOMPOZITA OJAČANIH PRIRODNIH VLAKNIMA

EMINA TUČIĆ✉, ADISA HASANBAŠIĆ

Tehnološki fakultet, Univerzitet u Tuzli, Univerzitetska 8, 75000 Tuzla, Bosna i Hercegovina
✉ eminatucic12@gmail.com

Cilj ovog rada je da se izvrši pregled karakterizacije polimernih kompozita ojačanih prirodnim vlaknima. Polimerni kompoziti ojačani prirodnim vlaknima privukli su pažnju zbog toga što su lagani, netoksični, jeftini i biorazgradivi. Široka upotreba polimernih kompozita ojačanih prirodnim vlaknima ubrzano raste u mnogim oblastima tehnike. Hemijski sastav i osobine prirodnih vlakana zavisi od same vrste vlakana. Prirodna vlakna zamjenjuju tradicionalna sintetička vlakana. Imaju nisku cijenu i zahtijevaju nižu potrošnju energije od sintetičkih vlakana.

Kompoziti sa polimernom matricom imaju nekoliko prednosti, kao što su niska cijena, niska gustoća i lako rukovanje. Posljednjih godina kompozitni materijali zamenjuju već postojeće materijale i zauzimaju važno mesto u industriji.

U radu će biti objašnjeno nekoliko metoda koje se mogu koristiti za karakterizaciju kompozitnih materijala. Termičke metode poput DSC i TG koje se primjenjuju za karakterizaciju polimernih kompozita ojačanih prirodnim vlaknima detaljnije će biti objašnjene u radu. Pregled mikroskopske analize kao i mehaničkih osobina različitih polimera ojačanih prirodnim vlaknima detaljno će biti obrazloženi.

Ključne riječi: prirodna vlakna, polimerni kompoziti, karakterizacija.

COPPER (II) SULFATE PENTAHYDRATE AS AGROCHEMICALIRMA VILIĆ✉, MIRZA MURATOVIĆ

Faculty of Natural Sciences and Mathematics, University of Tuzla, Univerzitetska 4, 75000 Tuzla, Bosnia and Herzegovina

✉ irma_vilic@outlook.com

The use of all pesticides as well as fungicides are one of the most important factors in agricultural production. Fungicides as one type of pesticide are used to fight fungi on the tree bark, leaf, flower and fruit of the plants. This paper focuses on the basic features and function of the predetermined fungicide, copper (II) sulfate pentahydrate, also known as blue vitriol.

Blue vitriol is the most significant, one of the most important, and probably most famous copper salt, evident and used since ancient Egypt. Copper (II) sulfate pentahydrate is a compound that sold under the names of tetra acetyl copper (II) sulfate monohydrate, blue vitriol, and kalkokianit. By chemical nature it is the salt of the bivalent copper and sulphate ion. Undoubtedly, blue vitriol is the most important and most famous bivalent copper compound. The crystals of this compound belong to a tricyclic crystal system and have transparent blue color.

Special emphasis of the research is dedicated to the production of Bordeaux mixture composed of hydrated lime and blue vitriol. The mixture is used to treat fungicidal diseases on watermelon leaves. Therefore, the experimental studies have been carried out to determine the optimal concentration of Bordeaux mixture for prevention and suppression of fungal diseases in watermelon.

It is also important to mention the toxicity of copper that is released into the soil while treating plants. The toxicity effects can damage plants, contaminate soil, surface, and groundwater.

Keywords: copper, blue vitriol, fungicide, toxicity.

BAKAR (II) SULFAT PENTAHIDRAT KAO AGROHEMIKALIJAIRMA VILIĆ✉, MIRZA MURATOVIĆ

Prirodno-matematički fakultet, Univerzitet u Tuzli, Univerzitetska 4, 75000 Tuzla, Bosna i Hercegovina

✉ irma_vilic@outlook.com

Upotreba svih pesticida, pa tako i fungicida jedan je od bitnijih faktora u poljoprivrednoj proizvodnji. Fungicidi, kao jedna od vrsta pesticida, bore se u suzbijanju gljivica na stablu, listu, cvijetu i plodu nekih biljaka. U ovom radu pažnja je usmjerena na osnovne karakteristike i djelovanje tačno određenog fungicida, bakar (II) sulfat pentahidrata, u narodu poznatijeg kao modra galica.

Modra galica je najznačajnija i jedna od najvažnijih bakrenih soli, te vjerovatno najpoznatija sol bakra, a bila je poznata još starim Egipćanima. Bakar (II) sulfat pentahidrat je spoj koji se također u prodaji može naći pod nazivima tetraakva-bakrov (II) sulfat monohidrat, plavi vitriol, kalkokianit, a na Balkanu je najpoznatiji kao modra galica. Po hemijskoj prirodi je sol dvovalentnog bakra i sulfatnog iona. Sa sigurnošću se može reći da je modra galica najvažniji i najpoznatiji spoj dvovalentog bakra. Kristali ovog spoja pripadaju triklnskom kristalnom sistemu i prozirno plave su boje.

Poseban fokus u istraživanju posvećen je proizvodnji tzv. bordoške čorbe, smjese modre galice i gašenog kreča, a koja se koristi u liječenju fungicidnih oboljenja na listovima lubenice. Stoga su vršena eksperimentalna istraživanja u svrhu određivanja optimalne koncentracije bordoške čorbe, koja bi se koristila u prevenciji i suzbijanju gljivičnih oboljenja na lubenici.

Također je važno spomenuti toksičnost bakra koji se prilikom korištenja u zaštiti biljaka oslobodi u zemljištu i kao takav štetno djeluje na biljke, zagađuje tlo, površinske i podzemne vode.

Ključne riječi: bakar, modra galica, fungicid, toksičnost.

COMMINUTION KINETICS OF DOLOMITE IN A LABORATORY BALL MILL

SAMIRA HOTIĆ^{1,✉}, GORDANA MATIJAŠIĆ², OSMAN PERVIZ³

¹Faculty of Biotechnology, University of Bihać, Luke Marjanovića bb, 77000 Bihać, Bosnia and Herzegovina

²Faculty of Chemical Engineering and Technology, University of Zagreb, Marulićev trg 20, 10000 Zagreb, Croatia

³Faculty of Biotechnology, University of Bihać, Luke Marjanovića bb, 77000 Bihać, Bosnia and Herzegovina

✉ samira_hotic@yahoo.com

Grinding is one of the most widely used methods of obtaining solid particles control systems / desired distributions in all branches of industry. Enlargement of this process is often based on experience and by methods of trying and error that requires a large number of experiments. The development of mathematical models enabled the transfer of results to a larger scale in similar systems.

The proposed research was conducted in laboratory scale. The modeling of the fractionation process with the population balance included a description of the kinetics of colonization of dolomite kinetic parameters and the development of models that enabled the estimation of kinetic parameters based on the particle size, the geometric characteristics of the mill and the process parameters. Rajamani and Herbst model is suggested for the development of selection function in a ball mill under given conditions process. Laboratory-level research and the development of mathematical models for transferring results to a larger scale is a potent way of reducing energy consumption.

Keywords: grinding, comminution kinetics, population balance, kinetic parameters

Chemical and biochemical engineering
Oral presentation. Section:

KINETIKA MLJEVENJA DOLOMITA U LABORATORIJSKOM KUGLIČNOM MLINU

SAMIRA HOTIĆ^{1,✉}, GORDANA MATIJAŠIĆ², OSMAN PERVIZ³

¹ Biotehnički fakultet, Univerzitet u Bihaću, Luke Marjanovića bb, 77000 Bihać, Bosna i Hercegovina

² Fakultet kemijskog inženjstva i tehnologije, Sveučilište u Zagrebu, Marulićev trg 20, 10000 Zagreb, Hrvatska

³ Biotehnički fakultet, Univerzitet u Bihaću, Luke Marjanovića bb, 77000 Bihać, Bosna i Hercegovina

✉ samira_hotic@yahoo.com

Usitnjavanje je jedna od najraširenijih metoda dobivanja sistema čvrstih čestica kontrolirane/željene raspodjele u svim granama industrije. Uvećanje ovog procesa često se temelji na iskustvu te metodama pokušaja i pogreške što iziskuje velik broj eksperimenata. Razvoj matematičkih modela omogućio je prenošenje rezultata na veće mjerilo u sličnim sistemima.

Predložena istraživanja provedena su u laboratorijskom mjerilu. Modeliranje procesa usitnjavanja populacijskom bilancom obuhvatilo je opis kinetike usitnjavanja dolomita kinetičkim parametrima i razvoj modela koji su omogućili procjenu kinetičkih parametara na temelju veličine čestica, geometrijskih karakteristika mlina i procesnih parametara. Rajamani i Herbst model je predložen za razvoj funkcije selekcije u kugličnom mlinu u danim uslovima procesa. Istraživanja provedena na laboratorijskoj razini, te razvoj matematičkih modela za prenošenje rezultata na veće mjerilo potencijalan je način smanjenja potrošnje energije.

Ključne riječi: usitnjavanje, kinetika usitnjavanja, populacijska bilanca, kinetički parametri

Chemical and biochemical engineering
Oral presentation. Section:

CORROSION COUPON TESTING OF COMMERCIAL INHIBITOR IN SIMULATED COOLING WATER

BORISLAV N. MALINOVIC^{1,✉}, DUSKO ZORIC², TIJANA DJURICIC¹

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

² EFT Mine and Thermal Power Plant Stanari Ltd., Stanari, Bosnia and Herzegovina

✉ borislav.malinovic@tf.unibl.org

ABSTRACT

In maintaining cooling systems, one of the biggest challenges is to control the corrosion process. Various corrosion inhibitors are often used for this purpose. Which type of corrosion inhibitor will be chosen depends on the material from which the plant has made. The main causes of corrosion in these systems are: pH, dissolved gas, ammonia, temperature and microbiology.

In this paper it was studied the efficiency of two multicomponent commercial corrosion inhibitors based on phosphates and one of which containing zinc chloride. For the purposes of research, the pilot plant of open recirculation cooling system is constructed and made of stainless steel (EN 1.4301) and copper (EN 13601). Experiments were performed in a simulated cooling water which recirculated for 3.5h. For the purpose of accelerating corrosion processes, it was added a corrosion activator (5% NaCl). It was monitored the corrosion rate of the mentioned materials in the cooling water with the corrosion activator, with and without inhibitor. Corrosion rate is determined by using corrosion coupons according standard ASTM D2688 and by analyzing physical-chemical parameters of cooling water.

The results showed it was achieved higher protection efficiency for copper and stainless steel by using an inhibitor containing zinc chloride in addition to phosphate.

Keywords: pilot plant, corrosion rate, stainless steel, copper.

ISPITIVANJE KOMERCIJALNOG INHIBITORA KOROZIJE METODOM KOROZIONIH KUPONA U SIMULIRANOJ RASHLADNOJ VODI

BORISLAV N. MALINOVIC^{1,✉}, DUSKO ZORIC², TIJANA DJURICIC¹

¹ Tehnološki fakultet, Univerzitet u Banjoj Luci, Stepe Stepanovića, 78000 Banja Luka, Bosna i Hercegovina

² EFT Rudnik i Termoelektrana Stanari d.o.o., 74208 Stanari, Bosna i Hercegovina

✉ borislav.malinovic@tf.unibl.org

U održavanju energetske rashladne sistema jedan od najvećih izazova je kontrola procesa korozije. U tu svrhu često se koriste razni inhibitori korozije. Odabir vrste inhibitora korozije zavisi od materijala od kojeg je izrađeno postrojenje. Glavni uzročnici korozije u ovim sistemima su: pH, rastvoreni gasovi, amonijak, temperatura i mikrobiologija.

U ovom radu ispitana je efikasnost dva multikomponentna inhibitora korozije na bazi fosfata, od kojih jedan sadrži i cink hlorid. Za potrebe eksperimenta konstruisano je i izrađeno pilot postrojenje otvorenog recirkulacionog sistema hlađenja. Pilot postrojenje je izrađeno od nerđajućeg čelika (EN 1.4301) i bakra (EN 13601). Eksperimenti su rađeni u simuliranoj rashladnoj vodi, koja je recirkulisala 3,5h. Za ubrzanje procesa korozije dodan je aktivator korozije (5% NaCl). Praćena je brzina korozije pomenutih materijala u rashladnoj vodi sa i dodatka inhibitora korozije. Brzina korozije je određivana upotrebom korozionih kupona, u skladu sa standardnom metodom ASTM D2688 i analizom fizičko-hemijskog sastava rashladne vode.

Rezultati su pokazali da se postiže bolja zaštita i nerđajućeg čelika i bakra od korozije, upotrebom inhibitora koji pored fosfata sadrži i cink hlorid.

Ključne riječi: pilot postrojenje, brzina korozije, nerđajući čelik, bakar.

MODELING OF SUSPENSION FLOWS IN THE CONTEXT OF SUSTAINABLE TECHNOLOGIES

STEFAN RADL

Institute of Process and Particle Engineering, Graz University of Technology, Inffeldgasse 13, 8010 Graz, Austria

✉ radl@tugraz.at

Processes that are used in industrial plants for sustainable energy and materials production (e.g., biorefineries) offer an excitingly large playground for scientific research. This is due to a number of challenges, of which (i) the structural complexity of renewable resources (e.g., wood), and (ii) the need to access operational windows for which even lab-scale experiments become extremely expensive, are prime examples. Some of these challenges are related to the flow of suspensions. Our present contribution will summarize mathematical models to describe such flows, and how flow models can be integrated with large-scale process models, e.g., for plant-scale optimization studies.

In a first example we will discuss models for gas-particle flow, including heat and mass transport. Such models can be used to predict the performance of future hydrogen production plants, e.g., based on Chemical Looping Reforming (CLR) of methane, or the well-known reformer steam iron cycle. In a second example we will discuss the wide application area of biorefineries. Specifically, we will consider the flow simulation of pulp fibre suspensions, and how flow information can be linked to optimization tools and large-scale plant simulations. Finally, we will discuss open-source flow simulations tools that have been further developed by us, including OpenFOAM®, LIGGGHTS®, CFDDEM® as our home-brew software (i) CPPPO for spatial filtering, and (ii) ParScale for intra-particle transport.

Keywords: suspensions, flow modeling, biorefineries, chemical looping reforming

APPLICATION OF ASPEN ENERGY ANALYZER SOFTWARE IN SOLVING HEAT INTEGRATION PROBLEMS

AMRA RIZVANOVIĆ, NIDRET IBRIĆ, ELVIS AHMETOVIĆ✉

University of Tuzla, Faculty of Technology, Univerzitetska 8, 75000 Tuzla, Bosnia and Herzegovina

✉ elvis.ahmetovic@untz.ba

Different computer-aided tools can be used for solving heat integration problems. Aspen Energy Analyzer is a software which can be used for developing heat integration projects and identifying the best heat exchanger network design solutions. This work describes the application of Aspen Energy Analyzer and a step-by-step procedure for solving the studied heat integration problem. The minimum utility consumption is determined and the heat exchanger network is synthesized for the studied problem.

Keywords: heat integration, Aspen Energy Analyzer, minimum utility consumption, heat exchanger network.

PRIMJENA ASPEN ENERGY ANALYZER SOFTVERA U RJEŠAVANJU PROBLEMA TOPLINSKE INTEGRACIJE

AMRA RIZVANOVIĆ, NIDRET IBRIĆ, ELVIS AHMETOVIĆ✉

Univerzitet u Tuzli, Tehnološki fakultet, Univerzitetska 8, 75000 Tuzla, Bosna i Hercegovina

✉ elvis.ahmetovic@untz.ba

Za rješavanje problema toplinske integracije koriste se različiti kompjuterski potpomognuti alati. Aspen Energy Analyzer je softver koji se može koristiti za razvijanje projekata toplinske integracije i identificiranje najboljih rješenja dizajna mreže izmjenjivača topline. Ovaj rad opisuje primjenu Aspen Energy Analyzer softvera i korak po korak proceduru u rješavanju studiranog problema toplinske integracije. Za primjer studiran u radu utvrđena je minimalna potrošnja energenata i sintetizirana mreža izmjenjivača topline.

Ključne riječi: integracija topline, Aspen Energy Analyzer, minimalna potrošnja energenata, mreža izmjenjivača topline.

APPLICATION OF ASPEN PLUS SOFTWARE FOR SOLVING CHEMICAL ENGINEERING PROBLEMS

AIDA SKEJIĆ, ELVIS AHMETOVIĆ✉

University of Tuzla, Faculty of Technology, Univerzitetska 8, 75000 Tuzla, Bosnia and Herzegovina
✉ elvis.ahmetovic@untz.ba

This work demonstrates an application of Aspen Plus software for solving chemical engineering problems and highlights its important role in chemical engineering education and the process industry. Several of numerous software capabilities were demonstrated on three case studies. In the first example, a process simulation and a sensitivity analysis was performed. In the second case study, an economic analysis of a simulated process was performed using *Aspen Activated Economics* and *Aspen Process Economic Analyzer* options. In the third case study, process simulation and optimization was executed with help of the *Fortran* programming language. The results of case studies were presented and discussed.

Keywords: process simulator, chemical process, economic analysis, sensitivity analysis, optimization

PRIMJENA ASPEN PLUS SOFTVERA U RJEŠAVANJU HEMIJSKO-INŽENJERSKIH PROBLEMA

AIDA SKEJIĆ, ELVIS AHMETOVIĆ✉

Univerzitet u Tuzli, Tehnološki fakultet, Univerzitetska 8, 75000 Tuzla, Bosna i Hercegovina
✉ elvis.ahmetovic@untz.ba

Ovaj rad demonstrira primjenu Aspen Plus softvera u rješavanju hemijsko-inženjerskih problema i ističe njegovu značajnu ulogu u hemijsko-inženjerskoj edukaciji i procesnoj industriji. Kroz tri studijska primjera demonstriran je dio brojnih mogućnosti ovog softvera. U prvom primjeru izvršena je simulacija tehnološkog procesa i analiza osjetljivosti. U drugom primjeru izvršena je ekonomska analiza simuliranog procesa upotrebom *Aspen Activated Economics* i *Aspen Process Economic Analyzer* opcija. U trećem primjeru izvršena je simulacija i optimizacija procesa uz pomoć programskog jezika *Fortran*. Za sve studijske primjere predstavljeni su i diskutirani rezultati.

Ključne riječi: procesni simulator, hemijski proces, ekonomska analiza, analiza osjetljivosti, optimizacija

IMPACT OF RAW MATERIALS AND ALTERNATIVE FUELS ON THE MOVEMENT OF ALKALI AND SULPHATES IN THE PRODUCTION OF CEMENT

ADISA HASANBAŠIĆ✉, EMINA TUČIĆ

Faculty of Technology, University of Tuzla, Univerzitetska 8, 75000 Tuzla, Bosnia and Herzegovina
✉ hasanbasica1@gmail.com

Cement is a basic material for building and construction industry. It is non-metallic, inorganic powder and hydraulic binder forming a paste with water, which sets and hardens due to hydration reaction. Cement factories used a various types of industrial and household waste as auxiliary raw materials and fuels to reduce production costs. To reduce its consumption of traditional fuels cement industry is using refuse-derived fuel (RDF). RDF increases the chlorine input into cement plants.

Chlorine and alkalis compounds are volatile in the kiln at high temperature and cause clogging within the kiln and preheater. The alkali metals are introduced into the kiln with the clay minerals. The volatile species that participate in alkali cycles are sulphates and chlorides of the alkali metals, potassium and sodium.

Bypass systems have been developed worldwide as a state-of-art technology to reduce the chlorine load in the cement manufacturing. Bypass system is important for cement kiln to decrease ability of alkali and chlorine cycles and the possibility of creating clogging.

The aim of this work is to review the process of Portland-clinker production with a special focus on chloride transfer in the rotary kiln and present influence of alternative fuels and raw materials on cement manufacturing.

Keywords: cement, alternative fuels, raw materials, chlorides, sulphates.

Chemical and ecological
sustainable technologies
Oral presentation. Section.

UTICAJ POLAZNIH SIROVINA I ALTERNATIVNIH GORIVA NA KRETANJE ALKALIJA I SULFATA U PROIZVODNJI CEMENTA

ADISA HASANBAŠIĆ✉, EMINA TUČIĆ

Tehnološki fakultet, Univerzitet u Tuzli, Univerzitetska 8, 75000 Tuzla, Bosna i Hercegovina
✉ hasanbasica1@gmail.com

Cement je osnovni materijal za građevinsku industriju. To je nemetalni, neorganski prah i hidraulično vezivo koje formira pastu sa vodom koja otvrdnjava zbog reakcija hidratacije. Tvornice cementa koristile su različite vrste industrijskog i kućnog otpada kao pomoćne sirovine i goriva za smanjenje troškova proizvodnje. Da bi se smanjila potrošnja tradicionalnih goriva, industrija cementa koristi gorivo dobiveno od otpada (RDF). RDF povećava unos hlora u proces proizvodnje. Hlorni i alkalni spojevi su isparljivi u peći na visokoj temperaturi i uzrokuju naljepe unutar peći i u predgrijaču. Alkalni metali se unose u peć sa mineralima gline. Hlapljive vrste koje učestvuju u alkalnim ciklusima su sulfati i hloridi alkalnih metala, kalijuma i natrijuma.

Bajpas sistemi su razvijeni širom svijeta kao vrhunska tehnologija za smanjenje opterećenja hlora u proizvodnji cementa. Bajpas sistem je važan za cementne peći kako bi se smanjila mogućnost ciklusa alkalija i hlora kao i stvaranje začepjenja.

Cilj ovog rada je da se da pregled procesa proizvodnje Portland klinkera sa posebnim osvrtom na transfer hlora u rotacionoj peći i da se prezentuje uticaj alternativnih goriva i polaznih sirovina na proizvodnju cementa.

Ključne riječi: cement, alternativna goriva, sirovine, hloridi, sulfati.

Chemical and ecological
sustainable technologies
Oral presentation. Section.

EFFICIENT AND GREEN EXTRACTION OF PHENOLIC COMPOUNDS FROM DRIED ARONIA USING NATURAL DEEP EUTECTIC SOLVENTS

MILENA IVANOVIĆ¹, MITJA KOLAR², PETER KRAJNC¹, MAŠA ISLAMČEVIĆ RAZBORŠEK¹, ✉

¹ Faculty of Chemistry and Chemical Engineering, University of Maribor, Smetanova ulica 17, SI-2000 Maribor, Slovenia

² Faculty of Chemistry and Chemical Technology, University of Ljubljana, Večna pot 113, SI-1000 Ljubljana, Slovenia

✉ masa.islamcevic@um.si

At the beginning of the 21st century, the concept of "green analytical chemistry" was established through twelve basic principles. One of the most important includes the use of environmentally friendly, biodegradable and non-toxicity solvents in the extraction processes. Consequently, newly formed solvents called Natural Deep Eutectic Solvents (NADESs) were developed as a promising alternative to traditional organic solvents used.

In the present study, different NADESs composed of quaternary ammonium salt (choline chloride) as hydrogen bond acceptor in combination with different hydrogen bond donors (poly-alcohols, organic acids, sugars and urea) were investigated as an extraction medium for one-step sample preparation for phenolic compounds characterization from dried aronia fruits. For the improving of extraction process ultrasound-assisted technique was applied, and results were compared with those obtained using 80% methanol as the extraction solvent. Total phenolic content (TPC), total flavonoid content (TFC), total anthocyanin content (TAC) as well as individual phenolic compound yields were determined as dependent variables in all extracts.

Results revealed that the highest value of TPC and TFC was found in the extract obtained with choline chloride–fructose NADES, while methanol exhibited the highest capacity for the extraction of TAC. Additionally, the extraction recoveries for the individual phenolic compounds were highly dependent on the phenolic compound structure, with the relative mean value ranging from 36% to 119%. Generally, it can be concluded that NADESs holds great promise for new sustainable extraction process of valuable plant bioactive compounds intended for future applications in food-processing, pharmaceutical and cosmetic industry.

Keywords: natural deep eutectic solvents, "green" extraction, phenolic compounds, aronia

EFIKASNA I ZELENA EKSTRAKCIJA FENOLNIH SPOJEVA IZ SUHE ARONIJE UZ UPOTREBU PRIRODNIH DUBOKO EUTEKTIČKIH RASTVARAČA

MILENA IVANOVIĆ¹, MITJA KOLAR², PETER KRAJNC¹, MAŠA ISLAMČEVIĆ RAZBORŠEK¹, ✉

¹ Fakultet za hemiju i hemijsku tehnologiju, Univerzitet u Mariboru, Smetanova ulica 17, SI-2000 Maribor, Slovenija

² Fakultet za hemiju i hemijsku tehnologiju, Univerzitet u Ljubljani, Večna pot 113, SI-1000 Ljubljana, Slovenija

✉ masa.islamcevic@um.si

Početkom 21 vijeka usvojen je koncept tzv. „zelene analitičke hemije“ postavljanjem dvanaest osnovnih principa. Jedan od najvažnijih principa zasniva se na upotrebi ekološki prihvatljivih, biorazgradljivih i netoksičnih rastvarača u ekstrakcijskim procesima. U cilju ispunjenja ovog zahtjeva, nedavno je razvijena nova klasa rastvarača, nazvanih prirodni duboko eutektički rastvarači (Natural Deep Eutectic Solvents-NADESs). NADESs predstavljaju obećavajuće alternativa tradicionalno korištenim organskim rastvaračima.

U ovom radu, različite vrste NADESs, sastavljenih od kvaternarne amonijeve soli (holin hlorida) kao akceptora vodikove veze u kombinaciji sa različitim donorima vodikove veze (poli-alkoholi, organske kiseline, šećeri i urea) su ispitivani kao mogući ekstrakcijski mediji za jednostepenu pripremu uzorka u svrhu određivanja fenolnih spojeva iz suhe aronije. U svrhu poboljšanja iskorištenja procesa ekstrakcije primjenjena je ultrazvučna ekstrakcija. Dobijeni rezultati su poređeni sa rezultatima dobijenim uz upotrebu 80% metanola kao konvencionalnog rastvarača. U svim dobijenim ekstraktima određene su sledeće veličine: ukupan sadržaj fenola (total phenolic content-TPC), ukupan sadržaj flavonoida (total flavonoid content-TFC), ukupan sadržaj antocijana (total anthocyanin content-TAC), kao i sadržaj individualnih fenolnih spojeva.

Rezultati su pokazali da su najveće vrijednosti TPC i TFC nađene u ekstraktima dobijenim upotrebom NADES na bazi holin hlorida i fruktoze, dok je najveći kapacitet za ekstrakciju totalnih antocijana pokazao 80% metanol. Procenat iskorištenja procesa ekstrakcije za individualne fenolne spojeve je bio zavistan od strukture pojedinačnog spoja i kretao se u intervalu od 36% do 119%. Generalno, može se zaključiti da NADES predstavljaju obećavajuću alternativu za nove, samoodržive ekstrakcijske procese značajnih bioaktivnih spojeva iz biljnog materijala, namjenjenih za dalju upotrebu u prehrambenoj, farmaceutskoj i kozmetičkoj industriji.

Ključne riječi: prirodni duboko eutektički rastvarači, "zelena" ekstrakcija, fenolni spojevi, aronija.

COARSENING KINETICS ANALYSIS OF NANOCRYSTALLINE COPPER DOPED CERIA

KATARINA MUŽINA^{1,✉}, ALEKSANDAR BAJROVIĆ¹,
MARTINA ŽUPANČIĆ², STANISLAV KURAJICA¹

¹ Faculty of Chemical Engineering and Technology, University of Zagreb, Marulićev trg 19, 10 000 Zagreb, Croatia

² Leibniz-Institut für Kristallzüchtung, Max-Born-Straße 2, 12489 Berlin, Germany

✉ kmuzina@fkit.hr

Cerium (IV) oxide (CeO₂) is used as a catalyst in many industrial processes, as well as in everyday life, i.e. for elimination of harmful components in car exhaust. The advantages of CeO₂ over conventional catalysts are low cost, availability, better poisoning resistance and high catalytic activity due to the facile Ce⁴⁺ / Ce³⁺ redox reaction, high oxygen storage capacity and the stability of the fluorite crystal structure during oxygen storage and release. CeO₂ nanoparticles have higher specific surface area and better redox properties, and thus an increased catalytic activity in comparison to bulk materials, but the problem occurs at elevated temperatures, since nanoparticles are very prone to aggregation and coarsening. In order to increase the thermal stability of CeO₂ nanoparticles, but also improve its catalytic properties, metal ions are incorporated into the CeO₂ crystal structure. In order to determine the effect of doping on thermal stability of CeO₂, it is essential to perform a coarsening kinetics analysis.

The aim of this study was to investigate the coarsening kinetics of nanocrystalline CeO₂ and CeO₂ doped with 10 mol. % of copper. Samples were prepared by hydrothermal synthesis, characterized, and thermally treated at different temperatures and processing times. The as-prepared and thermally treated samples were analyzed by X-ray diffraction analysis and the crystallite sizes were calculated using the Scherrer equation. Based on the obtained crystallite sizes, kinetic parameters were determined and it was found that copper addition has a positive effect on the thermal stability of CeO₂.

Keywords: cerium (IV) oxide, coarsening kinetics, hydrothermal synthesis, doping

KINETIKA OKRUPNJAVANJA ZRNA NANOKRISTALNOG CERJEVA (IV) OKSIDA DOPIRANOG BAKROM

KATARINA MUŽINA^{1,✉}, ALEKSANDAR BAJROVIĆ¹,
MARTINA ŽUPANČIĆ², STANISLAV KURAJICA¹

¹ Fakultet kemijskog inženjerstva i tehnologije, Sveučilište u Zagrebu, Marulićev trg 19, 10 000 Zagreb, Hrvatska

² Leibniz-Institut für Kristallzüchtung, Max-Born-Straße 2, 12489 Berlin, Germany

✉ kmuzina@fkit.hr

Cerijev (IV) oksid (CeO₂) primjenjuje se kao katalizator u brojnim industrijskim procesima, ali i svakodnevnom životu, primjerice za eliminaciju štetnih komponenti ispušnih plinova automobila. Prednosti cerijevog oksida u odnosu na konvencionalne katalizatore su niska cijena, dostupnost, bolja otpornost na trovanje te visoka katalitička aktivnost zahvaljujući lakoći Ce⁴⁺/Ce³⁺ redoks reakcije, velikom kapacitetu pohrane kisika i postojanosti fluoritne kristalne strukture tijekom pohrane i otpuštanja kisika. Nanočestice CeO₂ imaju veću specifičnu površinu i bolja redoks svojstva, a samim time i povećanu katalitičku aktivnost u odnosu na makromaterijal, no problem se javlja pri povišenim temperaturama, budući da su nanočestice veoma sklone agregaciji i okrupnjavanju. Kako bi se povećala toplinska stabilnost nanočestica CeO₂, spriječilo povećanje veličine kristalita i smanjenje specifične površine, ali ujedno i poboljšala katalitička svojstva, u kristalnu strukturu cerijevog (IV) oksida ugrađuju se metalni ioni. Kako bi se utvrdio njihov utjecaj na toplinsku stabilnost CeO₂, bitno je provesti kinetičku analizu procesa okrupnjavanja.

Cilj ovog rada bio je istražiti kinetiku okrupnjavanja nanokristalnog CeO₂ te CeO₂ dopiranog s 10 mol. % bakra. Uzorci su pripremljeni hidrotermalnom sintezom, okarakterizirani te termički obrađivani na različitim temperaturama i vremenima obrade. Neobrađeni i obrađeni uzorci analizirani su rendgenskom difrakcijskom analizom te je na temelju dobivenih difraktograma pomoću Scherrerove jednadžbe izračunata veličina kristalita. Na temelju dobivenih veličina kristalita određeni su kinetički parametri i doneseni zaključci o utjecaju dopiranja bakrom na stabilnost cerijevog oksida. Utvrđeno je kako dodatak bakra ima pozitivan utjecaj na toplinsku stabilnost CeO₂.

Ključne riječi: cerijev (IV) oksid, kinetika okrupnjavanja, hidrotermalna sinteza, dopiranje

HYDRODYNAMIC FRACTIONATION OF CELLULOSE FIBERS USING A MINI-CHANNEL

THOMAS SCHMID[✉], STEFAN RADL

Institute of Process and Particle Engineering, Graz University of Technology, Inffeldgasse 13, 8010 Graz, Austria

[✉] thomas.schmid@tugraz.at

The increasing need of sustainable processes is a seed for the development of new technologies. In the pulp and paper industry, future challenges are (i) the reduction of production energy cost and (ii) the increase of recycling rates. Both can be accomplished by the use of fiber fractionation: this is the separation of short fibers from long fibers which are suspended in a liquid (typically water). One example application is to fractionate fibers upstream a refining stage in order to selectively refine the long fiber fraction without damaging the short fibers: energy is saved within the refining stage and fiber quality is ensured for future refining processes of recycled paper.

To overcome the high energy consumption of traditional fiber fractionation technology, the hydrodynamic fractionator has been developed: a fiber suspension flows through a channel and is split by a suction slot in the channel wall. Thereby, short fibers will, by trend, enter the slot, while long fibers will agglomerate to a fiber network near the channel center. The lateral magnitude of this fiber network, as well as its extent of agglomeration is, in industrially sized pipes, a function of the Reynolds number Re , which limits the fractionator's operational window to a low- Re regime. Our recent experiments show, that this limitation can be overcome when a mini-channel with a diameter in the order of the fibre length is applied. This lays the cornerstone of industrial exploitation of hydrodynamic fractionation technology since much higher flow rates can be realized.

Keywords: hydrodynamic fractionation, mini-channel, fiber agglomeration, Reynolds number

DETERMINATION OF CAFFEINE AND SUGAR CONTENT IN ENERGY DRINKS

SULEJMAN HALILOVIĆ¹, MARTINA ANDREJAS^{2,✉}

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

² Faculty of Technology, University of Tuzla, Univerzitetska 8, 75000 Tuzla, Bosnia and Herzegovina

[✉] martina.andrejas@untz.ba

Energy drinks, especially those on the basis of caffeine, are today very widespread among the younger population. Caffeine has good and bad effects on human health when used in certain quantities. However, when consumed in excessive amounts and still in combination with alcohol and some other stimulating means, it can have a devastating effect.

The purpose of this paper is to determine the amount of caffeine in some energy drinks and to determine the amount of permitted limits, or to recommend daily consumption.

In order to improve the daily consumption of energy drinks between the age differences and the maximum permissions and the recommended amounts of certain ingredients, primarily caffeine and sugar, which are generated by the survey, the results will be presented in the paper.

Keywords: caffeine, coffee, tea, energy drinks

ODREĐIVANJE KOLIČINE KOFEINA I ŠEĆERA U ENERGETSKIM NAPITCIMA

SULEJMAN HALILOVIĆ¹, MARTINA ANDREJAS^{2,✉}

¹ Tehnološki fakultet, Univerzitet u Tuzli, Univerzitetska 8, 75000 Tuzla, Bosna i Hercegovina

² Tehnološki fakultet, Univerzitet u Tuzli, Univerzitetska 8, 75000 Tuzla, Bosna i Hercegovina

[✉] martina.andrejas@untz.ba

Energetski napitci, posebno oni na bazi kofeina, su danas vrlo rašireni i to među mlađom populacijom. Kofein ima i dobrih i loših utjecaja na ljudsko zdravlje kada se koristi u određenim količinama. Međutim, kada se konzumira u prevelikim količinama i još u kombinaciji sa alkoholom i nekim drugim stimulirajućim sredstvima, može imati pogubne posljedice.

Ovaj rad ima za cilj utvrditi količinu kofeina u pojedinim energetskim napitcima i utvrditi da li je ta količina u dozvoljenim granicama, odnosno u preporučenim za dnevnu konzumaciju. Pored određivanja količine kofeina, kao sporedni faktor je određivan i sadržaj šećera u istim energetskim napitcima.

U cilju uporedbe svakodnevne konzumacije energetskih napitaka između dobnih razlika te maksimalne dozvoljene i preporučene količine pojedinih sastojaka, prvenstveno kofeina te šećera, sprovedena je anketa, čiji će rezultati biti predstavljeni u radu.

Ključne riječi: kofein, kafa, čaj, energetski napitci.

QUALITY EVALUATION OF BREAD WITH ADDITIONS

ALDIN KARIĆ✉, AMELA KUSUR, HURIJA ALIBAŠIĆ, MARTINA ANDREJAŠ

Faculty of Technology, University of Tuzla, Univerzitetska 8, 75000 Tuzla, Bosnia and Herzegovina
✉ aldinkaric96@hotmail.com

White wheat flour bread was considered as the highest quality bread product for a long time due to its large volume, shape and color. This is all due to the quantity and properties of gluten. However, this bread is poor in vitamins and minerals because during milling in the production of white flour, peel wheat parts and germs are removed. Those parts contain high value ingredients. For this reason, the use of black, integral, whole wheat flour and other cereal grains, which were mainly mixed with wheat flour has begun. Another way of enriching white wheat flour is to add the variety of raw materials that will increase its nutritional value.

This paper will show that adding some spices and other raw materials can increase the nutritional value of bread while at the same time providing a product that will be acceptable for consumption. Additions will be added in amounts up to 10 percent or some of the flour will be replaced by them. Nutritional value of bread was determined, the sensors were evaluated and the durability or preservation of freshness was monitored.

Keywords: bread with additions, quality, enriching white bread

OCJENA KVALITETA KRUHA SA DODACIMA

ALDIN KARIĆ✉, AMELA KUSUR, HURIJA ALIBAŠIĆ, MARTINA ANDREJAŠ

Tehnološki fakultet, Univerzitet u Tuzli, Univerzitetska 8, 75000 Tuzla, Bosna i Hercegovina
✉ aldinkaric96@hotmail.com

Kruh od bijelog pšeničnog brašna je dugo vremena važio kao najbolji i najkvalitetniji zbog velikog volumena, oblika i boje koju je imao. To je sve zbog količine i svojstava glutena. Međutim, taj kruh je siromašan vitaminima i mineralima jer se tokom mljevenja pšenice kod proizvodnje bijelog brašna uklanjaju ljuska i klice u kojima se nalazi najveći dio visokovrijednih sastojaka. Zbog toga se počelo sa upotrebom crnog, integralnog i cjelozrnog brašna pšenice i upotrebe brašna drugih žitarica koje se uglavnom miješalo sa pšeničnim brašnom. Drugi način obogaćivanja bijelog pšeničnog brašna je dodatak različitih sirovina koje će povećati njegovu nutritivnu vrijednost.

Ovaj rad će pokazati kako dodatak nekih začina i drugih sirovina može povećati nutritivnu vrijednost kruha, a istovremeno dati proizvod koji će biti prihvatljiv za konzumaciju. Pri tome će se ti dodaci dodavati u količinama do 10 posto ili će se dio brašna zamijeniti nekim od njih. Kruhu će biti određena nutritivna vrijednost, biti će senzorski ocijenjen i pratiće se trajnost, odnosno očuvanje svježine.

Ključne riječi: kruh sa dodacima, kvalitet, obogaćivanje bijelog kruha.

WASTE GYPSUM RECYCLING

FILIP BRLEKOVIĆ✉, **BILJANA ŠANDOR**, **KRISTINA JAZVO**,
KATA ŠIPIĆ, **JURAJ ŠIPUŠIĆ**, **NEVENKA VRBOS**

Faculty of Chemical Engineering and Technology, University of Zagreb, Marulićev trg 19, 10000 Zagreb, Croatia

✉ fbrlekovi@fkit.hr

Gypsum and its products are all-present in everyday life and their usage results in high waste mass of the material. Gypsum waste demands a special care and disposal due to the possibility of developing toxic and flammable hydrogen sulphur gasses when in contact with organic compounds. The best alternative to special care of the gypsum waste is recycling of the material.

In this work the dehydration of waste gypsum from TONDACH d.o.o. factory from Đakovo, Croatia, was studied. Recycling of the waste gypsum has been carried out in hydrothermal reactor in open and closed systems with temperature range from 120 to 190 °C. Heat of hydration of the recovered gypsums was investigated with semi-isoperibol calorimeter and MC CAL micro calorimeter. The waste and recovered materials were subjected to X-ray diffraction analysis (XRD), while recycled material has been examined by Fourier transformation infrared spectroscopy (FTIR) and scanning electron microscopy (SEM).

XRD analysis in combination with weight loss measurements confirms the start of the dehydration which occurs between 120 and 130 °C. Temperatures higher than 160 °C result in formation of non-reactive anhydride phase. SEM micrographs show morphology changes in correlation with hydrothermal system conditions. The calorimetric results show the successful recovery of waste gypsum where the best results were displayed by samples treated at 130 °C. This research and its results demonstrate that waste gypsum recovery is possible. With further investigation of this topic the reuse of such recycled material in mundane and industrial setting could be achievable.

Keywords: waste gypsum, dehydration, X-ray diffraction analysis, heat of hydration, calorimetry

Environmental resources and waste management

Oral presentation. Section:

RECIKLIRANJE OTPADNOG GIPSA

FILIP BRLEKOVIĆ✉, **BILJANA ŠANDOR**, **KRISTINA JAZVO**,
KATA ŠIPIĆ, **JURAJ ŠIPUŠIĆ**, **NEVENKA VRBOS**

Fakultet kemijskog inženjerstva i tehnologije, Sveučilište u Zagrebu, Marulićev trg 19, 10000 Zagreb, Hrvatska

✉ fbrlekovi@fkit.hr

Gips i njegovi proizvodi prisutni su u svakodnevnom životu, pa njegova upotreba rezultira velikom otpadnom masom materijala. Otpadni gips zahtijeva posebnu njegu i zbrinjavanje zbog mogućnosti razvijanja otrovnih i zapaljivih sumporovodičnih plinova ako se nađe u kontaktu s organskim spojevima. Najbolja alternativa posebnom zbrinjavanju otpadnog gipsa je recikliranje materijala. U ovom radu ispitana je dehidracija otpadnog gipsa tvrtke TONDACH d.o.o. iz Đakova. Recikliranje otpadnog gipsa izvršeno je u hidrotermalnom reaktoru u otvorenim i zatvorenim sustavima s temperaturnim rasponom od 120 do 190 °C. Toplina hidratacije oporavljenog gipsa ispitivana je s semiizoperibolnim kalorimetrom i MC CAL mikrokolorimetrom. Otpadni i reciklirani materijali podvrgnuti su rendgenskoj difrakcijskoj analizi (XRD), dok je reciklirani materijal ispitan infracrvenom spektroskopijom s Fourierovom transformacijom (FTIR) i pretražnom elektronskom mikroskopijom (SEM).

XRD analiza u kombinaciji s mjerenjima gubitka mase potvrđuje početak reakcije dehidratacije između 120 i 130 °C. Temperature veće od 160 °C rezultiraju nastankom nereaktivne anhidridne faze. SEM mikrografije pokazuju promjenu morfologije u korelaciji s promjenama uvjeta hidrotermalnog sustava. Kalorimetrijski rezultati pokazuju uspješan oporavak otpadnog gipsa gdje su najbolji rezultat pokazali uzorci tretirani na 130 °C. Ovo istraživanje i njegovi rezultati ukazuju na mogućnost recikliranja otpadnog gipsa. Daljnjim istraživanjem moguće je postići oporavak i ponovnu upotrebnu otpadnog gipsa kako u svakodnevnom tako i u industrijskom okruženju.

Ključne riječi: otpadni gips, dehidratacija, rendgenska difrakcijska analiza, toplina hidratacije, kalorimetrija

Environmental resources and waste management

Oral presentation. Section:

PRESENCE OF HEAVY METALS IN THE SOIL OF URBAN AREA OF LUKAVAC AND KALESIJA AND DISEASES PREVALENCE

ABDEL ĐOZIĆ¹, [✉](mailto:elizabethb1943@hotmail.com), SANJA BREKALO – LAZAREVIĆ²,
VEDRAN STUHLI¹, HANA ALIHODŽIĆ³

¹Tehnološki fakultet, Univerzitet u Tuzli, 75000 Tuzla, Bosna i Hercegovina

²Medicinski fakultet, Univerzitet u Tuzli, 75000 Tuzla, Bosna i Hercegovina

³Udruženje za zaštitu prirode i okoline "Aer Aqua Terra" 75300 Lukavac, Bosna i Hercegovina

[✉ abdel.dozic@untz.ba](mailto:abdel.dozic@untz.ba)

Of all the surrounding environmental factors that could impact to public health the polluted soil becoming a greater threat. The concern of polluted soils is especially prevalent in industrial regions. People come into contact with soil more often than they realize. This work presents a research of heavy metals contents in soil samples of the urban area of Lukavac and their potential risk on the health of Lukavac residents. Concentrations of chromium (Cr), cadmium (Cd), cobalt (Co), nickel (Ni), and lead (Pb) in the soil samples were determined. Results show that all tested locations have higher concentration of heavy metals than permitted given by legal norms. Soil sample taken in nursery courtyard content Cd in concentration of 9,98 mg/kg which is 6,6 more than permitted level. The negative impact of polluted soil on the health of the population is the cause of many malignant, heart attack, stroke and pulmonary diseases. Statistical analysis of the official data with various diseases in the area of Lukavac and Kalesija municipality revealed significantly higher prevalence of malignant diseases of the breast, skin and lungs in comparison to Kalesija.

Keywords: heavy metals, soil, urban area, malignant diseases, health

ENGINEERING'S ETHICS

AZRA JAGANJAC

University of Sarajevo, Faculty of Science, Zmaja od Bosne 32, Sarajevo, Bosnia and Herzegovina

[✉ elizabethb1943@hotmail.com](mailto:elizabethb1943@hotmail.com)

The engineers work in manufacturing but also in designing, a research, consultancy and educational institutions. Because they assume different roles it is important that they are aware of their responsibility to the public, colleagues and employees, to the environment and to their profession. One of the main roles of engineers is to design processes and to manage producing products for specific customers at a profit. Another important role is to provide living conditions for the working staff and residents near the plant. Must comply with legislation on the environment not only with the context of production, but also further possible circulation of products and pollutants such as transportation, use of the customer, recycling activities and final disposal. The paper provides a historical overview of the development of environmental awareness with special focus on major disasters caused by poor design or management. It is underlined so-called *green* approach: *environmental awareness, eco-efficient production with prevention of pollution with special emphasis on green engineering.*

Keywords: engineering ethics, green engineering, environmental awareness

INŽENJERSKA ETIKA

AZRA JAGANJAC

Univerzitet u Sarajevu, Prirodnomatematički fakultet, Sarajevo, Zmaja od Bosne 32, B i H

[✉ elizabethb1943@hotmail.com](mailto:elizabethb1943@hotmail.com)

Inženjeri rade u proizvodnji ali i u projektantskim, istraživačkim, konsultantskim i edukacionim institucijama. Zato što preuzimaju različite uloge važno je da su svjesni svojih odgovornosti prema javnosti, kolegama i zaposlenima, prema okolišu i prema svojoj profesiji. Jedna od glavnih uloga inženjera je da kreiraju procese i da im upravljaju proizvođači proizvodeći proizvode specifične za kupce uz profit. Druga važna uloga je da osiguraju životne uslove za radno osoblje i stanovnike u blizini tvornice. Moraju se pridržavati zakonskih propisa o okolišu ne samo sa konteksta proizvodnje, nego i daljeg mogućeg kruženja produkata i polutanata kao što je transportovanje, korištenje od strane kupca, aktivnosti recikliranja i konačnog odlaganja. U radu se daje historijski pregled razvoja svijesti o okolišu sa posebnim osvrtom na velike katastrofe uzrokovane lošim projektom ili upravljanjem. Ističe se tzv. zeleni pristup: svijest o okolišu, eko-učinkovita proizvodnja sa prevencijom zagađivanja uz poseban osvrt na zeleni inženjering.

Ključne riječi: inženjerska etika, zeleni inženjering, svijest o okolišu

CONCEPTUAL DESIGN OF A GREEN POWER-TO-JET PROCESS UNDER VARYING ENERGY INPUTS

MAHMOUD MOSTAFA, CHRISTOPHER VARELA, EDWIN ZONDERVAN✉

University of Bremen, Laboratory of Process Systems Engineering, Leobener Straße 6, 28359 Bremen, Germany

✉ ezon@uni-bremen.de

The ever-growing levels of carbon dioxide in the atmosphere demands to revamp the industrial production systems, especially those highly dependent on fossil fuels. This transition could be possible by coupling the generation of renewable electricity with the production of commodity chemicals. Furthermore, the soaring growth rates of green-house gas (GHG) emissions in the aviation sector of up to 5 % annually, the need for a near zero-net emission alternative is essential. However, concerns arise on the feasibility of such processes under fluctuating power inputs and high investment costs. The novel concept of the Power-to-Jet pathway directly utilizes renewable electricity, carbon dioxide and water to synthesize a sustainable kerosene that chemically resembles the one produced from fossil sources, having 'Drop-in' capability allowing the use and distribution within existing architectures.

With fluctuating electricity inputs due to the intermittent wind power generation, the process units within the Power-to-Jet process have to be adjusted at each time-instant to satisfy the production constraints. To find the best operating strategy for these fluctuating conditions, dynamic models are needed. In this work we will propose a complete and innovative conceptual design for a Power-to-Jet process located in the state of Schleswig-Holstein, Germany. The facility includes hydrogen production via water electrolysis, CO₂ captured (for example from flue gas) then reacts with hydrogen to produce the intermediate methanol before being upgraded to the final synthetic jet fuel.

Keywords: conceptual design, Power-to-Jet, green processes, kerosene, renewable

ESTIMATING BIOMASS RESOURCES AND BIOENERGY POTENTIAL: A REVIEW OF METHODOLOGIES AND CHALLENGES

AHMET ALP ŞENOCAK✉, HACER GÜNER GÖREN

Department of Industrial Engineering, Faculty of Engineering, Pamukkale University, Kinikli Campus, 20020 Denizli, Turkey

✉ asenocak@pau.edu.tr

With the development of society and population growth, the demand for food and energy is increasing day by day. Especially since the industrial revolution, energy demand and consumption have increased significantly. Therefore, access to energy sources and energy security issues are of strategic importance all over the world. In the process of reaching safety food and energy sources, it is necessary to develop sustainable policies in order to meet the requirements without causing climate changes with as little damage to the environment as possible. Thus, viable, environmentally friendly renewable energy sources have started to replace finite fossil fuels to meet the global energy demand with the help of new laws, regulations and incentives set by governments, economic and political unions. The replacement of non-renewable energy by new and clean energy involves a long-term process. In the energy sector, it is very important to determine the resources in the policy-making and decision-making processes and to estimate the conditions and amounts of these resources in the next years as accurately as possible. To analyze and review the current literature on biomass resources and bioenergy potential estimation, this paper provides a systematic literature review on published researches between 2009 and 2019. The major goals of this paper are to determine the most widely used methodology to estimation of biomass resources and the planning horizon of studies and the affecting factors of biomass potentials.

Keywords: Biomass, bioenergy potential, forecasting, review

ISOLATION OF BACTERIAL CULTURES FOR EFFECTIVE COMPOSTING OF BIOWASTE

MONIKA ŠABIĆ RUNJAVEC[✉], VEDRAN VUČIĆ, DAJANA KUČIĆ GRGIĆ, MARIJANA VIDAKOVIĆ, ANITA ŠALIĆ, BRUNO ZELIĆ, MARIJA VUKOVIĆ DOMANOVAC

University of Zagreb, Faculty of Chemical Engineering and Technology, Zagreb, Croatia

✉ msabic@fkit.hr

The disposal of biodegradable waste represents a significant ecological problem for local communities. The collection and recycling of biowaste is an important factor for the success of circular economy as a component of modern waste management policy. Composting is a controlled aerobic, self-heating, solid-phase accelerated natural process of biodegradation of organic matter. Microbes play a key role as degraders during the composting process and the microbial activity leads to rapid increase in temperature inside the waste material. Different microbial cultures predominate during the various composting phases, where each of them is being adapted to a specific environment. Inoculation with more efficient microorganisms may prove beneficial and make the process of biodegradation quicker and economically viable. The study of enzymatic activities associated with composting gives a better insight into the biological process progress and the quality of finished compost.

In this work a collection of bacteria isolated at different stages of biowaste composting was obtained. Decimal serial dilution plate technique was adopted for the enumeration and isolation of bacteria using spread plate method. The streak plate method was performed several times in order to obtain purified bacterial colonies. The most dominant bacterial colonies were picked up and streaked across the nutrient agar. For the identification of purified isolates, matrix-assisted lasers desorption/ionization time of flight mass spectrometry (MALDI-TOF MS) analysis was carried out. The objective of the present study is to provide information regarding to the characterization of the enzymes produced by the mesophilic and thermophilic bacteria and to suggest how they could be used for the composting process improvement.

Keywords: composting, biowaste, mesophilic and thermophilic bacteria, isolation.

Environmental resources and waste management
Oral presentation. Section:

IZOLACIJA BAKTERIJSKIH KULTURA ZA UČINKOVITO KOMPOSTIRANJE BIOOTPADA

MONIKA ŠABIĆ RUNJAVEC[✉], VEDRAN VUČIĆ, DAJANA KUČIĆ GRGIĆ, MARIJANA VIDAKOVIĆ, ANITA ŠALIĆ, BRUNO ZELIĆ, MARIJA VUKOVIĆ DOMANOVAC

University of Zagreb, Faculty of Chemical Engineering and Technology, 10000 Zagreb, Hrvatska

✉ msabic@fkit.hr

Odlaganje biorazgradivog otpada značajan je ekološki problem za lokalne zajednice. Prikupljanje i recikliranje biootpada važan je čimbenik uspjeha kružnog gospodarstva kao sastavnog dijela moderne politike gospodarenja otpadom. Kompostiranje je kontrolirani aerobni, samozagrijavajući prirodni proces biorazgradnje organske tvari u čvrstoj fazi. Mikrobi igraju ključnu ulogu kao razlagači tijekom procesa kompostiranja, a aktivnost mikroba dovodi do brzog porasta temperature unutar otpadnog materijala. Tijekom različitih faza kompostiranja prevladavaju različite mikrobne kulture u kojima se svaka od njih prilagođava specifičnom okruženju. Inokulacija učinkovitijim mikroorganizmima može se pokazati korisnom i učiniti proces biorazgradnje bržim i ekonomičnijim. Proučavanje enzimatskih aktivnosti povezanih s kompostiranjem daje bolji uvid u napredak biološkog procesa i kvalitetu gotovog komposta.

U ovom radu dobivena je zbirka bakterija izoliranih iz različitih faza kompostiranja biootpada. Primijenjena je tehnika decimalnog serijskog razrjeđenja uzoraka za određivanje broja i izolaciju bakterija metodom nacjepljivanja na hranjivu podlogu. Metoda tehnike iscrpljivanja provedena je nekoliko puta kako bi se dobile pročišćene kolonije bakterija. Odabrane su najdominantnije bakterijske kolonije te su pročišćene na hranjivom agaru. Za identifikaciju pročišćenih izolata, provedena je matricom potpomognuta laserska desorpcija/ionizacija s vremenom preleta masena spektrometrija (MALDI-TOF MS). Cilj ove studije je pružiti informacije vezano za karakterizaciju enzima proizvedenih od mezofilnih i termofilnih bakterija te sugerirati kako ih se može upotrijebiti za poboljšanje procesa kompostiranja.

Ključne riječi: kompostiranje, biootpad, mezofilne i termofilne bakterije, izolacija.

Environmental resources and waste management
Oral presentation. Section:

REPRODUCTIVE INCOMPATIBILITY OF CHERRY**ZLATKO ČMELIK^{1,✉}, BESIM SALKIĆ², AHMED SALKIĆ²,
ENSAR SALKIĆ², EMIR IMŠIROVIĆ²**¹Faculty of Agriculture University of Zagreb, Svetošimunska cesta 25, 10000 Zagreb, Croatia²Faculty of Technology, University of Tuzla, Univerzitetska 8, 75000 Tuzla, Bosnia and Herzegovina✉ zcmelik@agr.hr

Cherry blooming in late March and early April, and average for cultivated varieties lasts 15-20 days. Blooming of individual variety usually lasts 3-4 days, and rarely 7-10 days. The information of the beginning, the duration and the end of blooming are significant because of the choice of pollinating varieties. Lack of pollen transmission or poor weather conditions can make the transfer of pollen and the success of fertilization difficult. However, the most important factors of fertilization success are the selection of pollinating varieties and their inter-compatibility and overlapping in blooming time. The cherries are mostly self-propagating, but also interspecific. It is a genetic phenomenon called gametophyte incompatibility controlled by S-locus with a large number of alleles. Sorts with the same S alleles are incompatible. The pollen of incompatible varieties successfully intergrowth on the pestle, spreads through pestle, but the growth of the pollen tubes stops in the transverse tissue of the pestle stylus. For successful fertilization of the egg cell the pollen tube should propagate through the styus of pestel and perform the fertilization of the ovary cell. Deviations in any of these processes can seriously endanger the nature. Effective blooming time of cherry is generally short, only a few days, depending on varieties, weather conditions in blooming, donor, pollen germination, stigma receptiveness, pollen tube growth rate and embryonic bag and ovary cell viability. From the climatic factors at the time of blooming the temperature is most important because it has a significant influence on all phases of the reproductive process. In high temperature conditions, the effective time of pollination and viability of the ovary cells is shortened, so it is very important to accurately overlap the blooming of the basic variety and pollinating varieties. Under lower temperature conditions, the viability of the ovary cell is prolonged, but the growth of the pollen tubes is slowed down, which may results poorer fertilization, longer retention of unfertilized fruits on birth shoots, and by a superficial inspection, fertilization has been successful ,and subsequently comes to their disposal.

Keywords: Domesticated varieties, usefulness of fruit, migration, introduction**REPRODUKTIVNA INKOMPATIBILNOST TREŠNJE****ZLATKO ČMELIK^{1,✉}, BESIM SALKIĆ², AHMED SALKIĆ²,
ENSAR SALKIĆ², EMIR IMŠIROVIĆ²**¹Agronomski fakultet, Sveučilište u Zagrebu, Svetošimunska cesta 25, 10000 Zagreb, Hrvatska²Tehnološki fakultet, Univerzitet u Tuzli, Univerzitetska 8, 75000 Tuzla, Bosna i Hercegovina✉ zcmelik@agr.hr

Trešnja cvate krajem ožujka i početkom travnja mjeseca, a prosječno za uzgajane sorte traje od 15-20 dana. Cvatnja pojedinih sorata obično traje 3-4 dana, a rjeđe 7-10 dana. Podaci o početku, trajanju i završetku cvatnje značajni su zbog izbora sorte oparašivača. Nedostatak prenosnika polena ili loši vremenski uvjeti mogu otežati prijenos polena i uspjeh oplodnje. Ipak, najznačajniji čimbenici uspješnosti oplodnje su odabir sorti oparašivača tj. njihova inter-kompatibilnost i preklapanje u vremenu cvatnje. Sorte trešanja su uglavnom samoneoplodne, a ujedno i međubesplodne. Riječ je o genetskom fenomenu tzv. gametofitskom inkompatibilitetu, koji je kontroliran S-lokusom s velikim brojem alela. Sorte s istim S alelima su inkompatibilne. Polen inkompatibilnih sorata uspješno klija na njuški tučka, prorasta njušku, ali rast polenove cijevi prestaje u prijenosnom tkivu vrata tučka. Za uspješnu oplodnju polenova cijev treba prorasti kroz vrat tučka i obaviti oplodnju jajne stanice. Odstupanja u bilo kojem od ovih procesa mogu ozbiljno ugroziti prirodu. Efektivno vrijeme oparašivanja trešnje općenito je kratko, svega nekoliko dana a ovisi o sorti, vremenskim prilikama u cvatnji, sorti donoru i klijavosti polena, receptivnosti stigme, brzini rasta polenove cijevi i viabilnosti embrionske vreće i jajne stanice. Od klimatskih čimbenika u vrijeme cvatnje temperatura je najvažnija jer ona ima značajan utjecaj na sve faze reproduktivnog procesa. U uvjetima visokih temperatura efektivno vrijeme oparašivanja i viabilnost jajne stanice se skraćuju pa je vrlo važno precizno preklapanje cvatnje osnovne sorte i sorte oparašivača. U uvjetima nižih temperatura produžava se viabilnost jajne stanice, ali se usporava rast polenove cijevi što za posljedicu može imati slabiju oplodnju, duže zadržavanje neoplođenih plodića na rodnom izbojima pa se površnim pregledom čini da je oplodnja bila uspješna, a naknadno dolazi do njihovog otpadanja.

Gljučne riječi: Odomaćene sorte, upotrebna vrijednost ploda, migracije, introdukcija

THE LINEAR MODEL FOR PREDICTING ZINC AVAILABILITY IN SOILS OF EASTERN CROATIA

HRVOJE HEFFER¹, DOMAGOJ RASTIJA², KRUNOSLAV DUGALIĆ¹, IVANA RUKAVINA¹,
MILENA ANDRIŠIĆ¹, DANIEL RAŠIĆ¹, KATARINA PERIĆ², ZDENKO LONČARIĆ².✉

¹Croatian Agency for Agriculture and Food, Vinkovačka cesta 63c, 31000 Osijek, Croatia

²Faculty of Agrobiotechnical Sciences Osijek, University of Josip Juraj Strossmayer in Osijek, Vladimira Preloga 1, 31000 Osijek, Croatia

✉ zdenko.loncaric@fazos.hr

Zinc (Zn) is an essential microelement whose available fraction in soil depends significantly on the total Zn concentration, soil pH, texture and SOM, and is important for the planning of fertilization in poor soils. The aim of this paper is to determine the suitability of linear regression models for Zn availability prediction based on the available data. Regression models created in 2010 were validated with new data sets with the results of Zn concentration in 229 and 342 soil samples (total Zn in the range 40.83-114.90 mg/kg and available Zn extracted with EDTA solution in the range 0.48-7.97 mg/kg) and the results (pH_{H2O}, pH_{KCl}, SOM) of 22,616 soils of eastern Croatia representing an area of 88,714.46 ha. In this case, a pH_{H2O} > 7.0 was found in 40.62 % of the analyzed areas and a pH_{KCl} > 6.0 in 44.61 %. The linear model was created in 3 steps: (1) prediction of total Zn (Zn_T) concentration based on Zn_T, pH_{H2O}, pH_{KCl} and SOM (set with 342 soil samples); (2) prediction of the available Zn fraction (Zn_{EDTA}) based on the total (Zn_T) and available (Zn_{EDTA}) Zn concentration, soil acidity and SOM (set with 229 soil samples); (3) prediction of total (Zn_T) and available Zn fraction (Zn_{EDTA}) based on pH_{H2O}, pH_{KCl} and SOM (set with 22,616 soil samples).

Validation of the 2010 regression model by new 229 samples determined the average model error of 0.80 mg/kg Zn_{EDTA} in the Zn_{EDTA} range 0.48-7.97 mg/kg. The new linear regression model ($r^2 = 0.800$) resulted in a lower average error (0.60 mg/kg) for the same range of Zn_{EDTA}, which reduced the error by 25 %. According to the results of the 229 analyzed soils, Zn availability was low (<1.5 mg/kg) in 56 %, medium (1.5-3 mg/kg) in 37 % and high (> 3 mg/kg) in only 7 % of samples. Using the new linear model, average concentrations of total Zn_T 61.46 mg/kg (range 35.77-211.08) and available Zn_{EDTA} 1.71 mg/kg (range 0.45-9.79) were predicted. According to the model, low Zn availability can be expected at 41.4 % of the area (36,764,91 from 88,714,46 ha), medium availability at 57.1 % (50,636,10 ha) and high availability at 1.5 % area (1,313, 45 ha). The high proportion of area with the expected low Zn availability is probably due to the high proportion of alkaline soils with pH_{H2O} > 7.

Linear Zn prediction models can be used to predict fertilization needs, but validation with more data about concentrations of total and available Zn in different soils is required.

Keywords: regression models, available Zn, total Zn content, EDTA extraction, soil acidity

LINEARNI MODEL PROCJENE RASPOLOŽIVOSTI ZN U TLIMA ISTOČNE HRVATSKE

HRVOJE HEFFER¹, DOMAGOJ RASTIJA², KRUNOSLAV DUGALIĆ¹, IVANA RUKAVINA¹,
MILENA ANDRIŠIĆ¹, DANIEL RAŠIĆ¹, KATARINA PERIĆ², ZDENKO LONČARIĆ².✉

¹Hrvatska agencija za poljoprivredu i hranu, Vinkovačka cesta 63c, 31000 Osijek, Hrvatska

²Fakultet agrobiotehničkih znanosti Osijek, Sveučilište Josipa Jurja Strossmayera u Osijeku, Vladimira Preloga 1, 31000 Osijek, Hrvatska

✉ zdenko.loncaric@fazos.hr

Cink (Zn) je esencijalni mikroelement čija biljkama raspoloživa frakcija u tlu značajno ovisi o ukupnoj koncentraciji Zn u tlu, pH vrijednosti tla, teksturi i humoznosti, a značajna je za planiranje fertilizacije na siromašnim tlima. Cilj ovog rada je utvrditi pogodnost korištenja linearnih regresijskih modela predviđanja raspoloživosti Zn na temelju raspoloživih podataka. Korišteni su regresijski modeli kreirani 2010. godine, validirani su novim setovima podataka s rezultatima analize koncentracije Zn u 229 i 342 uzorka tla (ukupni Zn ekstrahirani zlatotopkom u rasponu 40,83-114,90 mg/kg i raspoloživi Zn ekstrahirani otopinom EDTA u rasponu 0,48-7,97 mg/kg) te rezultatima analiza (pH_{H2O}, pH_{KCl}, sadržaj humusa) 22.616 uzorka tala istočnohrvatskih županija s analiziranom površinom 88.714,46 ha. Pri tome je na 40,62 % analiziranih površina utvrđen pH_{H2O} > 7,0, a na 44,61 % površina pH_{KCl} > 6,0. Linerani model kreiran je u 3 koraka: (1) predviđanje ukupne koncentracije Zn (Zn_T) na temelju Zn_T, pH_{H2O}, pH_{KCl} i sadržaja humusa (set 342 uzorka tla); (2) predviđanje raspoložive frakcije Zn (Zn_{EDTA}) na temelju podataka o ukupnoj (Zn_T) i raspoloživoj (Zn_{EDTA}) koncentraciji Zn, kiselosti tla i sadržaju humusa (set 229 uzoraka tla); (3) predviđanje ukupne (Zn_T) i raspoložive frakcije Zn (Zn_{EDTA}) na temelju pH_{H2O}, pH_{KCl} i sadržaja humusa (set 22.616 uzoraka tla).

Validacijom regresijskog modela iz 2010. godine s novih 229 uzoraka utvrđena je prosječna greška modela 0,80 mg/kg Zn_{EDTA} u rasponu Zn_{EDTA} 0,48-7,97 mg/kg. Novi linearni regresijski model ($r^2 = 0,800$) rezultirao je manjom prosječnom greškom (0,60 mg/kg) za isti raspon Zn_{EDTA}, što je smanjenje greške za 25 %. Prema rezultatima analize 229 analiziranih tala istočne Hrvatske, raspoloživost Zn je niska (< 1,5 mg/kg) u čak 56 % uzoraka, srednja (1,5-3 mg/kg) u 37 % uzoraka, a visoka (> 3 mg/kg) u samo 7 % uzoraka. Upotrebom novog lineranog modela, predviđene su prosječne koncentracije ukupnog Zn_T 61,46 mg/kg (raspon 35,77-211,08) i raspoloživog Zn_{EDTA} 1,71 mg/kg (raspon 0,45-9,79 mg/kg). Prema modelu nisku raspoloživost Zn možemo očekivati na 41,4 % površina (36.764,91 od 88.714,46 ha), srednju raspoloživost na 57,1 % površina (50.636,10 ha) i visoku raspoloživost na 1,5 % površina (1.313,45 ha). Veliki udio površina s očekivanom niskom raspoloživosti Zn vjerojatno je posljedica velikog udjela analiziranih alkalnih površina s pH_{H2O} > 7.

Linerani modeli predviđanja raspoloživosti Zn mogu se koristiti za predviđanje potreba u fertilizaciji, ali je potrebna validacija s analiziranim koncentracijama ukupnog i raspoloživog Zn u većem broju uzoraka različitih tala.

Ključne riječi: regresijski modeli, raspoloživi Zn, ukupni Zn, EDTA ekstrakcija, kiselost tala

PHYSICAL-CHEMICAL ANALYZES THE FRUITS OF STANDARD PEAR CULTIVARS GROWN IN TURKEY WITH VARIETIES THAT WERE DOMESTICATED IN OUR COUNTRY BUT THEY ARE ORIGIN FROM TURKEY

BESIM SALKIC^{1,✉}, AHMED SALKIĆ¹, AZRA SALKIĆ¹, ENSAR SALKIĆ¹, RAMZIJA CVRK¹, EMIR IMŠIROVIĆ¹, SEAD NOČAJEVIĆ²

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

² Gymnasium Živinice, Živinice, Bosnia and Herzegovina

✉ besim.salkic@untz.ba

The assortment of pear in BiH is very diverse. A significant contribution to the cultivation of a large number of sorts and varieties of pears was contributed by the constant migration of people who carried and planted fruit trees with them. The largest number of fruit varieties and pears in BiH came from two directions. From the east with the Ottoman Empire and from the west with the arrival of the Austro-Hungarian Empire. The pear, as a fruit species, takes a significant place in fruit production, considering that it can be grown in a wide range of climatic conditions, different ripen times, from early summer to late autumn, and multi-purpose use. The fact is that many varieties of pears arrived from Turkey centuries ago and that they were preserved and retained in BiH. This fact is corroborated by the names of variety / Karamut, Jeribasma, Black Izmir and others

The paper analyzes the following parameters: pH, total acidity in mmol / 100 g, pectic substance% Ca-pectinate, raw fiber (%), vitamin C in mg / 100 gr, natural invert (%), total invert (%), total phenols in mg / 100 g of fruit, soluble dry matter (° Brix).

The aim of this paper is to determine the usable value and, therefore, the possibility of introducing standard cultivars grown in Turkey to our area through physical and chemical analysis of fruits of indigenous and standard pear trees.

Keywords: Domesticated varieties, usable fruit value, migration, introduction

MORFOLOŠKO-HEMIJSKA ANALIZA PLODOVA STANDARDNIH SORATA KRUŠKE GAJENIH U TURSKOJ SA SORTAMA KOJE SU SE ODOMAČILE KOD NAS A VODE PORIJEKLO IZ TURSKE

BESIM SALKIC^{1,✉}, AHMED SALKIĆ¹, AZRA SALKIĆ¹, ENSAR SALKIĆ¹, RAMZIJA CVRK¹, EMIR IMŠIROVIĆ¹, SEAD NOČAJEVIĆ²

¹ Tehnološki fakultet, Univerzitet u Tuzli, Univerzitetska 8, 75000 Tuzla, Bosna i Hercegovina

² Gimnazija Živinice, Živinice, Bosna i Hercegovina

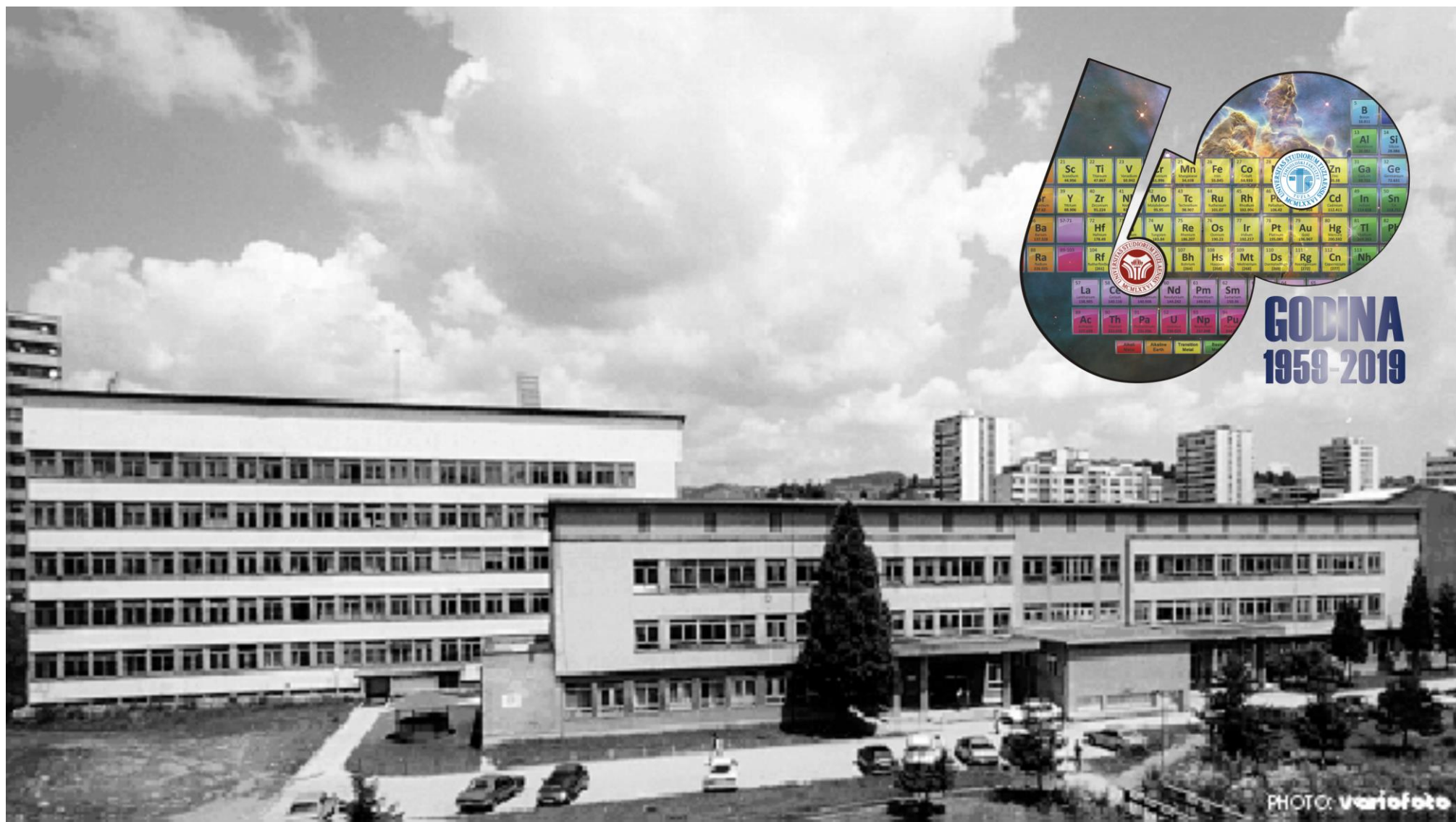
✉ besim.salkic@untz.ba

Sortiment kruške u BiH je vrlo šarolik. Značajan doprinos uzgoja velikog broja sorti i varijeteta kruške doprinijele su stalne migracije ljudi koje su sa sobom nosile i sadile voćke. Najveći broj sorata voća pa i kruške u BiH dolazio je iz dva pravca. Sa istoka sa Osmanskim carstvom i sa zapada sa dolaskom Austrougarske. Kruška, kao voćna vrsta, zauzima značajno mjesto u voćarskoj proizvodnji uzimajući u obzir da se može gajiti u širokom dijapazonu klimatskih uslova, različitom vremenu dozrijevanja, od ranog ljeta do kasne jeseni, i višenamjenske upotrebe. Činjenica je da su mnoge sorte krušaka stigle iz Turske prije više stoljeća i da su se očuvale i zadržale u BiH. Ova činjenica potkrijepljena je nazivima sorata /Kaaramut, Jeribasma, Crna izmirka i dr./

U radu su analizirani sledeći parametric: pH, ukupna kiselost u mmol/100 g, pektinske tvari % Ca-pektata, sirova vlakna (%), vitamin C u mg/100 gr, prirodni invert (%), ukupni invert (%), ukupni fenoli u mg/100 g voća, topljiva suha tvar (°Brix).

Cilj rada jeste da kroz fizičko-hemijsku analizu ploda odomaćenih i standardnih sorata kruške utvrdimo upotrebnu vrijednost a time i mogućnost introdukcije standardnih sorata uzgajanih u Turskoj na naše područje.

Ključne riječi: Odomaćene sorte, upotrebna vrijednost ploda, migracija, introdukcija



STUDY OF INTERACTION AND IN VITRO BIOLOGICAL ACTIVITY OF THE PRODUCT COPPER(II) AND NICKEL(II) WITH THENOYLTRIFLUOROACETONE

DEMIR BJELOŠEVIĆ^{1,✉}, AMILA ZUKIĆ¹, LAMIJA KOLAREVIĆ¹, EMIR HOROZIĆ²

¹ Faculty of Pharmacy, University of Tuzla, Univerzitetska 8, 75000 Tuzla, Bosnia and Herzegovina

² Faculty of Technology, University of Tuzla, Univerzitetska 4, 75 000 Tuzla, Bosnia and Herzegovina

✉ bjelosevicdemir@gmail.com

Thenoyltrifluoroacetone (TTA) is a cellular respiration inhibitor that blocks Complex II of the respiratory chain. Interaction of biometals such as copper, iron, cobalt, manganese and others can significantly affect the function of many biologically important organic molecules. This paper examines the interaction of TTA with biologically significant bivalent metals cobalt and nickel. Synthesis was carried out at pH = 7.3. The resulting products were characterized by spectroscopic methods. Antioxidant, antibacterial and antifungal activity was tested for the purpose of determining potential biological activity. Antibacterial activity was tested on strains from the ATCC collection (*Escherichia coli*, *Enterococcus faecalis*, *Staphylococcus aureus*, *Bacillus subtilis*, *Listeria monocytogenes* and *Pseudomonas aeruginosa*), while the antifungal activity was tested on *Candida albicans*.

The absence of a characteristic band on the FTIR spectrum of the complex confirms that TTA interacts with cobalt(II) and nickel(II) ions over the oxygen donor atoms of the carbonyl group. TTA acts as a bidentate O-donor ligand. The cobalt(II) complex exhibits significant antioxidant activity. A significant antibacterial effect of the cobalt(II) complex was found against *Escherichia coli*, *Bacillus subtilis* and *Listeria monocytogenes*. Poor activity was found against *Staphylococcus aureus* and *Pseudomonas aeruginosa*, while the complete absence of activity was observed in the case of *Enterococcus faecalis*. Ni(TTA)₂ complex exhibits weaker antibacterial activity compared to Co(TTA)₂. Antifungal activity was established in the Co(II) complex with an inhibition zone of 19 mm.

Keywords: TTA, biometals, FRAP, antimicrobial activity

STUDIJA INTERAKCIJE I IN VITRO BIOLOŠKA AKTIVNOST PRODUKATA KOBALT(II) I NIKL(II) SA TENOILTRIFLUOROACETONOM

DEMIR BJELOŠEVIĆ^{1,✉}, AMILA ZUKIĆ¹, LAMIJA KOLAREVIĆ¹, EMIR HOROZIĆ²

¹ Farmaceutski fakultet, Univerzitet u Tuzli, Univerzitetska 8, 75 000 Tuzla, Bosna i Hercegovina

² Tehnološki fakultet, Univerzitet u Tuzli, Univerzitetska 8, 75 000 Tuzla, Bosna i Hercegovina

✉ bjelosevicdemir@gmail.com

Tenoiltrifluoroacetone (TTA) je inhibitor ćelijske respiracije koji djeluje blokirajući respiratorni lanac u kompleksu II. Interakcija biometala poput bakra, željeza, kobalta, mangana i drugih može značajno utjecati na funkciju mnogih biološki značajnih organskih molekula. U ovom radu ispitana je interakcija TTA sa biološki značajnim dvovalentnim metalima kobaltom i niklom. Sinteza je provedena pri pH = 7,3. Dobijeni produkti su karakterizirani spektroskopskim metodama. U cilju određivanja potencijalnog biološkog djelovanja ispitana je antioksidativna, antibakterijska i antifungalna aktivnost. Antibakterijska aktivnost ispitana je na sojevima iz ATCC kolekcije (*Escherichia coli*, *Enterococcus faecalis*, *Staphylococcus aureus*, *Bacillus subtilis*, *Listeria monocytogenes* i *Pseudomonas aeruginosa*) dok je antifungalna aktivnost ispitana na *Candidi albicans*.

Izostanak karakteristične vrpce na FTIR spektrima kompleksa potvrđuje da TTA ostvaruje interakciju sa kobalt(II) i nikl(II) jonima preko kisikovih donorskih atoma karbonilne grupe. TTA djeluje kao bidentatni O-donorski ligand. Kobalt(II) kompleks pokazuje značajnu antioksidativnu aktivnost. Značajno antibakterijsko djelovanje kobalt(II) kompleksa utvrđeno je kod *Escherichia coli*, *Bacillus subtilis* i *Listeria monocytogenes*. Slabije djelovanje utvrđeno je kod *Staphylococcus aureus* i *Pseudomonas aeruginosa* dok je potpuni izostanak aktivnosti evidentiran kod *Enterococcus faecalis*. Ni(TTA)₂ kompleks pokazuje slabiju antibakterijsku aktivnost u odnosu na Co(TTA)₂. Antifungalno djelovanje utvrđeno je kod Co(II) kompleksa sa zonom inhibicije od 19 mm.

Ključne riječi: TTA, biometali, FRAP, antimikrobna aktivnost

KEMIJSKE I BIOLOŠKE ANALIZE MEDA

STIPE ČELAN¹, ✉, ZORA PILIĆ², JOSIPA KARAČIĆ³, ALDINA KESIĆ⁴, NADIRA IBRIŠIMOVIĆ MEHMEDINOVIĆ⁴, ANAMARIJA JURKIĆ²

¹ Zavod za hranu i veterinarstvo Hercegbosanske Županije, Obrtnička bb, Livno, Bosna i Hercegovina

² Fakultet prirodoslovno-matematičkih i odgojnih znanosti, Matice Hrvatske bb, Mostar, Bosna i Hercegovina

³ Fakultet zdravstvenih studija Sveučilišta u Mostaru, Bijeli Brijeg bb, Mostar, Bosna i Hercegovina

⁴ Prirodno matematički fakultet Univerziteta u Tuzli, Univerzitetska 4, Tuzla, Bosna i Hercegovina

✉ stipecelan@gmail.com

Med je prirodno sladak, tekući, viskozni ili kristalizirani proizvod koji proizvode medonosne pčele (*Apis mellifera*) iz nektara cvjetova medonosnih biljaka ili iz sekreta sa živih dijelova biljaka, koje pčele sakupljaju, dodaju im vlastite specifične tvari, transformiraju i prihranjuju u stanice sača da sazrije. Pravilnikom o medu i drugim pčelinjim proizvodima posebno se zabranjuje dodavanje drugih prehrambenih sastojaka medu, uključujući prehrambene aditive ili bilo kakve druge dodatke. Također zabranjuje se uklanjanje sastavnih dijelova karakterističnih za med, uključujući polen, osim ako je takvo uklanjanje neizbježno pri uklanjanju stranih tvari.

Prema statističkim podacima, patvorenja meda na tržištu BiH predstavlja značajan problem, zbog toga praćenje kakvoće meda predstavlja važan alat za zaštitu i uređivanje tržišta meda u Bosni i Hercegovini, a klasifikacija kakvoće meda putem kemijske i biološke analize može biti od najveće važnosti.

U ovom radu korišteni su rezultati analiza meda proizvođača s područja Općine Tomislavgrad, analize se odnose na period 2016.-2018. godine i provedene su na APTF-u Sveučilišta u Mostaru, analize su provedne u skladu sa međunarodnim standardom za metode analize meda (Harmonised Methods International Honey Commission 2009) i u skladu su s Pravilnikom o metodama za kontrolu meda i drugih pčelinjih proizvoda.

Rezultati ispitivanja su obuhvaćali kemijske i biološke parametre. Kemijski parametri uključuju: određivanje sadržaja vode (refraktometrijska metoda), električnu provodnost, određivanje slobodne kiselosti titracijom do pH 8,3, određivanje pH vrijednosti. Parametri biološke analize odnose se na udio peludnih zrnaca pojedine biljne vrste u medu. Rezultati kemijskih analiza ukazuju da su svi ispitivani parametri u skladu sa maksimalno dopuštenim vrijednostima, dok rezultati biološki analiza (peludnih) ukazuju da je med autentičnog geografskog porijekla, i udio peludnih zrnaca u medu odgovara području ispaše pčela. Ovi rezultati doprinose važnosti analiza u kontroli tržišta meda i zaštiti potrošača i proizvođača meda.

Ključne riječi: med, kemijska analiza, biološka analiza, patvorenje meda

DETECTION OF OXIDATION IN EXTRA VIRGIN OLIVE, HEMP OIL AND PUMPKIN OIL BY DSC, TGA AND FTIR TECHNIQUES

FABIO FARAGUNA¹, ✉, MATEA LILIĆ¹, LUCIJA KONJEVIĆ², DIJANA BLAŽEK², ROKO BLAŽIĆ¹, ELVIRA VIDOVIĆ¹, ANTE JUKIĆ¹

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

²INA-Industrija nafte d.d., Zagreb, Lovinčićeva 4, Croatia

✉ fabio.faraguna@fkit.hr

Extra virgin olive oil, hemp oil and pumpkin oil were isothermally heated in oxygen atmosphere and change in heat flow was measured by DSC. Start of oxidation was detected by an exothermic increase of isotherm which started at 9 min for hemp oil, 14 min for pumpkin oil and at 65 min for extra virgin olive oil. Amount of oxidation for different oils was determined by TGA measurements in air where an increase in mass was detected for all oils. The highest increases of mass, due to oxidation, had hemp oil, while the lowest was observed for extra virgin olive oil. For all oils standard Rancimat test was also performed at 110 °C and 150 °C. The results are in agreement with DSC and TGA results indicating that extra virgin olive oil has the highest oxidation stability. Virgin samples, samples after Rancimat test at 110 °C/150 °C and fully oxidized samples were analysed by FTIR. Change due to decrease of double bonds (at 3006 cm⁻¹) and increase of oxidized products (at 1740-1720 cm⁻¹) was observed.

Keywords: DSC, TGA, Rancimat, oil oxidation stability

DEVELOPMENT OF CALIBRATION MODEL FOR REAL-TIME MEASUREMENT OF PARTICLE SIZE DISTRIBUTION IN CRYSTALLIZATION PROCESS

HRVOJE DORIĆ✉, IVAN VRBAN, NENAD BOLF

Faculty of Chemical Engineering and Technology, University of Zagreb,
Marulićev trg 19, 10000 Zagreb, Hrvatska
✉ hdoric@fkit.hr

The subject of the research is development of a calibration model for a real-time measurement of the crystal size distribution (CSD) in laboratory crystallizer. CSD is crucial for product quality, i.e. process efficiency, as well as energy and utility consumption in subsequent batch production processes. In addition, the continuous measurement of CSD would have an important application in the transition from batch to continuous production which is trend in pharmaceutical industry.

Focused Beam Reflectance Measurement (FBRM) is a precise and sensitive technology for measuring particle size, number and shape changes. The measured data can be used for optimization and understanding of the process, and potentially for the crystallization process control. Output data of the FBRM instrument is Chord Length Distribution (CLD), which is dependent of the actual CSD, but the two are not identical.

Calibration model for the conversion of CLD to CSD was developed using experimental data. The developed model is based on multilayer perceptron neural network. Neural network model is trained on the FBRM data collected experimentally in the laboratory crystallizer and analytically determined CSD by the laser diffraction. Validation of the model was performed on an independent dataset not used for the neural network training the.

Real-time application of developed model would allow monitoring of the CSD during the course of process. The main advantage of developed method is in the fact it does not require theoretical knowledge of the FBRM operation, and allows monitoring of CSD for irregularly shaped particles. Real-time CSD information is prerequisite for the development of real-time CSD control methods, which would consequently ensure production of the crystalline product with consistent quality.

Keywords: crystallization, calibration model, neural networks, FBRM, CLD to CSD

Poster. Section: "Chemical analysis control and monitoring"

RAZVOJ KALIBRACIJSKOG MODELA ZA KONTINUIRANO PRAĆENJE RASPODJELE VELIČINA ČESTICA U PROCESU KRISTALIZACIJE

HRVOJE DORIĆ✉, IVAN VRBAN, NENAD BOLF

Fakultet kemijskog inženjerstva i tehnologije, Sveučilište u Zagrebu,
Marulićev trg 19, 10000 Zagreb, Hrvatska
✉ hdoric@fkit.hr

Predmet istraživanja je razvoj kalibracijskog modela za kontinuirano praćenje raspodjele veličina čestica (RVČ) u laboratorijskom kristalizatoru. RVČ ključna je za kvalitetu proizvoda, odnosno djelotvornost procesa, kao i za potrošnju energije i pomoćnih medija u slijednim šaržnim proizvodnim procesima. Osim toga, važna primjena kontinuiranog praćenja je u prelasku sa šaržnog na kontinuirani način proizvodnje kojemu se teži u farmaceutskoj industriji.

Sonda za mjerenje refleksije usredotočene zrake (engl. *focused beam reflectance measurement*, FBRM) precizna je i osjetljiva sonda za praćenje promjene veličine, broja i oblika čestica. Izmjereni podaci korisni su za optimizaciju i razumijevanje procesa, a potencijalno i za vođenje kristalizacije. Mjerni podatak FBRM uređaja je tzv. linijska raspodjela čestica (engl. *chord length distribution*, CLD), koja ovisi o stvarnoj RVČ, ali nisu identične.

U sklopu istraživanja razvijen je kalibracijski model za konverziju CLD u stvarnu RVČ na temelju eksperimentalnih podataka. Model je izveden višeslojnom neuronskom mrežom. Za učenje neuronske mreže primjenjeni su eksperimentalno prikupljeni podaci s FBRM uređajem u laboratorijskom kristalizatoru te analitički određena RVČ na uređaju za lasersku difrakciju. Validacija modela provedena je na nezavisnom skupu podataka, odnosno uzorku čestica čiji podaci nisu uzeti prilikom učenja neuronske mreže.

Primjena razvijenog modela u stvarnom vremenu omogućila bi praćenje stvarne RVČ tijekom provedbe procesa. Prednost ove metode je što ne zahtijeva poznavanje teoretskih osnova rada FBRM uređaja i omogućuje praćenje RVČ za čestice nepravilnog oblika. Poznavanje RVČ u stvarnom vremenu omogućilo bi razvoj metoda za vođenje RVČ u stvarnom vremenu, a osiguralo bi i redovitu proizvodnju kristalnog proizvoda željenih svojstava.

Ključne riječi: kristalizacija, kalibracijski model, neuronske mreže, FBRM, CLD to CSD

Poster. Section: "Chemical analysis control and monitoring"

EFFECT OF CONTACT TIME IN REMOVING Cr(IV) IONS FROM WATER USING LEMON PEEL AS LOW-COST BIOSORBENT

AMILA DUBRAVAC✉, MELDINA OMERČEVIĆ, MIRNESA ZOHOROVIĆ, EMIR HOROZIĆ

Faculty of Technology, University of Tuzla, Univerzitetska 8, 75000 Tuzla, Bosnia and Herzegovina

✉ dubravac.amila@gmail.com

High percent of industrialization and urbanization causes daily pollution of wastewater and water which is used in households. Conventional methods of removing pollution from wastewater that are forming as an heavy metal deposits includes ion exchange, extraction, and so on. Except conventional methods, today are more and more used methods that involve the use of biomass. One of them is biosorption. As an biosorbent in most cases is used waste material from agroindustry (peel of fruits and vegetables, rice flakes, coconut peel).

Chromium is very toxic pollutant introduced into wastewaters. it can exist in several oxidation states, of which the most dominant are Cr³⁺ and Cr⁶⁺. Cr⁶⁺ is hazardous for living organisms when it comes to his toxicity which can cause cancerogenic diseases. Over the years, amount of chromium in wastewaters constantly increase.

In this paper was examined the influence of the contact time on the efficiency of removing Cr⁶⁺ ions using the lemon peel as a low-cost biosorbent. Measurements were performed on the UV / VIS spectrophotometer Perkin Elmer λ25, at wavelength of 540 nm. The lemon peel is dried at room temperature for 30 days, after which it is chopped up and sieved for granulation of 800 μm. For the batch-adsorption diagram a range of solutions has been prepared in the range concentration of 0.1 - 0.5 mg / L ($y = 0.3402x + 0.0047$; $R = 0.9991$). The results show that lemon peel efficiently removes Cr⁶⁺ ions from water, with an efficiency of 73.59, 87.77 and 93.64%, mixed for the 5, 10 and 15 minutes, respectively. This research confirms the efficiency of this low-cost biosorbent in removing metals from water.

Keywords: chromium, toxicity, biosorption, lemon peel

EFEKAT KONTAKTNOG VREMENA NA UKLANJANJE Cr(VI) JONA IZ VODE PRIMJENOM KORE OD LIMUNA KAO NISKOTROŠKOVNOG ADSORBENSA

AMILA DUBRAVAC✉, MELDINA OMERČEVIĆ, MIRNESA ZOHOROVIĆ, EMIR HOROZIĆ

Tehnološki fakultet, Univerzitet u Tuzli, Univerzitetska 8, 75 000 Tuzla, Bosna i Hercegovina

✉ dubravac.amila@gmail.com

Visok stepen industrijalizacije i urbanizacije svakodnevno uzrokuje onečišćenje industrijskih otpadnih voda i voda koje se svakodnevno koriste u domaćinstvima. Konvencionalne metode uklanjanja onečišćenja iz otpadnih voda koja se formiraju u obliku nakupina teških metala uključuju jonsku izmjenu, ekstrakciju, adsorpciju i dr. Osim konvencionalnih metoda, danas su sve zastupljenije metode koje uključuju upotrebu biomase. Jedna od njih je biosorpcija. U svrhu biosorbenata danas se najčešće koriste otpadni materijali nastali kao nus proizvodi u prehrambenoj i agroindustriji (kore voća i povrća, rižine ljuspice, kora kokosa).

Hrom je izuzetno toksičan metal koji je zastupljen u otpadnim vodama. Može postojati u nekoliko oksidirajućih oblika od kojih su najdominatniji Cr³⁺ i Cr⁶⁺. Cr⁶⁺ predstavlja veliku opasnost za žive organizme sa obzirom na visoku toksičnost koja dovodi do razvijanja kancerogenih oboljenja. Tokom godina, količina hroma u otpadnim vodama se konstantno povećava.

U ovom radu ispitan je efekat kontaktnog vremena na efikasnost uklanjanja Cr⁶⁺ jona primjenom limunove kore kao niskotroškovnog biosorbensa. Mjerenja su vršena na UV/Vis spektrofotometru Perkin Elmer λ25, pri talasnoj dužini od 540 nm. Kora od limuna je sušena na sobnoj temperaturi 30 dana, nakon čega je ustinjena i prosijana na granulaciju 800 μm. Za izradu baždarnog pravca pripremljena je serija rastvora u opsegu koncentracija od 0,1 - 0,5 mg/L ($y = 0,3402x + 0,0047$; $R^2 = 0,9991$). Rezultati pokazuju da kora od limuna efikasno uklanja Cr⁶⁺ jone iz vode, sa efikasnošću od 73,59, 87,77 i 93,64 %, pri miješanju od 5, 10 i 15 minuta, respektivno. Ovim istraživanjem potvrđena je efikasnost ovog biosorbenta pri uklanjanju hroma iz vode.

Ključne riječi: hrom, toksičnost, biosorpcija, kora od limuna

SYNTHESIS, CHARACTERIZATION AND ANTIMICROBIAL ACTIVITY OF THE IMINE Co(II) COMPLEX DERIVED FROM NINHYDRIN AND GLYCINEEMIR HOROZIĆ^{1,✉}, JASMIN SULJAGIĆ¹, ADNA ŠERIFOVIĆ¹, DARJA HUSEJNAGIĆ², SNJEŽANA HODŽIĆ²¹ Faculty of Technology, University of Tuzla, Univerzitetska 8, 75000 Tuzla, Bosnia and Herzegovina² Faculty of Natural Sciences, University of Tuzla, Univerzitetska 4, 75 000 Tuzla, Bosnia and Herzegovina✉ emir.horozic@untz.ba

Imines (Schiff bases), named after Hugo Schiff, are organic compounds that have in their structure a double bond between the carbon and nitrogen atoms. They are formed by the addition of the primary amine to the carbonyl carbon aldehyde or ketone. Imine complexes are now the subject of study of many scientists in the world because of their biological, catalytic and inhibitory properties.

In this paper, the imine Co(II) complex was synthesized from ninhydrin and glycine. Structural characterization was performed using FTIR spectroscopy. The antimicrobial activity of the synthesized product was tested by diffusion technique on bacterial strains from the ATCC collection, such as: *Escherichia coli*, *Enterococcus faecalis*, *Staphylococcus aureus*, *Bacillus subtilis*, *Listeria monocytogenes* and *Pseudomonas aeruginosa*. Antifungal activity was studied at *Candida albicans*.

The ligand coordinating the metal ion as the tridentate ligand is in a molar ratio of 1:2 (M:L), which is ultimately obtained by a coordination complex of the number 6, the octahedral geometry. In forming a M-L bond, one oxygen atom (from the deprotonated COOH group and the carbonyl group) is engaged, and a nitrogen atom from the imine group. The complex showed significant activity in *S. aureus*, *L. monocytogenes* and *Candida albicans*.

Keywords: cobalt, imine, antibacterial activity, FTIR, UV**SINTEZA, KARAKTERIZACIJA I ANTIMIKROBNA AKTIVNOST IMINSKOG Co(II) KOMPLEKSA IZVEDENOG IZ NINHIDRINA I GLICINA**EMIR HOROZIĆ^{1,✉}, JASMIN SULJAGIĆ¹, ADNA ŠERIFOVIĆ¹, DARJA HUSEJNAGIĆ², SNJEŽANA HODŽIĆ²¹ Tehnološki fakultet, Univerzitet u Tuzli, Univerzitetska 8, 75 000 Tuzla, Bosna i Hercegovina² Prirodno-matematički fakultet, Univerzitet u Tuzli, Univerzitetska 4, 75 000 Tuzla, Bosna i Hercegovina✉ emir.horozic@untz.ba

Imini (Schiffove baze), nazvane po Hugu Schiffu, su organski spojevi koji u svojoj strukturi imaju dvostruku vezu između ugljikovog i azotnog atoma. Nastaju adicijom primarnog amina na karbonilni ugljik aldehida ili ketona. Iminski kompleksi danas su predmet izučavanja mnogih naučnika u svijetu zbog svojih bioloških, katalitičkih i inhibitorских svojstava.

U ovom radu sintetiziran je iminski Co(II) kompleks izveden iz ninhidrina i glicina. Strukturna karakterizacija izvršena je primjenom FTIR spektroskopije. Antimikrobna aktivnost sintetiziranog produkta ispitana je difuzionom tehnikom na bakterijskim sojevima iz ATCC kolekcije, i to: *Escherichia coli*, *Enterococcus faecalis*, *Staphylococcus aureus*, *Bacillus subtilis*, *Listeria monocytogenes* and *Pseudomonas aeruginosa*. Antifungalna aktivnost ispitana je na *Candida albicans*.

Ligand koordinira metalni jon kao tridentatni ligand, u molarnom odnosu 1:2 (M:L), čime je u konačnici dobijen kompleks koordinacijskog broja 6, oktaedarske geometrije. U formiranju veze M-L angažovan je po jedan kisikov atom (iz deprotonirane COOH grupe i karbonilne grupe) te atom azota iz iminske grupe. U pogledu antimikrobnog djelovanja, kompleks je pokazao značajnu aktivnost kod *S. aureus*, *L. monocytogenes* i *Candida albicans*.

Ključne riječi: kobalt, imin, antibakterijska aktivnost, FTIR, UV

REMOVAL OF M (II) IONS FROM REAL SAMPLES OF INDUSTRIAL WASTE WATER BY CHEM. ICAL PRECIPITATION

HALID JUNUZOVIĆ ✉, AMRA SELIMOVIĆ, SABINA BEGIĆ,
ABDEL ĐOZIĆ, MELISA AHMETOVIĆ

Faculty of Technology, University of Tuzla, Univerzitetska 8, 75000 Tuzla, Bosnia and Herzegovina
✉ halid.junuzovic@untz.ba

Heavy metals today are the main polluters of water, due to their toxic, non-destructive and persistent nature. The main industrial sources of heavy metals (such as cadmium, zinc, nickel, copper, lead, chrome and others) include galvanization and metal surface treatment processes.

In this paper, samples of industrial waste water from the galvanization process of plastic and galvanizing of iron were sampled to examine the effect of pH on the removal efficiency, as well as the effect of the added precipitator on the efficiency of removal of heavy metals. Removal of heavy metals was carried out using NaOH and Na₂CO₃ as precipitating agents. The atomic absorption spectrophotometric analysis determined the exact concentration of heavy metals in the sample industrial waste water, and the presence of Cu (II) and Ni (II) at concentrations of 28 mg/L and 32.953 mg/L for a real sample from the electroplating process was determined, while for the sample of industrial waste water from the galvanization process, the content of Zn (II) concentration of 5.145 mg/L was determined respectively. The results showed that the electrolysis from the electroplating process was achieved at a pH of 7.43, and at Ni (II) at a pH of 9.00 using Na₂CO₃, while the use of NaOH resulted in better removal results for both heavy metals (95-99%), but at higher pH values. A complete removal of Zn (II) at pH 9.35 was achieved in the sample from the galvanization process using NaOH, while using Na₂CO₃ the maximum removal rate was achieved at pH 9.55, which shows that the use of NaOH and Na₂CO₃ as precipitating agents is an effective method for removal of heavy metals from industrial waste waters.

Keywords: heavy metals, chemical precipitation, pH, AAS

Poster. Section:
"Chemical analysis
control and monitoring"

UKLANJANJE M (II) JONA IZ REALNIH UZORAKA INDUSTRIJSKE OTPADNE VODE HEMIJSKOM PRECIPITACIJOM

HALID JUNUZOVIĆ ✉, AMRA SELIMOVIĆ, SABINA BEGIĆ,
ABDEL ĐOZIĆ, MELISA AHMETOVIĆ

Tehnološki fakultet, Univerzitet u Tuzli, Univerzitetska 8, 75000 Tuzla, Bosnia and Herzegovina
✉ halid.junuzovic@untz.ba

Teški metali danas predstavljaju glavne zagađivače vode, zbog svoje toksične, nerazorive i perzistentne prirode. Glavni industrijski izvori teških metala (kao što su kadmiji, cink, nikl, bakar, olovo, hrom i drugi) uključuju procese galvanizacije i tretiranja površine metala.

U ovom radu uzorkovani su realni uzorci industrijske otpadne vode iz procesa galvanizacije plastike i pocinčavanja željeza kako bi se ispitalo utjecaj pH vrijednosti na efikasnost uklanjanja, kao i utjecaj dodanog precipijenta na efikasnost uklanjanja teških metala. Uklanjanje teških metala je izvršeno primjenom NaOH i Na₂CO₃ kao precipitacionih sredstava. Atomskom apsorpcionom spektrofotometrijskom analizom je utvrđena tačna koncentracija teških metala u uzorkovanoj industrijskoj otpadnoj vodi, te je utvrđeno prisustvo Cu (II) i Ni (II) u koncentracijama 28 mg/L i 32,953 mg/L za realni uzorak iz procesa galvanizacije plastike, dok je za uzorak industrijske otpadne vode iz procesa pocinčavanja željeza utvrđen sadržaj Zn (II) koncentracije 5,145 mg/L, respektivno. Rezultati su pokazali da je za uzorak iz procesa galvanizacije plastike maksimalni procenat uklanjanja Cu (II) ostvaren kod pH vrijednosti 7,43, a kod Ni (II) pri pH vrijednosti od 9,00 primjenom Na₂CO₃, dok su primjenom NaOH ostvareni bolji rezultati uklanjanja za oba teška metala (95-99%), ali pri većim pH vrijednostima. Kod uzorka iz procesa pocinčavanja željeza primjenom NaOH ostvareno je potpuno uklanjanje Zn (II) kod pH 9,35, dok je primjenom Na₂CO₃ maksimalan procenat uklanjanja ostvaren pri pH 9,55, što pokazuje da je primjena NaOH i Na₂CO₃ kao precipitacionih sredstava efikasan metod za uklanjanje teških metala iz otpadnih industrijskih voda.

Ključne riječi: teški metali, hemijska precipitacija, pH

Poster. Section:
"Chemical analysis
control and monitoring"

REMOVAL OF CHROMIUM (VI) FROM AQUEOUS SOLUTION USING ORANGE PEEL

MERISA LJEVAKOVIĆ✉, ALMASA DJEDOVIĆ, AMILA DUBRAVAC,
MIRNESA ZOHOROVIĆ, EMIR HOROZIĆ

Faculty of Technology, University of Tuzla, Univerzitetska 8, 75000 Tuzla, Bosnia and Herzegovina
✉ merisaljevakovic98@gmail.com

Heavy metals are not biodegradable, their permanent presence in the environment leads to accumulation in food chain which represents threat to human health. Because of that researches and applications of appropriate methods for their removal are very important. Alternative methods, unlike conventional, proved to be very good, innovative and cheap. One of alternative methods is removing heavy metals by using plant material. Nut shells, cereals, eggs, fruit and vegetable peel can be used as biosorbents. Their use in procedures of biosorption of heavy metals from water represent sustainable technology which offers significant advantages like simplicity of work, low prices and availability of biosorbents. Chromium (VI) is very known cancerogenic and mutagenic. It gets into the water through water deposits of the rivers, seas and sewage system.

In this research, the efficiency of removing Cr(VI) ions using orange peel as low-cost absorbent is tested. The measurements were made on UV/Vis spectrophotometer Perkin Elmer λ 25, at wavelength of 540 nm. Orange peel was dried at room temperature for 30 days, after which it is crushed and sifted to the granulation of 800 μ m. For making caliber line, a series of solutions were prepared in concentration of 0.1 - 0.5 mg/L ($y=0.3402x + 0.0047$; $R^2 = 0.9991$). The efficiency of Cr(VI) removal from water using orange peel is 80.54 %, 90.56% and 92.70% when stirred for 5, 10 and 15 minutes. According to the results, it can be concluded that orange peel has a good potential in removing Cr (VI) from water.

Keywords: biosorption, chromium, orange peel

Poster. Section: "Chemical analysis control and monitoring"

UKLANJANJE HROMA (VI) IZ VODENOG RASTVORA POMOĆU KORE NARANDŽE

MERISA LJEVAKOVIĆ✉, ALMASA DJEDOVIĆ, AMILA DUBRAVAC,
MIRNESA ZOHOROVIĆ, EMIR HOROZIĆ

Tehnološki fakultet, Univerzitet u Tuzli, Univerzitetska 8, 75000 Tuzla, Bosna i Hercegovina
✉ merisaljevakovic98@gmail.com

Teški metali nisu biorazgradivi, a njihovo stalno prisustvo u okolini dovodi do akumulacije u lancu ishrane, što predstavlja prijetnju ljudskom zdravlju. Zbog toga su istraživanja i primjene odgovarajućih metoda za njihovo uklanjanje od velikog značaja. Alternativne metode, za razliku od konvencionalnih, pokazale su se kao jako dobre, inovativne i jeftine. Jedna od alternativnih metoda je uklanjanje teških metala pomoću biljnog materijala. Kao biosorbensi mogu se koristiti ljuske orašastog voća, žitarica i jaja, te kora voća i povrća. Njihova primjena u postupcima biosorpcije teških metala iz vode predstavlja održivu tehnologiju koja nudi značajne prednosti poput jednostavnosti rada, niske cijene te dostupnosti biosorbensa. Hrom (VI) je poznati kancerogen i mutagen. Dospijeva u vodu putem vodenih nanosa rijeka, mora i kanalizacije.

U ovom istraživanju ispitana je efikasnost uklanjanja Cr (VI) jona primjenom narandžine kore kao niskotroškovnog adsorbensa. Mjerenja su vršena na UV/Vis spektrofotometru Perkin Elmer λ 25, pri talasnoj dužini od 540 nm. Narandžina kora sušena je na sobnoj temperaturi 30 dana, nakon čega je ustinjena i prosijana na granulaciju od 800 μ m. Za izradu baždarnog pravca pripremljena je serija standardnog rastvora u opsegu koncentracija od 0.1 - 0.5 mg/L ($y = 0.3402x + 0.0047$; $R^2 = 0.9991$). Efikasnost uklanjanja jona hrom (IV) iz vode primjenom narandžine kore je 80.54, 90.56 i 92.70 %, miješanjem na magnetnoj mješalici u trajanju od 5, 10 i 15 minuta, retrospektivno. Prema rezultatima, može se zaključiti da narandžina kora ima dobar potencijal u uklanjanju jona Cr (VI) iz vode.

Ključne riječi: biosorpcija, hrom, narandžina kora

Poster. Section: "Chemical analysis control and monitoring"

TESTING THE EFFICIENCY OF REMOVING CHROMIUM (VI) IONS FROM WATER USING GRAPEFRUIT PEEL

MELDINA OMERČEVIĆ✉, HARIS BEGOVIĆ, MIRNESA ZOHOROVIĆ, KANITA HUKIĆ

Faculty of Technology, University of Tuzla, Univerzitetska 8, 75000 Tuzla, Bosnia and Herzegovina
✉ melymeli997@gmail.com

Chromium is a chemical element that's part of composition of rock, soil, volcanic dust and gases. Hexavalent chromium is generally a product of industrial processes. It enters the body by inhalation, by consuming contaminated food or water, or by direct contact with the skin. It has been proven that hexavalent chromium compounds cause lung cancer in people during inhalation. Some harmful effects on health during exposure to hexavalent chromium include nasal and sinus cancers, kidney and liver damage, irritation, and nasal and skin infections. The most common contact of a person with this chromium problem is via water. In order to purify the water from this pollutant, at present time we resort to cheaper techniques such as biosorption. As a biosorbent, waste material for food or agroindustry, such as fruit and vegetables peel, grain cereals, plums etc., can be used.

The aim of this research is to examine the effectiveness of removal of chromium (VI) by applying the grapefruit peel as an adsorbent. The grapefruit peel was dried at room temperature for 30 days, after which it was stained and sifted, with average granule diameter lesser than about 800 microns. Measurements were performed on the UV/Vis spectrophotometer Perkin Elmer λ 25, at a wavelength of 540 nm. A series of solutions were prepared for the calibration curve, with concentration range of 0.1-0.5 mg/L ($y = 0.3402x + 0.0047$; $R^2 = 0.9991$). Adsorbents were added in the same amount of water solutions containing a known concentration of Cr (VI) ions, and then, the effect of time of stirring on removing this metal was examined. The solutions are changed at a rate of 300 rpm for 5, 10, and 15 minutes, respectively. The results show that the grapefruit crust added to the same amount of water in the Cr (VI) ion solution positively affects the efficacy of the removal, but no significant effect of the mixing time on efficiency is noticed. After 5 minutes of stirring, the effectiveness of chromium removal was 79.51%, after 10 minutes it was 84.83%, while the highest efficiency of 90.91% was observed after stirring the sample for 15 minutes, which confirms the justification of using this light-chain adsorbent in the removal of Cr (VI) ions.

In future researches, it is necessary to pay attention to the other parameters (quantity and size of adsorbent particles, stirring speed, pH value), which could have a significant influence on the efficiency of removal of chromium specimens of this adsorbent.

Keywords: chromium, contamination, biosorption, grapefruit peel

ISPITIVANJE EFIKASNOSTI UKLANJANJA HROM (VI) JONA IZ VODE PRIMJENOM KORE OD GREJPFRUTA

MELDINA OMERČEVIĆ✉, HARIS BEGOVIĆ, MIRNESA ZOHOROVIĆ, KANITA HUKIĆ

Tehnološki fakultet, Univerzitet u Tuzli, Univerzitetska 8, 75000 Tuzla, Bosna i Hercegovina
✉ melymeli997@gmail.com

Hrom je hemijski element koji ulazi u sastav stijena, zemljišta, vulkanske prašine i gasova. Šestovalentni hrom je generalno proizvod industrijskih procesa. Dospijeva u organizam udisanjem, putem konzumiranja kontaminirane hrane ili vode, ili putem direktnog kontakta s kožom. Dokazano je da šestovalentni spojevi hroma uzrokuju rak pluća kod ljudi prilikom udisanja. Neki štetni efekti po zdravlje prilikom izloženosti šestovalentnom hromu uključuju nazalne i sinusne kancere, oštećenja bubrega i jetre, iritacije i infekcije nosa i kože. Najčešći kontakt čovjeka sa ovim oblikom hroma je preko vode. Da bi se voda prečistila od ovog polutanta danas se pribjegava jeftinim tehnikama, kao što je biosorpcija. Kao biosorbent može poslužiti otpadni materijal prehrambene ili agroindustrije (kore voća i povrća, ljuske žitarica, orašnica i sl.).

Cilj ovog rada je ispitivanje efikasnosti uklanjanja hrom (VI) jona primjenom kore grejpfruta kao adsorbensa. Kora grejpfruta je sušena na sobnoj temperaturi 30 dana, nakon čega je ustinjena i prosijana na granulaciju 800 μ m. Mjerenja su vršena na UV/Vis spektrofotometru Perkin Elmer λ 25, pri talasnoj dužini od 540 nm. Za izradu baždarnog pravca pripremljena je serija rastvora u opsegu koncentracija od 0,1-0,5 mg/L ($y = 0,3402x + 0,0047$; $R^2 = 0,9991$). Adsorbens je dodan u istoj količini u vodene rastvore koji sadrže poznatu koncentraciju Cr (VI) jona, a zatim je praćen uticaj vremena miješanja na efikasnost uklanjanja ovog metala. Rastvori su miješani brzinom od 300 rpm u trajanju od 5, 10 i 15 minuta, pojedinačno. Rezultati pokazuju da kora grejpfruta dodana u istoj količini u vodene rastvore Cr (VI) jona pozitivno utiče na efikasnost uklanjanja, međutim nije uočen veliki uticaj vremena miješanja na efikasnost. Pri miješanju od 5 minuta efikasnost uklanjanja hroma iznosila je 79.51%, nakon 10 minuta iznosila je 84.83%, dok je najveća efikasnost od 90.91% uočena miješanjem uzorka u trajanju od 15 minuta, što potvrđuje opravdanost korištenja ovog lakopristupačnog adsorbensa u uklanjanju Cr (VI) jona. U budućim istraživanjima potrebno je obratiti pažnju na druge parametre (količina i veličina čestica adsorbensa, brzina miješanja, pH vrijednost), koji bi mogli imati značajan uticaj na efikasnost uklanjanja hroma primjenom ovog adsorbensa.

Ključne riječi: hrom, kontaminacija, biosorpcija, kora grejpfruta

DETERMINATION OF THE CONTENT OF HEAVY METALS IN PELLET AND PELLET ASH BY FAAS TECHNIQUE

MIRHA PAZALJA^{1,✉}, MIRSADA SALIHOVIĆ¹, JASMINA SULEJMANOVIĆ², MUSTAFA MEMIĆ², SABINA BEGIĆ²

¹Faculty of Pharmacy, University of Sarajevo, Zmaja od Bosne 8-Kampus, 71000 Sarajevo, Bosnia and Herzegovina

²Faculty of Science, University of Sarajevo, Zmaja od Bosne 33-35, 71000 Sarajevo, Bosnia and Herzegovina

✉ mirha.pazalja@ffsa.unsa.ba

Due to the natural gas and oil prices rise, as well as environmental awareness, wood as an energy source is increasingly recovering for use, especially for heat generation. The use of pellets as an energy source is becoming more attractive because it is a renewable energy source. However, the chemical composition of pellets and their ash, especially the content of harmful substances, e.g. heavy metals, is very important. In recent years, the world has been concerned about the heavy metals environmental pollution. These ions are stable and persistent contaminants because they are non-degradable, with a harmful effect on humans and other biological systems.

The aim of this study was to determine the content of heavy metals in pellet and ash pellets by FAAS (*flame atomic absorption spectrometry*) technique. The content of Cu, Zn, Cr, Cd, Co, Mn, Ni, and Pb was determined in the pellet sample (commercially available on the market of Bosnia and Herzegovina) as well as in pellet ash. The obtained concentrations of the listed heavy metals in the pellet samples were in the range from 3 to 76.7 mg/kg, and in pellet ash from 1 to 60.8 mg/kg.

Concentrations of Cd, Cr, and Ni in the pellet samples were higher than allowed according to standards used in European Union countries.

Based on the obtained results, it can be concluded that monitoring of heavy metals in pellets is necessary in order to achieve a clean and healthy environment that will not affect human health.

Keywords: heavy metals, pellet, ash, FAAS

ODREĐIVANJE SADRŽAJA TEŠKIH METALA U PELETU I NJEGOVOM PEPELU FAAS TEHNIKOM

MIRHA PAZALJA^{1,✉}, MIRSADA SALIHOVIĆ¹, JASMINA SULEJMANOVIĆ², MUSTAFA MEMIĆ², SABINA BEGIĆ²

¹ Farmaceutski fakultet, Univerzitet u Sarajevu, Zmaja od Bosne 8-Kampus, 71000 Sarajevo, Bosna i Hercegovina

² Prirodno matematički fakultet, Univerzitet u Sarajevu, Zmaja od Bosne 33-35, 71000 Sarajevo, Bosna i Hercegovina

✉ mirha.pazalja@ffsa.unsa.ba

Usljed rasta cijena prirodnog plina i nafte, te ekološke osviještenosti, drvo kao energent sve više se vraća u upotrebu posebno za dobijanje toplotne energije. Upotreba peleta kao energenta sve više je aktuelna, jer predstavlja obnovljivi izvor energije. Međutim, pored navedenog važan je i hemijski sastav peleta i pepela, prije svega sadržaj štetnih supstanci kao što su teški metali. Zadnjih godina u svijetu je naglašena zabrinutost zbog onečišćenja okoliša teškim metalima. Njihovi joni su stabilni i postojani kontaminanti jer se ne mogu degradirati i uništiti, imaju potencijalno štetan efekat na ljudsko zdravlje i druge biološke sisteme.

Cilj ovog istraživanja je odrediti sadržaj teških metala u peletu i njegovom pepelu FAAS (*flame atomic absorption spectrometry*) tehnikom. U uzorku peleta (komercijalno dostupnog na tržištu Bosne i Hercegovine), kao i u njegovom pepelu određen je sadržaj sljedećih teških metala: Cu, Zn, Cr, Cd, Co, Mn, Ni i Pb. Dobivene koncentracije navedenih teških metala u uzorku peleta i imale su vrijednosti u rasponu od 3 do 76,7 mg/kg, a u pepelu od 1 do 60,8 mg/kg.

Koncentracije Cd, Cr i Ni u analiziranom peletu su veće u odnosu na koncentracije koje su dozvoljene prema standardima koji se koriste u Zemljama Evropske Unije.

Na osnovu dobijenih rezultata može se zaključiti da je neophodno vršiti monitoring teških metala u peletu s ciljem postizanja čistog i zdravog okruženja koje neće uticati na zdravlje ljudi i razvojni potencijal budućih generacija.

Ključne riječi: Teški metali, pelet, pepeo, FAAS

DENSITY FUNCTIONAL THEORY: $^1\text{H-NMR}$ AND $^{13}\text{C-NMR}$ SPECTRA OF SOME SCHIFF BASES

SALIHović MIRSADA^{1,✉}, PAZALJA MIRHA¹, ROCA SUNČICA²; ŠPIRTOVIĆ-HALILOVIĆ SELMA¹, VELJOVIĆ ELMA¹, ŠAPČANIN AIDA¹, BEGIĆ SABINA²

¹Faculty of Pharmacy, University of Sarajevo, Zmaja od Bosne 8, 71000 Sarajevo, Bosnia and Herzegovina

²NMR Centre, Ruđer Bošković Institute, Bijenička cesta 54, 10000 Zagreb, Croatia

³Faculty of Science, University of Sarajevo, Zmaja od Bosne 33-35, 71000 Sarajevo, Bosnia and Herzegovina

✉ mirsada.salihovic@ffsa.unsa.ba

The density functional theory (DFT) is a computational quantum chemistry method used in the research of the electron structure of atoms, molecules, and condensed phases, with the goal of molecular modeling. Using this theory, the properties of many systems can be determined using functions, or functions of other functions, which are in fact electronic density.

For some synthesized Schiff bases, $^1\text{H-NMR}$ and $^{13}\text{C-NMR}$ isotropic chemical shifts and some other molecular properties were calculated using the DFT.

The geometry optimizations of some Schiff base were calculated at the DFT level and the 6-31G* basis set. The calculations were carried out with the B3LYP functional, in which Becker's non-local exchange and the Lee-Yang-Parr correlation functional were applied.

Selected structural parameters of the optimized geometries of the Schiff bases were obtained by DFT method. The vibration frequencies of the fundamental modes of the compounds were precisely assigned and analyzed, and the theoretical results were compared with the experimental vibrations. The $^1\text{H-}$ and $^{13}\text{C-NMR}$ chemical shifts were calculated and the assignments were compared with the experimental values. The conducted research provided complete vibration assignments, structural information and NMR chemical shifts of these compounds.

The DFT study has yielded respectable results because they were in good correlation with experimental results. The obtained theoretical results provide good guidelines in experimental work.

Keywords: $^1\text{H-NMR}$; $^{13}\text{C-NMR}$; DFT; Spartan 14

TEORIJA FUNKCIONALNA GUSTOĆE: $^1\text{H-NMR}$ I $^{13}\text{C-NMR}$ SPEKTRI NEKIH SCHIFF-OVIH BAZA

SALIHović MIRSADA^{1,✉}, PAZALJA MIRHA¹, ROCA SUNČICA²; ŠPIRTOVIĆ-HALILOVIĆ SELMA¹, VELJOVIĆ ELMA¹, ŠAPČANIN AIDA¹, BEGIĆ SABINA²

¹Univerzitet u Sarajevu Farmaceutski fakultet Zmaja od Bosne 71 000 Sarajevo Bosna i Hercegovina

²NMR Centar, Ruđer Bošković Institut, Bijenička cesta 54, 10000 Zagreb, Hrvatska

³Prirodno matematički fakultet, Univerzitet u Sarajevu, Zmaja od Bosne 33-35, 71000 Sarajevo, Bosna i Hercegovina

✉ mirsada.salihovic@ffsa.unsa.ba

Teorija funkcionala gustoće (*density functional theory*, DFT) je komputacijska kvantnohemijska metoda koja se koristi u istraživanju elektronske strukture atoma, molekula i kondenziranih faza, s ciljem molekuskog modeliranja. Pomoću ove teorije osobine mnogih sistema mogu se odrediti koristeći funkcionalne, odnosno funkcije drugih funkcija, koje su zapravo elektronska gustoća.

DFT metodom su izračunati izotropni hemijski pomaci $^1\text{H-NMR}$ i $^{13}\text{C-NMR}$ kao i neke druge molekulske osobine sintetiziranih Schiff-ovih baza.

Geometrijska optimizacija, Schiff-ovih baza izračunata je na DFT nivou 6-31G* baznom grupom. Proračuni su izvedeni sa B3LYP funkcijom, u kojoj su primijenjene Becker-ova ne-lokalna razmjena i Lee-Yang-Parr korelacijski funkcionalni.

Odabrani strukturni parametri optimizirane geometrije Schiff-ovih baza dobiveni su DFT metodom. Frekvencije vibracija osnovnih modula datih spojeva su precizno određene i analizirane, a teoretski rezultati su upoređeni sa eksperimentalnim. Izračunati su hemijski pomaci $^1\text{H-NMR}$ i $^{13}\text{C-NMR}$, a rezultati su upoređeni sa eksperimentalnim dobijenim vrijednostima. Sprovedena istraživanja daju potpune strukturne informacije o vibracijama i NMR hemijskim pomacima Schiff-ovih baza.

DFT studija je dala respektabilne rezultate jer su bili u dobroj korelaciji sa eksperimentalnim rezultatima. Dobijeni teorijski rezultati daju dobre smjernice u eksperimentalnom radu.

Ključne riječi: $^1\text{H-NMR}$; $^{13}\text{C-NMR}$; DFT; Spartan 14.

DETERMINATION OF α -SOLANINE CONTENT IN TWO VARIETIES OF POTATOES BY THE DENSITOMETRIC METHOD

ISMET TAHIROVIĆ^{1,✉}, MAJA RADIĆ¹, LEJLA KLEPO¹, LUTVIJA KARIĆ², HURIJA DŽUDŽEVIĆ-ČANČAR³, ATIFA AJANOVIĆ⁴, ALIJA UZUNOVIĆ⁵

¹ Faculty of Science, University of Sarajevo, Zmaja od Bosne 33-35, 71000 Sarajevo, Bosnia and Herzegovina

² Faculty of Agriculture and Food Science, University of Sarajevo, Zmaja od Bosne 8, 71000 Sarajevo, Bosnia and Herzegovina

³ Faculty of Pharmacy, University of Sarajevo, Zmaja od Bosne 8, 71000 Sarajevo, Bosnia and Herzegovina

⁴ Faculty of Veterinary Medicine, University of Sarajevo, Zmaja od Bosne 90, 71000 Sarajevo, Bosnia and Herzegovina

⁵ Control Laboratory of the Agency for Medicinal Products and Medical Devices of Bosnia and Herzegovina, 71000 Sarajevo, Bosnia and Herzegovina

✉ ismet68t@gmail.com

Solanine is a glycoalkaloid found in *Solanaceae* family, such as potatoes. It is very poisonous even in small quantities because it has pesticide and fungicide effects and represents a natural plant defense mechanism. Its concentration increases when the plant is exposed to some stress (fertilization, insecticide use, etc.). This paper aims to examine the influence of three conditions of cultivation (conventional, organic and natural) on the biosynthesis of α -solanine (α S) through his quantification in young potatoes using densitometry. Two types of potatoes were analyzed: *Aladdin (Ala)* and *Mona Lisa (MoL)*. For statistical analysis, the Student's t-test was used.

The results showed that the use of artificial insecticides caused a very intense biosynthesis of α S in the *Ala* variety by the conventional cultivation [1.19 mg/100 g of fresh tubers (f.t.)] in comparison to the average α -solanine content (A α SC) by the organically cultivated *Ala* (0.62 mg/100 g of f.t.) [it is close to the statistical significance, (p=0.08)]. It is complicate to explain the very high A α SC of natural *Ala* cultivation (1.62 mg/100 g of f.t.).

Analysis of potatoes of the *MoL* variety showed that the A α SC of conventional cultivation (1.35 mg/100 g of f.t.) was statistically higher than the A α SC of natural cultivation (0.59 mg/100 g of f.t.) (p* < 0.05). Also, the organically cultivated A α SC of (1.40 mg/100 g of f.t.) was higher than the A α SC of natural cultivated *MoL*, but without statistical significance (p > 0.05).

The found concentrations of α S in the case of conventional, organic and natural cultivation of potatoes considered safe and such potatoes are suitable for consumption. However, because of a slight reduction in toxic α S, it is recommended to consume organic potatoes (*Ala* variety), and natural potatoes (*MoL* variety).

Keywords: glycoalkaloids, α -solanine, potatoes, densitometry.

ODREĐIVANJE SADRŽAJA α -SOLANINA U DVIJE SORTE KROMPIRA DENZITOMETRIJSKOM METODOM

ISMET TAHIROVIĆ^{1,✉}, MAJA RADIĆ¹, LEJLA KLEPO¹, LUTVIJA KARIĆ², HURIJA DŽUDŽEVIĆ-ČANČAR³, ATIFA AJANOVIĆ⁴, ALIJA UZUNOVIĆ⁵

¹ Prirodno-matematički fakultet, Univerzitet u Sarajevu, Zmaja od Bosne 33-35, 71000 Sarajevo, Bosna i Hercegovina

² Poljoprivredno-prehrambeni fakultet, Univerzitet u Sarajevu, Zmaja od Bosne 8, 71000 Sarajevo, Bosna i Hercegovina

³ Faculty of Pharmacy, Univerzitet u Sarajevu, Zmaja od Bosne 8, 71000 Sarajevo, Bosna i Hercegovina

⁴ Faculty of Veterinary Medicine, Univerzitet u Sarajevu, Zmaja od Bosne 90, 71000 Sarajevo, Bosna i Hercegovina

⁵ Kontrolna laboratorija Agencije za medicinske proizvode i medicinska pomagala Bosne i Hercegovine, 71000 Sarajevo, Bosna i Hercegovina

✉ ismet68t@gmail.com

Solanin je glikoalkaloid, nađen u vrstama porodice *Solanaceae*, kao što je krompir. Vrlo je toksičan, čak i u malim količinama, jer ima pesticidno i fungicidno djelovanje i predstavlja prirodni odbrambeni mehanizam biljke. Njegova koncentracija raste kada se biljka izloži nekom stresu (đubrenje, upotreba insekticida itd.). Cilj ovog rada je da se ispita uticaj različitih načina uzgoja (konvencionalnog, organskog i prirodnog) na biosintezu α -solanina (α S) putem njegove kvantifikacije u mladom krompiru denzitometrijskom metodom. Analizirane su dvije sorte krompira: *Aladin (Ala)* i *Mona Lisa (MoL)*. Za statističku analizu korišten je Studentov t-test.

Rezultati su pokazali da upotreba vještačkih insekticida izaziva intenzivnu biosintezu α S kod sorte *Ala* konvencionalnog uzgoja [1,19 mg/100 g svježe krtole (s.k.)] u odnosu na prosječni sadržaj α -solanina (PS α S) kod organski uzgojenog *Ala* (0,62 mg/100 g s.k.) [razlika je blizu statističke značajnosti, (p=0,08)]. Iznenađujući rezultat je znatno viši PS α S kod prirodno uzgojenog *Ala* (1,62 mg/100 g s.k.).

Analiza krompira sorte *MoL* pokazala je da su PS α S konvencionalnog (1,35 mg/100 g s.k.) i organskog (1,40 mg/100 g s.k.) uzgoja ujednačeni, kao i to da je PS α S konvencionalnog uzgoja statistički značajno viši u odnosu na PS α S prirodnog uzgoja (0,59 mg/100 g s.k.) (p* < 0,05). Također, PS α S organskog uzgoja viši je u odnosu na PS α S prirodnog uzgoja, ali bez statističke značajnosti (p > 0,05).

Nađene koncentracije α S u obje sorte krompira konvencionalnog, organskog i prirodnog uzgoja smatraju se bezbjednim i ovakav krompir je pogodan za ishranu. Ipak, zbog znatno manje količine toksičnog α S, preporučuje se konzumiranje krompira organskog (sorta *Ala*), odnosno prirodnog (sorta *MoL*) uzgoja.

Ključne riječi: glikoalkaloidi, α -solanin, krompir, denzitometrija.

COMPARISON OF CORROSION STABILITY OF ALLOYED MATERIALS BASED ORTHOPEDIC IMPLANTS

FEHIM KORAC✉, SELMA BUROVIĆ, SELMA KORAĆ

Faculty of Science, University of Sarajevo, Zmaja od Bosne 33 – 35, 71000 Sarajevo, Bosnia and Herzegovina

✉ fkorac@pmf.unsa.ba

Chemical stability, mechanical properties and biocompatibility are the basic requirements that must be fulfilled in order to successfully apply implants for fracture and bone replacement. The most commonly used materials for making implants are: 316L stainless steel, CoCr alloys, titanium and its alloys. Corrosion is the biggest problem that occurs when orthopedic implants are used. Corrosion causes oxidation of the material, which results in the release of elements into the organism in the form of an ion and increases the concentration of elements that can affect the organism. The human organism represents an extremely aggressive environment for these materials due to high oxygen concentration, the presence of different salts, especially chlorides, and the temperature of the human body. It is therefore necessary to carry out a series of experiments and tests to prove that some material meets the requirements for application in the human organism. In this paper an analysis was carried out on orthopedic implants based on alloyed materials. Samples were tested in saline solutions by linear polarization method, cyclic polarization and electrochemical impedance spectroscopy.

Keywords: orthopedic implants, linear polarization, cyclic polarization, electrochemical impedance spectroscopy, stainless steel.

POREĐENJE KOROZIJE STABILNOSTI ORTOPEDSKIH IMPLANTATA NA BAZI LEGIRANIH MATERIJALA

FEHIM KORAC✉, SELMA BUROVIĆ, SELMA KORAĆ

Prirodno – matematički fakultet, Univerzitet u Sarajevu, Zmaja od Bosne 33 – 35 71000 Sarajevo, Bosna i Hercegovina

Hemijska stabilnost, mehanička svojstva i biokompatibilnost su osnovni zahtjevi koji moraju biti ispunjeni da bi se implantati mogli uspješno primjenjivati za liječenje preloma i zamjenu kostiju. Materijali koji se najčešće koriste za izradu implantata su: nehrđajući čelik tipa 316L, CoCr – legure, titanijum i njegove legure. Najveći problem koji se javlja kod primjene ortopedskih implantata jeste korozija. Korozijom materijala dolazi do oksidacije pri čemu dolazi do otpuštanja elemenata u organizam u formi jona i dolazi do povećanja koncentracije elemenata koji mogu djelovati toksično na organizam. Ljudski organizam predstavlja izuzetno agresivnu sredinu za ove materijale razlog tome je visoka koncentracija kisika, prisustvo različitih soli, naročito hlorida, te temperatura ljudskog tijela. S toga je potrebno vršiti niz eksperimenata i testova da bi se dokazalo da neki materijal ispunjava uslove za aplikaciju u ljudskom organizmu. U ovom radu je izvršena analiza ortopedskih implantata na bazi legiranih materijala. Uzorci su ispitani u fiziološkim otopina metodama linearne polarizacije, ciklične polarizacije i elektrohemijske impedancijske spektroskopije.

Ključne riječi: ortopedski implantati, linearna polarizacija, ciklična polarizacija, elektrohemijska impedancijska spektroskopija, nehrđajući čelik.

DISSOLUTION RATE ENHANCEMENT OF AN ACTIVE PHARMACEUTICAL INGREDIENT VIA SOLID DISPERSION

JOŠKO BARBARIĆ✉, KRUNOSLAV ŽIŽEK

Faculty of Chemical Engineering and Technology, University of Zagreb, Marulićev trg 19, 10000 Zagreb, Croatia

✉ barbaric@fkit.hr

Poor solubility in the physiological pH range is a feature of many active pharmaceutical ingredients (APIs) that results in poor drug absorption across gastrointestinal tract membranes and, ultimately, limited pharmacological effect of the drug. Solid dispersion preparation is one of the methods focused towards drug solubility enhancement.

Within this research, solid dispersions of lurasidone hydrochloride (LRS HCl) in a hydrophilic polymer matrix have been prepared by solvent evaporation method. The effect of adding a polymer in various weight fractions on wetting properties of API particles has been investigated by a technique of contact angle measurement using goniometer. API-polymer interfacial parameters have been detected and quantitative prediction of interactions has been evaluated using two parametric models (Owens-Wendt and Wu model).

Use of hydrophilic polymers in solid dispersion preparation could improve the wetting of API particles and, consequently, improve its solubility and dissolution rate. Therefore, dissolution rate tests of prepared solid dispersion at a specific pH value have been performed within the second phase of this research.

Keywords: lurasidone-hydrochloride, solid dispersion, hydrophilic polymer, solubility enhancement.

Poster. Section: "Chemical and biochemical engineering"

POVEĆANJE BRZINE OSLOBAĐANJA DJELATNE TVARI PRIPRAVOM ČVRSTIH DISPERZIJA

JOŠKO BARBARIĆ✉, KRUNOSLAV ŽIŽEK

Fakultet kemijskog inženjerstva i tehnologije, Sveučilište u Zagrebu, Marulićev trg 19, 10000 Zagreb, Hrvatska

✉ barbaric@fkit.hr

Loša topljivost u fiziološkom rasponu pH vrijednosti odlika je mnogih djelatnih tvari farmaceutске industrije što za posljedicu ima slabu apsorpciju lijeka kroz membrane probavnog sustava te ograničen farmakološki učinak lijeka. Jedan od metoda usmjerenih ka povećanju topljivosti djelatnih tvari je priprava čvrstih disperzija.

U okviru ovog istraživanja pripravljene su čvrste disperzije lurasidon-hidroklorida (LRS HCl) u hidrofilnoj polimernoj matrici primjenom metode isparavanja otapala. Ispitan je utjecaj dodatka polimera u različitim masenim udjelima na kvašenje čestica djelatne tvari pri čemu je korištena tehnika mjerenja kontaktnog kuta goniometrom. Detektirani su parametri međupovršine djelatna tvar-polimer, a u kvantitativnom predviđanju interakcija korišteni su dvoparametarski modeli (Owens-Wendtov i Wuov model).

Korištenje hidrofilnih polimera u pripravi čvrstih disperzija lijeka može poboljšati kvašenje djelatne tvari te posljedično povećati njenu topljivost i brzinu oslobađanja (otapanja). Stoga, u drugoj fazi istraživanja provedena su ispitivanja brzine oslobađanja djelatne tvari iz pripremljenih čvrstih disperzija pri definiranoj pH vrijednosti medija.

Ključne riječi: lurasidon-hidroklorid, čvrsta disperzija, hidrofilni polimer, povećanje topljivosti.

Poster. Section: "Chemical and biochemical engineering"

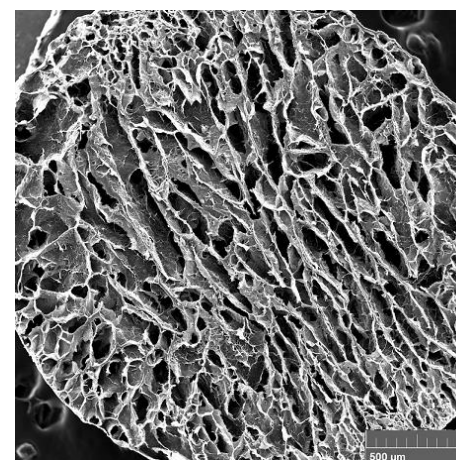
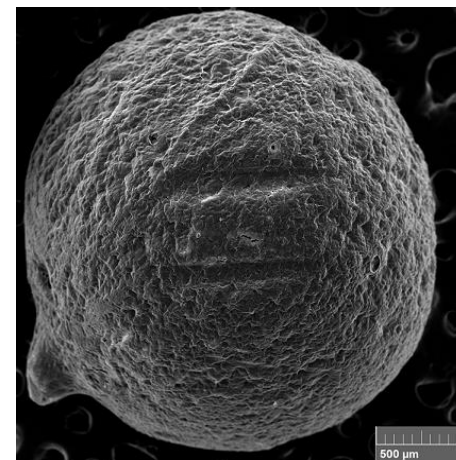
CELULOZA-G-DIMETILAMINOETIL METAKRILATNI HIDROGELOVI SA SREBROVIM NANOČESTICAMA

ROKO BLAŽIĆ, KATARINA LENAC, ELVIRA VIDOVIĆ✉

Fakultet kemijskog inženjerstva i tehnologije, Sveučilište u Zagrebu

✉ evidov@fkit.hr

Celuloza je široko rasprostranjen polisaharid, kojeg odlikuju biokompatibilnost i biorazgradivost. Hidroksilne skupine u ponavljajućoj jedinici polimernog lanca daju celulozi hidrofilan karakter što je čini pogodnim materijalom za pripremu hidrogelova. Fizikalnom ili kemijskom modifikacijom celuloznih hidrogelova s funkcijskim punilima ili polimerima širi se područje njihove primjene. Mnoga istraživanja su usmjerena na pripremu celuloznih hidrogelova sa srebrovim nanočesticama u cilju postizanja atibakterijskih svojstava. U ovom radu provedena je *in situ* polimerizacija *N, N*-dimetilaminoetil-metakrilata (DMAEMA) u otopini celuloze uz peroksidni inicijator i umreživalo *N,N*-metilen-bis-akrilamid (MBA). Kako bi se ispitao utjecaj PDMAEMA na stupanj bubrenje hidrogela i vezanje nanočestica srebra u pripremljenom hidrogelu, hidrogelovi su bubreni u vodi, suspenziji nanočestica srebra i otopini srebrova nitrata. Prilikom pripreme hidrogelova mijenjani su količinski omjeri celuloze i DMAEMA (1:1 i 1:3) te celuloze i MBA (5:1 i 2,5:1). Određivanjem stupnja bubrenja u vodi utvrđeno je da hidrogel s manjom količinom MBA bubri najviše (oko 500 %), hidrogel s većom količinom MBA bubri otprilike 250 %, dok hidrogel celuloze bubri otprilike 80 %. Pomoću pretražnog elektronskog mikroskopa (SEM) i energijsko disperzivnog spektrometra utvrđeno je da su se nanočestice srebra, nakon bubrenja sfera hidrogela u suspenziji, vezale samo na hidrogelove s PDMAEMA. Nakon bubrenja sfera hidrogelova u otopini srebrova nitrata uočena je prisutnost čestica srebra i na hidrogelovima s PDMAEMA i hidrogelu čiste celuloze.



Slika 1. SEM mikrografija hidorgela s omjerom celuloze i DMAEMA 1:1 i omjerom celuloze i MBA 5:1:
lijevo - površina sfere hidrogela, desno - presjek sfere hidrogela.

Ključne riječi: hidrogel, celuloza, poli(dimetilaminoetil-metakirlat), nanočestice srebra

AN EXAMPLE OF BLENDING COMMERCIAL MOTOR GASOLINE

TATJANA BOTIC, PERO DUGIC¹, [ALEKSANDRA SINIK¹](mailto:aleksandra.sinik@tf.unibl.org)✉

¹ Faculty of Technology, University of Banja Luka, Stepe Stepanovica 73, 78000 Banja Luka, Bosnia and Herzegovina

✉ aleksandra.sinik@tf.unibl.org

The production of gasoline is specific to each refinery, because different components obtained from different process plants, are used for blending it. In order to meet the specifications of commercial motor gasoline defined by the quality standard, finding the optimum ratio of components for blending is required. The greatest limitations are the values of physicochemical characteristics and the availability of intermediates. This paper gives an example of blending commercial motor gasoline, where it shows the influence of the values of the characteristics of the input components on the quality of the finished product.

Additives that are mixed into gasoline to improve some characteristics are added in very small quantities due to the high cost of the additives themselves and also due to the negative effect on other characteristics of the finished product.

Keywords: motor gasoline, blending, quality standard

PRIMJER NAMJEŠAVANJA KOMERCIJALNOG MOTORNOG BENZINA

TATJANA BOTIC, PERO DUGIC¹, [ALEKSANDRA SINIK¹](mailto:aleksandra.sinik@tf.unibl.org)✉

¹ Tehnološki fakultet, Univerzitet u Banjoj Luci, Stepe Stepanovića 73, 78000 Banja Luka, Bosna i Hercegovina

✉ aleksandra.sinik@tf.unibl.org

Proizvodnja benzina je specifična za svaku rafineriju, jer se za njegovo namješavanje koriste različiti poluproizvodi dobijeni sa različitih procesnih postrojenja. Da bi se ispunile specifikacije komercijalnog motornog benzina definisane standardom kvaliteta, potrebno je iznalaženje optimalnog odnosa komponenata za namješavanje. Najveća ograničenja jesu vrijednosti fizičko-hemijskih karakteristika kao i dostupnosti međuproizvoda. U ovom radu je dat primjer namješavanja komercijalnog motornog benzina, na osnovu koga je prikazan uticaj vrijednosti karakteristika ulaznih komponenata na kvalitet gotovog proizvoda.

Aditivi koji se namješavaju u motorni benzin radi poboljšanja nekih karakteristika, dodaju se u veoma malim količinama, zbog visoke cijene samih aditiva ali i zbog negativnog djelovanja na druge karakteristike gotovog proizvoda.

Ključne riječi: motorni benzin, namješavanje, standard kvaliteta

STUDYING THE HEAT EXCHANGE PROCESS IN A TUBULAR EXCHANGER

SUAD GRAPKIĆ, NIDRET IBRIĆ, ELVIS AHMETOVIĆ✉

University of Tuzla, Faculty of Technology, Univerzitetska 8, 75000 Tuzla, Bosnia and Herzegovina

✉ elvis.ahmetovic@untz.ba

This work describes a study of the heat exchange process in the extended tubular heat exchanger (HT36) used in conjunction with a computer compatible service unit (HT30XC). The heat exchange process is studied for different flow rates of hot and cold water streams which counter currently flows through the heat exchanger. The aim of the paper is to determine the experimental values of the temperatures of hot and cold water streams along the length of the heat exchanger and to calculate the overall efficiency of the heat exchange process, temperature efficiencies of water streams and the overall heat transfer coefficient in the heat exchanger.

Keywords: heat exchange, tubular heat exchanger, counter-current flow of fluids, overall heat transfer coefficient.

STUDIRANJE PROCESA IZMJENE TOPLINE U CIJEVNOM IZMJENJIVAČU

SUAD GRAPKIĆ, NIDRET IBRIĆ, ELVIS AHMETOVIĆ✉

Univerzitet u Tuzli, Tehnološki fakultet, Univerzitetska 8, 75000 Tuzla, Bosna i Hercegovina

✉ elvis.ahmetovic@untz.ba

Ovaj rad opisuje proces izmjene topline u proširenom cijevnom izmjenjivaču topline (HT36) spojenim sa kompjuterski kompatibilnom servisnom jedinicom (HT30XC). Proces izmjene topline je studiran za različite protoke tokova tople i hladne vode koji protusmjerno protiču kroz izmjenjivač topline. Cilj rada je odrediti eksperimentalne vrijednosti temperatura tokova tople i hladne vode po dužini izmjenjivača topline i izračunati koeficijent efikasnosti izmjene topline, temperaturne efikasnosti i koeficijent prolaza topline u izmjenjivaču.

Ključne riječi: izmjena topline, cijevni izmjenjivač topline, protusmjerno proticanje fluida, koeficijent prolaza topline.

SYNTHESIS OF GEL AIR FRESHENER AND ITS STABILITY

AMRA BRATOVCIC

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

✉ amra.bratovic@untz.ba

Fragrance compounds have been used since antiquity to freshen the air or to mask the odours. Different types of air fresheners are known such as electric air fresheners with 30% market share, sprays, including aerosol air fresheners with 27%, car air fresheners with 16%, gel air fresheners with 9%, candle air fresheners and wax melts with 7%, liquid air fresheners with 6% and others.

According to research studies, in the United States, 34.7 % of the population reported health problems, such as migraine headaches and respiratory difficulties, when exposed to fragranced products. Thus, there is a number of studies with strong evidence that fragranced products can trigger adverse health effects in the general population.

Considering that air fresheners have been associated with adverse negative health effects that was the motive for proposing an alternative way of synthesis of gel air fresheners which is more green and more healthy.

In this paper the gel air freshener was synthesized by simple and sol-gel reaction using natural biodegradable polymer gelatin and lavender essential oil. The 3D structures of gel air fresheners of desired shapes and odours were obtained. The change in the 3D structure at room temperature was evident, probably as a result of temperature degradation and water evaporation.

Anyway, the gel air freshener obtained in this research is more acceptable for human health than commercially available one. The results obtained also suggest that further improvement on stability should take place.

Keywords: gel air freshener, synthesis, gelatin, lavender essential oil, health impact.

SINTEZA GELSKOG OSVJEŽIVAČA ZRAKA I NJEGOVA STABILNOST

AMRA BRATOVCIC

Faculty of Technology, University of Tuzla, Univerzitetska 8, 75000 Tuzla, Bosnia and Herzegovina

Mirisni spojevi korišteni su od davnina za osvježanje zraka ili za maskiranje neugodnih mirisa. Poznate su različite vrste osvježivača zraka poput električnih osvježivača zraka sa 30% tržišnog udjela, sprejevi, uključujući aerosolne osvježivače zraka sa 27%, osvježivače zraka za automobile sa 16%, gel osvježivače zraka sa 9%, svijeće i voskove sa 7 %, tečni osvježivači zraka sa 6% i drugi.

Prema istraživanjima, u Sjedinjenim Američkim Državama, 34.7% stanovništva prijavilo je zdravstvene probleme, poput migrenske glavobolje i respiratornih poteškoća, kada su bili izloženi mirisnim proizvodima. Dakle, postoji niz studija sa jakim dokazima da mirisni proizvodi mogu izazvati štetne zdravstvene učinke na opću populaciju.

S obzirom da su osvježivači zraka povezani sa štetnim negativnim učincima na zdravlje, to je bio motiv za predlaganje alternativnog načina sinteze gelskog osvježivača zraka koji je zeleniji i zdraviji. U ovom je radu gelski osvježivač zraka sintetiziran jednostavnom i sol-gel reakcijom pomoću prirodnog biorazgradivog polimernog želatina i esencijalnog ulja lavande. Dobivene su 3D strukture gelskog osvježivača željenog oblika i mirisa. Promjena 3D strukture na sobnoj temperaturi bila je evidentna, vjerojatno kao rezultat termičke degradacije i isparavanja vode. U svakom slučaju, gelski osvježivač zraka dobiven u ovom istraživanju je prihvatljiviji za ljudsko zdravlje od komercijalno dostupnih. Dobiveni rezultati također upućuju na to da bi trebalo dalje poboljšati stabilnost.

Ključne riječi: gelski osvježivač zraka, sinteza, želatin, esencijalno ulje lavande, utjecaj na zdravlje.

MICROENCAPSULATION OF ACTIVE INGREDIENT**MATIJA GRETIĆ**✉, GORDANA MATIJAŠIĆ, JURAJ PETANJEK

Faculty of Chemical Engineering and Technology, University of Zagreb, Marulićev trg 19, 10000 Zagreb, Croatia

✉ mgretic@fkit.hr

Microencapsulation is a method often used in various industries because of its wide use, and one of the many advantages is that controlled release of the active substance is achievable. The aim of this study was to study and prepare microcapsules by spray drying, changing the process conditions and proportions of the components that make up the dosage form; poly (vinyl alcohol) and dronedarone hydrochloride.

Dosage forms of poly (vinyl alcohol) and dronedarone hydrochloride were prepared in 1: 1, 2: 1 and 3: 1 weight ratios, and the solutions were dried in a Büchi B-290 laboratory dryer at four spray air flows. The morphology of the obtained microcapsules was examined using a scanning electron microscope (SEM). The release kinetics of the active substance from the microcapsules were tested by *in vitro* laboratory testing and the resulting release profiles were described using the Weibull model.

The results showed that by increasing the flow of spray air, smaller microcapsules are formed, as confirmed by SEM micrographs. Also, by increasing the polymer content, the droplet size is controlled by the viscosity of the solution, not by the flow of spray air. The microencapsulation efficiency of all samples obtained is greater than 50%. The most uniform efficacy was observed for samples with a 3: 1 ratio of polymer and active substance. Microcapsules with the highest polymer content showed the slowest release of the active substance, and complete release was achieved after 24 hours.

Keywords: microencapsulation, spray drying, dronedarone hydrochloride, poly(vinyl alcohol), *in vitro* drug release

MIKROKAPSULIRANJE DJELATNE TVARI**MATIJA GRETIĆ**✉, GORDANA MATIJAŠIĆ, JURAJ PETANJEK

Fakultet kemijskog inženjerstva i tehnologije, Sveučilište u Zagrebu, Marulićev trg 19, 10000 Zagreb, Hrvatska

✉ mgretic@fkit.hr

Mikrokapsuliranje je metoda koja se često koristi u raznim granama industrije zbog široke mogućnosti upotrebe, a jedna od brojnih prednosti je što je moguće postići kontrolirano oslobađanje djelatne tvari. Cilj ovog istraživanja bio je proučiti i pripremiti mikrokapsule sušenjem raspršivanjem, mijenjajući procesne uvjete te udjele komponenti koje čine dozirni oblik; poli(vinil-alkohola) i dronedaron-hidroklorida.

Pripremani su dozirni oblici poli(vinil-alkohola) i dronedaron-hidroklorida u masenim omjerima 1:1, 2:1 i 3:1, a otopine su sušene u laboratorijskom sušioniku Büchi B-290 pri četiri protoka zraka za raspršivanje. Morfologija dobivenih mikrokapsula ispitana je pomoću pretražnog elektronskog mikroskopa (SEM). Kinetika oslobađanja djelatne tvari iz mikrokapsula ispitana je *in vitro* laboratorijskim ispitivanjima, a dobiveni profili oslobađanja opisani su pomoću Weibullovog modela.

Rezultati su pokazali da povećanjem protoka zraka za raspršivanje nastaju sitnije mikrokapsule što je potvrđeno i SEM-mikrografijama. Također, povećanjem udjela polimera veličina kapljica pod kontrolom je viskoznosti otopine, a ne protoka zraka za raspršivanje. Djelotvornost mikrokapsuliranja kod svih je dobivenih uzoraka veća od 50 %. Najujednačenija djelotvornost primijećena je kod uzoraka s omjerom polimera i djelatne tvari u odnosu 3:1. Mikrokapsule s najvećim udjelom polimera pokazale su najsporije oslobađanje djelatne tvari, a potpuno oslobađanje postignuto je nakon 24 sata.

Ključne riječi: mikrokapsuliranje, sušenje raspršivanjem, dronedaron-hidroklorid, poli(vinil-alkohol), *in vitro* oslobađanje

MEASUREMENT AND MODELLING OF HYDROGEN SOLUBILITY IN FURFURAL

GORICA IVANIŠ, LJUDMILA FELE ŽILNIK, BLAŽ LIKOZAR, MIHA GRILC ✉

Department of Catalysis and Chemical Reaction Engineering, National Institute of Chemistry, Hajdrihova 19, Ljubljana, Slovenia

✉ miha.grilc@ki.si

Conversion of biomass into bio-based chemicals and polymers at high yield and selectivity is still a great issue and subject of research. The main reason why lignocellulose is not equivalent to conventional energy sources is a high oxygen content (various oxygenated functional groups) in its oils, which entails chemical instability, immiscibility with hydrocarbon and fuels and lower energy density. One of solutions to this is the reduction of oxygen content by means of various defunctionalisation processes. Hydrodeoxygenation is a process of oxygen removal from an oxygenated compound at high temperature under hydrogen pressure in the presence of heterogeneous catalyst and represents an influential step in reaction pathway from biomass to biofuel and added value chemicals. Due to numerous competitive reactions that can overlap, finding optimal process parameters, pressure and temperature, that would favour hydrodeoxygenation reaction is a very important task. Further, process parameters affect solubility of hydrogen in liquid reactant so knowledge of gas-liquid equilibria of hydrogen in various chemicals that can be produced from lignocellulose is of great importance.

One of the promising platform bio-based compounds that can be further converted to valuable chemicals through hydrotreatment reactions is furfural. Therefore, hydrogen solubility in furfural was studied in the temperature range (323.15-423.15) K and pressures up to 25 MPa. The experimental data were modelled using cubic equations of state and interaction parameters, valuable for prediction of phase equilibria behaviour of the studied system, were determined.

Keywords: gas-liquid equilibrium, high pressure, furfural, hydrogen, hydrodeoxygenation, modelling.

MJERENJE I MODELOVANJE RASTVORLJIVOSTI VODONIKA U FURFURALU

GORICA IVANIŠ, LJUDMILA FELE ŽILNIK, BLAŽ LIKOZAR, MIHA GRILC ✉

Odsjek za katalizu i reakcijsko inženjerstvo, Hemijski institut, Hajdrihova 19, Ljubljana, Slovenija

✉ miha.grilc@ki.si

Pretvaranje biomase u razne hemikalije i polimere sa visokim prinosom i selektivnošću je i dalje važno pitanje i predmet mnogih istraživanja. Glavni razlog zašto lignoceluloza nije ekvivalentna konvencionalnim izvorima energije je visok udio kiseonika u njenim uljima (razne funkcionalne grupe koje sadrže kiseonik), što povlači za sobom hemijsku nestabilnost, nemješljivost s ugljovodicima i gorivima i manju gustinu energije. Jedno od rješenja za to je smanjenje udjela kiseonika pomoću različitih procesa defunkcionalizacije. Hidrodeoksigenacija je proces uklanjanja kiseonika iz oksidisanih grupa na visokoj temperaturi pod pritiskom vodonika u prisustvu heterogenog katalizatora i predstavlja bitan korak na reakcionom putu od biomase do biogoriva i hemikalija s dodatnom vrijednošću. Zbog brojnih konkurentnih reakcija koje se mogu preklapati, pronalaženje optimalnih parametara procesa, temperature i pritiska, koji bi pogodovali reakciji hidrodeoksigenacije, vrlo je važan zadatak. Procesni parametri utiču i na rastvorljivost vodonika u tečnom reaktantu, pa je od velike važnosti poznavanje ravnoteže gas-tečnost vodonika u raznim hemikalijama koje se mogu dobiti iz lignoceluloze.

Jedna od obećavajućih platformnih bio-hemikalija, koja se dalje hidrotretmanom može pretvoriti u razna vrijedna jedinjenja, jeste furfural. Stoga je u ovom radu proučavana rastvorljivost vodonika u furfuralu u temperaturnom opsegu (323,15-423,15) K i na pritiscima do 25 MPa. Eksperimentalni podaci su modelovani korišćenjem kubnih jednačina stanja i optimizovani su interakcioni parametri neophodni za predviđanje ponašanja ispitivanog sistema pri uslovima fazne ravnoteže.

Ključne riječi: ravnoteža gas-tečnost, visok pritisak, furfural, vodonik, hidrodeoksigenacija, modelovanje.

SIMULATION OF DISTILLATION PROCESS USING CHEMSEP SIMULATOR**ALDIN KARIĆ, MUHAMED ŠIŠIĆ, NIDRET IBRIĆ, ELVIS AHMETOVIĆ**✉

University of Tuzla, Faculty of Technology, Univerzitetska 8, 75000 Tuzla, Bosnia and Herzegovina

✉ elvis.ahmetovic@untz.ba

Chemsep is a simulator for unit operations, such as distillation, absorption and extraction, which take place in the column-type equipment. This paper describes the basics of its use and the steps for running the simulation and solving problems. The focus of this paper is to demonstrate the application of the ChemSep simulator in solving distillation problems. The distillation processes of different mixtures are considered as illustrative examples, the simulation results (flow-rates, liquid and vapor phase compositions, K values, temperature and pressure profiles) are presented and the main conclusions highlighted.

Keywords: distillation, chemsep, simulation

SIMULACIJA PROCESA DESTILACIJE UPOTREBOM CHEMSEP SIMULATORA**ALDIN KARIĆ, MUHAMED ŠIŠIĆ, NIDRET IBRIĆ, ELVIS AHMETOVIĆ**✉

Univerzitet u Tuzli, Tehnološki fakultet, Univerzitetska 8, 75000 Tuzla, Bosna i Hercegovina

✉ elvis.ahmetovic@untz.ba

Chemsep je simulator tehnoloških operacija, kao što su destilacija, apsorpcija i ekstrakcija, koje se odvijaju u aparatima kolonskog tipa. Ovaj rad opisuje osnove njegovog korištenja i korake za pokretanje simulacije i rješavanje problema. Fokus ovog rada je na demonstraciji primjene ChemSep simulatora u rješavanju problema destilacije. Kao ilustrativni primjeri razmotreni su procesi destilacije različitih smjesa, predstavljeni su simulacijski rezultati (protoci, sastavi tečne i parne faze, K vrijednosti, profili temperature i pritiska) i istaknuti glavni zaključci.

Cljučne riječi: destilacija, chemsep, simulacija.

FORWARD OSMOSIS IN WATER TREATMENT PROCESSES – CASE STUDIES**I. PETRINIĆ**¹, ✉, **H. BUKŠEK**¹, **M. S. SHELDON**²,
AMRA BRATOVIĆ³, **C. HELIX-NIELSEN**^{1,4}¹ Faculty of Chemistry and Chemical Engineering, University of Maribor, Slovenia² Cape Peninsula University of Technology, Department of Chemical Engineering, P.O. Box 1906, Bellville, 7535, South Africa³ Faculty of Technology, University of Tuzla, Univerzitetska 8, 75000 Tuzla, Bosnia and Herzegovina⁴ Technical University of Denmark, Department of Environmental Engineering, Miljøvej 113, 2800 Kgs. Lyngby, Denmark✉ irena.petrinic@um.si

Last decades forward osmosis (FO) attracted a great attention of researchers around the world. FO has been labelled as a low energy separation method with a range of potential applications (i.e., fertigation, emergency water supply, treatment of high salinity wastes, wastewater treatment, osmotic dilution of reverse osmotic (RO) feed source and RO pre-treatment). FO is a separation process driven by differences in osmotic pressure across a semi-permeable membrane. Water permeates from a solution with low osmotic pressure to high osmotic pressure without the application of a hydraulic driving force. The product is a diluted draw solution and concentrated feed solution. In recent years, improvements to FO systems, including draw solution testing and membrane material development, have allowed for increased flux while minimizing internal concentration polarization, improving energy requirements and fouling effects. This research reviews the current state of water recovery from textile wastewater and water reclamation from synthetic winery wastewater using a fertiliser drawn forward osmosis (FDFO) system giving an evaluation of likelihood for future implementation. In this study real textile wastewater was used as feed solution with 1M NaCl, 1M MgCl₂, blue dye mixture, and green dye mixture as draw solution in FO. Pre-determined concentrations of green and blue dye mixtures based on final desired concentrations (for further use in dyeing process), gave comparable water flux with 1M NaCl and 1M MgCl₂, however, slightly higher reverse salt flux values were obtained with dyes compared to the inorganic salts. A FDFO system for water reclamation from synthetic winery wastewater was examined where performance of aquaporin (AqP) based biomimetic and cellulose triacetate (CTA) membranes was evaluated when using 1M KCl and 1M NH₄NO₃ as draw solutions. The average *J_w* observed were 8.39 and 9.46 L/m²h (AqP) and 4.98 and 5.6 L/m²h (CTA). After cleaning, the *J_w* recovered between 80 to 98% and 83 to 89% for the AqP and CTA membranes, respectively.

Keywords: forward osmosis, fertiliser drawn forward osmosis, water flux, reverse salt flux.

DEEP EUTECTIC SOLVENTS FOR PURIFICATION OF WASTE COOKING OIL AND CRUDE BIODIESEL

ANA PETRAČIĆ✉, MATEA GAVRAN, ANA ŠKUNCA,
LUCIJA ŠTAJDUHAR, ALEKSANDRA SANDER

Faculty of Chemical Engineering and Technology, University of Zagreb, Marulićev trg 19, 10000 Zagreb, Croatia
✉ apetracic@fkit.hr

The goal of this work was to explore the applicability of deep eutectic solvents in biodiesel production process. Biodiesel was produced from waste cooking oil via base-catalysed transesterification. The efficacy of two base catalysts KOH and NaOH on the conversion of triglycerides into biodiesel was tested.

Eutectic mixtures DES 1 ($K_2CO_3 : C_2H_6O_2 = 1 : 10$) and DES 2 ($C_5H_{14}ClNO : C_2H_6O_2 = 1 : 2$) were prepared. DES 1 was used for feedstock deacidification and DES 2 for biodiesel purification via extraction.

Effects of DES 2 to biodiesel ratio and the extraction duration on free glycerol removal were tested. Samples were analysed using FTIR spectroscopy, 1H NMR and gas chromatography for characterization biodiesel.

Synthesis of biodiesel was carried out for 3 h at 60 °C with mass ratio KOH : methanol : oil = 1 : 40 : 100. DES 2 to biodiesel ratio of 1 : 1 proved to be the best, with 45 minutes being the most effective extraction duration.

Keywords: biodiesel, glycerol, extraction, deep eutectic solvent, waste edible oil

PRIMJENA NISKOTEMPERATURNIH EUTEKTIČKIH OTAPALA U PROČIŠĆAVANJU OTPADNOG JESTIVOG ULJA I BIODIZELA

ANA PETRAČIĆ✉, MATEA GAVRAN, ANA ŠKUNCA,
LUCIJA ŠTAJDUHAR, ALEKSANDRA SANDER

Fakultet kemijskog inženjerstva i tehnologije Sveučilišta u Zagrebu, Marulićev trg 19, 10000 Zagreb, Hrvatska
✉ apetracic@fkit.hr

Cilj ovog rada bio je istražiti mogućnost primjene niskotemperaturnih eutektičkih otapala za pročišćavanje sirovine i sirovog biodizela dobivenog kemijskim procesom transesterifikacije s lužnatim katalizatorom. Kao sirovina korišteno je otpadno jestivo ulje. Ispitana je učinkovitost dva lužnata katalizatora KOH i NaOH za konverziju triglicerida u metilne estere masnih kiselina.


Pripremljene su eutektičke smjese DES 1 ($K_2CO_3 : C_2H_6O_2 = 1 : 10$) i DES 2 ($C_5H_{14}ClNO : C_2H_6O_2 = 1 : 2,5$). DES 1 korišten je za pročišćavanje sirovine, a DES 2 za pročišćavanje sirovog biodizela ekstrakcijom.

Ekstrakcijom je ispitan utjecaj omjera DES-a 2 i biodizela te utjecaj vremena na uklanjanje glicerola. Za karakterizaciju biodizela uzorci su analizirani FTIR spektrometrijom, 1H NMR te plinskom kromatografijom.

Sinteza biodizela provedena je pri 3 h i 60 °C uz KOH kao katalizator u masenom omjeru KOH : metanol : ulje = 1 : 40 : 100. Kao najbolji omjer DES-a 2 i biodizela pokazao se 1 : 1, a 45 minuta kao najučinkovitije vrijeme ekstrakcije.

Ključne riječi: biodizel, glicerol, ekstrakcija, niskotemperaturna eutektička otapala, otpadno jestivo ulje

INFLUENCE OF PROCESS PARAMETERS ON AROMATIC FIVE-MEMBERED HETEROCYCLES CATALYTIC CONVERSION IN A THREE PHASE BATCH REACTOR

ROK ŠIVEC¹, NIKA MARINČ^{1,2}, MIHA GRILC¹, , BLAŽ LIKOZAR¹

¹ Department of Catalysis and Chemical Reaction Engineering, National Institute of Chemistry, Hajdrihova 19, 1000 Ljubljana, Slovenia

² Faculty of Chemistry and Chemical Technology, University of Ljubljana, Večna pot 113, 1000 Ljubljana, Slovenia

 miha.grilc@ki.si

Furfural is a promising platform chemical, derived from biomass and can be used as an alternative source for the production of many chemicals and bio-derived fuels. Furfural is already isolated in large quantities from lignocellulosic biomass by solvolysis of C5 sugars in classic or novel (DES) solvents. With the use of heterogeneous catalysts, added value chemicals can be produced, which could make the use of renewable sources more feasible and provide a greener alternative to fossil fuels. Many attempts were already made towards upgrading furfural, but the reaction mechanisms are still not well understood. A multiscale reaction model, based on elementary steps is needed to develop a feasible production process. However, only a few multiscale modeling attempts were made.

In this work, furfural hydrodeoxygenation was studied in a three phase batch reactor with a 300 mL vessel and a Rushton turbine stirrer. Liquid furfural was used as a reactant, while isopropanol was added as a hydrogen donor solvent. Afterwards, a solid catalyst was added in the reaction vessel. The reaction vessel was closed and flushed with N₂. Hydrogen gas was added at high pressure (50 bar) and the reaction mixture was heated up to different temperature plateaus (up to 200 °C). Liquid and gas samples were collected out of the sampling line during the reaction and were analyzed by GC-FID/MS (liquid samples) and by μ GC (gas samples). Various products were observed. By varying experimental conditions, a reaction pathway was analyzed and a kinetic model developed. As a result, a multiscale model is presented.

Keywords: Furfural, heterogeneous catalysis, lignocellulosic biomass, reaction pathway analysis, kinetic modeling.

ISTRAŽIVANJE MOGUĆNOSTI RECIKLIRANJA MIJEŠANOG PLASTIČNOG OTPADA TERMIČKIM PROCESIMA

AZRA KOVAČEVIĆ^{1,3}, , STANKO BLATNIK², ZORAN ILIČKOVIĆ¹, JASMIN SULJAGIĆ¹

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

² IPAK Institut Velenje, Koroška cesta 18, 3320 Velenje, Slovenija

³ Dunnicy Consulting Agency, 75000 Tuzla, Bosna i Hercegovina

 azra.zaimovic@outlook.com

Polimeri se u znatno manjoj mjeri recikliraju u odnosu na druge krute materijale koji su danas u upotrebi (papir/karton, staklo, metal itd.). Očigledne teškoće u efikasnom prikupljanju i sortiranju ove vrste materijala čine ovu oblast (recikliranje do polaznih komponenti) manje vrijednom i nepopularnom kod lokalnih samouprava (općina) i kompanija koje se bave otpadom.

Eksperimentalni dio ovog rada je rađen u Sloveniji. Naime, riječ je o firmi KIV iz Vranskog koja se bavi proizvodnjom postrojenja za spaljivanje različitih vrsta krutog otpada kao i biomase. Termički procesi (spaljivanje, gasifikacija itd.) predstavljaju jednu od opcija kojom je moguće na ekonomski i ekološki prihvatljiv način izvršiti i zbrinjavanje miješanog plastičnog otpada.

U izvođenju eksperimentalnog dijela ovog rada korišteni su različiti materijali koji su bili na raspolaganju i to:

- Različiti uzorci otpadne biomase.
- RDF-frakcija iz postrojenja u Celju.
- RDF-frakcije iz postrojenja Kolicovo.
- RPF frakcija pripremljena iz različitih vrsta plastike i papira.

Rezultati ovog istraživanja pokazuju da goriva sa malim udjelom miješanog plastičnog otpada (različiti udjeli RDF frakcije) se primjenom odgovarajućih režima spaljivanja i parametara postrojenja mogu efikasno tretirati na ovom tipu postrojenja. Različiti omjeri RDF/biomasa daju različite kalorične vrijednosti dobijenog sinteznog plina. Gorivo koje predstavlja kombinaciju biomase i RDF frakcije u omjeru 50/50 daje sintezni plin sa CV od 15-17MJ/kg. RDF u kombinaciji sa biomasom i inertnim materijalom u omjeru 30/20/50 nije prihvatljivo gorivo za spaljivanje postrojenjima ovakvog tipa zbog tehničkih i ekoloških problema koje izaziva.

Ključne riječi: miješani plastični otpad, recikliranje, termički procesi, spaljivanje.

ENVIRONMENT, ENERGY, MATERIALS AND BIOGAS PRODUCTION

VLADAN MIČIĆ¹, AYSE AROGUZ², JAROSLAVA BUDINSKI SIMENDIĆ^{3,✉}, SABINA BEGIĆ⁴, LJILJANA TANASIĆ⁵, MILICA MIJATOVIĆ⁶, JELENA PAVLIČEVIĆ³,

¹ Faculty of Technology, University of East Sarajevo, 75400 Zvornik, Bosnia and Herzegovina

² Istanbul University, Engineering Faculty, 34320Avcilar, Istanbul, Turkey

³ Faculty of Technology, University of Novi Sad, Bulevar Cara Lazara, 21000 Novi Sad, Serbia

⁴ Faculty of Technology, University of Tuzla, Univerzitetska 8, 75000 Tuzla, Bosnia and Herzegovina

⁵ High Agricultural School of Vocational Studies, Šabac, Serbia

⁶ Smrcak d.o.o., Karakaj bb, 75400 Zvornik, Bosnia and Herzegovina

✉ jarkamer@gmail.com

Alternative energy sources play significant role in limiting the CO₂ emissions. Energy from biomass and waste is regarded as one of the most dominant future renewable energy sources, since it can provide a continuous power generation. In this regard, the application of anaerobic digestion is emerging spectacularly. Different types of biomass and waste are suitable for anaerobic digestion the organic fraction of municipal solid waste, waste oils and animal fat, energy crops and agricultural waste, manure and sewage sludge. Anaerobic digestion is the simplest approach to recover energy from biomass in the form of biogas. Anaerobic digestion is a microbial conversion method that occurs in an aqueous environment, meaning that biomass sources containing high water levels (even containing less than 40% dry matter) can be processed without any pre-treatment. This is not the case for most other conversion technologies. This review gives the overview of recent key developments associated with challenges in the anaerobic digestion process. Recent advancements in the strategies of biogas enhancement, anaerobic membrane bioreactors, biogas purification technologies, and advanced materials for biogas digesters are also discussed.

Keywords: biogas, membrane bioreactors, purification technologies, renewable energy sources

OKOLINA, ENERGIJA, MATERIJALI I PROIZVODNJA BIOGASA

VLADAN MIČIĆ¹, AYSE AROGUZ², JAROSLAVA BUDINSKI SIMENDIĆ^{3,✉}, SABINA BEGIĆ⁴, LJILJANA TANASIĆ⁵, MILICA MIJATOVIĆ⁶, JELENA PAVLIČEVIĆ³,

¹ Tehnološki fakultet, Univerzitet Istočno Sarajevo, 75400 Zvornik, Bosna i Hercegovina

² Fakultet za inženjerstvo, Univerzitet u Istanbulu, 34320Avcilar, Istanbul, Turska

³ Tehnološki fakultet, Univerzitet u Novom Sadu Bulevar Cara Lazara, 21000 Novi Sad, Srbija

⁴ Tehnološki fakultet, Univerzitet u Tuzli, Univerzitetska 8, 75000 Tuzla, Bosna i Hercegovina

⁵ Visoka poljoprivredna škola strukovnih studija, Šabac, Srbija

⁶ Smrcak d.o.o., Karakaj bb, 75400 Zvornik, Bosna i Hercegovina

✉ jarkamer@gmail.com

Alternativni energetske izvori imaju značajnu ulogu u ograničenju emisije CO₂ u okruženje. Energija iz biomase i otpada smatra se jednim od najdominantnijih budućih obnovljivih izvora energije, jer može osigurati kontinuiranu proizvodnju energije. U tom smislu, primena anaerobne digestije je sve značajnija i izazovnija. Različiti tipovi biomase i otpada pogodni su za anaerobnu digestiju organske frakcije komunalnog čvrstog tpada, otpadnih ulja i životinjskih masti, energetskih useva i poljoprivrednog otpada, stajnjaka i kanalizacionog mulja. Anaerobna digestija je najjednostavniji pristup za dobijanje energije iz biomase u obliku biogasa. To je metoda mikrobne konverzije koja se odvija u vodenoj sredini, što znači da se izvori biomase koji sadrže visok nivo vode (čak i manje od 40% suve materije) mogu procesirati bez prethodne obrade. To nije slučaj kod većine drugih tehnologija za konverziju. Ovaj pregledni rad daje prikaz najnovijih ključnih događaja vezanih sa izazovima u procesu anaerobne digestije. Takođe se razmatraju najnovija dostignuća u strategijama poboljšanja biogasa, zatim anaerobni membranski bioreaktori, tehnologije za prečišćavanje biogasa kao i primena savremenih materijala za reaktore u proizvodnji biogasa.

Ključne riječi: biogas, membranski bioreaktori, tehnologije prečišćavanja, obnovljivi izvori energije

COMBUSTION SYNTHESIS OF Al_2O_3 WITH ASPARAGINE AS FUEL

IVANA KATARINA MUNDA^{1,✉}, IVONA MATANČEVIĆ, VILKO MANDIĆ¹, GORDANA MATIJAŠIĆ¹, STANISLAV KURAJICA¹

¹ Faculty of Chemical engineering and Technology, University of Zagreb, Marulićev trg 19, 10000 Zagreb, Croatia

✉ imunda@fkit.hr

Most approaches to porous materials syntheses require the use of templates for gaining the requested morphology and thus are complex, time consuming and costly. Due to its effectiveness and low cost, combustion synthesis is used as an alternative method of porous materials synthesis. It does not need to use a template because of the formation of gases which create a porous structure while escaping the sample. It can be used for production of nanoparticles and gives a pure, homogeneous oxide powder.

Alumina was prepared via combustion synthesis from aluminum nitrate nonahydrate using asparagine as a fuel. Equivalence ratio of fuel and oxidizer, ϕ , on product properties is investigated. Equivalence ratios used were $\phi=0,5$ for a fuel lean mixture, $\phi=1$ for a stoichiometric sample and $\phi=1,5$ for a fuel rich sample. Methods of analysis used were X-ray diffraction (XRD), infrared spectroscopy with Fourier transformation (FTIR), scanning electron microscopy (SEM) and N_2 adsorption/desorption isotherms.

XRD analysis showed that the heat liberated in samples during the course of the synthesis was not high enough to obtain $\gamma-Al_2O_3$ so additional thermal treatment of samples was necessary. DTA analysis showed that in all of the as prepared samples there is considerable quantity of residual organic phase. According to SEM analyses and N_2 adsorption/desorption isotherms it was determined that equivalence ration has great influence on microstructure and pore distribution of prepared $\gamma-Al_2O_3$.

Keywords: combustion synthesis, γ -alumina, asparagine

SINTEZA Al_2O_3 SAGORIJEVANJEM UZ ASPARAGIN KAO GORIVO

IVANA KATARINA MUNDA^{1,✉}, IVONA MATANČEVIĆ, VILKO MANDIĆ¹, GORDANA MATIJAŠIĆ¹, STANISLAV KURAJICA¹

¹ Fakultet kemijskog inženjerstva i tehnologije, Sveučilište u Zagrebu, Marulićev trg 19, 10000 Zagreb, Hrvatska

Porozni materijali često se dobivaju metodama koje koriste predloške za postizanje željene morfologije, te su zbog toga složene, dugotrajne i skupe. Zbog učinkovitosti i pristupačnosti kao alternativna metoda za sintezu poroznih materijala koristi se sinteza sagorijevanjem. Ova metoda ne zahtijeva korištenje predložaka jer se tijekom same sinteze stvaraju plinovi koji tijekom izlaska iz uzorka tvore pore u strukturi. Može se koristiti za dobivanje nanočestica i daje čisti homogeni metalni oksid.

Provedena je sinteza sagorijevanjem aluminijeva nitrata nonahidrata i asparagina kao goriva za dobivanje $\gamma-Al_2O_3$. Istražen je utjecaj ekvivalentnog omjera goriva i oksidansa, ϕ , na svojstva krajnjeg produkta. Korišteni su ekvivalentni omjeri $\phi=0,5$ za uzorak siromašan gorivom, $\phi=1$ za uzorak u stehiometrijskom omjeru te $\phi=1,5$ za uzorak sa suviškom goriva. Korištene su slijedeće metode karakterizacije: rendgenska difrakcijska analiza (XRD), infracrvena spektroskopija s Fourierovom transformacijom (FTIR), pretražna elektronska mikroskopija (SEM) te N_2 adsorpcijsko-desorpcijske izoterme.

XRD analizom utvrđeno je da je toplina razvijena tijekom sinteze uzoraka premala za nastajanje $\gamma-Al_2O_3$ te da je zbog toga potrebna dodatna termička obrada uzoraka. DTA analizom utvrđeno je da je u svim uzorcima prisutna značajna količina zaostale organske faze. Na temelju SEM analize i N_2 adsorpcijsko-desorpcijskih izoterma utvrđeno je da ekvivalentni omjer ima velik utjecaj na mikrostrukturu i raspodjelu pora produkta sinteze $\gamma-Al_2O_3$.

Ključne riječi: sinteza sagorijevanjem, γ -aluminijev oksid, asparagin

INFLUENCE OF ACTIVATED CARBON ADDITION ON SOME TEXTURAL CHARACTERISTICS OF ACID-ACTIVATED BENTONITE**ZORAN PETROVIĆ^{1,✉}, SABINA BEGIĆ², MILOMIRKA ŠKRBA¹,
SANJA PANIĆ³, DRAGANA KEŠELJ¹**¹ Faculty of Technology, University of East Sarajevo, Karakaj bb, 75400 Zvornik, Bosnia and Herzegovina² Faculty of Technology, University of Tuzla, Univerzitetska 8, 75000 Tuzla, Bosnia and Herzegovina³ Faculty of Technology, University of Novi Sad, Bulevar cara Lazara 1, 21000 Novi Sad, Serbia✉ petrovic.ozren@tfzv.ues.rs.ba

Different types of inorganic and organic adsorbents are used in various industrial processes. These adsorbents should have good adsorption power, which depends on the chemical and mineralogical composition, physicochemical, textural and morphological characteristics. Among inorganic adsorbents, various types of commercially active aluminosilicate based clays, zeolites, bentonites, bauxites, etc. are of great use, with activated carbon being the most used organic ones. Some adsorbents are applied in natural form and some after chemical, mechanical, thermal or other modification. For some processes, such as bleaching of edible oils, commercial activated clays with activated carbon are used.

In this paper, the influence of activated carbon addition on some textural characteristics of sulfuric acid modified natural bentonite from the Šipovo area was examined. The test results showed that the addition of a small amount of activated carbon to acid activated bentonite led to an improvement in the textural characteristics of the resulting mixture, primarily the specific surface area and porosity. The textural characteristics of the mixture of acid-activated bentonite and activated carbon will also increase the adsorption efficiency in the bleaching process of edible oils. These tests were conducted with a view to possibly using native bentonite in the bleaching process instead of imported commercial clay.

Keywords: adsorbents, activated carbon, natural bentonite, acid modification, textural characteristics

UTICAJ DODATKA AKTIVNOG UGLJA NA NEKE TEKSTURALNE KARAKTERISTIKE KISELINOM AKTIVIRANOG BENTONITA**ZORAN PETROVIĆ^{1,✉}, SABINA BEGIĆ², MILOMIRKA ŠKRBA¹,
SANJA PANIĆ³, DRAGANA KEŠELJ¹**¹ Tehnološki fakultet, Univerzitet u Istočnom Sarajevu, Karakaj bb, 75400 Zvornik, Bosna i Hercegovina² Tehnološki fakultet, Univerzitet u Tuzli, bb, 75000 Tuzla, Bosna i Hercegovina³ Tehnološki fakultet, Univerzitet u Novom Sadu, Bulevar cara Lazara 1, 21000 Novi Sad, Srbija✉ petrovic.ozren@tfzv.ues.rs.ba

U raznim industrijskim procesima primjenjuju se različiti tipovi adsorbenata neorganske i organske prirode. Ovi adsorbenti treba da imaju dobru adsorpcionu moć, koja zavisi od hemijskog i mineraloškog sastava, fizičko-hemijskih, teksturalnih i morfoloških karakteristika. Od neorganskih adsorbenata veliku primjenu imaju različite vrste komercijalno aktivnih glina na bazi aluminosilikata, zatim zeoliti, bentoniti, boksiti i dr., a od organskih najviše se primjenjuje aktivni ugalj. Neki adsorbenti se primjenjuju u prirodnom obliku, a neki nakon hemijske, mehaničke, termičke ili druge modifikacije. Za neke procese, kao npr. bijeljenje jestivih ulja primjenjuju se komercijalne aktivne gline sa dodatkom aktivnog uglja.

U ovom radu je ispitivan uticaj dodatka aktivnog uglja na neke teksturalne karakteristike sumpornom kiselinom modifikovanog prirodnog bentonita iz okoline Šipova. Rezultati ispitivanja su pokazali da je dodatkom male količine aktivnog uglja kiselinom aktiviranom bentonitu došlo do poboljšanja teksturalnih karakteristika nastale smješe, prvenstveno specifične površine i poroznosti. Teksturalne karakteristike smješe kiselinom aktiviranog bentonita i aktivnog uglja utiče i na povećanje adsorpcione efikasnosti u procesu bijeljenja jestivih ulja. Ova ispitivanja su provedena u cilju eventualne primjene domaćeg bentonita u procesu bijeljenja umjesto uvozne komercijalne gline.

Ključne riječi: adsorbenti, aktivni ugalj, prirodni bentonit, kiselinska modifikacija, teksturalne karakteristike

THE DETERMINATION CARBONATED AND NATURAL JUICES COMPOSITION

ALMEDINA ALIBAŠIĆ✉, JASMINA ALIBAŠIĆ, SUAD DJEDOVIĆ

Faculty of Technology, University of Tuzla, Univerzitetska 8, 75000 Tuzla, Bosnia and Herzegovina
✉ alibasicamedina@hotmail.com

Carbonated juices and beverages are getting more popular and their use is becoming more efficient, especially among children and adolescents. From nutritive and health aspect, that is not so good, because, those beverages contain a large amount of sugar, aditives and orthophosphoric acid, or phosphates. On the other hand, natural juices do not contain extra sugar, nor aditives, which are part of carbonated juices. When it comes to aditives, it can be added some of the acids that is already in the fruits juice is made of (citric acid, ascorbic acid, malic acid).

In this paper will be tested several types of carbonated and natural juices.

Therefore, amount of ascorbic acid, sugar and ortophosphoric acid will be determined, and the juices will be organoleptically tested.

Keywords: Carbonated juices, natural juices, orthophosphoric acid, ascorbic acid

ODREĐIVANJE SASTAVA GAZIRANIH I PRIRODNIH VOĆNIH SOKOVA

ALMEDINA ALIBAŠIĆ✉, JASMINA ALIBAŠIĆ, SUAD DJEDOVIĆ

Tehnološki fakultet, Univerzitet u Tuzli, Univerzitetska 8, 75000 Tuzla, Bosna i Hercegovina
✉ alibasicamedina@hotmail.com

Gazirani sokovi i napitci postaju sve popularniji i sve više se povećava njihova upotreba, pogotovo među djecom i mladima. Sa nutritivnog i zdravstvenog aspekta to nije dobro jer ti napitci sadrže veliku količinu šećera, aditiva i ortofosforne kiseline ili fosfata. Sa druge strane, prirodni voćni sokovi ne sadrže dodani šećer niti aditive prisutne u gaziranim sokovima. Od aditiva može biti dodana neka od kiselina koje su već prirodno prisutne u voću od kojeg je sok napravljen (limunska, askorbinska, jabučna kiselina).

U ovom radu će biti ispitano nekoliko vrsta gaziranih i prirodnih sokova. Pri tome će biti određena količina askorbinske kiseline, šećera i ortofosforne kiseline, odnosno fosfata, te će sokovi biti organoleptički ispitani.

Ključne riječi: gazirani sokovi, prirodni sokovi, ortofosforna kiselina, askorbinska kiselina

THE DETERMINATION OF THE CONTENT OF POLYPHENOLS, ASCORBIC ACID, PECTIN AND ANTIOXIDANT CAPACITY IN APPLES AND CITRUS FRUITS

JASMINA ALIBAŠIĆ✉, ALMEDINA ALIBAŠIĆ, SUAD DJEDOVIĆ

Faculty of Technology, University of Tuzla, Univerzitetska 8, 75000 Tuzla, Bosnia and Herzegovina
✉ alibasicjasmina@hotmail.com

Apples and citrus fruits are known to contain a large amount of pectin and polyphenols. Of course the amount depends on the variety and the conditions of cultivation. The apple (trop) that remains after the production of vinegar, juice and other products, contains a large amount of pectin and is used for its production. The white part of the citrus peel serves as raw material for the production of pectin. In addition, apples are full of polyphenols and citrus fruits are full of vitamin C. The aim of this thesis is to compare the content of polyphenols, ascorbic acid, pectins and antioxidants and as well the capacity in apples and some citrus fruits (lemon, orange). Standard methods are used to determine pectin substances, ascorbic acid, polyphenols (Folin Ciocalteu method) and antioxidant capacity (FRAP method).

Keywords: polyphenols, antioxidant capacity, apple fruit, citrus fruit, pectin

ODREĐIVANJE KOLIČINE POLIFENOLA, ASKORBINSKE KISELINE, PEKTINA I ANTIOKSIDATIVNOG KAPACITETA U JABUKAMA I CITRUSIMA

JASMINA ALIBAŠIĆ✉, ALMEDINA ALIBAŠIĆ, SUAD DJEDOVIĆ

Tehnološki fakultet, Univerzitet u Tuzli, Univerzitetska 8, 75000 Tuzla, Bosna i Hercegovina

Jabuke i citrus plodovi su poznati po velikoj količini pektinskih i polifenolnih tvari. Naravno, to ovisi o sorti i uvjetima uzgoja. Jabučni trop koji ostaje nakon proizvodnje sirćeta, soka ili nekog drugog proizvoda sadrži veliku količinu pektina i koristi se za njegovu proizvodnju. Bijeli dio kore citrusa također služi kao sirovina za proizvodnju pektina. Osim toga, jabuke su bogate polifenolima, a citrusi vitaminom C. Cilj ovog rada je da se upoređi sadržaj polifenola, askorbinske kiseline, pektinskih tvari i antioksidativni kapacitet jabuka i nekih citrus plodova (limun, narandža). Pri tome će se koristiti standardne metode za određivanje pektinskih tvari, askorbinske kiseline, polifenola (Folin Ciocalteu metoda) i određivanje antioksidativnog kapaciteta (FRAP metoda).

Ključne riječi: polifenoli, antioksidativni kapacitet, jabuka, citrusi, pektini

COMPARISON OF QUALITY PARAMETERS OF SELECTED APPLE VARIETIES DURING STORAGE

HATIDŽA NURKIĆ, RAMZIJA CVRK✉, BESIM SALKIĆ,
AMEL SELIMOVIĆ, TIJANA BRČINA

Faculty of Technology, University of Tuzla, Univerzitetska 8, 75000 Tuzla, Bosnia and Herzegovina
✉ ramzija.cvrk@untz.ba

Apple is one of the most important fruits for human consumption. According to the production and consumption of fruits in the world, apple is in fourth place, after grapes, citrus fruits and bananas. This fact shows the importance of apples in the daily consumption, processing in various food products, and thus the importance of storage conditions of apples.

In this paper, investigated the influence of storage conditions on apple quality parameter selected apple cultivars: Jonagold, Idared, Golden Delicious and Granny Smith. Primary, investigated the physico-chemical properties of apples, and presence of nutritionally important components (crude fiber, sugars, phenolic compounds, vitamin C, etc.). Those parameters are analyzed after nine months of storage of apples.

The results show that presence of vitamin C has the highest value in the variety Granny Smith (7.28 mg / 100 g), and the lowest in Jonagold (3.94 mg / 100 g). Results of acidity of apple cultivars, indicated that the total acidity of the largest for Idared (13.03 mmol / 100 g), and the lowest for Jonagold (3.99 mmol / 100 g). Results of acidity were correlated with the pH values of samples. Investigated of apple varieties have a high values of dry matter, respectively: Jonagold (14.25 Brix), Granny Smith (13.00 Brix), Idared (11.75 Brix), and Golden Delicious (10.5 Brix). Results of sugar content show that the least amount of sugar had a variety Granny Smith (2.28%), and the other three cultivars studied had approximately the same amount of total sugar. The highest content of crude fiber was measured in the variety Golden Delicious (0.0856%), and the smallest value at Jonagold (0.0251%). Results of radical inhibition as quenching percentage (IC₅₀ value), showed the highest value of the variety Golden Delicious (10.72), then Idared (4.11), Jonagold (1.84), and Granny Smith (1.26).

In general, it can be concluded that the quality of the analyzed varieties of apples satisfying, in storing test period, and that obtained values in accordance with legislation on the quality of apples, and confirming the storage in suitable conditions.

Keywords: Apple, storage period, physico-chemical and nutritional properties of apple.

USPOREDBA PARAMETARA KVALITETA ODABRANIH SORTI JABUKA TOKOM SKLADIŠTENJA

HATIDŽA NURKIĆ, RAMZIJA CVRK✉, BESIM SALKIĆ,
AMEL SELIMOVIĆ, TIJANA BRČINA

Tehnološki fakultet, Univerzitet u Tuzli, Univerzitetska 8, 75000 Tuzla, Bosna i Hercegovina
✉ ramzija.cvrk@untz.ba

Jabuka predstavlja jednu od najznačajnijih vrsta voća u današnjoj prehrani ljudi. Prema proizvodnji i potrošnji voća u svijetu, jabuka je na četvrtom mjestu, nakon grožđa, citrusa i banana. Ova činjenica ukazuje na značaj jabuke u svakodnevnoj konzumaciji i preradi u različite prehrambene proizvode, a time i na značaj uslova čuvanja jabuke u toku skladištenja.

U ovom radu, istraživano je uticaj uslova skladištenja jabuke na parametar kvaliteta odabranih sorti jabuke: Jonagold, Idared, Golden Delicious i Granny Smith. Primarno su analizirana fizikalno-hemijska svojstva jabuke, te prisustvo nutritivno značajnih sastojaka (sirova vlakna, šećeri, fenolni spojevi, vitamin C itd.). Navedeni parametri su analizirani nakon devet mjeseci skladištenja jabuke.

Rezultati dobijeni u istraživanju, pokazuju da sadržaja vitamina C ima najveću vrijednost kod sorte Granny Smith (7.28 mg/100g), a najmanju kod sorte Jonagold (3.94 mg/100g). Rezultati analize kiselosti ispitivanih sorti jabuka pokazuju da je ukupna kiselost najveća kod sorte Idared (13.03 mmola/100 g), a najmanja kod sorte Jonagold (3.99 mmola/100 g), a rezultati kiselosti su u korelaciji sa vrijednostima pH uzoraka. Ispitivane sorte jabuka imale visok udio suhe tvari, respektivno: Jonagold (14.25 Brix), Granny Smith (13.00 Brix), Idared (11.75 Brix), a najmanju vrijednost suhe tvari je imala sorta Zlatni delišes (10.5 Brix). Rezultati sadržaja šećera pokazuju da je najmanju količinu šećera imala sorta Granny Smith (2.28%), a ostale tri analizirane sorte imale su približno jednaku količinu ukupnih šećera.

Najveći sadržaj sirovih vlakana izmjerena kod sorte Zlatni delišes (0.0856%), a najmanja vrijednost kod sorte Jonagold (0.0251%). Rezultati inhibicije DPPH radikala, tj. postotak gašenja (IC₅₀ vrijednost) pokazali su najveću vrijednost kod sorte Zlatni delišes (10.72), zatim Idared (4.11), Jonagold (1.84), i Granny Smith (1.26).

Općenito, može se zaključiti da je kvalitet analiziranih sorti jabuke zadovoljavajući u ispitivanom periodu skladištenja, te da su dobijene vrijednosti u skladu sa legislativom o kvalitetu jabuke, što potvrđuje skladištenje u odgovarajućim uslovima.

Gljučne riječi: jabuka, dužina skladištenja, fizikalno-hemijska i nutritivna svojstva jabuke.

ASSESSMENT OF WATER SOURCES QUALITY IN DOBOJ EAST AREA

MUHAMED ŠIŠIĆ, RAMZIJA CVRK✉, SABINA BEGIĆ, AMRA SELIMOVIĆ

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

✉ ramzija.cvrk@untz.ba

Water is one of the most resources for life, but due to constant population growth and industrial development it is necessary to constantly find new water sources, in order to provide sufficient water for drinking and industry.

The subject of this investigation is the assessment of water sources quality in Doboj East area average quality of ground water resources in the area of Doboj East, given that this municipality in development, and there is a trend of development of small and medium enterprises, as well as the development of agriculture, it is necessary to carry out preliminary investigations water quality of existing water sources because of the possible need inclusion in the existing network of drinking water supply. It is necessary to consider the quality and quantity of water, and the availability of existing water sources.

In this work, investigated the physico-chemical and indicator parameters of the water, microbiological quality of the water in the sources, and identified location of the sources. The study consisted of water sources "Hajr česma" (U-1), "Velika voda" (U-2), "Orah" (U-4), "Vodica" (U-5), and water from the public water supply (U-3), for comparison.

The results indicate a good of water quality of investigated sources, since that water not pre-treated. Results for conductivity, of the samples were less than 2500 $\mu\text{S}/\text{cm}$, consumption KMnO_4 in all samples was less than 5.0 mg/l O_2 , total hardness is 5.90-10.80°dH, nitrate content increased in the sample U-1 (86.35 mg/l) and sample U-2 (66.48 mg/l), and other samples in accordance with legislation. The nitrite content in all samples is in line with legislation, while the sulfate content increased in all samples. In terms of microbiological showed the presence of *E.Coli*, *Proteus vulgaris*, and *coliform* bacteria, because previously not conducted disinfection of investigated sources. In general, it can be concluded that the water quality tested sources satisfactory, because the parameters are not in accordance with prescribed by legislation, can be corrected by simple and available water treatment.

Keywords: water sources, water quality

PROCJENA KVALITETA IZVORIŠTA VODE NA PODRUČJU DOBOJ ISTOKA

MUHAMED ŠIŠIĆ, RAMZIJA CVRK✉, SABINA BEGIĆ, AMRA SELIMOVIĆ

Tehnološki fakultet, Univerzitet u Tuzli, Univerzitetska 8, 75000 Tuzla, Bosna i Hercegovina

✉ ramzija.cvrk@untz.ba

Voda je jedan od najvažnijih resursa za život, a zbog stalnog rasta populacije i razvoja industrije neophodno je stalno iznalaženje novih izvorišta vode, kako bi se obezbijedile dovoljne količine vode za piće i industriju.

Predmet istraživanja u ovom radu je analiza kvaliteta vode u dostupnim izvorištima na području općine Doboj Istok, obzirom da je ova općina u razvoju, te je prisutan trend razvoja malih i srednjih preduzeća, kao i razvoj poljoprivrede, neophodno je provesti preliminarna istraživanja kvaliteta vode postojećih izvorišta zbog eventualne potrebe uključenja u postojeću mrežu snabdijevanja pitkom vodom. Pri tome je neophodno istražiti kvalitet i količine vode, te dostupnost postojećih izvorišta vode.

U ovom radu su istraživani fizikalno-hemijski parametri vode, indikatorski parametri vode, te mikrobiološki status vode u ispitivanim izvorištima, te su identificirane lokacije izvorišta. Istraživana su izvorišta vode Hajr česma (U-1), Velika voda (U-2), Orah (U-4), Vodica (U-5), i voda iz gradskog vodosnabdijevanja (U-3), radi komparacije.

Rezultati ukazuju na zadovoljavajući kvalitet vode ispitivanih izvorišta, obzirom da voda nije predhodno tretirana. Dobile vrijednosti elektroprovodljivosti, ispitivanih uzoraka su manja od 2500 $\mu\text{S}/\text{cm}$, utrošak KMnO_4 je u svim uzorcima je manji od 5.0 mg/l O_2 , ukupna tvrdoća vode je od 5.90-10.80°dH, sadržaj nitrata je povišen u uzorku U-1 (86.35 mg/l) i uzorku U-2 (66.48 mg/l), dok je u ostalim uzorcima u skladu sa legislativom. Sadržaj nitrata je u svim uzorcima u skladu sa legislativom, dok je sadržaj sulfata povećan u svim uzorcima. U pogledu mikrobiološke ispravnosti dokazano je prisustvo *E.Coli*, *Proteus vulgaris*, i *koliformne* bakterije, obzirom da nije izvršena dezinfekcija izvorišta.

Općenito se može zaključiti da je kvalitet vode ispitivanih izvorišta zadovoljavajući, obzirom da navedeni parametri koji odstupaju od vrijednosti propisanih legislativom mogu biti popravljivi jednostavnim i dostupnim postupcima obrade vode.

Ključne riječi: izvorišta vode, kvalitet vode.

THE DETERMINATION OF ANTIOXIDANT CAPACITY AND THE CONTENT OF POLYPHENOLS IN DIFFERENT TYPES OF TEA

SUAD DJEDOVIĆ✉, JASMINA ALIBAŠIĆ, ALMEDINA ALIBAŠIĆ

Faculty of Technology, University of Tuzla, Univerzitetska 8, 75000 Tuzla, Bosnia and Herzegovina

✉ suad_uyas@live.com

Tea is a beverage that came in Europe from Asia, where its use had started. Even today, in some countries there is a belief that the real is the one that comes from leaf buds of the plant *Thea cameli*, and that includes green, black, white and yellow tea (there are varieties, depending on the way of processing and the level of fermentation). Herbal and fruit teas, from that view of classification, are not real teas, and it has to be accentuated from which plant they come from. On the market, there are teas in filter bags and in form of bulk tea, and there are differences in its composition. The aim of this paper is to determine the difference in content of the most valuable tea ingredients, which are polyphenols and the antioxidant capacity. Also, it will be determined the presence of some others components which are normally contained in tea.

Keywords: tea, poliphenolic compounds, antioxidant capacity

ODREĐIVANJE ANTIOKSIDATIVNOG KAPACITETA I KOLIČINE UKUPNIH POLIFENOLA U RAZLIČITIM VRSTAMA ČAJA

SUAD DJEDOVIĆ✉, JASMINA ALIBAŠIĆ, ALMEDINA ALIBAŠIĆ

Tehnološki fakultet, Univerzitet u Tuzli, Univerzitetska 8, 75000 Tuzla, Bosna i Hercegovina

✉ suad_uyas@live.com

Čaj je napitak koji je u Evropu došao iz Azije gdje je počela njegova upotreba. I danas se u nekim zemljama smatra da je pravi čaj samo onaj koji potječe od listova i lisnih pupoljaka biljke *Thea Cameli* i tu spadaju zeleni, crni, bijeli i žuti čaj (varijacije ovisno o načinu prerade i stupnju fermentacije). Biljni i voćni čajevi se prema toj klasifikaciji ne ubrajaju u prave čajeve i mora se naglasiti od koje biljke potječu. Na tržištu se čajevi nalaze u filter vrećicama i u rinfuzi i postoje razlike u njihovom sastavu. Cilj ovog rada je da se utvrdi razlika u količini najvažnijih sastojaka čaja, a to su polifenolni spojevi i antioksidativna aktivnost. Također će se utvrditi i prisutnost nekih drugih sastojaka koji su inače prisutni u čaju.

Ključne riječi: čaj, polifenolni spojevi, antioksidativna aktivnost.

POBOLJŠANJE ORGANOLEPTIČKIH I SENZORSKIH OSOBINA GOTOVOG PROIZVODA – SO I BILJNI ZAČINI

EMA OBRALIĆ✉, AMIRA BRKIĆ, ENVER ZULIĆ

Solana d.d. Tuzla, Ul. Soli br.3, Tuzla, BiH

✉ ema.obralic@solana.ba

So i biljni začini je aromatizirani proizvod na bazi soli namijenjen konzumaciji krajnjeg potrošača.

Gotov proizvod koji predstavlja začinsku smjesu najbolje kombinacije biljaka visoke kvalitete i soli izuzetne čistoće, primjenjuje se kao pojačivač okusa, odnosno mirisa za pravljenje svih vrsta variva, supa, umaka i salata.

Proces proizvodnje je šaržni proces, a sve sirovine koje se koriste zadovoljavaju svojom kvalitetom. Prema usvojenoj recepturi Solana d.d. Tuzla iste komponente se miješaju dok se ne postigne potpuna homogenizacija smjese.

Senzorska ispitivanja su vršena upravo u cilju poboljšanja postojeće recepture, odnosno kvaliteta gotovog proizvoda. Izmjene koje napravljene kako bi se dobio kvalitetniji proizvod su u dijelu pripreme sirovina (usitnjavanje) te samog postupka dalje homogenizacije. Ispitivanja su rađena na tri uzorka, na svojstvima kvaliteta senzorskih ocjena mirisa, ukusa, usitnjenosti, boje, sipkosti i zgrudnjavanja. Na osnovu rezultata, uzorak koji je napravljen sa usitnjenom kombinacijom prirodnih biljaka i daljom homogenizacijom sa soli ostvario je najveći broj bodova 21,69 od ukupno 22 boda, koja definišu svojstva kvalitete.

Način pripreme začina na bazi soli sa najvišom ocjenom se dalje nastavio primjenjivati u procesu proizvodnje. Monitoring procesa proizvodnje i pakovanja se vrši kroz implementirane standarde ISO 9001:2015, ISO 22000:2005, HACCP, HALAL BAS 1049:2010, KOSHER.

Cilj Solana d.d. Tuzla je da se poboljša kvalitet gotovog proizvoda u svrhu potrošača, a samim tim da proizvod bude zdravstveno ispravan i zadovoljavajućih senzornih osobina.

Ključne riječi: So i biljni začini, zdravstvena ispravnost, senzorske osobine

BACTERIOLOGICAL ANALYSIS OF WELL WATER IN THE AREA OF BRČKO DISTRICT

SNJEŽANA HODŽIĆ✉, AMELA HERCEGOVAC, SUAD ŠIRANOVIĆ, ALDIJANA AVDIĆ,
DARJA HUSEJNAGIĆ, EDINA HAJDAREVIĆ

Faculty of Natural Sciences and Mathematics, University of Tuzla, Univerzitetska 4, 75000 Tuzla, Bosnia and Herzegovina

✉ snjezana.hodzic@untz.ba

Drain wells are usually intended for individual use, as water supply for the rural settlements, temporary water supply systems, etc. These wells are mainly constructed of rock, concrete, reinforced concrete and wood. Open wells imply wells that do not have water drainage mechanisms, but water is retrieved by auxiliary equipment such as wooden or bronze pots, etc. Standard methods used for microbiological assessment of drinking water are based on the determination of its fecal contamination. As a certain indicator of fecal contamination, presence of these microorganisms in water are included: *Escherichia coli*, *Enterococcus faecalis* and representative genus of *Proteus*, while additional indicators are coliform bacilli (*Citrobacter*, *Klebsiella*, *Enterobacter* and *Serratia*), *Clostridium perfringens* and bacteriophages. Results of the bacteriological analysis of the well water, from the village Čande in the area of Brčko district, are presented in this paper. Samples are taken from ten sites, and all the wells belonged to the open type of wells. Results showed 100% (10/10) microbiological contamination with presence of fecal contamination indicators: *Escherichia coli* in 70% of the tested samples, *Enterococcus faecalis* in all samples (100%), *Clostridium sp.* in 20% of samples, *Enterobacter sp.* in 20% of the samples and *Citrobacter sp.* in 10% of the samples.

The results of this work should be an initiative to continue research in this area in order to implement the protection of well source areas, to provide regular monitoring of water quality and develop educational programs in order to raise the awareness and knowledge in rural population on how to use safe sources of drinking water.

Keywords: well, water, bacteriological, analysis, Brčko

BAKTERIOLOŠKA ANALIZA BUNARSKIH VODA NA PODRUČJU BRČKO DISTRIKTA

SNJEŽANA HODŽIĆ✉, AMELA HERCEGOVAC, SUAD ŠIRANOVIĆ, ALDIJANA AVDIĆ,
DARJA HUSEJNAGIĆ, EDINA HAJDAREVIĆ

Prirodno-matematički fakultet, Univerzitet u Tuzli, Univerzitetska 4, 75000 Tuzla, Bosna i Hercegovina

✉ snjezana.hodzic@untz.ba

Kopani bunari se koriste za uzimanje malih količina vode za individualno korištenje, snabdijevanje vodom seoskih naselja, u privremenim vodovodima i sl. Kopani bunari mogu biti kameni, betonski, armiranobetonski i drveni. Otvoreni bunari su bunari koji ne posjeduju mehanizme za crpljenje vode, već se voda hvata pomoću pomoćnih sredstava, kao što su drveni lonci limene posude itd. Osnova propisanih metoda za određivanje mikrobiološke ispravnosti vode za piće je utvrđivanje njene fekalne kontaminacije. Među sigurne indikatore fekalnog zagađenja vode za piće spadaju: *Escherichia coli*, *Enterococcus faecalis* i predstavnici roda *Proteus*, dok su dodatni indikatori: koliformni bacili (*Citrobacter*, *Klebsiella*, *Enterobacter* i *Serratia*), *Clostridium perfringens* i bakteriofagi. Nalaz ovih mikroorganizama u vodi znak je fekalne kontaminacije i ukazuje na mogućnost prisustva i patogenih crijevnih mikroorganizama u vodi. U ovom radu prezentirani su rezultati bakteriološke analize bunarskih voda naselja Čande na području Brčko distrikta. Bakteriološka analiza vode bunara rađena je na deset lokaliteta. Svi bunari su pripadali tipu otvorenih bunara, a analizom je dokazana 100% (10/10) mikrobiološka neispravnost vode. U bunarskim vodama prisutni su indikatori fekalne kontaminacije vode i to: *Escherichia coli* u 70% ispitivanih uzoraka, *Enterococcus faecalis* u svim uzorcima (100%), *Clostridium sp.* u 20% uzoraka, *Enterobacter sp.* u 20% uzoraka i *Citrobacter sp.* u 10% uzoraka.

Rezultati ovog rada trebaju biti podsticaj za nastavak istraživanja u cilju provođenja zaštite izvorišnih područja, redovitog kontroliranja sastava voda, te razvoja edukativnih programa u cilju podizanja nivoa znanja stanovništva o korištenju sigurnih izvora vode za piće.

Ključne riječi: bunar, voda, bakteriološka, analiza, Brčko

CHANGE IN THE QUANTITY OF ASCORBIC ACID AFTER THERMAL PROCESSING OF POTATO

AMELA KUSUR✉, ALDIN KARIĆ, MARTINA ANDREJAŠ, HURIJA ALIBAŠIĆ

Faculty of Technology, University of Tuzla, Univerzitetska 8, 75000 Tuzla, Bosnia and Herzegovina
✉ amelakusur@hotmail.com

Potato is the fourth most important food in the world, after wheat, corn and rice. Although potato is widely consumed, many people aren't familiar with its nutritional value, thus considering it only a great source of starch. It has a great starch content, but it contains other significant quantity of vitamins and other nutrients. The major nutrient is the vitamin C (ascorbic acid) which is essential for people's diet and its significance for people's health is well-known. Potato isn't eaten raw, it has to be thermally processed which influences the presence of the vitamin C considering its sensitivity, fast degradability, and a great loss of vitamin C is expected. Many different ways of thermal processing are used such as boiling, frying, baking and similar. The vitamin C loss depends on the different processing ways and potato preparation. This phenomenon is even more present when a potato is peeled and cut into smaller pieces. When being boiled unpeeled, a potato keeps a larger quantity of vitamin C, and a significant quantity is kept during baking and frying as well.

This paper aims to show how much quantity of ascorbic acid that is kept in the potato after boiling it peeled, unpeeled and when cut into pieces, as well as after frying and baking in an oven and in a foil. The goal of thermal processing is to keep as many nutritional ingredients as possible, and this paper will show which way of processing and preparation is the most convenient for eating.

Keywords: potato, vitamin C, thermal processing.

PROMJENA KOLIČINE ASKORBINSKE KISELINE NAKON TERMIČKE OBRADJE KROMPIRA

AMELA KUSUR✉, ALDIN KARIĆ, MARTINA ANDREJAŠ, HURIJA ALIBAŠIĆ

Tehnološki fakultet, Univerzitet u Tuzli, Univerzitetska 8, 75000 Tuzla, Bosna i Hercegovina
✉ amelakusur@hotmail.com

Krompir je četvrta najvažnija namirnica u svijetu, poslije pšenice, kukuruza i riže. Iako se krompir puno konzumira, mnogi nisu upoznati sa njegovom nutritivnom vrijednošću, smatrajući ga samo velikim izvorom škroba. Ima veliki sadržaj škroba, ali sadrži i značajne količine vitamina i drugih nutrijenata. Najzastupljeniji je vitamin C (askorbinska kiselina) koji je esencijalni nutrijent u ljudskoj ishrani, a njegov značaj za zdravlje ljudi je općepoznat. Krompir se ne konzumira sirov, mora se uvijek termički obraditi što će uticati na prisutnost vitamina C s obzirom da je jako osjetljiv, brzo se razgrađuje te se očekuje poprilično veliki gubitak. Koriste se različiti načini termičke obrade poput kuhanja, prženja, pečenja i sl. Gubitak vitamina C je različit pri različitim načinima obrade i pripreme krompira. Ta pojava je izraženija kada se krompir kuha oguljen i izrezan na manje kocke. U krompiru koji se kuha u ljusci ostaje veća količina vitamina C, a značajna količina se zadržava i tokom pečenja i prženja.

Ovaj rad ima za cilj da pokaže koliko se askorbinske kiseline zadržava u krompiru nakon kuhanja u ljusci, bez ljuske te izrezan na kocke, kao i nakon prženja i pečenja u rerni i u foliji. Cilj obrade je da se u što većoj mjeri očuvaju prisutni nutritivni sastojci, a ovaj rad će prikazati koji je najpogodniji način obrade i pripreme za konzumiranje.

Ključne riječi: krompir, vitamin C, termička obrada.

THE INFLUENCE OF RECIPE MODIFICATION ON SENSORY PROPERTIES OF A MIXTURE OF SPICES – A COMPLEMENT OF DISHES

MILICA VILUŠIĆ✉, AMILA MEHANOVIĆ, TIJANA BRČINA,
MIDHAT JAŠIĆ, SABINA BEGIĆ

Faculty of Technology, University of Tuzla, Univerzitetska 8, 75000 Tuzla, Bosnia and Herzegovina
✉ milica.vilusic@untz.ba

Salt and dried vegetables are high-value foods that are indispensable and widely represented in everyday use. Therefore, the addition of spice mix is almost irreplaceable in savory dishes, especially in the Balkans.

The aim of the study was to examine the influence of modification of spice mixture on sensory properties of products and dietary habits of consumers. Produced variations spice mixture differed per unit of salt (salt, dietary salt), without additive (monosodium glutamate), but with the addition of curcuma. The sensory properties of spice mixture were evaluated by a consumers of two age groups.

The results of both age groups of consumers showed that the highest average grade of sensory properties was obtained by the sample of the spice mixture with 54% salt, and the worst grade by the sample with curcuma and without the addition of monosodium glutamate. Analysis of variance showed significant differences ($p < 0.05$) of all sensory properties. A high correlation was also found between color and odor, color and taste, and odor and taste. The results are a good indicator of the awareness of certain consumers to reduce the use of spices - complement of dishes, as well as their modifications in relation to commercial products.

Keywords: salt, dry vegetables, additive, spice mixtures, sensory properties

UTJECAJ MODIFIKACIJE RECEPTURE NA SENZORSKA SVOJSTVA MJEŠAVINE ZAČINA – DODATKA JELIMA

MILICA VILUŠIĆ✉, AMILA MEHANOVIĆ, TIJANA BRČINA,
MIDHAT JAŠIĆ, SABINA BEGIĆ

Tehnološki fakultet, Univerzitet u Tuzli, Univerzitetska 8, 75000 Tuzla, Bosna i Hercegovina
✉ milica.vilusic@untz.ba

So i sušeno povrće su visokovrijedne namirnice koje su neizostavne i široko zastupljene u svakodnevnoj upotrebi. Samim tim, dodatak mješavine začina je gotovo nezamjenjiv u slanim jelima, osobito na području Balkana.

Cilj rada je bio ispitivanje utjecaja modifikacije recepture mješavine začina na senzorska svojstva proizvoda i prehrambene navike potrošača. Proizvedene varijacije mješavine začina razlikovale su se po udjelu soli (so, dijetalna so), bez aditiva (mononatrij glutaminat), ali uz dodatak kurkume. Senzorska svojstva mješavine začina ispitali su potrošači dvije starosne skupine.

Rezultati ispitivanja obje starosne skupine su pokazali da je najveću prosječnu ocjenu senzorskih svojstava dobio uzorak mješavine začina sa 54% soli, a najlošije je ocijenjen uzorak sa kurkumom i bez dodatka mononatrij glutaminata. Analiza varijance je pokazala značajne razlike ($p < 0,05$) svih senzorskih svojstava. Utvrđena je i visoka korelacija između svojstava boje i mirisa, boje i okusa, te mirisa i okusa. Dobiveni rezultati su dobar pokazatelj osviještenosti pojedinih potrošača za smanjenje upotrebe začina - dodatka jelima, kao i njegove modifikacije u odnosu na komercijalne proizvode.

Ključne riječi: so, suho povrće, aditiv, mješavina začina, senzorska svojstva

ENVIRONMENTAL IMPACT ASSESSMENT OF FACTORY CEMENT LUKAVAC USING H1 METHODOLOGY

HANA ALIHODŽIĆ^{1,✉}, ABDEL ĐOZIĆ², DAMIR MULAMEHMEDOVIĆ³, EMIR ĆILIMKOVIĆ³, AZRA KOVAČEVIĆ^{1,4}

¹ Udruženje za zaštitu prirode i okoline "Aer Aqua Terra" 75300 Lukavac, Bosnia and Herzegovina

² Tehnološki fakultet, Univerzitet u Tuzli, 75000 Tuzla, Bosnia and Herzegovina

³ Fabrika Cementa Lukavac, 75300 Lukavac, Bosnia and Herzegovina

⁴ Dunny Consulting Agency, 75000 Tuzla, Bosnia and Herzegovina

✉ alihodzichana0@gmail.com

Environmental impact assessment (EIA) can be defined as a process of collecting information about environmental impacts of existing objects or proposed projects and consequent relevant decision making. EIA requires that a range of solutions to an determined negative environmental problem which must be developed, analyzed and compared. This paper presents a research of application of H1 methodology in EIA process for Factor Cement Lukavac (FCL). The H1 methodology is structured in a four stage risk assessment which requires the applicant to: identif risks from their activity, assess the risk and check that they are acceptable, justify appropriate measures to control the risks if necessary, and then submit their assessment. Based on practical experience, the main activities by stages of evaluation are outlined. Problems and misunderstandings that arise if there are no clear guidelines for identifying, evaluating and evaluating potential negative impacts. By carrying out the EIA in the principles of H1 methodology, it can be concluded that FCL has aligned its production process with the requirements given in the best available techniques for the cement industry. Emissions of pollutants into the air and water are within the prescribed limits. It has been observed that FCL is constantly monitoring the technological process, emissions and continuously making improvements in terms of reducing its negative impact on the environment.

Keywords: cement, environment, impact, assessment, emission

IMPACT OF ALTERNATIVE FUELS ON REDUCING THE EMISSION CONCENTRATION OF GASEOUS POLLUTANTS IN CEMENT FACTORY LUKAVAC

HANA ALIHODŽIĆ^{1,✉}, ABDEL ĐOZIĆ², DAMIR MULAMEHMEDOVIĆ³, EMIR ĆILIMKOVIĆ³

¹ Udruženje za zaštitu prirode i okoline "Aer Aqua Terra" 75300 Lukavac, Bosnia and Herzegovina

² Tehnološki fakultet, Univerzitet u Tuzli, 75000 Tuzla, Bosnia and Herzegovina

³ Fabrika Cementa Lukavac, 75300 Lukavac, Bosnia and Herzegovina

✉ alihodzichana0@gmail.com

The production of cement is a very intensive process that requires large amounts of energy to reach extremely high temperatures. For this reason, in order to reduce the negative impact on the environment, the use of alternative fuels is resorted to, which is the recommendation of the BAT in the cement industry. This paper presents the impact of the use of alternative fuels on the reduction of air pollutant emissions. The analysis and systematization of the data obtained by the FCL was performed. The data refer to the following pollutants: nitrogen oxides, sulfur dioxide, carbon monoxide, total organic carbon, hydrogen fluoride, hydrogen chloride and particulate matter. Based on the data processed, the impact of the use of alternative fuels on air quality was evaluated. The paper also outlines the numerous benefits of using alternative fuels over fossil fuels and provides a brief overview of the legal regulations used in the FBiH. Based on the presented results, we can conclude that the use of alternative fuels in the production process does not affect the increase of emission concentrations of the analyzed pollutants and it does not adversely affect air quality.

Keywords: cement, air quality, emission, alternative fuels

AN INVESTIGATION ON THE EFFECT OF WATER-SOLUBLE POLYMERS ON THE PROPERTIES OF CEMENT AND CONCRETE

ANIL UTKU ÇETİNKAYA✉, MUSTAFA İNCİ, NECİP ATAR

Faculty of Engineering, University of Pamukkale, 20020, Denizli, Turkey

✉ anilutkucetinkaya@outlook.com

In this study, the effect of DMA-MMA diblock copolymer on the properties of ordinary Portland cement and cement containing boron has been investigated. Variation in setting time, compressive strength, and volume expansion have been determined. Cement hydration was monitored by X-ray diffraction (XRD) and by Fourier transforms infrared spectroscopy, in combination with the thermoanalytical methods (TG/DTA). The microstructural observation of the hydrated cement paste was performed by scanning electron microscopy (SEM). The result showed that DMA-MMA prolongs the early setting time of the Portland cement and composite cement, and has no noticeable effect on the final setting time of the both cement types. The DMAMMA diblock copolymer reduced the water-to-cement ratios (w/c) from 0.5 to 0.42, which improved the compressive strength of the mortars at all curing ages. The experimental results also indicated that the DMA-MMA does not only change the rate of cement paste hydration, but also the microstructure of calcium-silicatehydrate (C-S-H).

Keywords: Retardation, microstructure, strength, chemical admixture, cement pas

THE IMPACT OF WHEY VALORIZATION ON THE QUALITY OF THE WASTEWATER IN THE DAIRY INDUSTRY

ALEKSANDAR CHADIKOVSKI✉, JANA SIMONOVSKA, DALIBOR MLADENOVSKI, VESNA RAFAJLOVSKA

Faculty of Technology and Metallurgy, Ss. Cyril and Methodius University in Skopje, Rudjer Boskovic 16, 1000 Skopje, R. Macedonia

✉ acadik@gmail.com

Global environmental pollution is one of the major issues, griping the earth day by day. Dairy industry has a high impact on the environment, producing large volumes of wastewater that are characterized with high quantity of organic nutrients and extreme pH variations, as well as inorganic salts, detergents and sanitizers that are used as cleaning agents.

Whey is the liquid byproduct obtained during the cheese production. Although, it has a several commercial uses, in many dairy industries the whey is still not valorized as a final product. Around 50 % of the world's whey produced, especially the acid whey is dispose in effluents, so, it provoke a great requirement to used it in development of new whey based product.

The aim of this study was to to improve the waste water quality in dairy industry through valorization of the semi-acid waste whey from white cheese production in the final product-whey cheese „urda“. The physicochemical parameters of the effluent were characterized by using official standard analytical procedures.

The results obtained with whey valorization in „urda“ indicate to a great contribution in improvement of physicochemical parameters of wastewater (COD, BOD, TN, TP etc.) and environmental protection, also. The values of physicochemical parameters were decreased: COD 10 times, BOD 13 times, TN 10 times and TP 25 times. On yearly basis, financial impact from whey valorization is approx. 18 kEUR.

Keywords: dairy industry, wastewater, whey valorization, physicochemical parameters

DEGREE OF POLLUTION OF AGRICULTURAL SOIL AFTER ACCIDENT ON DISPOSAL SITE IV "WHITE SEA"

ABDEL ĐOZIĆ^{1,✉}, VEDRAN STUHLI¹, MIRNES ZOHOROVIĆ¹, HANA ALIHODŽIĆ²

¹ Tehnološki fakultet, Univerzitet u Tuzli, 75000 Tuzla, Bosnia and Herzegovina

² Udruženje za zaštitu prirode i okoline "Aer Aqua Terra" 75300 Lukavac, Bosnia and Herzegovina

✉ abdel.dozic@untz.ba

At the end of March 2018, for reasons not yet identified caused a slope to collapse a part of dam of disposal site IV "white sea". As a result, certain amount of sediment and liquid phase flow out into the circulation channel, the surrounding soil and the river Spreča. On agricultural soil near the point of accident, a solid phase in the form of a white silt mass filled the existing depressions and channels where a layer of sediment of different thickness was formed. Through this layer, the liquid phase flowed down the Spreča River, carrying with it part of the solid silt phase, which caused the river to stain. The pH value of contaminated soil ranged from 8.32 to 10.75. A very high conductivity value from 31530 $\mu\text{S} / \text{cm}$ to 44860 $\mu\text{S} / \text{cm}$ was observed in all samples, indicating very high soil salinity. The soil is saline to depth of 30 cm with high chloride and sulfate content. According to the chromium contamination rate of 202.73% of the analyzed samples, we can classify the soil with high pollution, nickel soil pollution is 438.68% which is extreme pollution. According to a cadmium contamination rate of 93.33%, the soil was increased by contamination with the heavy metal. With respect to soil pollution by heavy metals, there is no clear difference between soil covered with sediment and soil not affected by accidental leakage, as very high concentrations of heavy metals have been observed in soil samples from unpolluted surfaces.

Keywords: accident, degree of pollution, heavy metals, chlorides

REMOVAL OF TEXTILE DYE FROM AQUEOUS SOLUTIONS BY USING HYDROXYAPATITE-MAGNETITE NANOCOMPOSITE MATERIALS

RAMAZAN KOCA, AYŞENUR ÖZTÜRK, ARZU YAKAR[✉]

Faculty of Engineering, Pamukkale University, Kınıklı Campus, 20070, Denizli, TURKEY

✉ ayakar@pau.edu.tr

With increasing human population and industrialization, our water resources are getting more and more polluted. Especially wastewater released to the environment without treatment of textile industries are very dangerous. Dyes are organic molecules. They are toxic to aquatic organisms. Also, because they are colored, they cover the water layer and prevent sunlight from reaching deep. At the same time, they consume oxygen dissolved in water, reduce the oxygen supply of living things. Therefore, cost-effective and practical solutions for the treatment of textile wastewater should be proposed.

For this purpose, in this study, magnetite-hydroxyapatite, which is the main material of bone, (MHAP) nanocomposites were produced and textile dye removal performance from aqueous medium was investigated. The nanocomposite materials were characterized by Scanning Electron Microscopy (SEM), Energy Dispersive Spectroscopy (EDS), Fourier Transform Infrared (FTIR) Spectroscopy and Vibrating Sample Magnetometry (VSM). Dye removal studies from aqueous solutions were performed in a batch reactor at different experimental conditions such as adsorbent dosage, pH, contact time, initial dye concentration and temperature by using MHAP. Adsorption isotherm was determined by using experimental data.

Keywords: Adsorption, Hydroxyapatite-Magnetite Nanocomposite, Textile Dye, Wastewater Treatment

COMPOSTING OF A MIXTURE OF ACTIVATED SLUDGE AND BIOWASTE IN A CLOSED REACTOR

DAJANA KUČIĆ GRGIĆ^{1,✉}, MARIJA VUKOVIĆ DOMANOVAC¹, MARTINA MILOLOŽA¹,
MONIKA ŠABIĆ RUNJAVEC¹, TOMISLAV DOMANOVAC²

¹ Faculty of Chemical Engineering and Technology, University of Zagreb, Trg Marka Marulića 19, 1000 Zagreb, Croatia

² IPZ Uniprojekt TERRA d.o.o., Voćarska cesta 68, 10000 Zagreb, Croatia
✉ dkucic@fkit.hr

Today, with the increase in population and the development of industry, the amount of wastewater that needs to be treated is growing globally. The biological treatment of wastewater, which is one of the most acceptable treatments due to its simplicity and economic viability, lags behind the activated sludge that must be disposed appropriately. There are various ways of treating activated sludge, such as mechanical, biological and physical processes. Composting is a natural biological process that is carried out by various natural microorganisms, including bacteria and fungi that utilize solid waste as an energy source and break down organic material into simpler substances.

The aim of this work was to investigate treatment of activated sludge by composting process. Activated sludge (AS) was mixed with biowaste (BW) in ratio, AS:BW = 1:2.5, and the structural material was added. The composting process was carried out in adiabatic reactor with working volume of $V_r = 10$ L during 16 days and the following parameters were monitored: temperature, CFU, C/N ratio, moisture content, volatile matter content, substrate and condensate pH, condensate volume, evolved CO_2 and NH_3 and conversion was calculated.

The maximum achieved temperature was 58 °C and thermophilic phase lasted 4 days. The cumulative evolved CO_2 was 344.42 g $\text{kgV}_{\text{M}0}^{-1}$ and NH_3 was not detected. At the beginning of process pH value was 6.2 and at the end 8.5. The obtained conversion was 42 %.

Keywords: Composting process, Activated sludge, Biowaste, Adiabatic reactor

OPTIMIZATION OF REACTION PARAMETERS OF BIODIESEL PRODUCTION BY USING WASTE COOKING OIL

ALIME ŞENOCAK[✉], EZGI ZEKIYE YİĞİT, NAZAN KARAPINAR

Faculty of Engineering, University of Pamukkale, 20020, Denizli, Turkey

✉ alimey@pau.edu.tr

This work aims to production of biodiesel from waste cooking oil by using homogenous and heterogeneous catalysts. Transesterification reaction parameters were investigated for improving of biodiesel production. Reaction time, waste oil and catalyst type were optimized. All reactions were at constant temperature, 60 °C, constant agitation speed, 500 rpm. KOH and HCl were used as base and acid catalysts respectively. Vegetable and olive oil waste oil types were used for transesterification reaction also.

According to results, reaction time was 4 hour, waste oil type was olive oil and catalyst type was base (KOH) catalyst were determined for high biodiesel production amount. KOH catalyzed reaction produced biodiesel under the optimized reaction conditions of methanol:oil molar ratio 6:1, temperature 60°C and speed agitation 500 rpm with a reaction time of 4 hour.

Keywords: Transesterification, biodiesel, catalyst

BIODIESEL PRODUCTION FROM WASTE COOKING OIL BY USING WASTE CHICKEN EGG SHELL CATALYSIS

EZGI ZEKIYE YIĞIT[✉], ALIME ŞENOCAK, NAZAN KARAPINAR

Faculty of Engineering, University of Pamukkale, 20020, Denizli, Turkey

✉ ezgizekiyeyigit@gmail.com

This work illustrates synthesis of biodiesel from waste olive oil and waste sunflower oil by using waste eggshells as a heterogeneous base catalyst. Effect of waste oil types on structure and activity of eggshell catalyst was investigated. Utilization of eggshell as a catalyst for biodiesel production not only provides a cost-effective and environmental effects, but also reduces the price of biodiesel to make biodiesel competitive with petroleum diesel. Eggshell catalyzed reaction produced biodiesel under the optimized reaction conditions of methanol:oil molar ratio 6:1, temperature 60°C and speed agitation 100 rpm with a reaction time of 4 hour. The collected chicken eggshells waste was washed with tap water number of times to remove impurities adhered to its surface and finally rinsed with distilled water. The washed chicken eggshells were dried in an oven at 105°C for 24 hour, ground to fine powder and calcined in a muffle furnace at 850°C for 3 hour to decompose CaCO₃ into CaO. After the reaction ends, the mixture was poured into a separating funnel. The biodiesel layer was separated by gravity and located in the upper layer. The glycerol, extra methanol and undesired products were in the lower layer and were decanted.

Keywords: Waste eggshell, biodiesel, catalyst

ENVIRONMENTAL SUSTAINABILITY OF AEROBIC TREATMENT OF BIOWASTE

MONIKA ŠABIĆ RUNJAVEC¹ DAJANA KUČIĆ GRGIĆ¹ TOMISLAV DOMANOVAC^{2✉} DOMINIK KNAPIĆ¹ MARIJA VUKOVIĆ DOMANOVAC¹

¹ University of Zagreb, Faculty of Chemical Engineering and Technology, Marulićev trg 19, 10000 Zagreb, Croatia;

² IPZ UNIPROJEKT TERRA, Voćarska cesta 68, 10000 Zagreb, Croatia

✉ tomislav@ipz-uniprojekt.hr

Waste is one of the biggest environmental problems in today's time. With the growth of the human population on the planet Earth, the quantity of waste generated proportionally increases. Under the domain of waste management, great importance is placed on the reduction of waste disposal in landfills. A considerable amount of municipal solid waste is biowaste which can cause greenhouse gas and leachate emissions leading to environmental problems. The production of biowaste across the supply chain is inevitable and it is desirable to reclaim value from this waste stream. Through composting process organic biodegradable fractions from biowaste are biochemically decomposed to stable end products. Generated leachate can be treated by aerobic biodegradation process. Biological treatment is cost effective and environmentally acceptable approach for biowaste and leachate management.

In this work the influence of substrate composition on the biodegradation process was investigated. The biodegradation of organic matter in the leachate from biowaste and the composting process were conducted in batch conditions where physico-chemical and microbiological analyses of the leachate and biowaste were carried out. The efficiency of biodegradation of organic matter from leachate and composting of biowaste was 91 % and 46 %, respectively.

Keywords: biowaste, leachate, aerobic treatment.

OKOLIŠNA ODRŽIVOST AEROBNE OBRADE BIOOTPADA

MONIKA ŠABIĆ RUNJAVEC¹ DAJANA KUČIĆ GRGIĆ¹ TOMISLAV DOMANOVAC^{2✉} DOMINIK KNAPIĆ¹ MARIJA VUKOVIĆ DOMANOVAC¹

¹ Sveučilište u Zagrebu, Fakultet kemijskog inženjerstva i tehnologije, Marulićev trg 19, 10000 Zagreb, Hrvatska

² IPZ UNIPROJEKT TERRA, Voćarska cesta 68, 10000 Zagreb, Hrvatska

Otpad je jedan od najvećih problema zaštite okoliša u današnje vrijeme. Rastom ljudskog stanovništva planeta Zemlje, proporcionalno raste i količina nastalog otpada. Pod domenom gospodarenja otpadom, veliki se značaj pridaje smanjenju odlaganja otpada na odlagališta. Značajna količina čvrstog komunalnog otpada je biootpad koji može uzrokovati emisiju stakleničkih plinova i izluživanja koji mogu dovesti do ekoloških problema. Proizvodnja biootpada u lancu opskrbe neizbježna je i poželjno je povratiti vrijednost iz ovog toka otpada. Procesom kompostiranja organska biorazgradiva frakcija iz biootpada biokemijskim putem se razgrađuje do stabilnih krajnjih produkata. Nastala procjedna voda može se obraditi aerobnim procesom biorazgradnje. Biološka obrada je ekonomičan i ekološki prihvatljiv način gospodarenja biootpadom i procjednom vodom.

U ovom radu istraživan je utjecaj sastava supstrata na proces biorazgradnje. Biorazgradnja organskih tvari u procjednoj vodi iz biootpada i proces kompostiranja provedeni su u šaržnim uvjetima pri čemu su provedene fizikalno-kemijska i mikrobiološka analiza procjedne vode i biootpada. Učinkovitost procesa biorazgradnje organskih tvari iz procjedne vode i kompostiranja biootpada iznosila je 91 % i 46 %.

Cljučne riječi: biootpad, procjedna voda, aerobna obrada.

CALIBRATION AND VALIDATION OF LINEAR MODELS FOR PREDICTING SOIL HYDROLYTIC ACIDITY

ZDENKO LONČARIĆ^{1,✉}, HRVOJE HEFFER², IVANA RUKAVINA², KRUNOSLAV DUGALIĆ², DANIEL RAŠIĆ², MILENA ANDRIŠIĆ², MARIO MITROVIĆ¹, DOMAGOJ RASTIJA¹

¹ Faculty of Agrobiotechnical Sciences Osijek, University of Josip Juraj Strossmayer in Osijek, Vladimira Preloga 1, 31000 Osijek, Croatia

² Croatian Agency for Agriculture and Food, Vinkovačka cesta 63c, 31000 Osijek, Croatia

✉ zdenko.loncaric@fazos.hr

Excessive soil acidity limits fertility at about 40% of the world's arable land, which could be neutralized by liming. The required liming intensity is calculated on the basis of different soil properties, and hydrolytic acidity is among most important ones. The aim of this paper is to determine the accuracy and suitability of linear models for prediction soil hydrolytic acidity based on available soil data. For that purpose, regression models created in 2013 were used and validated with a new set of results (pH_{H2O}, pH_{KCl}, SOM content, hydrolytic acidity and texture class) of 10,654 soil samples from 5 eastern Croatian counties (area of the analyzed soils 41,426.30 ha). Linear regression models were created in 4 ways: (1) model_(A) based on actual soil acidity data (pH_{H2O}); (2) model_(S) based on soil substitution acidity data (pH_{KCl}); (3) model_(AS) based on both soil acidity data (pH_{H2O} and pH_{KCl}); (4) model_(ASH) based on pH_{H2O}, pH_{KCl} and SOM content. Regardless of the aforementioned, each model was created as a universal model for all available samples and as a set of segmented models by specific classes according to soil properties (eg. 6 texture classes, 3 humidity classes, 3 pH classes).

The validation of the 2013 simple regression model_(ASH) with new 10,654 samples confirmed the accuracy of the model with an average error of 15.8 %. A new linear regression model_(ASH) calibrated with a new sample set resulted in a significantly lower average error (12.39 %) for all 10,654 samples, what represents 21.6 % error reduction over the previous model (12.39 vs. 15.80 %). Additional segmentation of the model_(ASH) by texture classes (6 classes) resulted in a reduction of the error to an average of 12.05 % with the lowest average error on soils of the highest texture class of only 0.37 cmol(+)kg⁻¹, i.e. 9.73 %. Model accuracy on all datasets increased with the addition of new soil data, starting with the least precision of model_(A) (r² = 0.517-0.765) and model_(S) (r² = 0.527-0.793), with increasing model_(AS) accuracy based on both soil acidity data (r² = 0.551-0.851) up to the highest model_(ASH) precision (range r² 0.767-0.878). The smallest average model_(ASH) error (11.97 %) was achieved by segmenting the model_(ASH) by texture classes and SOM content in the soil.

Linear models for prediction hydrolytic acidity can be used with average precision for all soils 85-88 %, and precision can be significantly increased (up to 93 %) by segmenting the model according to pH, SOM content and/or texture class.

Keywords: regression models, soil acidity, liming, soil classes, SOM content

KALIBRACIJA I VALIDACIJA LINERANIH MODELA PROCJENE HIDROLITIČKE KISELOSTI TLA

ZDENKO LONČARIĆ^{1,✉}, HRVOJE HEFFER², IVANA RUKAVINA², KRUNOSLAV DUGALIĆ², DANIEL RAŠIĆ², MILENA ANDRIŠIĆ², MARIO MITROVIĆ¹, DOMAGOJ RASTIJA¹

¹ Fakultet agrobiotehničkih znanosti Osijek, Sveučilište Josipa Jurja Strossmayera u Osijeku, Vladimira Preloga 1, 31000 Osijek, Hrvatska

² Hrvatska agencija za poljoprivredu i hranu, Vinkovačka cesta 63c, 31000 Osijek, Hrvatska

✉ zdenko.loncaric@fazos.hr

Oko 40 % svjetskih obradivih poljoprivrednih površina limitirane je plodnosti zbog prekomjerne kiselosti tla koju neutraliziramo kalcizacijom. Potreban intenzitet kalcizacije izračunavamo na temelju različitih svojstava tla, a u grupi najznačajnijih je hidrolitička kiselost tla. Cilj ovog rada je utvrditi preciznost i pogodnost lineranih modela predviđanja hidrolitičke kiselosti tla na temelju raspoloživih podataka o tlima. Korišteni su regresijski modeli kreirani 2013. godine koji su validirani novim setom rezultata analiza (pH_{H2O}, pH_{KCl}, sadržaj humusa, hidrolitička kiselost i teksturna klasa) 10.654 uzorka tla iz 5 istočnohrvatskih županija (površina analiziranih tala 41.426,30 ha). Linerani regresijski modeli kreirani su na 4 načina: (1) model_(A) na temelju podatka o aktualnoj kiselosti tla (pH_{H2O}); (2) model_(S) na temelju podatka o supstitucijskoj kiselosti tla (pH_{KCl}); (3) model_(AS) na temelju oba podatka o kiselosti tla (pH_{H2O} i pH_{KCl}); (4) model_(ASH) na temelju pH_{H2O}, pH_{KCl} i sadržaja humusa. Bez obzira na navedeni način, svaki je model kreiran kao univerzalni model za sve raspoložive uzorke i kao skup segmentiranih modela po određenim klasama prema svojstvima tla (npr. 6 teksturnih klasa, 3 klase humoznosti, 3 klase pH).

Validacijom jednostavnog regresijskog modela_(ASH) iz 2013. godine s novih 10.654 uzoraka potvrđena je preciznost modela s prosječnom greškom 15,8 %. Novi linearni regresijski model_(ASH) kalibriran novim setom uzoraka rezultirao je znatno manjom prosječnom greškom (12,39 %) za sva 10.654 uzorka, što je smanjenje greške za 21,6 % u odnosu na prethodni model (12,39 vs. 15,80 %). Dodatno segmentiranje modela_(ASH) prema teksturnim klasama (6 klasa) rezultiralo je smanjenjem greške na prosječnih 12,05 % uz najmanju prosječnu grešku na tlima najviše teksturne klase od samo 0,37 cmol(+)kg⁻¹, tj. 9,73 %. Preciznost modela ne svim setovima podataka povećavala se dodavanjem novih podataka o tlu, počevši od najmanje preciznosti modela_(A) (r² = 0,517-0,765) i modela_(S) (r² = 0,527-0,793), uz povećanje preciznosti modela_(AS) temeljenog na oba podatka o kiselosti tla (r² = 0,551-0,851) sve do najveće preciznosti modela_(ASH) (raspon r² 0,767-0,878). Najmanja prosječna greška modela_(ASH) (11,97 %) ostvarena je segmentiranjem modela_(ASH) prema teksturnim klasama i sadržaju humusa u tlu.

Linerani modeli predviđanja hidrolitičke kiselosti tla mogu se koristiti uz prosječnu preciznost za sva tla 85-88 %, a preciznost se može znatno povećati (do 93 %) segmentiranjem modela prema pH, sadržaju humusa i/ili teksturnoj klasi.

Gljučne riječi: regresijski modeli, kiselost tala, kalcizacija, klase tala, humoznost

BIODYNAMIC AGRICULTURE AS A SYSTEM OF SUSTAINABILITY AND A WAY OF PRESERVING SOIL FERTILITY

EMINA MEŠINOVIĆ^{1,✉}, ADELA MUJIĆ², ALISA FRKIĆ¹, ERNAD KUCALOVIĆ¹, AHMED SALKIĆ¹, BESIMA BULJUBAŠIĆ¹

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

² Faculty of Agriculture and Food Science, University of Sarajevo, Zmaja od Bosne 8, 71 000 Sarajevo, Bosnia and Herzegovina

✉ emina.mesinovic93@hotmail.com

Biodynamic (BD) agriculture, although the oldest organic approach to agriculture, is an advanced form of organic farming, which is getting more and more attention due to the emphasis on quality of food and soil health which, in addition to traditional organic farming practices such as composting, fertilization, exclusion of pesticide and using synthetic fertilizers on soil and plants, used characteristic preparations obtained from plants, mineral substances and organic fertilizers included in the list of materials and techniques permitted in ecological farming under the EC Regulation (834/2007).

This study presents the importance of biodynamic agriculture as an alternative approach to contemporary agriculture and the importance of BD preparations on quality, soil fertility and biodiversity, as well as a positive impact on the environment in terms of energy and efficiency utilization.

The results obtained in this study indicate a system that recognizes the importance of saving nature and human health through the ways on which treated the soil, plants and human involved in the production process, as well as an overview of current research of effects of preparation 500 on soil structure, microbiological activity, humus percentage, regulation pH values, and mineral solubility in deeper layers of soil.

Keywords: biodynamic agriculture, soil quality and fertility, biodiversity, sustainability

Poster. Section: Agronomy

BIODINAMIČKA POLJOPRIVREDA KAO SISTEM ODRŽIVOSTI I NAČIN OČUVANJA PLODNOSTI TLA

EMINA MEŠINOVIĆ^{1,✉}, ADELA MUJIĆ², ALISA FRKIĆ¹, ERNAD KUCALOVIĆ¹, AHMED SALKIĆ¹, BESIMA BULJUBAŠIĆ¹

¹ Tehnološki fakultet, Univerzitet u Tuzli, Univerzitetska 8, 75000 Tuzla, Bosna i Hercegovina

² Poljoprivredno-prehrambeni fakultet, Univerzitet u Sarajevu, Zmaja od Bosne 8, 71 000 Sarajevo, Bosna i Hercegovina

✉ emina.mesinovic93@hotmail.com

Biodinamička (BD) poljoprivreda, iako najstariji organski pristup u poljoprivredi, predstavlja napredni oblik organskog uzgoja koji dobiva sve veću pažnju zbog naglašavanja kvalitete hrane i zdravlja tla koji, uz uobičajene organske poljoprivredne prakse, kao što su, kompostiranje, plodored, isključenje upotrebe pesticida i sintetičkih gnojiva na tlu i biljkama, koriste i karakteristične preparate dobivene od bilja, mineralnih tvari i gnojiva organskog porijekla, koji su uključeni u popis materijala i tehnika dopuštenih u ekološkom uzgoju prema Uredbi EZ-a (834/2007).

U ovom radu prikazan je značaj biodinamičke poljoprivrede kao alternativnog pristupa u savremenoj poljoprivredi i značaj BD preparata na kvalitet, plodnost tla i bioraznolikost, te pozitivan uticaj na okoliš u smislu korištenja energije i efikasnosti. Akcenat je na integraciji usjeva i stoke, recikliranju hranjivih tvari za održavanje tla i zdravlju i dobrobiti usjeva i životinja, gdje i poljoprivredni proizvođač igra važnu ulogu.

Rezultati ovog rada ukazuju na sistem koji prepoznaje važnost očuvanja prirode i zdravlja ljudi kroz načine na koje se postupa prema tlu, biljkama te čovjeku koji sudjeluje u procesu proizvodnje, kao i pregled dosadašnjih istraživanja djelovanja preparata 500 na strukturu tla, mikrobiološku aktivnost, procenat humusa, regulaciju pH vrijednosti, te na topivost minerala u dubljim slojevima tla.

Ključne riječi: biodinamička poljoprivreda, kvalitet i plodnost tla, bioraznolikost, održivost

Poster. Section: Agronomy