



**Josip Juraj Strossmayer University of Osijek**

in collaboration with

**International Federation of Environmental Health (IFEH)  
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# **1st International Students' GREEN Conference**

**17-18 May 2018**

**Faculty of Agriculture in Osijek  
Osijek  
Croatia**



# **ISC GREEN 2018**

**1st International Students' GREEN Conference  
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# **BOOK OF ABSTRACTS**





**Sveučilište Josipa Jurja Strossmayera u Osijeku**

u suradnji s

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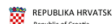
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**Plenarna predavanja / *Plenary lectures***







## WHAT IS ECOTOXICOLOGY AND WHY IS IT SO IMPORTANT TO THE ENVIRONMENT?

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Ecotoxicology is the study of the effects of chemicals on biological organisms, especially at the individual, population, community and ecosystem levels. Ecotoxicology is a multidisciplinary approach, which integrates both toxicology and ecology. It is considered by environmental scientists to be the most important factor for ensuring the protection of the environment from anthropogenic stressors. This presentation will briefly explore the world of ecotoxicology and the methods that are used to inform on the potential hazards of chemicals in the environment, and to show how these data are used within regulatory frameworks to inform about the potential risks to the environment. Several examples of the possible effects of different classes of chemicals in the aquatic environment will also be presented.



## MJESTO ČOVJEKA U SVEMIRU

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Čovjek je samo jedna od mnogo milijunâ vrsta koje su živjele i žive na našem planetu, no prva vrsta koja ima izgleda da se proširi svemirom. Hoće li čovjek nastaniti svemir ili će prouzrokovati još jedno masovno izumiranje, šesto po redu? Po čemu je čovjek jedinstven, a opet podložan istim zakonima prirodnog odabiranja kao sve živo na našem planetu; što povezuje kemijsku, biološku i povijesnu evoluciju; kako se životinjske vrste, pa tako i vrsta *Homo sapiens* prilagođuju promjenama okoliša – sve su to pitanja na koja ću ponuditi odgovore na ovom predavanju, a reći ću nešto i o pitanju svih pitanja: „Jesmo li sami u svemiru?“

## MAN'S PLACE IN THE UNIVERSE

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Man is just one of many millions of species that lived and still live on our planet, but the first species that is likely to expand throughout the universe. Will man inhabit the universe or cause yet another mass extinction, the sixth in a row? What makes man unique, yet subject to the same laws of natural selection as all forms of life on our planet; what links chemical, biological and historical evolution; how animal species, including *Homo sapiens*, adapt to environmental changes - these are all the questions I will offer the answers to in this lecture, and I will also say something about the ultimate question: "Are we alone in the universe?"



## O VREMENU, KLIMI I JOŠ KOJEČEMU...

Zoran Vakula

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Je li Hladno pivo u pravu kada pjeva: „Nije sve tako sivo“, ili nam je stanje s vremenom i klimom još „sivije“ pa TBF opravdano zaključuje: „U, nema nam pomoći“, a Rundek se pita: „Što čovjeku radi vrijeme...“. (Ne)vrijeme, prognoze, meteoalarmi, globalno zatopljenje i klimatske promjene godinama pune medijski prostor. Opravdano? Prema nekima: „Da!“, prema drugima: „Ne!“, a ima i onih s odlučnim: „Možda...“. Premda i u meteorologiji vrijedi ono: „Istina je voda duboka.“, neprijeporno je neuobičajenih vremenskih događanja – naglih zahladnjenja, zatopljenja, tuča – i uličnih i iz oblaka, olujnih vjetrova i koječega drugoga bilo i prije, ali subjektivni je dojam mnogih, koji potvrđuju i objektivne statističke analize na dugim nizovima podataka, kako su meteorološki ekstremi sve češći i žešći. Hoće li se taj trend nastaviti? Klima li se klima? Možemo li i što učiniti? U ovom radu ukratko će se predstaviti važnost i mogućnosti meteorologije, osobito prognoza i upozorenja, problematika klimatskih promjena i globalnog zatopljenja, neki mogući scenariji i posljedice, te aktivnosti koje se mogu poduzeti pokušavajući barem djelomično umanjiti problem. Pritom će se naglasiti važnost ne samo onog Donneovog: „Nijedan čovjek nije otok, sasvim sam za sebe“, nego i Lorcinog: „Zeleno, što volim zeleno...“.

## ABOUT WEATHER, CLIMATE AND MUCH MORE...

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Is Croatian band Hladno pivo right when they sing: „It's not all that gray“, or is our situation concerning weather and climate even „more gray“ so that band TBF justifiably concludes: „Oh, we are beyond salvation“, while poet Darko Rundek wonders: „What time does to a man...“. (Bad) weather, forecasts, meteoalarms, global warming and climate change have been filling media space for years. Justifiably? According to some: „Yes!“, according to others: „No!“, while there are also those who shout decisively: „Maybe...“. Even in meteorology, the old saying: "The truth runs deep" applies. It is indisputable that the unusual weather conditions - sudden coolings, warmings, hails - both from the streets and from the clouds, storm winds and whatever else – occurred before, but the subjective impression of many people, also confirmed by the objective statistical analysis on long series of data, is that meteorological extremes are getting more frequent and tougher. Will this trend continue? Is the climate „shaking“? Can we do anything about it and what? This paper will briefly present the importance and possibilities of meteorology, in particular forecasts and warnings, climate change and global warming issues, some possible scenarios and consequences, as well as activities that can be undertaken with the aim to, at least, partially reduce the problem. It will also emphasize the importance not only of Donne's words: "No man is an island, entire of itself", but also of Lorca's: "Green, how I love you green...".



## PRIMJENA MIKROSTRUKTURIRANIH UREĐAJA U RAZVOJU PROCESA

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Mikrostrukturirani uređaji imaju višestruku primjenu u biotehnologiji i medicini kao i u različitim područjima kemijske i farmaceutske industrije. Prema podacima dostupnim u literaturi, više od 50 % reakcija industrijske proizvodnje finih kemikalija i farmaceutski aktivnih komponenti može biti unaprijedeno primjenom kontinuiranih procesa temeljenih na primjeni mikrostrukturiranih uređaja, a za većinu njih (44 %) mikroreaktori će biti prioritetni izbor reaktora.

Mala dimenzija (promjer kanala u području 10 – 500  $\mu\text{m}$ ) je ključni čimbenik koji utječe na povećanje učinkovitosti procesa provedenih u mikrostrukturiranim uređajima. Veliki omjer površine i volumena, brži prijenos tvari, povećana brzina prijenosa topline i s njom povezan manji utrošak energije, učinkovita kontrola procesa, korištenje minimalnih ( $\mu\text{L}$ ) volumena sirovina i povećana produktivnost samo su neke od prednosti mikrostrukturiranih uređaja koje se obično ističu.

Iako je najveći dio reakcijskih sustava istraživanih u mikrostrukturiranim uređajima povezan s kemijskim sintezama, biotransformacije u mikroreaktorima su se također pokazale kao obećavajuća alternativa klasičnim procesima.

Primjena mikrostrukturiranih uređaja bit će prikazana na tri ogledna primjera, (i) proizvodnja heksanala katalizirana enzimom alkohol dehidrogenaza s *in situ* regeneracijom kofaktora  $\text{NAD}^+$  i separacijom produkta, (ii) ekstrakcija polifenola vodenim dvofaznim sustavima i (iii) biokatalitička proizvodnja biodizela katalizirana enzimom lakaza s integriranim pročišćavanjem produkta.

**Ključne riječi:** mikrostrukturirani uređaji, razvoj procesa, proizvodnja heksanala, ekstrakcija polifenola, proizvodnja biodizela



## APPLICATION OF MICROSTRUCTURED DEVICES FOR PROCESS DEVELOPMENT

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Microstructured devices are finding more and more applications in biotechnology and medicine as well as in different fields of chemical and pharmaceutical industry. According to the literature more than 50% of reactions in the fine chemical or pharmaceutical industry could benefit from continuous processes based mainly on microstructured devices, and for the majority (44%) a microreactor would be the preferred reaction device. The small dimension (channel diameters in the range of 10 – 500  $\mu\text{m}$ ) is a key factor that leads to increased efficiency of processes performed in microstructured devices. A high surface to volume ratio, faster mass transport, enhanced heat transfer and thus reduced energy demands, efficient process control, usage of minimal (microliters) of raw materials volumes, increased productivity, are some of a microstructured devices advantages that are usually pointed out.

Most of the reaction systems that are studied in microstructured devices are connected with chemical syntheses. However, biotransformations in microreactors proved to be a promising alternative when compared with classical processes.

Application of microstructured devices will be demonstrated in three case studies, namely, (i) alcohol dehydrogenase catalyzed hexanal production with *in situ* NAD<sup>+</sup> cofactor regeneration and product separation, (ii) two-phase aqueous extraction of polyphenols and, (iii) biocatalytic production of biodiesel using an enzyme lipase with integrated biodiesel purification.

**Keywords:** microstructured devices; process development; hexanal production; extraction of polyphenols; biodiesel production



**Usmena priopćenja / *Oral lectures***



PRIRODNE ZNANOSTI / NATURAL SCIENCES

## DETERMINATION OF THE RADON $^{222}\text{Rn}$ ACTIVITY CONCENTRATION IN BOTTLED MINERAL WATER USING LIQUID SCINTILLATION DETECTOR

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Usually, commercially available bottled mineral water is filled from groundwater sources such as springs, wells and boreholes. These sources of water normally have higher concentrations of radon than surface water from reservoirs, rivers or lakes. In this paper physical and chemical properties of radon and its short-lived progeny are described, as well as the mechanism of radon transfer through the soil in water and air. Certain conclusions on the influence of radon and radon progeny on public health are presented. The main goal of this research is to determine the radon activity concentrations in several bottled mineral waters that are commercially available in stores in Croatia. Radon activity concentrations are determined using the liquid scintillation detector TriCarb 2900 (Perking Elmer) and the appropriate dosage due to ingestion of that water are calculated. Conclusions about the used method and obtained results are given.

**Keywords:** radon in mineral water, dose, liquid scintillation detector





PRIRODNE ZNANOSTI / NATURAL SCIENCES

## REDUKCIJA KARBONILNIH SPOJEVA BIOKATALIZATORIMA IZ BILJAKA – EKOLOŠKI PRISTUP PROIZVODNJI ALKOHOLA

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S razvojem industrijske proizvodnje u drugoj polovici 20. stoljeća došlo je do ekonomskog razvoja i povećanja životnoga standarda. Nastavljajući s trendom započetim u 20. stoljeću industrije, osobito kemijska i farmaceutska, su rasle, ali s njima i količina otpada koji se ispušta u okoliš. Kemijska i farmaceutska industrija temeljene su na organskoj sintezi, stoga se javila potreba za novim „zelenim“ metodama organske sinteze. Uporaba biokatalizatora za industrijsku sintezu brojnih kemikalija sve više se ispituje kao ekološki prihvatljivija metoda organske sinteze. Jedna od reakcija u kojoj se primjenjuju biokatalizatori je redukcija karbonilnih spojeva, aldehida i ketona, do primarnih i sekundarnih alkohola. U tu svrhu ispituju se različite biljke koje posjeduju odgovarajuće enzime koji mogu u blagim uvjetima (pH, temperatura) katalizirati reakcije redukcije sa zapanjujućom kemo-, regio- i stereoselektivnošću. Same reakcije često imaju visok prinos, a količina nastalih produkata u odnosu na proizvedeni otpad je visoka (nizak E-faktor). U ovom radu opisane su reakcije bioredukcije aldehida i ketona uz upotrebu različitih biljaka (mrkva, koraba, tikvica, grah, grašak, jabuka, marakuja, itd), prikazana su iskorištenja pojedinih reakcija te enantioselektivnost reakcija.

**Ključne riječi:** karbonilni spojevi, biokatalizatori, biljke, asimetrična redukcija



## REDUCTION OF CARBONYL COMPOUNDS BY BIOCATALYSTS FROM PLANTS - ECOLOGICAL APPROACH TO ALCOHOL PRODUCTION

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With the development of industrial production in the second half of the 20th century, economic development and living standard was increased. Continuing with the trend from the 20th century, industries especially chemical and pharmaceutical continued to grow, but their growth meant also the growth of the amount of waste released into the environment. Chemical and pharmaceutical industries are based on organic synthesis, therefore it was needed to find new "green" organic synthesis methods. Usage of biocatalysts for industrial synthesis of numerous chemicals is increasingly being considered as an ecologically more acceptable method for organic synthesis. One of the reactions where biocatalysts are applied is the reduction of carbonyl compounds, aldehydes and ketones, to primary and secondary alcohols. For this purpose, various plants that possess appropriate enzymes which can in mild conditions (pH, temperature) catalyze reduction reactions with stunning chemo-, regio- and stereoselectivity are tested. These reactions often have high yields and the amount of produced products compared to the produced waste is high (low E factor). In this paper, reactions of bioreduction of aldehydes and ketones by using different plants (carrots, rhizomes, flakes, beans, peas, apples, marachi, etc.) are described, yields of individual reactions and enantioselectivity of reactions are shown.

**Keywords:** carbonyl compounds, biocatalysts, plants, asymmetric reduction



PRIRODNE ZNANOSTI / NATURAL SCIENCES

**INTEGRIRANI ODGOVOR BIOMARKERA ZA PROCJENU  
FIZIOLOŠKIH ODGOVORA NA STRES INDUCIRANIM  
OKOLIŠNIM KONCENTRACIJAMA KOFEINA  
U MEDITERANSKOJ DAGNJI  
*MYTILUS GALLOPROVINCIALIS***

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Kofein pripada u novi tip zagađivača koji je široko rasprostranjen u svijetu, a osobito u obalnim vodama morskih ekosustava. Iako se u prirodi učinkovito uklanja njegov većinski dio zbog visoke stope biodegradacije, još uvijek se istražuje učinak pri koncentracijama koje nemaju izravan utjecaj na organizme već predstavljaju izloženost prema mogućnosti budućeg stresa. Standardni ekotoksikološki pristupi ne mogu pružiti pouzdanu procjenu zbog čega se njegov utjecaj proučava upotrebom različitih skupina biomarkera.

U ovom radu istraživana je utjecaj izloženosti kofeina koncentracije 5, 50 i 500 ng/L tijekom 7 dana kod dagnje *Mytilus galloprovincialis*. Mjerena je koncentracija kofeina u samom tkivu dagnje, lizosomalni parametri (stabilnost lizosomalne membrane u hemocitima, razina nezasićenih neutralnih lipida iz probavne žlijezde, razina lipofuscina, omjer volumena lizosoma i citoplazme); peroksidacija lipida (oksidativni stres), aktivnost acetilkolinesteraze te razine primarnog oštećenja DNA. Integracijom izmjerenih parametara utvrđena je niska razina stresa pri nižim koncentracijama kofeina, dok je najveća koncentracija kofeina uzrokovala smanjenje stabilnosti lizosomalne membrane, nakupljanje neutralnih masti i povećanu razinu antioksidativnih enzima. Integrirani pristup praćenja promjena fiziološkog stanja organizma pruža cjelovitu sliku o stupnju utjecaja stresa na morske beskralješnjake.

**Ključne riječi:** kofein, integrativni odgovor biomarkera, dagnja



PRIRODNE ZNANOSTI / NATURAL SCIENCES

**USE OF AN INTEGRATED BIOMARKER-BASED STRATEGY TO  
EVALUATE PHYSIOLOGICAL STRESS RESPONSES INDUCED BY  
ENVIRONMENTAL CONCENTRATIONS OF CAFFEINE IN THE  
MEDITERRANEAN MUSSEL *MYTILUS GALLOPROVINCIALIS***

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Caffeine is an emerging contaminant that is widespread in the aquatic systems, especially in the coastal waters of marine environments. Although naturally caffeine has high biodegradation rates, its effect is still being investigated at concentrations that have no direct impact on the marine organisms but present a potential of future stress. Standard approaches cannot provide a reliable estimate, which is why its impact is studied using different groups of biomarkers.

In this study, the effect of 5.50 and 500 ng/L caffeine on mussel *Mytilus galloprovincialis* was investigated during 7 days. The concentration of caffeine in mussel tissue was measured in addition to lysosomal parameters (lysosomal membrane stability in haemocytes, levels of unsaturated neutral lipids from the digestive gland, lipofuscin levels, lysosomal volume ratio and cytoplasm); lipid peroxidation (oxidative stress), acetylcholinesterase activity and primary DNA damage level. Integration of the measured parameters revealed a low level of stress at lower caffeine concentrations, while the highest caffeine concentration caused a decrease in the stability of the lysosomal membrane, the accumulation of neutral lipids and an increased level of antioxidant enzymes. An integrated biomarker-based strategy provides a complete response of the degree of stress on marine invertebrates.

**Keywords:** caffeine, integrated biomarker-based strategy, mussel



PRIRODNE ZNANOSTI / NATURAL SCIENCES

## KAKO KLIMATSKE PROMJENE UTJEČU NA IHTIOFAUNU JADRANSKOG MORA?

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Posljednjih godina su u Jadranu utvrđene nove vrste riba u različitim razvojnim stadijima. Radi se pretežno o termofilnim vrstama, koje preferiraju toplija mora. Nadalje, vrste uobičajene za južni dio Jadrana pomiču se sjevernije te su sve prisutnije u ribarskim lovinama tih područja. Stručnjaci objašnjavaju kako se zbog povećane brojnosti novih vrsta, Jadran nalazi pod utjecajem procesa „tropikalizacije“. Porast temperature i promjene u kemijskom sastavu mora pomažu uspostavljanju njihovih populacija. Određene vrste utvrđene su jednom ili nekoliko puta te još uvijek nije izvjesno jesu li stalni stanovnici ili samo povremeni gosti Jadrana. Putevi unosa brojnih vrsta još su uvijek nepoznati. Mnogi od njih su „lesepsijski migranti“, vrste koje su migrirale iz Crvenog mora kroz Sueski kanal. Osim ovim putem, neke su vrste unesene balastnim vodama, pomorskim transportom, bijegom ili uvođenjem novih vrsta u marikulturu. Kao putevi širenja spominju se i morske struje, koje s Otranta, uz nakupine smeća, najvjerojatnije donose i različite razvojne stadije novih vrsta. Za determinaciju novopridošlih vrsta te utvrđivanje njihovoga zemljopisnog podrijetla, uz klasične metode se sve češće rabe i molekularne. U ovom su radu prikazane nove vrste riba u Jadranu, promjena prostorne distribucije već prisutnih, mogući učinci na morski ekosustav te potencijalna mogućnost gospodarskoga iskorištavanja pojedinih vrsta.

**Ključne riječi:** klimatske promjene, termofilne vrste, Jadransko more



PRIRODNE ZNANOSTI / NATURAL SCIENCES

## HOW DO CLIMATE CHANGES AFFECT THE ADRIATIC ICHTHYOFAUNA?

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In recent years, new species of fish in different stages of development have been identified in the Adriatic Sea. Those found are mainly thermophilic, species that prefer warmer water. Additionally, species common to the southern Adriatic are moving northward, and proof of this migration is found most often in the regional fishing catch. Experts explain, that due to the increased number of new species, the Adriatic is affected by the process "tropicalization". Rising water temperatures and changes in the chemical composition of sea water help establish their populations. Certain species have been identified intermittently, so it is still not certain whether they are permanent residents or occasional guests of the area. It is also unknown how certain species enter the area. Many are "Lessepsian migrants", species that have migrated from the Red Sea through the Suez Canal. Other feasible means include introduction by ballast water, maritime transport, or through mariculture. Another possible migration path is likely to bring different developmental stages of new species along with accumulations of litter that transported by water currents from Otranto. Along with the classical methods, molecular methods are increasingly used for the identification of newly arrived species and help determine their geographical origin. This paper presents some new species of fish in the Adriatic, their possible effects on the marine ecosystem, the potential for economic exploitation, and changes in the spatial distribution of already existing affected species.

**Keywords:** climate changes, thermophilic species, Adriatic Sea



## UTJECAJ BUKE NA ZDRAVLJE ČOVJEKA

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Izlaganje djelovanju buke nosi sa sobom rizik za zdravlje. Utjecaj buke na zdravlje ljudi može biti izravan i neizravan. Cilj je rada bio pregledom dostupnih znanstvenih istraživanja prikazati utjecaj buke na auditorne i najčešće neauditorne manifestacije kod stanovništva koje je izloženo buci u životnoj sredini.

Istraživanja su pokazala da su u porastu neauditorni učinci koji utječu na ljudsko zdravlje. Opservacijske i eksperimentalne analize pokazuju da izlaganje buci dovodi do stresa, poremećaja sna, potrebe za spavanjem tijekom dana, pogoršava kronična oboljenja ležećih pacijenata, povećava učestalost hipertenzije i kardiovaskularnih oboljenja. Buka dovodi do promjena krvnog tlaka, frekvencije pulsa i disanja, povećava se razina serumskoga kolesterola, kao i lučenja adrenalinskih hormona te stvara povećan rizik za infarkt miokarda. Istraživanja pokazuju da je tri četvrtine mladih koji redovno slušaju preglasnu glazbu u opasnosti od trajnoga oštećenja sluha, a oko 15 % ih već ima oštećen sluh. Zagađenje bukom veoma je rašireno i nameće dugoročne posljedice za zdravlje ljudi.

**Ključne riječi:** buka, utjecaj na zdravlje ljudi, auditorne i neauditorne manifestacije



## THE IMPACT OF NOISE ON HUMAN HEALTH

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Exposure to noise is a risk to health. The impact of noise on human health can be direct and indirect. The aim of this study was to review the available scientific studies that examine the influence of noise on auditory and most often non-auditory manifestations in populations exposed to noise in the environment. Studies have shown that non-auditory effects on human health are increasing. Observational and experimental analyzes show that exposure to noise leads to stress, sleep disorders, sleeping needs during the day, exacerbates chronic illness of lying patients, increases the incidence of hypertension and cardiovascular disease. The noise causes blood pressure changes, pulse and breathing frequencies, increases serum cholesterol levels, and increases adrenal hormone levels, and creates increased risk for myocardial infarction.

Studies have shown that three quarters of young people that regularly listen to loud music are in danger of permanent hearing damage, and about 15% already have hearing already impaired. Noise pollution is very widespread and imposes long-term consequences on human health.

**Keywords:** noise, impact on human health, auditory and non-auditory manifestations





## ZAJEDNICA TRZALACA (CHIRONOMIDAE, DIPTERA) U SEDIMENTU UMJETNIH VODENIH TIJELA

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Makrozoobentos su vodeni beskralježnjaci veći od 500  $\mu\text{m}$ , makroskopski vidljivi, koji većinu svoga života provode na samom dnu. Ličinke trzalaca (Chironomidae, Diptera) su često najbrojniji predstavnici makrozoobentosa, ključna su komponenta hranidbenih mreža i indikatori stanja i kvalitete vodenih tijela. Vrlo su prilagodljivi i naseljavaju sve tipove vodenih staništa.

Krajem kolovoza te početkom rujna 2016. godine, provedeno je istraživanje u akumulacijama Jošava (srednja dubina 1 m) i Pakra (srednja dubina 2,7 m). U svakoj akumulaciji, na dva lokaliteta, bentos je uzorkovan ručnom mrežom okvira 25 cm x 25 cm, veličine pora 500  $\mu\text{m}$  na četiri različite dubine, uz iznimku lokaliteta akumulacije Pakra-2, gdje je uzorkovano na dvije dubine. U laboratoriju su organizmi izolirani iz sedimenta i pripremljeni za determinaciju. Također, određeni su i fizikalno-kemijski parametri vode (npr.  $\text{O}_2$ , pH, nitrati, KPK, TSS).

Na lokalitetu Pakra-1 najbrojnije su dvije svojte potporodice Orthoclaadiinae *Cricotopus intersectus* i *Cricotopus* gr. *sylvestris*. Također, u značajnom broju, na lokalitetu Pakra-2 pronađen je predstavnik potporodice Chironominae *Cladotanytarsus* sp. Oba lokaliteta Jošave karakterizira puno manji broj jedinki, nego u Pakri, s najbrojnim svojutama *Glyptotendipes pallens* agg. te *Parachironomus* gr. *arcuatus*.

Razlike u strukturi zajednice trzalaca istraživanih akumulacija, uz izmjerene fizikalno-kemijske parametre, mogu biti dobri pokazatelji kakvoće vode.

**Ključne riječi:** makrozoobentos, akumulacije, Chironomidae, raznolikost



## CHIRONOMID (CHIRONOMIDAE, DIPTERA) ASSEMBLAGES IN THE SEDIMENT OF MAN-MADE WATERBODIES

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Macrozoobenthos are aquatic invertebrates larger than 500 $\mu$ m, which spend most of their lives at the bottom substrate. Chironomidae larvae are often most abundant representatives of macrozoobenthos, crucial component of food-webs and indicators of water quality. They are very adaptable and live in all types of aquatic habitats.

At the end of August and beginning of September 2016, benthos was sampled with a hand net (25cm x 25cm, 500 $\mu$ m mash) in two reservoirs, Jošava (medium depth 1m) and Pakra (medium depth 2.7m). Each reservoir was sampled at two locations and at 4 different depths, except at Pakra-2 with 2 different depths sampled. In the laboratory, sampled invertebrates were isolated and prepared for the identification. Also, we analysed physico-chemical parameters of waters (e.g. O<sub>2</sub>, pH, nitrates, COD).

At Pakra-1, the most abundant taxa were *Cricotopus intersectus* and *Cricotopus* gr. *sylvestris* (subfamily Orthocladiinae). *Cladotanytarsus* sp. (subfamily Chironominae) was found in a significant number at the locality Pakra-2, while at both Jošava localities, we found much lower number of individuals, with *Glyptotendipes pallens* agg. and *Parachironomus* gr. *arcuatus* as the most abundant taxa.

Differences in chironomid assemblages' structure, along with the differences of physico-chemical parameters, could be used as indicators of water quality.

**Keywords:** macrozoobenthos, reservoirs, Chironomids, diversity



PRIRODNE ZNANOSTI / NATURAL SCIENCES  
**ZNANJE, STAV I PRAKSA GRAĐANA O ZDRAVSTVENOM I  
EKOLOŠKOM ZNAČAJU VODE**

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Voda je osnovna životna namirnica bez koje nema života, a o njezinom značaju ne zna se dovoljno. Cilj je rada ocijeniti znanje, stav i praksu o zdravstvenom i ekološkom značaju vode građana Sarajeva i potrebu za promocijom u ovom području.

U istraživanju je sudjelovalo 272 ispitanika izabranih metodom slučajnog izbora, a anketiranje je provedeno u okviru promocije i obilježavanja 22. ožujka - Svjetskog dana voda 2018. godine.

Vodu u odnosu na druge napitke konzumira 85,7 % ispitanika. Iako 91,5 % ispitanika smatra da redukcije vode mogu imati negativan utjecaj na zdravlje, ipak 76,1 % ispitanika daje prioritet vodi iz vodovoda. Većina ispitanika ne zna šta su ftalati (93,0 %) i trihalometani (88,6 %), a 45,2 % ispitanika nije navelo niti jedno oboljenje koje se prenosi vodom. Racionalan odnos prema potrošnji vode je nezadovoljavajući: 69,5 % ispitanika štedi vodu, dok je prijedloge za zaštitu voda dalo 77,2 % ispitanika.

Zaključuje se da znanje, stav i praksa građana o vodi na području grada Sarajeva nije zadovoljavajući, što opravdava provođenje preventivnih edukativnih programa i promocije.

**Ključne riječi:** voda, redukcije vode, štednja vode, promocija zdravlja



PRIRODNE ZNANOSTI / NATURAL SCIENCES

## KNOWLEDGE, ATTITUDE AND PRACTICE OF CITIZENS ON HEALTH AND ECOLOGICAL IMPORTANCE OF WATER

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Water is essential substance for life and its significance is not known enough. The aim of this study was to evaluate the knowledge, attitude and practice on the health and ecological importance of water among citizens of Sarajevo and the need for promotion in this field.

The survey involved 272 respondents selected by random selection method, and the survey was conducted within the promotion and celebrating 22<sup>nd</sup> of March -World Water Day in 2018.

85.7% of the respondents consume water rather than other beverages. Although 91.5% of respondents believe that water reductions could have a negative impact on health, 76.1% of respondents prioritize tap water. Most of respondents do not know what are the phthalates (93.0%) and trihalomethanes (88.6%), and 45.2% of the respondents did not report any diseases that could be transmitted by water.

The rational attitude towards water consumption is unsatisfactory, 69.5% of the respondents save water, while 77.2% of respondents submitted proposals for water protection. It is concluded that the knowledge, attitude and practice on water in the area of the city of Sarajevo is not satisfactory, which justifies the implementation of preventive and educational programs and promotion.

**Keywords:** water, water reduction, water saving, promotion of health



PRIRODNE ZNANOSTI / NATURAL SCIENCES

## COMPARISON OF SEVERAL METHODS FOR THE DETERMINATION OF THE RADON $^{222}\text{Rn}$ ACTIVITY CONCENTRATION IN DRINKING WATER

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In many countries, drinking water is obtained from groundwater sources such as springs, wells and boreholes. These sources of water normally have higher concentrations of radon than surface water from reservoirs, rivers or lakes. In this paper physical and chemical properties of radon and its short-lived progeny are described, as well as the mechanism of radon transfer through the soil in water and air. Some conclusions on the influence of radon and radon progeny on public health are presented. The main goal of this work is to determine the radon activity concentrations of drinking water samples and the appropriate dose due to ingestion of that water. In experimental part of this work several methods of radon measurements in water are described (alpha spectrometer, gamma spectrometer, ionization chamber and liquid scintillation detector) and results are presented. Conclusions about the methods used, the obtained results and discussion of the performances of all used methods are given.

**Keywords:** radioactivity, radon in drinking water, dose, alpha spectrometer, gamma spectrometer, ionization chamber, liquid scintillation detectors



## ZAGRIJAVANJE ZEMLJINE POVRŠINE

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Toplinska jednadžba ili jednadžba provođenja topline je u matematici poznata kao poseban slučaj paraboličke parcijalne diferencijalne jednadžbe. Temelji se na osnovnom fizikalnom zakonu: Fourierovom zakonu provođenja topline, a uz zadane početne i rubne uvjete ima jedinstveno rješenje.

Cilj predavanja je predstaviti jednodimenzionalnu (1D) toplinsku jednadžbu i objasniti njezinu ulogu u problemu zagrijavanja Zemljine površine.

Nakon objašnjenja osnovnih pojmova vezanih za toplinu (kondukcija topline, specifični toplinski kapacitet, koeficijent toplinske vodljivosti, toplinska difuzija), ukratko ćemo objasniti izvod 1D jednadžbe topline, a zatim objasniti metode njezinog rješavanja.

Glavni dio predavanja odnosi se na predstavljanje i analitičko rješavanje 1D jednadžbe topline kojom se opisuje proces zagrijavanja Zemljine površine.

Kao specijalne primjere, navest ćemo problem određivanja idealne dubine vinskog podruma i problem toplinske difuzije podzemnih stijena. Rješenja ćemo tražiti u analitičkom i numeričkom obliku, a za ilustraciju ćemo koristiti programske pakete Mathematica i Matlab.

**Ključne riječi:** parcijalna diferencijalna jednadžba, toplinska jednadžba, Fourierov zakon, toplinska difuzija



## HEATING OF THE EARTH'S SURFACE

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In mathematics the heat equation is known as a special case of a parabolic partial differential equation. It is based on Fourier's law, which is the basic law of physics, and with given initial and boundary conditions, its solution is unique.

The goal of this lecture is to present the one-dimensional (1-D) heat equation and to explain its application in the problem of heating of the Earth's surface.

After defining basic terms related to the notion of heat (heat conduction, specific heat capacity, thermal conductivity, thermal diffusivity), we will briefly explain the derivation of the 1-D heat equation, and then explain the methods for finding the solution.

The main part of the lecture is devoted to the representation and providing an analytical solution to the one-dimensional heat equation which describes the process of heating of the Earth's surface.

We will concentrate on specific examples: the ideal wine cellar depth problem and the problem of thermal diffusivity of subsurface rocks. Solutions will be presented in both analytical and numerical form with the help of technical computing systems such as *Mathematica* and MATLAB.

**Keywords:** partial differential equation, heat equation, Fourier's law, thermal diffusivity



## REDUCING THE LEVEL OF SOIL EROSION BY USING GAP

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As a result of antropogenous factors, the natural pace of soil erosion in all of its forms has been dramatically increased turning erosion into a global problem which directly dictates society's sustainable development and the condition of all life-crucial factors – land, water, biodiversity and air. Soil erosion is the change of the upper layer of the earth landscape caused as a result of rain, snow, ice, temperature differences, wind, running waters and human- caused factors. This degrades, destroys and completely alters the state of the soil, causing it to be no longer fertile or operable. The consequences both for humans and the nature are devastating – it is considered that entire ancient civilizations have vanished because of it, and in today's world, it causes a higher level of migration and poverty than wars do. Because the promotion of all elementary economical branches are directly dependent on this phenomenon – such as agriculture, water managment, forestry, energetics, traffic, urban and spatial planning and the environment, it is evident that introducing new practices in these fields is the way to tackle the issue. As agriculture accounts for a significant percentile in every country's economy, if we were to shift to GAP (Good Agricultural Practices), we would witness a staggering 43% decline in the pace of soil erosion.

**Keywords:** soil, erosion, GAP





PRIRODNE ZNANOSTI / NATURAL SCIENCES

## ISTRAŽIVANJE ZNANJA VLASNIKA OBITELJSKO POLJOPRIVREDNIH GOSPODARSTAVA O ZBRINJAVANJU OTPADA ŽIVOTINJSKOG PODRIJETLA

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Zbrinjavanje životinjskoga otpada u Republici Hrvatskoj još je uvijek vrlo osjetljiva tema, zbog različitih razloga poput: mnogih divljih odlagališta ubijenih životinja, bacanja životinjskog konfiskata, uvoza životinja bez ušnih markica, needuciranosti populacije te nejasnih procedura o zbrinjavanju životinjskoga otpada. Veliki veleposjednici i stočari su donekle upoznati i informirani o proceduri odvoza lešina i konfiskata. Za obične građane ili one koji se tek počinju baviti poljoprivredom, cijeli je postupak prilična nepoznanica. U radu su prikazani rezultati istraživanja na temu koliko su vlasnici obiteljskih poljoprivrednih gospodarstava (OPG-ova), upoznati sa zakonskom regulativom o načinu postupanja sa životinjskim lešinama i otpadom životinjskoga podrijetla te svjesni zagađenja okoliša, ukoliko se ne pridržavaju zakona kao i od kojih nadležnih institucija dobivaju informacije. Istraživanje je provedeno na području Krapinsko-zagorske županije, na broju od 20 različitih OPG-ova, koji su podijeljeni bez obzira na broj uzgojenih životinja u 4 kategorije prema uzgoju životinja kojima se bave; na uzgajivače svinja, goveda, pilića te purana. Istraživanje je provedeno pomoću anketnoga upitnika, a rezultati ukazuju da su vlasnici OPG-ova odgovorni u onoj mjeri koliko sam zakon u pravilu traži od njih.

**Ključne riječi:** otpad životinjskoga podrijetla, obiteljsko poljoprivredno gospodarstvo (OPG), zakonska regulativa



PRIRODNE ZNANOSTI / NATURAL SCIENCES

## RESEARCH ON HOW KNOWLEDGEABLE AND INFORMED THE OWNERS OF FAMILY AGRICULTURAL FARMS ARE ON THE TOPIC OF ANIMAL ORIGIN WASTE TREATMENT

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Animal waste disposal in Croatia is still a very sensitive issue for various reasons, such as many wild animal landfills, animal confiscation, animal imports without ear tags, population inadequacy and unclear procedures for animal waste disposal. The great ambassadors and cattle-breeders are somewhat acquainted and informed about the procedure of carcase and confiscation. For ordinary builders or those who are just starting to engage in agriculture, the whole process is quite unknown. The paper presents the results of the research on how the owners of family farms (OPGs) are familiar with the legal regulations on the treatment of animal carcasses and the waste of animal origin and the awareness of environmental pollution if they do not comply with the law as well as the competent authorities' institutions receive information. The survey was conducted in the Krapina-Zagorje County, on the number of 20 different OPGs, which were divided regardless of on the number of animals reared in 4 categories according to the breeding of the animals they deal with; to breeders of pigs, cattle, chicks and turkeys. The survey was conducted using a questionnaire survey, and the results indicate that OPG owners are responsible to the extent that law as a rule requires them.

**Keywords:** waste of animal origin, family farm (OPG), legislation



PRIRODNE ZNANOSTI / NATURAL SCIENCES

## COLORX: MODIFICIRANA KOLORIMETRIJSKA METODA ZA KVANTITATIVNU ANALIZU U JEDNOSTAVNIM SUSTAVIMA

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Razvijena je metoda kolorimetrijskog određivanja različitih kemijskih analita na temelju aditivnog modela boja (RGB, eng. *Red, Green, Blue*) procesiranjem slika. Različite RGB vrijednosti omogućuju široki raspon boja koje u konačnici mogu poslužiti u kolorimetrijskom mjerenju.

Ova studija prikazuje jednostavnu, brzu i novčano prihvatljivu metodu kvantitativnoga određivanja pojedinih kemijskih analita. Za potrebe mjerenja dizajnirana je posebna okolina kako bi se reducirali i optimizirali izvanjski utjecaji. Razvijena je aplikacija kojom je omogućeno procesiranje podataka regresijskom analizom dobivenih iz snimki digitalne kamere. Program je kreiran programskim jezikom *Visual Basic*. Odvojeni RGB kanali omogućuju selektivnije korištenje podataka u svrhu dobivanja osjetljivijeg mjerenja.

Cilj kreiranja ove aplikacije je prezentirati jednostavan model koji omogućuje kolorimetrijsku analizu i može poslužiti u praktične i edukacijske svrhe. Aplikacija je testirana na otopinama kalijeva permanganata u koncentracijskom području od  $1 \cdot 10^{-4}$  do  $1 \cdot 10^{-3}$  mol dm<sup>-3</sup> te je pokazana linearna ovisnost. Daljnji razvitak aplikacije otvara mogućnosti kolorimetrijske analize velikog broja kemijskih analita (kolorimetrijsko određivanje fosfata, nitrata, amonijaka) ili mjerenja pH vrijednosti kreiranjem posebnog algoritma.

**Ključne riječi:** *Windows* aplikacija, kolorimetrija, RGB, kamera



## COLORX: A MODIFIED COLORIMETRIC METHOD FOR QUANTITATIVE ANALYSIS IN SIMPLE SYSTEMS

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A new method for the colorimetric determination of various chemical analytes was developed based on additive color model (RGB; *Red, Green, Blue*) with image processing techniques. Different RGB values produce a wide range of colors which could be applicable to colorimetric measurements.

Here we present a simple, fast and effective method for quantitative determination of various chemical analytes. For that purpose, specific environment was designed and optimized to reduce and/or avoid different external factors. The application was developed to provide processing of data obtained from the camera images, and it is based on linear regression modeling. Separate RGB channels provide more selective and sensitive data processing.

The aim of this project was to develop a simple application for the colorimetric determination for both practical and educational purposes. The application has been tested over a concentration range of potassium permanganate solutions from  $1 \cdot 10^{-4}$  to  $1 \cdot 10^{-3}$  mol dm<sup>-3</sup> with resulting linear response. Further research should allow detection of multiple chemical species (including colorimetric determination of phosphate, nitrate, ammonia) or pH measurement by creating a new algorithmic solution.

**Keywords:** Windows application, colorimetry, RGB, camera



## UPOTREBA ENZIMA IZOLIRANIH IZ VOĆA ZA BIOKATALIZU INDUSTRIJSKIH SINTEZA

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Upotreba enzima kao (bioloških, bio-) katalizatora je glavna karakteristika biokatalitičkih reakcija. Enzimi su proteinske molekule, velikih molekulskih masa te vrlo visoke katalitičke moći i specifičnosti prema supstratima te sposobnosti regulacije svojih aktivnosti. Svojim iznimnim katalitičkim sposobnostima, privukli su pažnju znanstvenika koji istražuju njihovu moguću primjenu, između ostaloga i u brojnim industrijskim sintezama. Industrijske sinteze kemikalija, farmaceutika, goriva i dr. dugi niz godina kao katalizatore koriste anorganske i organske spojeve koje je vrlo teško reciklirati ili ukloniti, te su kao takvi postali vrlo štetni, najviše za okoliš. Ovaj se rad bavi izolacijom enzima iz voća (kokosa, marakuje...) te njihovom upotrebom u kemijskoj, petrokemijskoj i farmaceutskoj industriji, kao zamjenom za štetne anorganske i organske katalizatore s ciljem poboljšanja kvalitete konačnih produkata sinteza te kvalitete života na Zemlji. Uvođenjem enzima u navedene industrije došlo je do značajnog smanjenja potrebne količine otapala te otpada zaostalog tijekom i nakon sinteza.

**Ključne riječi:** enzimi, biokataliza, industrijska sinteza



PRIRODNE ZNANOSTI / NATURAL SCIENCES

## USAGE OF FRUIT ISOLATED ENZYMES AS BIOCATALYSTS FOR INDUSTRIAL SYNTHESIS

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Usage of the enzymes as (biological, bio-) catalysts is the main characteristic of biocatalytic reactions. Enzymes are protein molecules of high molecular masses with a very high catalytic power, substrate specificity and ability to regulate their activity. With their exceptional catalytic capabilities, the enzymes have attracted the scientists' attention to explore their possible application in numerous industrial synthesis. Industrial synthesis of chemicals, pharmaceuticals, fuels etc., for many years employs organic and inorganic compounds as catalysts that are very difficult to recycle or remove, and have become very harmful for the environment. Our topic deals with fruit isolated enzymes (from coconut, passion fruit...) and their usage in the chemical, petrochemical and pharmaceutical industries as a substitute for harmful inorganic and organic catalysts with the main aim of improving the quality of final synthesis products and the quality of life on the Earth. By introducing the enzymes into the before mentioned industry, a significant reduction in the required solvent amount and residual waste during and after synthesis has occurred.

**Keywords:** enzymes, biocatalysis, industrial synthesis



PRIRODNE ZNANOSTI / NATURAL SCIENCES

## AZIJSKI TIGRASTI KOMARAC (*Aedes albopictus*) - INVAZIVNA STRANA VRSTA SLAVONSKOGA BRODA

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Azijski tigrasti komarac *Aedes (Stegomyia) albopictus* (Skuse, 1894) novi je član faune Republike Hrvatske u kojoj se pojavio 2004. godine. Potječe iz tropskih šuma jugoistočne Azije iz koje se preko trgovine rabljenim automobilskim gumama te biljkom *sretni bambus*, proširio svijetom, a opstao zahvaljujući velikoj prilagodljivosti, sposobnosti preživljavanja zimskih uvjeta i agresivnosti pri osvajanju novih područja. Komarac *Ae. albopictus* u Slavanskom Brodu po prvi je puta zabilježen u lipnju 2016. godine u sklopu nacionalnog monitoringa invazivnih vrsta komaraca, a tijekom nastavka provedbe istoga projekta potvrđen je i ove godine. Zbog izuzetnog vektorskog kapaciteta za brojne virusne zarazne bolesti, *Ae. albopictus* je postao globalna javnozdravstvena prijetnja. Stoga je važno senzibilizirati javnost o invazivnim stranim vrstama komaraca i edukacijom podići razinu svijesti kod ljudi o važnosti preventivnih radnji u cilju suzbijanja i kontrole komaraca. Samo dobro informirani i odgovorni građani mogu svojim ponašanjem značajno doprinijeti smanjenju rasprostranjenosti i brojnosti komaraca na korist i zdravlje šire društvene zajednice.

**Ključne riječi:** *Aedes albopictus*, Slavonski Brod, invazivna strana vrsta, edukacija



PRIRODNE ZNANOSTI / NATURAL SCIENCES

## ASIAN TIGER MOSQUITO (*Aedes albopictus*) - INVASIVE ALIEN SPECIES OF SLAVONSKI BROD

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Asian tiger mosquito *Aedes (Stegomyia) albopictus* (Skuse, 1894) is a relatively new member of Croatian fauna, where it appeared in 2004. It originates from the tropical forests of Southeast Asia from which it has spread through the world by used car tyres and decorative lucky bamboo trade, and survived thanks to its great adaptability, ability to survive the winter conditions and aggressiveness in taking over new areas. The mosquito *Ae. albopictus* was detected for the first time in Slavonski Brod in June 2016 within the national monitoring of invasive mosquito species and during the continuation of the implementation of the same project it was confirmed this year as well. Due to exceptional vector capacity for many viral infectious diseases *Ae. albopictus* has become a global public health threat. Therefore it is important to sensitize the public about invasive alien mosquito species and educate the citizens to raise awareness of the importance of preventive actions in order to suppress and control mosquito populations. Only a well-informed and responsible citizen can significantly contribute to reducing the spread and number of mosquitoes to the benefit and health of the wider community.

**Keywords:** *Aedes albopictus*, Slavonski Brod, invasive alien species, education





## ZELENA SINTEZA SIMVASTATINA

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Simvastatin je spoj koji se ubraja u statine, skupinu lijekova koji smanjuju razinu kolesterola u krvi. Zbog velike potrošnje lijekova koji u svom sastavu sadrže simvastatin kao aktivni sastojak, veliki se naponi ulažu u modifikaciju postojećih metoda sinteze, ali i u pronalazak ekološki i ekonomski prihvatljivije organske sinteze. U ovom su radu prikazane i uspoređene tradicionalna i suvremena metoda sinteze simvastatina, s naglaskom na „zelenu“ sintezu. „Zelena“ sinteza simvastatina je inovativan kemijski proces koji teži razviti učinkovitiju i čistiju sintezu kao održivu alternativu konvencionalnim sintezama u farmaceutskoj industriji. „Zeleni“ proces sinteze i proizvodnje ostvaruje se kroz nekoliko dominantnih točaka. Tu se ubrajaju: redukcija upotrebe štetnih kemikalija, pojednostavljenje reakcije (smanjenje broja stupnjeva sinteze) te povećanje energetske učinkovitosti i atomske ekonomičnosti. Isto tako, u radu su prikazani i objašnjeni stupnjevi „zelene“ sinteze, kao i njene prednosti. Također, opisana je enzimska biokataliza lovastatina do simvastatina pomoću biosintetske aciltransferaze (LovD). LovD se nalazi u plijesni *Aspergillus terreus* i odgovorna je za prevođenje neaktivnog prekursora monakolin J kiseline u simvastatin regioselektivnim aciliranjem u prisutnosti DMB-SMMP. Na taj se način postiže više od 99% pretvorbe simvastatina iz monakolina J i to samo u jednom koraku.

**Ključne riječi:** simvastatin, tradicionalna sinteza, zelena sinteza, enzimska biokataliza



## GREEN SYNTHESIS OF SIMVASTATIN

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Simvastatin is a compound which belongs to statins, a class of drugs that lower cholesterol levels in the blood. Due to the large amount of consumed drugs that contain simvastatin as an active ingredient, great efforts are being made to modify the existing synthetic methods, and also to find ecologically and economically more acceptable organic synthesis. This paper presents comparisons of traditional and modern synthesis of simvastatin, with an emphasis on „green“ synthesis. „Green“ synthesis of simvastatin is an innovative chemical process that seeks to develop more effective and cleaner synthesis as a sustainable alternatives to conventional strategies in the pharmaceutical industry. „Green“ synthesis and production process is realized through several dominant points. This includes: reduction in hazardous chemical use, simplification of synthesis reactions (minimizing the number of synthesis steps) and increasing energy efficiency and atom economy. This paper also presents and explains steps of the „green“ synthesis and its advantages. Furthermore, the enzymatic biocatalysis of lovastatin to simvastatin was described by means of biosynthetic acyltransferase (LovD). LovD is found in mold *Aspergillus terreus* and it is responsible for conversion inactivated monacolin J acid precursor into simvastatin by regioselective acylation in the presence of DMB-SMMP. In this way, it is possible to obtain more than 99% conversion rate of simvastatin from monacolin J in a single step.

**Keywords:** simvastatin; traditional synthesis; green synthesis; enzymatic biocatalysis



PRIRODNE ZNANOSTI / NATURAL SCIENCES

**DETERMINATION OF THE RADON  $^{222}\text{Rn}$  ACTIVITY  
CONCENTRATION IN WATER FROM THE PUBLIC WATER SUPPLY  
AND PRIVATE WELLS IN SLAVONSKI ŠAMAC MUNICIPALITY  
USING LIQUID SCINTILLATION DETECTOR**

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In this part of Croatia, drinking water is usually obtained from groundwater sources such as springs, wells and boreholes. These sources of water normally have higher concentrations of radon than surface water from reservoirs, rivers or lakes. In this paper physical and chemical properties of radon and its short-lived progeny are described, as well as the mechanism of radon transfer through the soil in water and air. Some conclusions on the influence of radon and radon progeny on public health are presented. The main goal of this work is to determine the radon activity concentrations in several water samples taken from the public water supply in the Slavonski Šamac municipality. Since many households are not connected to a public water supply or are still using the private wells as well, several samples of water from the private wells are taken. Radon activity concentrations are determined using the liquid scintillation detector TriCarb 2900 (Perking Elmer) and the appropriate dose due to ingestion of that water are calculated. Conclusions about the used method and obtained results are given.

**Keywords:** radon in water, public water supply, private wells, liquid scintillation detector



## THE CHALLENGE OF GREEN CHEMISTRY

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Chemistry, together with physics, biology, geography and geology, develops thanks to the man's curiosity and his need for answers to questions about his origin, evolution, role and place in nature and universe.

Ryoji Noyori, Nobel Prize winner in Chemistry, stressed: In the 21st century, the field of chemistry will face more than just academic challenges. Indeed, our ability to devise straightforward and practical chemical syntheses is indispensable to the survival of our species. Chemistry is the only science among natural sciences with the biggest influence on different industries: agriculture, pharmacy, food, for instance Green chemistry is a new paradigm that provides solutions to contemporary, ecological and sustainable challenges.

The purpose of our paper is to discover holistic perspective of green chemistry. Our goal is to present examples of green business based on green chemistry. Methodology encompasses case studies of companies with green business.

Although the implementation of green chemistry is connected with investment, our results show that ecological and sustainable benefits are much higher than the financial costs. Our paper contributes in three ways: it spreads the knowledge and good experience, it shows long term benefits and it raises awareness of paradigm shift towards ecology and sustainability.

**Keywords:** green chemistry, green business, interdisciplinary approach, ecology, sustainability



BIOMEDICINA I ZDRAVSTVO / BIOMEDICINE AND HEALTH  
**ODVAJAMO ZAJEDNO!**

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Plastični otpad predstavlja jedno od najvećih izvora zagađenja okoliša, a samo u kućanstvima obujam plastike čini oko 30 % ukupnog otpada. Plastična ambalaža omogućuje jeftiniji i ekološki prihvatljiviji način skladištenja i transporta namirnica, ali problem predstavlja jednokratna plastična ambalaža čije recikliranje ovisi o krajnjim potrošačima. Projektom EKO ZVU grupe Zdravstvenog veleučilišta „Odvajamo zajedno“, u okviru dobivene međunarodne licence *Eco Schools* za dopinose u području zaštite okoliša, ispitivano je koliko su studenti Zdravstvenog veleučilišta spremni odvajati plastične čaše s aparata za tople napitke uvođenjem kanti za odvajanje. Za dobivanje rezultata korištene su sljedeće metode: anketni upitnici prije i nakon provođenja projekta (procjena znanja studenata o odvajanju otpada i zadovoljstvo uvođenjem kanti), uvođenje kanti za odvajanje plastičnih čaša s aparata za tople napitke, mjerenje količine odvojenih čaša u usporedbi s količinom iskorištenih čaša odnosno čaša postavljenih u aparat. Svrha je projekta utvrditi utjecaj dostupnosti adekvatnih mjesta za odvajanje na količinu odvojenog otpada, smanjiti količinu i štetnost nastalog otpada u zgradama Zdravstvenog veleučilišta Zagreb (Mlinarska cesta 38; Ksaver 209) te osvijestiti studente i djelatnike Zdravstvenog veleučilišta Zagreb koliko stvaramo otpada kad smo toga najmanje svjesni. Rezultati provedenog projekta potencijalno će poslužiti kreiranju politika očuvanja okoliša Zdravstvenog veleučilišta Zagreb te budućim aktivnostima EKO ZVU grupe.

**Ključne riječi:** Odvajanje plastičnog otpada, EKO ZVU grupa, Eco Schools



BIOMEDICINA I ZDRAVSTVO / BIOMEDICINE AND HEALTH  
**WE SEPARATE TOGETHER!**

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Making up to 30% of total household waste, plastic is among the biggest environmental pollutants. Plastic packaging provides cheaper and environment-friendly ways of food storing and transporting. However, disposable plastic packaging depends on consumer's awareness and acts, which creates an issue.

The international *Eco Schools* license holders for their environmental protection contribution, ECO ZVU Group of University of Applied Health Sciences, examined University student's readiness to separate plastic cups from coffee machines by placing the recycling bins through the "We Separate Together" project.

The following methods were used to obtain the results: conducting student surveys before and after the project implementation, setting recycling bins for plastic cups from the coffee machines and comparing the number of collected cups with those placed in the machine.

The project's aim is to assess if the availability of adequate separating sites impacts the amount of separated waste, to reduce the volume and harmfulness of the accumulated waste at two of the University's locations (Mlinarska cesta 38; Ksaver 209) and to raise awareness amongst the students and employees on waste reduction.

The project results could be used as a guidance tool for the University's environmental protection policies and future activities of the EKO ZVU Group.

**Keywords:** separation of plastic waste, EKO ZVU group, Eco Schools



BIOMEDICINA I ZDRAVSTVO / BIOMEDICINE AND HEALTH  
**WATER QUALITY - MYTHS AND EVIDENCE**

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In this case study our aim was to display the dangers of kidney health associated with drinking water quality.

The data is collected through review of published articles on the issue of water quality impact on kidney disease, as part of evidence search (evidence-based medicine). On PubMed, articles are depicted by keywords drinking water quality and kidney disease.

Published articles rarely deal with this topic. Mostly, they refer to geographically specific areas in Asia, always looking for a responsible chronic renal failure agent unknown etiology in Sri Lanka (chronic interstitial nephritis). There is evidence that water hardness is epidemiologically associated with the incidence of chronic kidney disease, as well as fluoride content.

Despite the frequent allegations of drinking water quality and kidney disease, there is not much scientific evidence to support this hypothesis. Hardness of water expressed by the concentration of calcium carbonate and higher fluoride content in drinking water is found in areas with a higher prevalence of chronic kidney disease, but wider research is needed in this area of research.

**Keywords:** drinking water quality and kidney disease, renal failure, calcium carbonate in water and kidney disease



BIOMEDICINA I ZDRAVSTVO / BIOMEDICINE AND HEALTH

**PRIMJENA MEHANIČKE DEZINFEKCIJE U SVRHU SMANJENJA  
KORIŠTENJA DEZINFICIJENSA (KEMIJSKE DEZINFEKCIJE)**

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Pojam dezinfekcija suprotan je pojmu infekcije. Provedbom postupaka dezinfekcije nastoji se maksimalno reducirati broj živih mikroorganizama na predmetima, vodi, hrani, materijalima i predmetima koji bi mogli biti izvor infekcije ili kojima bi se infekcija mogla prenositi.

Spominjanjem riječi dezinfekcija, najčešće mislimo na provođenje dezinfekcije nekim od kemijskih agensa. Iako se život suvremenog čovjeka ne može zamisliti bez kemijske dezinfekcije, treba znati da se u velikom broju slučajeva traženi zahtjevi mogu postići i drugim metodama dezinfekcije.

Dezinfekcija se može provoditi različitim fizikalnim, mehaničkim i kemijskim metodama. Najveće značenje u praksi imaju dezinfekcija čišćenjem i pranjem, dezinfekcija toplinom i dezinfekcija kemijskim preparatima.

Čišćenje i pranje vrlo su djelotvorne metode dezinfekcije. Ovim postupkom mikroorganizmi se jednostavno uklanjaju, smanjuje se njihov broj s predmeta i s površina koje se tretiraju. Prema tome, čišćenje može biti jedina i sasvim zadovoljavajuća metoda rutinske dezinfekcije jer je moguće ukloniti i razrijediti veliki broj mikroorganizama.

Cilj je ovoga rada ukazati kako se dobrom sanitacijom, odnosno, ispravnim čišćenjem i pranjem, mogu dobiti rezultati zadovoljavajuće mikrobiološke čistoće, a sve to u vidu smanjenja korištenja kemijskih dezinficijensa, te u konačnici zaštite okoliša (vode, hrane i tla).

**Ključne riječi:** dezinfekcija, mehanička dezinfekcija, dezinficijens, sanitacija, kemijska dezinfekcija





BIOMEDICINA I ZDRAVSTVO / BIOMEDICINE AND HEALTH

## APPLYING MECHANICAL DISINFECTION IN ORDER TO REDUCE USAGE OF DISINFECTANTS (CHEMICAL DISINFECTANTS)

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The term disinfection is the exact opposite of infection. Through implementation of disinfection the goal is to reduce the number of living microorganisms on various objects, in water, food and materials which could be the source or host of infectants.

By the term disinfection, we most often think about disinfection through certain chemical agents. Although the life of the modern man couldn't be fathomed without chemical disinfection, it is worth mentioning that a great number of case requirements can be met through other methods.

Disinfection can be implemented through various physical, mechanical or chemical procedures. The greatest significance is accomplished through disinfection by cleaning and washing, through heat application, and chemical methods.

Cleaning and washing are highly effective means of disinfection. This procedure removes microorganisms easily, and reduces their quantity on treated surfaces. Hence, cleaning can be the only, and completely satisfactory, method of routine disinfection because of its ability to reduce vast quantities of microorganisms.

The goal of this paper is to indicate that with proper sanitation, or proper cleaning and washing the results can be of sufficient microbiological purity, and all in the effort of reducing the usage of chemical agents, and in the bottom line, protecting the environment.

**Keywords:** disinfection, mechanical disinfection, disinfectants, sanitation, chemical disinfection



## MICROPLASTICS AND THEIR IMPACT ON THE LIVING WORLD

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Recently, concern was raised about the latest studies which indicate that microplastics are ubiquitous, and their presence is rapidly growing in the environment. Microplastics are defined as plastic with the diameter ranging from  $< 10\text{mm}$  to  $< 1\text{mm}$ , depending on the study. Increased density of microplastics has been found in the waters and sediments. Saying that, it interacts with living organisms and environment in many ways. On its surface it can adsorb potential pollutants in the water environment and/or release toxic additives. Microplastics have the potential of bioaccumulating inside the food chain starting from the most primitive organisms to the man himself as a last link. Increased concern is raised on the effect of a low dose, i.e. exposure to the toxic substance in a low dose for a longer period of time, that can potentially cause adverse effects in humans, bearing in mind that most plastics contain toxic additives such as (PCB, BPA, phthalates). Since, Croatia is the third richest country in Europe in terms of natural water resources, its important that scientific community is aware of dangerous potential that microplastics have, given the fact it's not well studied and ignorance can cost us dearly.

**Keywords:** mikroplastics, bioaccumulation, potential danger



BIOMEDICINA I ZDRAVSTVO / BIOMEDICINE AND HEALTH  
**ULOGA LEPTINA U ORGANIZMU I PERSPEKTIVE  
NJEGOVOG KORIŠTENJA U TERAPIJI**

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Pretilost i prekomjerna tjelesna težina velik su svjetski zdravstveni problem. Procjenjuje se da je u 2016. godini oko 1,9 milijardi ljudi starijih od 18 godina imalo prekomjernu tjelesnu težinu. Pretilost i prekomjerna tjelesna masa mogu uzrokovati različite zdravstvene poremećaje kao što su kardiovaskularne bolesti, diabetes, neoplazije i muskuloskeletni poremećaji. Trenutno u svijetu od diabetesa mellitusa boluje oko 150 milijuna ljudi, a procjenjuje se da će se do 2025. godine taj broj udvostručiti. To je kronična bolest koja nastaje. Kloniranje i karakterizacija leptina donijeli su ogroman napredak u razumijevanju kontrole apetita i reguliranja tjelesne mase. Istraživanjem je utvrđeno da ljudi koji boluju od pretilosti obično imaju visoke koncentracije leptina zbog rezistencije na leptin nepoznate etiologije. Ljudi s kongenitalnom deficijencijom leptina dobro reagiraju na terapiju leptinom te pokazuju gubitak tjelesne mase i redukciju masnog tkiva. Leptin također posreduje rezistenciji na inzulin kod diabetesa mellitusa tipa 2. Zbog toga postoji perspektiva za tretiranje rezistencije na inzulin leptinom.

**Ključne riječi:** leptin, pretilost, diabetes mellitus



*BIOMEDICINA I ZDRAVSTVO / BIOMEDICINE AND HEALTH*  
**THE ROLE OF LEPTIN IN THE BODY AND THE PERSPECTIVE  
OF ITS USE IN THERAPY**

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Obesity and excessive body mass are a major global health problem. It is estimated that in 2016 approximately 1.9 billion people over the age of 18 had excessive body mass. Obesity and excessive body mass can cause various health disorders such as cardiovascular disease, diabetes, neoplasia and musculo-skeletal disorders. At present, diabetes mellitus has around 150 million people worldwide and it is estimated that by 2025 this number will double. Cloning and characterization of leptin has made tremendous progress in understanding appetite control and regulating body mass. The study found that people with obesity usually have high leptin concentrations due to resistance to leptin in unknown etiology. People with congenital deficiency of leptin respond well to leptin therapy and show loss of body mass and fat tissue reduction. Leptin also mediates insulin resistance in type 2 diabetes mellitus. Therefore, there is a prospect for the treatment of insulin resistance in leptin.

**Keywords:** leptin, obesity, diabetes mellitus



BIOMEDICINA I ZDRAVSTVO / BIOMEDICINE AND HEALTH  
**IMPLEMENTACIJA PROJEKTA ZA VODU, SANITACIJU  
I HIGIJENU (VSH) U ŠKOLAMA NA PODRUČJU  
OSJEČKO-BARANJSKE ŽUPANIJE**

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Primjerenom osobnom higijenom te higijenom i sanitacijom prostora doprinijeli bismo manjem broju dijarealnih oboljenja u svijetu. Prema Svjetskoj zdravstvenoj organizaciji (SZO), u Europi dnevno umire 14 ljudi od dijareje.

Parmskom deklaracijom obratila se pozornost na higijenu i sanitaciju u školama implementacijom Regionalnog prioritetnog cilja 1. Suradnjom SZO i Zavoda za javno zdravstvo Osječko-baranjske županije. 2012. proveo se pilot projekt u dvije srednje škole u Osijeku o higijenskim navikama učenika, higijeni sanitarnih čvorova i sanitaciji. Nakon pilot projekta, od 2012. do 2016. pristupilo se nacionalnom programu Ministarstva zdravstva, Ministarstva znanosti i obrazovanja te Hrvatskog zavoda za javno zdravstvo uz potporu SZO u 200 osnovnih škola. U Osječko-baranjskoj županiji (OBŽ) sudjelovalo je 606 učenika, pri čemu je obuhvaćeno 10 osnovnih škola (5 urbanih i 5 ruralnih) u kojima je proveden inspekcijski pregled 56 sanitarnih čvora. U 2016. nastavljeno je istraživanje u OBŽ u 7 urbanih i 8 ruralnih osnovnih škola (anketirano 350 učenika i pregledano 74 sanitarnih čvora). Rezultati istraživanja ukazali su na nedostatak toaletnoga papira i sapuna u sanitarnim čvorovima i na neprovođenje programa edukacije o higijeni. Posebni problem predstavlja što pojedina djeca ne obavljaju nuždu tijekom školskog dana zbog neodgovarajuće higijene i opreme sanitarnih čvorova.

**Ključne riječi:** higijena, sanitacija, škole, WASH program



BIOMEDICINA I ZDRAVSTVO / BIOMEDICINE AND HEALTH

## IMPLEMENTATION OF WATER, SANITATION & HYGIENE (WASH) SURVEY IN OSIJEK-BARANJA COUNTY SCHOOLS

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Adequate personal hygiene, hygiene and sanitation of indoor surfaces can reduce diarrheal diseases in the world. According to the World Health Organization (WHO), 14 people in Europe die from diarrhea daily. Parma Declaration has been focused on hygiene and sanitation in schools by implementing the Regional Priority Goal 1. WHO and the Public Health Institute of Osijek-Baranja County conducted a pilot survey in 2012 in two secondary schools in Osijek on sanitation, hygiene practices of pupils and hygiene of sanitation facilities. After the pilot survey, the National Program of the Ministry of Health, the Ministry of Science and Education and the Croatian Public Health Institute has been conducted from 2012 to 2016 supported by WHO in 200 primary schools. 606 pupils from 10 primary schools (5 urban and 5 rural) have been involved in Osijek-Baranja County (OBC) and 56 sanitation facilities have been inspected. Expanded survey has been conducted in OBC in 2016. 7 urban and 8 rural primary schools were involved (350 pupils were interviewed and 74 sanitation facilities were inspected). The results pointed the lack of soap and toilet paper in sanitation facilities and the lack of adequate hygiene training. One of the major problems is that some pupils do not use sanitation facilities during the school day because of the inadequate hygiene and equipment of sanitation facilities.

**Keywords:** hygiene, sanitation, school, WASH program



TEHNIČKE ZNANOSTI / TECHNICAL SCIENCES

## UTJECAJ PREHRAMBENOG INDUSTRIJSKOG POGONA NA KVALITETU ELEKTRIČNE ENERGIJE

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Zanimanje za kvalitetu električne energije počelo je zapravo još od samoga početka uporabe električne energije. Tada se najveća pozornost pridavala iznosu opskrbnog napona, odnosno opsegu u kojem trošila mogu ispravno raditi. U osamdesetim godinama 20. stoljeća dolazi do naglog porasta primjene elektroničkih uređaja – u kućanstvima, u uslužnoj djelatnosti te u industrijskim pogonima. Elektronički nelinearni uređaji mogu izazvati brojne probleme vezane za kvalitetu opskrbnog napona, a u isto vrijeme su vrlo osjetljivi na “lošu” kvalitetu napona. Zbog toga 1989. godine počinju pripreme za izradu standarda koji će dati smjernice i ograničenja vezane za glavne pokazatelje kvalitete napona: frekvencije, amplitude, valnog oblika i simetrije trofaznog napona, a u studenom 1994. godine izlazi standard EN 50160 Naponske karakteristike električne energije iz javnih distribucijskih mreža. Posebnu pozornost potrebno je posvetiti kvaliteti električne energije u industrijskim postrojenjima jer povećani problemi često izazivaju probleme u proizvodnji, a najgorem slučaju i prekide proizvodnih procesa. Stoga se u ovom radu prikazuju rezultati mjerenja kvalitete električne energije u industrijskom pogonu za proizvodnju slatkiša, analiza (eventualnih) problema te preporuke za poboljšanja kvalitete električne energije.

**Ključne riječi:** kvaliteta električne energije, norma EN 50160, prehrambeni industrijski pogon, mjerenje i analiza kvalitete električne energije



TEHNIČKE ZNANOSTI / TECHNICAL SCIENCES

## THE INFLUENCE OF A FOOD INDUSTRIAL PLANT ON THE POWER QUALITY

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The interest in power quality has begun since the very beginning of the use of electricity. Then the greatest attention was paid to the amount of supply voltage, or the voltage range in which certain loads can work properly. In the eighties of the 20th century there was a sharp increase in the use of electronic devices - in households, in service and in industrial plants. Electronic nonlinear devices can cause numerous problems related to the quality of supply voltage and at the same time are very sensitive to "poor" voltage quality. Therefore, in 1989, preparations are being made for the development of standards that will give guidelines and limitations related to the main indicators of voltage quality: frequency, amplitude, wave form and three-phase voltage symmetry. In November 1994, the EN 50160 standard yields the electrical characteristics of electricity from public distribution network. Special attention should be paid to the power quality in industrial plants, as increased problems often cause problems in production, and worst case and breakdown of production processes. Therefore, this paper presents the results of the measurement of the power quality in the industrial plant for the production of candy, analysis of (possible) problems and recommendations for improving the power quality.

**Keywords:** power quality, standard EN 50160, food industrial plant, measurement and analysis of power quality





## POLYMERS' LIFE CYCLE AND BIOPOLYMER MATERIALS

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Progress in science and technology has resulted in the rapid development of modern society, which led to excessive consumption and even the full exploitation of some natural resources. The energy and materials needed to sustain the growth and development of the human population are largely obtained from nonrenewable fossil sources. Although positive we have the economic growth and development of society in all respects, man by its influence has led to a negative impact on the ecosystem that is globally manifested by climate change or the exploitation of non-renewable natural resources. Life Cycle Analysis (LCA) is an analytical instrument that sets the framework for analyzing the impact of any product or process on the environment. In order to assess the ecological suitability of the biopolymer, LCA life cycle analysis is carried out. LCA is an analytical instrument that sets the framework for analyzing the impact of any product or process on the environment. The aim of this paper is a brief insight into the life cycle of biopolymer materials from which polyethylene and polylactic acid is being considered.

**Keywords:** Life Cycle Analysis, polymers, biopolymer materials, environment



TEHNIČKE ZNANOSTI / TECHNICAL SCIENCES

## CHARACTERIZATION OF $Al_2O_3$ SUSPENSIONS STABILIZED WITH POLYELECTROLYTE DISPERSANT

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In this paper the procedure of preparing  $Al_2O_3$  suspension for ceramic molding by slip casting is described. To achieve suspension stability, it is necessary to add a certain type of an additive. Dispersants are one of the types of additives added to a suspension to achieve stability, but they must be added in optimal amount to achieve optimal viscosity. The research is focused on finding the optimal concentration of Darvan C-N (ammonium polymethacrylate) dispersant. During the assay, five 70% suspensions with different concentrations of dispersant were prepared: 0.4 to 1.2%. Preparation of the suspension consists of the homogenization of  $Al_2O_3$  powder with dispersant and water in the planetary ball mill, removal of the air bubbles in the ultrasonic bath, then measuring the pH value with pH meter and the rheological properties on the rotational viscosimeter. Viscosimeters record flow curves (viscosity vs. shear rate and shear stress vs. shear rate). The results are then compared to the Power-law (potential) model, the Herschel-Bulkley model and the Bingham model. From the results of rheological measurements, it was found that the  $Al_2O_3$  suspension with 0.6% Darvan C-N dispersant has the most favorable properties for ceramic molding by slip casting.

**Keywords:**  $Al_2O_3$ , dispersant, rheological properties



TEHNIČKE ZNANOSTI / TECHNICAL SCIENCES  
**INDUSTRIJSKA BAŠTINA GRADA SISKA**

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Problemi postindustrijskoga doba uvelike se očituju u arhitekturi i urbanizmu jednoga grada. Sisak kao bivše značajno hrvatsko industrijsko središte, danas obiluje ispraznom industrijskom izgradnjom čiji potencijal u većini primjera nije dovoljno istražen, pa time niti iskorišten. Na području grada identificirano je tridesetak građevina i sklopova koji su uvršteni i u *Kartu industrijske baštine Siska*, te se tim potezom pokušava osvijestiti javnost o njihovoj važnosti i mogućnostima njihove prenamjene te daljnje korištenja. Smještaj grada na važnim prometnim pravcima i u blizini sirovina potrebnih za metaluršku, naftnu ili prehrambenu industriju glavni su čimbenici njegovog razvoja do današnjeg dana, te se trebaju iskoristiti i za njegov daljnji razvoj. Jedinstvena poruka je da se u jednom gradu koji se stoljećima razvijao kao obrtnički i industrijski grad, može prepoznati prošlost, prihvatiti sadašnja realnost, ali i uhvatiti se u koštac s trenutnim stanjem da bismo znali što moramo i možemo činiti za njega u budućnosti. U Sisku već postoje neki manji ili veći projekti kojima se upravo takvi prostori ponovno aktiviraju i prenamjenjuju, te bi se ovakav pozitivan trend trebao potencirati kako bi industrijska baština sjedinila s urbanom cjelinom.

**Ključne riječi:** industrijska baština, revalorizacija, razvojni potencijal, konzervacija, revitalizacija



TEHNIČKE ZNANOSTI / TECHNICAL SCIENCES  
**INDUSTRIAL HERITAGE OF THE CITY OF SISAK**

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Problems of postindustrial era are quite remarkable within cities, i.e. their urban nuclei and architecture. The city of Sisak, one of former industrial centres in Croatia, has multiple industrial complexes which are nowadays abandoned. The potentials of most industrial buildings and complexes is not adequately researched and therefore not used. Within city area there are thirty buildings that have been identified and presented within the *Sisak Industrial Heritage Map* by City Museum Sisak, that has aim to raise awareness of their importance and present possibilities of their regeneration. The City of Sisak is located on important European traffic routes and close to sources based on which metallurgical, petroleum and food industry was developed. Those were the main factors of its development in the past, and could be in the future as well. The unique message is that in Sisak, which development was based at craftsmanship and industry, we can recognize its history, accept the present day reality and deal with current situation so that we can know better what to do for it in the future. In Sisak there are some projects already, of smaller or larger scale, that were meant to reactivate, convert and reuse such spaces, and this positive trend should be emphasized in order to bring industrial heritage together with the urban whole.

**Keywords:** industrial heritage, reevaluation, development potential, conservation, revitalization



TEHNIČKE ZNANOSTI / TECHNICAL SCIENCES

## PRIMJENA ANALIZE TOKOVA MATERIJALA U UPRAVLJANJU OTPADNIM PAPIROM U SRBIJI

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Osnovni je cilj ovoga rada prikazati trenutno stanje u upravljanju otpadnim papirom u Republici Srbiji. Uočljivo je da svijest građana nije na zadovoljavajućem nivou što se tiče odvajanja papira namjenjenoga reciklaži. To pokazuju i provedene ankete u gradu Zrenjaninu i Novom Sadu, koje mogu oslikati i opće stanje u našoj zemlji. U radu su prikazane količine papira koje se skupe na godišnjem nivou u Republici Srbiji, kao i udio papira koji se tretira. Pomoću softvera STAN i analize tijekova materijala, na temelju raspoložive količine otpadnoga papira, procijenjeno je koja se količina papira upotrebljava kao sekundarna sirovina, a koji dio odbačenoga papira završava na uređenim i neuređenim deponijama.

**Ključne riječi:** sekundarna sirovina, reciklaža, analiza tijekova materijala



TEHNIČKE ZNANOSTI / TECHNICAL SCIENCES

## USE OF MATERIAL FLOW ANALYSIS IN WASTE PAPER MANAGEMENT IN SERBIA

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The main aim of this paper is to present the current situation in the waste paper management in the Republic of Serbia. It is obvious that citizens are not conscientious enough regarding the separation of the waste paper. This is also shown by the surveys carried out in the towns of Zrenjanin and Novi Sad, which can reflect the general situation in our country. The paper presents the quantities of the waste paper that are collected on an annual basis in the Republic of Serbia, as well as the share of paper that goes to treatment. Using STAN software and material flow analysis, based on the available amount of the waste paper, it is estimated which amount of the paper is used as a secondary raw material, and which part of the waste paper are disposed on sanitary and unregulated landfills.

**Keywords:** secondary raw material, recycling, material flow analysis



## DARCYJEV ZAKON – PRIMJER UPOTREBE FIZIKALNOG MODELA

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Održivi razvoj suštinski sadrži zaštitu okoliša kao najbitniji segment. Bazično uporište svemu su prirodne i tehničke znanosti, a prvenstveno znanja o tlu i vodi te njihovoj interaktivnoj vezi. Ovaj se rad bavi problematikom protjecanja vode kroz tlo i iskazivanjem mjere toga (koeficijentom provodljivosti) u svrhu raznih inženjerskih analiza. U prvoj polovici XIX. stoljeća jedan je mladi inženjer, rješavajući problem vodoopskrbe francuskog grada Dijona, koristio pijesak kao filter za pročišćavanje vode. Pritom je osmislio i izveo prikladan izraz za opis protjecanja vode kroz pijesak. On je danas poznat kao Darcyjev zakon, a otad je generaliziran i primjenu nalazi u širokom spektru poroznih medija. Tako je postao neizostavan alat svakog inženjera hidrotehničara.

U prvom dijelu rada objašnjavaju se osnovne postavke, izvod i osnovni elementi Darcyjevog zakona. Osnovu rada predstavlja prikaz fizikalnog modela na bazi Darcyjevog zakona koji je instaliran u prostoru laboratorija Zavoda za hidrotehniku i zaštitu okoliša, Građevinskog fakulteta u Osijeku. Ovaj laboratorijski instrument (*The W3 Permeability/Fluidisation Apparatus*) omogućuje studentima građevinarstva spoznavanje suštine procjeđivanja kroz poroznu sredinu i uočavanje utjecajnih trenutaka pri izvođenju eksperimenata. Autori su proveli pripremu modela i mjerenja na njemu. U radu se detaljno opisuje provođenje eksperimenta s ciljem određivanja vrijednosti koeficijenta provodljivosti (Darcyjevog koeficijenta ili koeficijenta filtracije) za analizirani medij (vrstu poroznoga tla).

Na kraju je ukazano na praktični značaj analizirane zakonitosti, a zaključno se ističe vrijednost prikazanoga laboratorijskog instrumenta u stjecanju bazičnih hidrogeoloških znanja budućih građevinskih inženjera.

**Ključne riječi:** podzemna voda, Darcyjev zakon, koeficijent provodljivosti



## DARCY'S LAW – AN EXAMPLE OF PHYSICAL MODEL APPLICATION

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Environmental protection is the core element of sustainable development. The basic points of reference are natural and technical sciences, and primarily the scientific discoveries about ground and water and their interactive relationship. This paper deals with the problem of water flowing through the ground and with the ways of expressing the measurement for that phenomenon (hydraulic conductivity coefficient) for the purpose of various engineering analyses.

During the first half of the 19<sup>th</sup> century, a young engineer, solving the problem of water supply in the French city of Dijon, used sand as a water purifier. While doing that, he came up with a suitable expression to describe the flow of water through the sand. Today, the expression is known as Darcy's law and has since been generalized and applied on a wide range of porous media. In that way, it became an inevitable tool for every hydrotechnical engineer.

The first part of the paper explains the basic principles, the derivation and the basic elements of Darcy's law. The basis of this research paper is the representation of a physical model based on Darcy's law. The model was installed in the laboratory of the Institute for Hydrotechnics and Environmental Protection at Faculty of Civil Engineering in Osijek. This laboratory instrument (The W3 Permeability/Fluidisation Apparatus) enables civil engineering students to recognize the essence of filtering through the porous medium and to notice the important impacts while conducting experiments. The authors prepared the model and made the necessary measurements. The paper describes in detail the conduct of the experiment with the purpose of determining the hydraulic conductivity coefficient (Darcy's coefficient or filtration coefficient) for the analyzed medium (type of porous ground).

Finally, the practical significance of the analyzed law was pointed out, as well as the value of the represented laboratory instrument for future civil engineers and their acquisition of basic hydrogeological knowledge.

**Keywords:** groundwater, Darcy's law, hydraulic conductivity coefficient





TEHNIČKE ZNANOSTI / TECHNICAL SCIENCES

## PERFORMANCE ANALYSIS OF HOUSEHOLD MICROGRID WITH RENEWABLE ENERGY SOURCES

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In this paper, we have carried out the electrical performance and the cost-benefit analysis of a domestic microgrid based on renewable energy sources. The software used in this work in order to perform the simulations is Homer Pro, which enabled the modeling of microgrid and all its parameters in a period of one year, accounting the real weather conditions and usage hours of the electric loads of the building we are working with. The microgrid consists of polycrystalline photovoltaic panels, a set of batteries, the utility (depending on the case study), the load which represents a prototype house and an inverter and controller that allow us to manage the energy flows between all the elements of the microgrid. Two case studies were conducted; in first our microgrid was isolated from the electrical network and in the other we counted on its support.

**Keywords:** microgrid, PV, batteries, cost-benefit analysis, electrical performance analysis



TEHNIČKE ZNANOSTI / TECHNICAL SCIENCES

## DIDAKTIČKA OPREMA ZA UČENJE O FOTONAPONSKIM SUSTAVIMA

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Predloženi su pokusi za učenje o proizvodnji električne energije iz sunčevoga zračenja, tj. iz sunca kao obnovljivoga izvora energije, korištenjem didaktičke opreme. 24 fotonaponskih (FN) ćelija je fizički spojeno u 4 FN modula, na kojima su snimane u-i karakteristike s obzirom na jačinu svjetlosti i temperaturu, pri čemu su kao dio opreme korišteni umjetni izvor svjetlosti, te senzori za mjerenje temperature i osvijetljenosti. Snimane su i analizirane u-i karakteristike nizova pri serijskom i paralelnom spajanju više FN modula. Provedena je analiza osjetljivosti s obzirom na razmještaj i međusobno spajanje FN modula. Također, snimane su u-i karakteristike nizova prilikom zasjenjena pojedinog modula, tj. prikazan je utjecaj nailaska oblaka prilikom proizvodnje električne energije iz FN sustava.

**Ključne riječi:** obnovljivi izvori energije, fotonaponski sustavi, didaktička oprema, pokusi, učenje



## SMALL SCALE PHOTOVOLTAIC LEARNING PLATFORM

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Experiments for learning about electrical energy production from insolation, i.e. the Sun as renewable energy source are proposed by using multimedia equipment. 24 photovoltaic (PV) cells are physically connected to four PV modules, on which the  $v-i$  characteristics are recorded regarding to brightness and temperature. Embedded artificial light source, temperature and irradiance sensors are used in experiments as part of the test equipment. PV  $v-i$  strings characteristics are recorded and analysed on various parallel and series PV modules connections. Sensitivity analysis regarding to the light angle and irradiance for the purpose of determining the optimal power production, considering the arrangement and PV modules interconnections is conducted. Furthermore, the  $v-i$  strings characteristics in the case of the partly shaded are recorded, i.e. cloudiness influence on PV energy production is shown.

**Keywords:** renewable energy sources, photovoltaic system, multimedia equipment, experiments, learning



TEHNIČKE ZNANOSTI / TECHNICAL SCIENCES

## REPRODUCIBILITY AND REPEATABILITY OF THE CNC COORDINATE MEASURING MACHINE

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The requirements for precision in modern manufacturing industry has led to a situation where three coordinate CNC measuring machines are found in almost all but smallest workshops. However, majority of those machines are used as inspection tool for pass/fail tests, usually applying general rule that the measuring machine uncertainty should be no more than one-fifth (ideally one-tenth) of measured value. In this paper comparison between such rule of the thumb approach and calculated reproducibility and repeatability of the measuring machine will be described. Comparison is performed in real work environment with actual products.

**Keywords:** reproducibility and repeatability, measuring machine



## STRUJNA MREŽA – PREDODŽBA PROTOKA KROZ TLO

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Protjecanje vode kroz tlo predstavlja problematiku kojom se inženjeri bave već stoljećima. Henry Darcy, Jules Dupuit i Karl von Terzaghi istaknutiji su istraživači kod kojih je interakcija tla i vode izvukla najbolje iz njih. Njihova ostavština dobra je podloga za daljnja istraživanja i produbljivanje shvaćanja procesa i karakteristika protjecanja vode pod zemljom. Ovaj specifični inženjerski problem teži interdisciplinarnosti te zahtijeva suradnju inženjera hidrologije, hidraulike, geologije, geomehanike i geokemije.

Temeljenje brana, pregrada, općenito građevina, izgradnja retencija, akumulacija, zdenaca za vodoopskrbu i drugo zahtijevaju poznavanje procesa protjecanja vode kroz tlo. Konkretnije, traže se vrijednosti potencijala okolne vode, brzine i količine protoka koje se mogu očekivati bilo da se radi o procjeđivanju kroz građevinu ili vodi koja protječe ispod razmatranog objekta. Dosta je teško stvoriti predodžbu ovog, prirodno čestog procesa.

Rad opisuje laboratorijski instrument za uspostavu fizikalnog modela protjecanja vode kroz poroznu sredinu. Instrument (HM 169 Visualisation of Seepage Flows) je osmišljen za uspostavu raznih situacija protjecanja te vizualnom doživljaju strujne mreže, a dio je opreme laboratoriju Zavoda za hidrotehniku i zaštitu okoliša, Građevinskog fakulteta Osijek. Nadalje se u radu prikazuje priprema i provođenje eksperimenta kojim su autori simulirali tok vode kroz određeni porozni medij te definirali strujnu mrežu za zadane uvjete.

Dobiveni rezultati fizikalnog modela uspoređeni su s rezultatima numeričkog modeliranja. U zaključku se ističu mogućnosti raznih složenijih analiza i velik doprinos stjecanju predodžbe o strujnoj mreži kod studenata u okviru hidrotehničkih predmeta.

**Ključne riječi:** tok podzemne vode, strujna mreža, fizikalni model HM 169



## FLOW NETWORK – A SIMULATION OF GROUNDWATER FLOW

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The flow of water through the ground is a problem that has been occupying engineers for centuries. Henry Darcy, Jules Dupuit, and Karl von Terzaghi are some of the most prominent researchers who made the majority of their most important scientific contributions thanks to the interaction between the water and the ground. The scientific legacy of these researchers is a good basis for further research and deepening the understanding of the processes and characteristics of groundwater flow. This specific engineering problem strives for an interdisciplinary approach and requires collaboration between engineers dealing with hydrology, hydraulics, geology, geomechanics and geochemistry.

The construction of the foundations for dams, barriers and buildings in general, as well as the construction of retarding basins, storage reservoirs, water supply wells or other objects requires knowledge of the process groundwater flow. More specifically, the necessary values are the surrounding water potential, the flow rate and the flow quantity that can be expected, whether it comes to the filtering through the building or to the water flowing below the object of interest. It is rather difficult to create the notion of this naturally common process.

The paper describes a laboratory instrument for establishing a physical model of water flowing through a porous medium. The instrument (HM 169 Visualisation of Seepage Flows) is designed to simulate various flow situations and provide a visual experience of the flow network, and is part of the equipment of the Institute of Hydrotechnics and Environmental Protection at the Faculty of Civil Engineering in Osijek. Furthermore, the paper describes the preparation and the conduct of an experiment in which the authors simulated the flow of water through a certain porous medium and defined the flow network for the given conditions. The results of the physical model were compared to the results of numerical modeling. The final part represents the possibilities of various more complex analyzes and points out the great contribution to creating the notion of flow network among the students in terms of hydrotechnical courses.

**Keywords:** groundwater flow, flow network, physical model HM169



TEHNIČKE ZNANOSTI / TECHNICAL SCIENCES

## ANALIZA UTJECAJA ŽIVOTNOG KRUGA ELEKTRIČNE GRIJALICE VODE NA OKOLIŠ - SA I BEZ RECIKLIRANJA

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U radu je provedena usporedba životnog kruga električne grijalice vode sa i bez recikliranja primjenom Eco – indicator 99 metode kroz pet koraka. Analizom obaju slučajeva stječe se uvid u utjecaj životnoga kruga električne grijalice vode na ljudsko zdravlje, okoliš i resurse. Ova analiza provodi se s ciljem prepoznavanja najvećih utjecaja pojedinih komponenata, podsklopova, procesa i aktivnosti u životnom krugu električne grijalice vode, kako bi se mogla predložiti daljnja poboljšanja sa stajališta ekološkoga dizajna. Primjena Eco – indicator 99 metode u ovom radu, kao i svi popratni dijagrami i stabla životnih krugova, formirani su pomoću softvera *SimaPro 8.3.0*.

**Ključne riječi:** ekološki dizajn, okoliš, električna grijalica vode, Eco – indicator 99 metoda, životni krug proizvoda



TEHNIČKE ZNANOSTI / TECHNICAL SCIENCES

## ENVIRONMENTAL LIFE CYCLE ASSESSMENT ANALYSIS OF ELECTRIC WATER HEATER - WITH AND WITHOUT RECYCLING

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In this paper, a comparison of the life cycle of the electric water heater, with and without recycling, by using Eco-indicator 99 method in five steps, is given. By analyzing both cases, an insight into the impact of the life cycle of the electric water heater on human health, the environment and resources is gained. This analysis is carried out with the purpose to identify the biggest impacts of individual components, sub-assemblies, processes and activities in the life cycle of the electric water heater, in order to suggest further improvements from the standpoint of ecological design.

The application of the Eco-indicator 99 method in this paper, as well as all the accompanying diagrams and life cycle trees, were formed using *SimaPro 8.3.0* software.

**Keywords:** ecological design, environment, electric water heater, Eco-indicator 99 method, life cycle assessment





TEHNIČKE ZNANOSTI / TECHNICAL SCIENCES  
**ZELENI KROVOVI – NAŠA BUDUĆNOST**

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Zeleni krovovi su krovne konstrukcije prekrivene raznolikom vegetacijom. Budući da je u današnje vrijeme vidljiv trend ekstremnih klimatskih pojava kao što su suše, poplave i velike vrućine, izgradnja zelenih krovova ima veliku opravdanost. Također, značajne su prednosti zelenih krovova. Iako je gradnja ovakve krovne konstrukcije u početku skuplja, ulaganje se relativno brzo vraća kroz uštedu energije za grijanje i hlađenje te smanjenje otjecanja oborinske vode u kanalizaciju. Posredno, na ovaj se način smanjuje potreba za pročišćavanjem oborinske vode, što svjedoči o poboljšanju njezine kvalitete. U ostale prednosti zelenih krovova ubrajaju se povoljan učinak na zdravlje ljudi, smanjenje buke u urbanim sredinama, mogućnost uzgoja hrane, povećanje kvalitete zraka unutar građevine i u području gdje se nalazi zeleni krov, povećanje zaštite od požara te blagotvorno djelovanje u pogledu povećanja kvalitete života ljudi. Pravilno izveden zeleni krov, suprotno mišljenju većine, traje isto, ili čak i duže, nego konvencionalni krov. Unatoč češćoj izgradnji zelenih krovova u zemljama višeg ekonomskog standarda te razvijenijoj svijesti o održivom razvoju, zeleni krovovi ne smiju biti privilegija samo bogatih zemalja, odnosno, potrebno je specifičnim marketinškim naporima potencijalne korisnike educirati o svim navedenim prednostima.

**Ključne riječi:** izbor flore, održivi razvoj, odvodnja, ravni krov, zeleni krov



## GREEN ROOFS – OUR FUTURE

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Green roofs are roofs with various types of vegetation. Nowadays extreme climate changes, like drought, flood and high temperature are evident and therefore the construction of green roofs are highly justified. Green roofs have major benefits too. Although initially the construction itself is more expensive, the investment is relatively fast returning through energy savings for heating, cooling and reducing the drainage of precipitations into sewerage. Indirectly in this way reduces the need of precipitations treatment, the evidence of it is the quality improvement. Other benefits are beneficial effects on human health, noise reduction in urban environments, and the possibility of growing food, increasing indoor air quality, increased fire protection and beneficial effects on the quality of life. Unlike the opinion of the majority, properly constructed green roof last as long as conventional roof or even longer. Although the majority of green roofs appear in the countries with high economy standard and more developed awareness of sustainable development, green roofs must not be the rich states privilege. It is necessary to educate potential users about all the above-mentioned benefits through specific marketing efforts.

**Keywords:** selection of flora, sustainable development, drainage, flat roof, green roof



TEHNIČKE ZNANOSTI / TECHNICAL SCIENCES

SMANJENJE EMISIJA CO<sub>2</sub> U PRIMJENI ČELIKA U GRAĐEVINARSTVU

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Održiva gradnja i u sklopu nje smanjenje emisija CO<sub>2</sub> predstavljaju trend unutar kojega se osvještava društvo i konkretno pokušava smanjiti negativan utjecaj na okoliš kroz proizvodnju, transport, ugradnju, korištenje, odlaganje i uporabu materijala – životni ciklus materijala. Prema nekoliko metoda procjene utjecaja materijala na okoliš i prema zastupljenosti u građevinarstvu čelik kao materijal ima potencijal za značajna smanjenja emisija. Osnova za takva smanjenja je razmatranje utjecaja materijala kroz sve faze građevinskih projekata, uz angažman svih dionika tijekom, prije i nakon tih faza. Racionalizacija u pogledu željenoga smanjenja emisija prvenstveno je moguća primjenom optimizacijskih modela te potencijalnom uporabom otpadnih materijala u druge svrhe. U kontekstu optimizacije životnog ciklusa čelika u literaturi su poznati model transportnog problema, *product-mix* optimizacijski model, *blending* modeli, modeli za određivanje optimalnih izmjera ingota te *cutting stock* modeli. Danim pregledom primjenjivih modela kroz različite faze omogućuje se uvid u potencijale za promjenu trenutnog stanja i daju se upute za dionike na koji način mogu pristupiti promjenama. Dodatno, prikazom područja gdje se nusprodukti određenih faza mogu primijeniti, djeluje se izravno na smanjenje crpljenja prirodnih resursa i smanjenje opterećenja na postojeća odlagališta otpada.

**Ključne riječi:** održiva gradnja, okoliš, optimizacija, optimizacijski modeli, životni ciklus

REDUCTION OF CO<sub>2</sub> EMISSIONS IN STRUCTURAL APPLICATIONS OF STEEL

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Sustainable construction and within it the reduction of CO<sub>2</sub> emissions is a trend which raises social awareness and specifically tries to reduce the negative impact on the environment through production, transportation, installation, use, disposal and use of materials - life cycle of materials. According to several methods of assessing the impact of materials on the environment and their representation in construction, steel as a material has the potential for significant emission reductions. The basis for such reductions is consideration of the impact of materials throughout all stages of construction projects, with the involvement of all stakeholders during, before, and after these phases. Rationalization of the desired reduction of emissions is primarily possible by using optimization models and the potential use of waste materials for other purposes. In the context steel life cycle optimization, transport problem model, product-mix optimization model, blending models, models for optimum ingot measurement and cutting stock models are well known in published work. By reviewing applicable models through different phases, insight into potentials for changing the current state and guidance to stakeholders on how they can access these changes is given. Additionally, depicting areas where by-products of certain phases can be applied directly reduces extraction of natural resources and strain on existing landfills.

**Keywords:** sustainable construction, environment, optimization, optimization models, life cycle



TEHNIČKE ZNANOSTI / TECHNICAL SCIENCES

## REMOVAL OF CR(VI) IONS FROM AQUEOUS SOLUTIONS BY NATURAL SORBENT

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In the present study, the potential to remove Cr(VI) ions from aqueous solutions through adsorption, using pemza as a natural mineral adsorbent, was investigated. Pemza was used in its natural form, without any chemical or physical treatment. The following experimental techniques were used for pemza characterization: XRD, TGA-DTA and FT-IR. The surface area of the sorbent was measured by BET method. Determination of point of zero charge of the material is performed too. AAC method and UV/Vis spectrophotometric analysis are used for quantitative monitoring of the dynamics of the studied system regarding the presence of Cr(VI) ions in the model solutions. Different factors influencing metal adsorption such as contact time, initial metal ion concentration (0.3-0.6 mg/l), pH (1-3) and adsorbent dosage were investigated. The optimum initial pH for Cr(VI) adsorption was 1. In order to investigate the adsorption equilibrium, four isotherm models, Langmuir, Freundlich, Langmuir-Freundlich and Redlich-Peterson, were analyzed. Several kinetic models have been investigated to recognize the chromium ions adsorption mechanism onto pemza. The adsorption process was found to follow pseudo-second-order kinetic model. The results confirm the possibility of applying the natural mineral pemza as an effective low cost sorbent for the removal of Cr(VI) ions.

**Keywords:** Cr(VI), pemza, adsorption, equilibrium, kinetics



TEHNIČKE ZNANOSTI / TECHNICAL SCIENCES  
**EKOLOŠKO-TOKSIKOLOŠKE SMJERNICE OPTIMIRANJA PROCESA  
BOJENJA POLIAMIDNOG PLETIVA**

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Veliko područje primjene bojila i kemikalija očituje se u svakodnevnom čovjekovom životu, od stvari koje ga okružuju do odjeće koju nosi na sebi. Sve intenzivniji razvoj industrije i potražnja tržišta doveli su do povećanja broja zahtjeva i normi, koje se odnose na zaštitu čovjekovoga zdravlja i okoliša, kako u drugima, tako i u tekstilnoj industriji. Kao najveći uzrok onečišćenja u tekstilnoj industriji smatra se oplemenjivanje tekstila, pri čemu se posebno ističu otpadne vode nastale u procesu bojenja. Prilikom bojenja tekstilnoga supstrata može se utjecati na brojne procesne parametre kao što su izbor bojila, temperatura i vrijeme bojenja, dodatak elektrolita i dr., u svrhu što manjega onečišćenja okoliša bez smanjenja kvalitete i trajnosti proizvoda. Zahtjevi koji se postavljaju na bojila su mali stupanj onečišćenja otpadnih voda, visoki stupanj zaštite od UV zračenja, iscrpljenje bojila, postojanost obojenja, toksičnost, stabilnost, reaktivnost, tako da proizvođači prilikom plasiranja bojila i kemikalija, koje se koriste u procesu, izrađuju sigurnosne tehničke liste (STL) u kojima su sadržane upute za sigurno postupanje i mjere zaštite čovjeka i okoliša. U ovom radu ispitivat će se utjecaj kiselih bojila u industrijskom procesu bojenja poliamidnoga pletiva s naglaskom na optimiranje procesa s ciljem povećanja iscrpljenja bojila te poboljšanja kvalitete boja i njihovih uporabnih svojstava.

**Ključne riječi:** proces bojenja, iscrpljenje bojila, okoliš



TEHNIČKE ZNANOSTI / TECHNICAL SCIENCES

## ECOLOGICAL-TOXICOLOGICAL GUIDELINES FOR OPTIMIZING THE PROCESS OF DYEING POLYAMIDE KNITTING

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A large implementation area of dyes and chemicals is manifested in the everyday life of humans, from things in surrounding to the clothing people wear. Growing industry and the market demand have led to an increase in demands and norms, which are related to the protection of human health and environment in all industries including the textile industry. It is considered that the biggest pollution in textile industry is textile finishing, especially waste water in textile dyeing process. During textile dyeing, with the purpose of achieving less pollution without the reduction of quality and durability of the products, parameters such as the choice of dyes, temperature and dyeing time, electrolytes etc. can be affected. Requirements that are set on dyes are a small degree of contamination of waste water, a high degree of UV protection, exhaustion, color fastness, toxicity, stability, and reactivity. Therefore, manufacturers, before placing dyes or chemicals on market, which are used in process, makes Material Safety Data Sheets (MSDS) which contain safety treatment instructions and security measures for humans and the environment. In this paper, the influence of acid dyes in the industrial process of dyeing polyamide knitting will be studied, especially the optimization process with a view to increasing dye exhaustion and improving dye and wear properties.

**Keywords:** dyeing process, dye exhaustion, environment



TEHNIČKE ZNANOSTI / TECHNICAL SCIENCES

## COMPARATION OF PERMEABILITY CHARACTERISTICS OF FLAT SHEET CERAMIC AND POLYMERIC MEMBRANE MODULE FOR DIFFERENT AQUEOUS SOLUTIONS

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The membrane processes are trending new technologies which are used in water and waste water treatment. The application properties of different membrane types and configuration around the world have an emerging trend. In this article a ceramic and polymeric membranes permeability properties were compared. In the frame of this work membrane flat sheet modules were designed and constructed. The dimensions of the constructed submersible flat sheet modules were 40x40x4 cm (LxHxW) and 40x30x4 cm (LxHxW), each membrane module having an active filtration area of 0.11 m<sup>2</sup>. The following membrane properties were tested and compared:

- trans-membrane pressure (TMP),
- the effect of the pH value of the solution,
- the working temperature,
- the aeration effect on the specific membrane flux and permeability characteristics on the membrane module.

The results are shown in tables and graphics, and they are related to systems tested with water from the central supply (real systems).

**Keywords:** membrane, membrane configuration, modules, TMP



## CONCEPTS OF SOLAR TECHNOLOGY ON SHIPS

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Ships are undoubtedly one of the biggest contributors to air pollution on Earth. Global economy, among other, relies on marine traffic. As the economy grows, so does the number of ships. The problem of air pollution from the ships was recognized by the International Maritime Organization (IMO). The measures for air pollution reduction were introduced by International Convention for the Prevention of Pollution from Ships (MARPOL) in 1997 with Annex VI. There are various technologies that offer air pollution reduction. Bio-fuel, Liquefied natural gas (LNG), dual-fuel engines, low-sulphur fuels, internal engine modification, scrubbers and renewable energy technology are some examples of these technologies. Renewable energy technology alone offers various approaches like wind turbines, Flettner rotors, towing kites, fuel cells and photovoltaic technology. In this paper the accent is put on solar energy. Concepts and technical solutions of solar technology utilization on ships are presented in the paper. Ships with different purpose have different constructions (LNG carrier, container ship, tanker, bulk carrier) which are more or less convenient for photovoltaic panels' installation. In the paper the solar energy production is investigated for bulk carrier along with the influence on the fuel consumption reduction, i.e. air pollution reduction.

**Keywords:** solar energy, ships, air pollution, bulk carrier





TEHNIČKE ZNANOSTI / TECHNICAL SCIENCES

## EXHAUST GASES FROM SHIPS AND GREEN TECHNOLOGIES

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Emissions of harmful exhaust gases from ships have been considerably affecting marine and atmospheric environment over the last decades. Owing to new technologies, ships are getting bigger and so are their engines. Exhaust gases contain NO<sub>x</sub>, SO<sub>x</sub>, CO<sub>2</sub> and other compounds which adversely affect the environment and contribute to global warming, greenhouse effects, acid rains, and other events that reveal how serious the situation has become. International conventions (e.g. MARPOL) and national regulations have been introduced to address the problem of continuing marine environment pollution from ships. This paper gives an overview of these efforts and points out the importance of green technologies and alternative methods, in addition to raising awareness, for the benefit of our environment, quality of life and survival on the Earth.

**Keywords:** ship exhaust gases, marine environment, green technologies



## ODRŽIVI RAZVOJ U MODNOJ INDUSTRIJI

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Moda prelaskom iz moderne u postmoderanu, iz postmoderne u suvremenu, javlja se kao znak društvenih promjena. Aktualnost ekološke svijesti prožima samu modu. Očuvanje okoliša i održivi razvoj u samom su središtu zanimanja cjelokupne svjetske zajednice. Posljedice klimatskih promjena i čovjekov utjecaj na njih usko su povezane, što znači da ovise o zagađivanju i mijenjaju okoliša te korištenju prirodnih izvora. Modna industrija, objedinjujući proizvodnju tekstila, odjeće i obuće, jedan je od najvećih svjetskih zagađivača. Trend brze mode (*fast fashion*) rezultat je konzumerizma, u kojem smo dio kulta potrošnje, gdje je prolaznost jedan od vodećih pojmova današnjice. Taj fenomen obilježen je brzim ciklusima proizvodnje i jeftinoj, niskoj kvaliteti. Kao odgovor na trenutnu brzu modu, nastaje održiva moda koja obuhvaća termin spore mode (*slow fashion*). Sporu modu karakterizira trajnost, stil, dizajn i kvaliteta materijala. Potrebno je cjelovito razumijevanje održive mode i pristup mnogim razinama, uključujući ponovno korištenje, recikliranje i obnavljanje materijala, nove tehnologije izrade vlakana i savjesnu potrošnju. Ovo izlaganje donosi pregled dizajnerskih ostvarenja gdje je održiva moda imperativ budućnosti.

**Ključne riječi:** modna industrija, održivi razvoj, brza moda, održivost, spora moda



## SUSTAINABLE DEVELOPMENT IN THE FASHION INDUSTRY

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With the transition from modern to postmodern, from postmodern to contemporary, fashion appears as a sign of social change. The actuality of ecological awareness pervades fashion. Preservation of the environment and sustainable development are at the heart of the global community's interest. The consequences of climate change and man's influence on that change are closely related, which means that it depends on pollution, changes in the environment and the use of natural resources. The fashion industry, combining textile, clothing and footwear manufacture, is one of the world's largest polluters. The trend of fast fashion is the result of consumerism, in which we are part of the consumption cult, where transience is one of the leading concepts of today. This phenomenon is characterised by fast production cycles and cheap, low quality. As a response to the current fast fashion emerged sustainable fashion, which includes the concept of slow fashion. Slow fashion is characterised by durability, style, design and material quality. Complete understanding of sustainable fashion and access to many levels, including re-use, recycling and recovery of material, new fibre-making technologies and conscientious consumption are necessary. This presentation brings an overview of designer achievements where a sustainable fashion is the imperative of the future.

**Keywords:** fashion industry, sustainable development, fast fashion, sustainability, slow fashion



BIOTEHNIČKE ZNANOSTI / BIOTECHNICAL SCIENCES  
**EKOLOŠKA PROIZVODNJA HRANE**

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Ekološka proizvodnja hrane podrazumijeva uzgoj povrća, voća i žitarica pri kojemu se ne koriste suvremene agrotehničke mjere poput uporabe pesticida i umjetnih gnojiva, odnosno podrazumijeva uzgoj životinja bez upotrebe preparata veterinarske medicine. Ekološka proizvodnja hrane nadalje podrazumijeva i procesiranje sirovina do završnog prehrambenog proizvoda bez dodavanja aditiva, pojačivača okusa ili umjetnih prehrambenih boja. Tijekom prošlog desetljeća, ekološka proizvodnja hrane postala je jedna od najbrže rastućih grana gospodarstva Europske unije, a istraživanja provedena u cilju usporedbe kakvoće prehrambenih proizvoda proizvedenih konvencionalnim i ekološkim načinom proizvodnje, nepobitno ukazuju da su prehrambeni proizvodi dobiveni ekološkim načinom proizvodnje boljih nutritivnih svojstava. Također nije zanemariv niti cjelokupno smanjen utjecaj na okoliš jer se ekološkom proizvodnjom hrane osigurava bioraznolikost staništa u neposrednoj blizini uzgoja, izravno ili neizravno je smanjena potrošnja količine fosilnih goriva po jedinici proizvoda kao i količina pri proizvodnji nastalih stakleničkih plinova. Konzumacija ekološki proizvedenih prehrambenih proizvoda osigurava unos makro i mikronutrijenata u organizam što doprinosi boljem zdravstvenom stanju pojedinaca, ali i šire populacije te i na taj način utječe na očuvanje prirode.

**Ključne riječi:** proizvodnja hrane, ekološka proizvodnja, zdravlje ljudi



## ORGANIC FOOD PRODUCTION

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Organic food production involves the cultivation of vegetables, fruits and cereals without modern agrotechnical techniques such as the usage of pesticides and artificial fertilizers, as well as animal farming without the usage of veterinary medicine products. Organic food production also implies the processing of raw vegetable or animal materials to the final product without adding additives, flavor enhancers or artificial food colors.

During the past decade, organic food production has become one of the fastest growing branches of the European Union.

Various studies investigated and compared the quality of food produced by conventional agrotechnical methods with organic methods and most of them emphasized that food produced by organic methods have better nutritional value.

Beside the better quality, organic food production has an overall reduced environmental impact since absence of various herbicides and pesticides ensures the biodiversity of habitats close to plants. The consumption of fossil fuel and quantity of greenhouse gases produced during the organic food production per unit of product are also reduced.

Consumption of organically produced food provides elevated macro and micronutrient intakes which also contributes to a better health of the population and, thus, contributing to the preservation of the nature.

**Keywords:** food production, organic, human health



BIOTEHNIČKE ZNANOSTI / BIOTECHNICAL SCIENCES

**MIKROPLASTIKA U OKOLIŠU**

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Mikroplastika je naziv za čestice plastike promjera manjeg od 5 milimetara. Iako su sitne, čestice mikroplastike predstavljaju opasan oblik zagađenja kada se nađu u moru ili sedimentu. Svepristupa je u okolišu i svakodnevnom životu. Možemo je naći u raznim kozmetičkim preparatima kao npr. u zubnim pastama, pjenu za brijanje, gelovima za tuširanje i drugim sličnim proizvodima. Pojava mikroplastike uzrokuje značajne probleme u hranidbenom lancu jer se na njezinoj površini nakupljaju različite toksične tvari, a koje primjerice ribe mogu unijeti u svoj probavni trakt. Tim putem postoji mogućnost akumulacije toksina u organizmima koji žive u vodenom okolišu čime mikroplastika predstavlja opasnost za ljudski organizam. Unos mikroplastike u organizam riba i drugih životinja, koje žive u ili uz vodu, također može uzrokovati i tih organizama ili organizama koji ih nenamjerno konzumiraju.

Mikroplastika može u okolišu nastati i usitnjavanjem krupnijih komada plastike i njihovim raspadanjem uslijed djelovanja UV-zračenja, slane vode, valova i drugih abiotičkih čimbenika. Jedan od problema koje uzrokuje mikroplastika je i zagađenje izvorišta pitke vode jer sustavi za pročišćavanje otpadnih voda nemaju mogućnost otkaljanja čestica mikroplastike filtracijom. Na taj način mikroplastika dospjeva u vodne cjeline, a zagađenje mikroplastikom se smatra globalnim problemom. Napore za rješavanje ovog problema ulažu mnogobrojni znanstvenici i stručnjaci u želji da teško razgradivu plastiku zamjene novim, ekološki prihvatljivijim materijalima. U ovom radu bit će prikazani rezultati više znanstvenih istraživanja o pojavnosti mikroplastike u svijetu i pokušajima njena uklanjanja iz okoliša.

**Ključne riječi:** mikroplastika, okoliš, vode, uklanjanje



## MICROPLASTICS IN THE ENVIRONMENT

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Microplastics are plastic particles less than 5mm in diameter. Although small, microplastic particles represent a dangerous form of pollution when they end up in the ocean or in the sediments. Microplastics are present all around us, in the environment and in everyday life. We can find it in various cosmetic products, for example toothpaste, shaving creams, shower gels and other similar products. Presence of microplastics causes a significant problem in the food chain because of different toxic substances that gather on its surface, which fish, for example, can ingest into their digestive tract. There is a chance of toxins accumulating in the organisms that live in the water environment, therefore microplastics represent a danger for humans. Also, ingestion of microplastics by fish or other marine organisms or animals living by the sea can cause their injury or death, or that of other organisms that inadvertently ingest them. Microplastics can also appear in the environment due to breakdown of larger pieces of plastic and their decomposition as a result of UV radiation, salt water, waves and other abiotic factors. One of the problems caused by microplastics is the pollution of the sources of drinking water, as waste water treatment systems do not have the capability of microplastic particles removal through filtration. That way microplastic enters the bodies of water. Microplastics pollution is considered a global problem. Many scientists and experts are working on a solution to this problem, with a goal of replacing non degradable plastics with new, ecologically more acceptable materials. This paper presents the results of several researches on appearance of microplastics in the world and attempts to remove it from the environment

**Keywords:** microplastic, environment, water, removal



## MOSES AS A BIOINDICATOR OF HEAVY METAL POLLUTION

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Biomonitoring by using plants has been shown in several countries as a cost-effective tool for assessing trace element atmospheric deposition. In order to exclude the possibility of adsorption of heavy metals from the soil mosses were used because they have no roots, no cuticle, and acquire all their nutrients from direct exposure to the atmosphere. The research was conducted during 2016 when samples of *Brachythecium rutabulum* and *Hylocomium splendens* were collected during the rainy and dry (when the soil was also sampled) season from five sites in the Risnjak National Park. The trace metals Cd, Cr, Pb and Zn were analysed by inductively coupled plasma optical emission spectroscopy (HRN ISO 22036:2011), while Hg was analysed by cold-vapor atomic absorption spectrophotometry (HRN ISO 16772:2009). Measured concentrations indicate there is no strong correlation between metal concentrations in soil and mosses. In order to deduce anthropogenic or natural contributions of metals in mosses, the enrichment factors were calculated according to Salomons and Förstner (1984). Enrichment factors were less than 2 for Cd, between 3 and 5 for Cr, greater than 10 for Hg, as well as for the Pb. According to enrichment factors moss samples were highly enriched with Hg and Pb, slightly enriched with Cr, and not enriched with Cd. All the above points to the fact that moss can serve as good bioindicators of atmospheric pollution.

**Keywords:** mosses, heavy metals, bioindicators, Risnjak National Park





BIOTEHNIČKE ZNANOSTI / BIOTECHNICAL SCIENCES

## ISPIRANJE NITRATA U UVJETIMA NAVODNJAVANJA I GNOJIDBE DUŠIKOM

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Cilj je ovoga rada prikazati složen odnos između biljne proizvodnje i okoliša što je česta tema znanstvenih istraživanja u kojima se naglasak daje sustavu gospodarenja najvažnijim čimbenicima za biljnu proizvodnju, vodi i hranivima te njihovom utjecaju na okoliš. Gnojidba dušikom, koja nije provedena u skladu s pravilima struke (analiza hraniva i preporuka gnojidbe), može imati za posljedicu štetno djelovanje nitrata ( $\text{NO}_3^-$ ) i nitrita ( $\text{NO}_2^-$ ) za ljudsko zdravlje, a potom prekomjernim nakupljanjem tlu i podzemnim vodama može narušiti ravnotežu hraniva te vodenih ekosustava. Povećanjem učinkovitosti gnojidbe dušikom mogući gubitci N hraniva, te onečišćenje okoliša uslijed gubitaka, jednako kao i ekonomski gubitci mogu biti svedeni na minimum. Ispiranje nitrata izraženije je u uvjetima navodnjavanja, a posebice u sustavima intenzivne proizvodnje kao što je slučaj kod povrćarske proizvodnje. U takvim sustavima visoki su inputi N hraniva, učestala je obrada tla, a vegetacijsko razdoblje je relativno kratko pri čemu dolazi do nedovoljne učinkovitosti N gnojidbe. Nadalje u takvoj intenzivnoj proizvodnji navodnjava se velikim normama uslijed čega je povećano ispiranje hraniva. Osim norme navodnjavanja na količinu ispranog nitrata utječe obrok navodnjavanja, sustav (metoda) navodnjavanja, tip i količina N gnojiva, usjev te ostali agroekološki čimbenici.

**Ključne riječi:** ispiranje nitrata, navodnjavanje, gnojidba dušikom



BIOTEHNIČKE ZNANOSTI / BIOTECHNICAL SCIENCES

## NITROGEN LEACHING AS AFFECTED BY IRRIGATION AND NITROGEN FERTILIZATION MANAGEMENT

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The main goal of this paper is to present the complex relationship between plant production and environment what is often the subject of scientific researches with the accent put on the most important factors for plant production, water and nutrients and impact they have on environment. High rates of nitrogen fertilizers can lead to harmful effects of nitrates ( $\text{NO}_3^-$ ) and nitrites ( $\text{NO}_2^-$ ) on human health. Subsequently due to accumulation in soil and leaching in surface and ground water it causes further contamination of aquatic ecosystems. By improving N fertilization efficiency, possible N losses, environmental pollution as well as economic loss can be reduced to a minimum. The mass of nitrate percolated in soil is directly related to the volume of irrigation water, especially in intensive plant production such as in vegetable production where the high N input, frequent soil tillage, short vegetation period comes to low nitrogen use efficiency. Furthermore the amount of irrigation water in intensive agriculture is high which causes the higher rates of percolate. Beside the amount of water the amount of nitrate leached depends on irrigation method, the rate and type of N fertilizers, crop and other agroecological factors.

**Keywords:** nitrate leaching, irrigation, nitrogen fertilization



## SEQUESTERING CARBON DIOXIDE WITH MYCORRHIZAL FUNGI

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Applying biomimicry and biomimetic design methods, we developed a design for a carbon dioxide sequestering unit that is based on the symbiosis of plants and matching mycorrhizal fungi which together are capable of transferring a very high percentage of plant sugar from the plant to the fungi (fungal biomass). The fungal biomass will eventually be utilized in a way that deposits carbon into a final sink. We incorporated knowledge about the effect of nutrient conditions, moisture, and oxygen on the plant-fungus carbon transfer to maximise the rate of sequestering carbon into fungal biomass. We further suggest ways to utilize the resulting fungal and plant biomass, e.g. in building materials and other ways that can assure that the carbon trapped will not be returned to the air as carbon dioxide. The design itself is a modular unit which can be assembled into larger units of various shapes and capacities to adapt to and match the specific needs and opportunities for carbon dioxide sequestering within varying target environments.

**Keywords:** Carbon sequestration; carbon sink, arbuscular mycorrhiza; ectomycorrhizal symbiosis, utilizing carbohydrates, building materials



BIOTEHNIČKE ZNANOSTI / BIOTECHNICAL SCIENCES

## HERBICIDES APPLIED IN SOYBEAN IN INTEGRATED WEED MANAGEMENT

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The aim of this study was to determine the presence of weeds in soybean crop and the effectiveness of their suppression by integrated approach, mechanical measures using inter-row cultivation and chemical measures in combination with the inter-row cultivation. At the location of Ruski Krstur, during 2016, a split application of herbicides was applied after soybeans emerge with the addition of microbiological fertilizer. Weed species were identified by Josifović, Jávorka and Csapody, Tutin et al. The experiment with examined herbicides has been placed in order to investigate the efficacy and phytotoxicity of the herbicide (imazamox, thifensulfuron methyl). In the soybean crop, 17 weed species were determined. The applied inter-row cultivation had poor efficiency (60%) due to the subsequent emergence of the weeds. The best yield of soybean from 3.6 t/ha was achieved on the plot where chemical weed control measures were applied in combination with mechanical measures, and with a minimum of impurities from 2%. On the experimental plot, where inter-row cultivation was applied without herbicide, a slightly lower soybean yield of 3.4 t/ha was achieved with 7% of impurity, while in control, the yield was significantly lower and amounted to 2.8 t/ha with impurity of 15%.

**Keywords:** soybean, weeds, inter-row cultivation, herbicides, yield



BIOTEHNIČKE ZNANOSTI / BIOTECHNICAL SCIENCES

## IMPROVED GERMINATION OF WHEAT SEEDS BY COLD PLASMA TREATMENT

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The use of nonthermal plasma is a new approach for reducing stresses at germination and seedling stages. Plasma interacts with seeds and changes their surface characteristics by etching, introducing functional groups and coating with exotic materials. Plasma treatment induces changes on the seed surface and allows radicals to penetrate into the seed and affect the metabolic process of plant growth for wheat and oat treatment. The plasma discharge produces radicals  $H_2O_2$ ,  $O_3$ ,  $OH^-$ ,  $NO_3^-$ ,  $NO_2^-$  which can modify the water uptake rate and increase the germination metabolisms. The goal of our study was to investigate the effect of cold plasma treatment on germination of wheat seeds. Soaked seeds and water were exposed to the treatment for 10 minutes at frequency of 90 Hz, with 4 types of gases (air, argon, oxygen, nitrogen). Spring, winter and commercial wheat were incubated in Paper towel test and watered with the same plasma activated water (PAW) for 6 days. The stem length (root and shoots) increased about 60% compared to the control sample. The results indicate that the developed cold plasma can significantly improve the seed germination as well as plant growth.

**Keywords:** germination, seed, PAW, cold plasma, wheat



BIOTEHNIČKE ZNANOSTI / BIOTECHNICAL SCIENCES

## BIOLOŠKA KONTROLA ŠTETNIH KUKACA S ENTOMOPATOGENIM GLJIVAMA *METARHIZIUM* SPP.

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Integrirana zaštita biljaka podrazumjeva kombiniranu primjenu svih mjera zaštite biljaka, pri čemu se kemijske mjere koriste kao posljednja mogućnost u zaštiti od štetnih organizama. Biološke mjere kontrole štetnih kukaca u poljoprivrednoj proizvodnji temelje se na primjeni entomopatogena, parazita i grabežljivaca. *Metarhizium* spp. su entomopatogene gljive koje uspješno suzbijaju veliki broj različitih vrsta štetnih kukaca, a postižu učinkovitost koja može konkurirati kemijskim mjerama. Cilj ovog rada je pregledom literature prikazati potencijal vrsta, mogućnosti primjene, prednosti i nedostatke mikoinsekticida na bazi *Metarhizium* spp. te kompatibilnost pri miješanju s kemijskim pesticidima i drugim sredstvima za zaštitu biljaka. U radu je opisana taksonomija, biologija i ekologija ove gljive te su izdvojeni uspješni primjeri primjene *Metarhizium* sp. pri suzbijanju žičnjaka (*Elateridae*), maslinove muhe (*Bactrocera oleae*), običnog crvenog pauka (*Tetranychus urticae*) i kruškine buhe (*Calopsylla pyri*). *Metarhizium* spp. kompatibilna je s velikim brojem djelatnih tvari kemijskih pesticida, što smanjuje broj potrebnih tretmana suzbijanja i može povećati učinkovitost u suzbijanju štetnika.

**Ključne riječi:** entomopatogene gljive, štetni kukci, integrirana zaštita bilja, biološka kontrola



BIOTEHNIČKE ZNANOSTI / BIOTECHNICAL SCIENCES  
**BIOLOGICAL CONTROL OF INSECT PESTS BY  
ENTOMOPATHOGENIC FUNGI *METARHIZIUM SPP.***

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Integrated plant protection implies the combined application of all plant protection measures, whereby chemical measures are used as the last possibility to protect plants against harmful organisms. Biological measures for the control of insects pests in agricultural production are based on the use of entomopathogens, parasites and predators. *Metarhizium spp.* are entomopathogenic fungi that successfully suppress a large number of different types of insects pests, and achieve efficiency that is often comparable with chemical measures. The aim of this paper is to review the literature about the potential of *Metarhizium*, the possibilities of application, the advantages and disadvantages of these mycoinsecticides, and the compatibility to mix with chemical pesticides and other plant protection products. This work describes the taxonomy, biology and ecology of the fungus. Successful application examples of *Metarhizium spp.* in the control of wireworms (*Elateridae*), olive fruit fly (*Bactrocera oleae*), two-spotted spider mite (*Tetranychus urticae*) and pear psylla (*Cacopsylla pyri*) have been elaborated. *Metarhizium spp.* are compatible with a large number of chemical pesticides, which reduce the number of treatments required to suppress the pests and can increase the effectiveness of pest control.

**Keywords:** entomopathogenic fungi, insects pests, integrated plant protection, biocontrol



BIOTEHNIČKE ZNANOSTI / BIOTECHNICAL SCIENCES

## REMOVAL OF CONGO RED USING WASTE WOOD BIOMASS AS ADSORBENT

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In this study, poplar (deciduous hardwood) and fir (coniferous softwood) sawdusts were used as adsorbents for the removal of Congo red (CR) dye from aqueous solution. The study was carried out under various experimental conditions such as initial CR concentration (10, 30, 50 and 100 mg L<sup>-1</sup>), pH (4-9) and adsorbent concentration (1 – 10 g L<sup>-1</sup>) on dye removal at 25 °C. Removal efficiencies of 74% and 42% were achieved with experimentally obtained adsorption capacities at equilibrium 1.7 and 3.04 mg g<sup>-1</sup> for poplar and fir, respectively. The results showed that both, poplar and fir, sawdust could be used as adsorbents for Congo red removal from aqueous solutions.

**Keywords:** adsorption, Congo red, waste wood biomass, sawdust





## TRADITIONAL WALNUT LIQUEUR – COCKTAIL OF POLYPHENOLS

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People's beliefs and centuries of experience have shown that walnuts consumed in the form of liqueur have a significant positive impact on health. The objective of this paper is to prepare a walnut liqueur according to a traditional recipe using from the young fruit of walnut cultivars and selections (Šampion, Rasna, Sava) created at the Faculty of Agriculture in Novi Sad. The liqueurs prepared from walnut were analyzed for the accumulation of extracted proanthocyanidins, tannins, flavonoids and a polyphenolic profile was established for the liqueurs and DPPH scavenging activity, which was the highest in Rasna (89.94%) and the lowest in Šampion (68.17%). The highest content of phenols (83.28 mg of gallic acid/g of dry material), tannins (71.54 mg GAE/g of dry 100 material), flavonoids (quercetin 0.83 mg/g) and the accumulation of proanthocyanidins (14.75 mg of catechin/g) was found in Šampion whole fruits. The polyphenolic profile depends on the method of preparation of the young walnut fruits used for making the liqueur, as well as the variety/selection of the walnut. Walnut represents a significant source of polyphenols, which are very beneficial for the human body as a source of functional foods, especially in the form of an extract liqueur.

**Keywords:** walnut liqueur, polyphenol profile, DPPH



BIOTEHNIČKE ZNANOSTI / BIOTECHNICAL SCIENCES  
**TOPLINSKA ZAGAĐENJA OKOLIŠA**

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Susret s modernim ljudskim potrebama, kao i onima ekonomskog i industrijskog razvitka, zahtijeva veliku količinu energije. Energetika ima veliki utjecaj na industrije kao što su promet, poljoprivreda i ekonomija općenito, te okoliš. Proizvodnja energije još uvijek uglavnom koristi metode spaljivanja fosilnih goriva, ugljena i u posljednje vrijeme u većim količinama - plin, ali one ostavljaju posljedice na okoliš. Onečišćenje toplinom uglavnom šteti vodenim ekosustavima, a dolazi otpadom iz industrije, termoneuklearnih i ugljenih elektrana, koje koriste vodu za hlađenje. Takve industrije imaju puno toplih emisija koje se emitiraju u okoliš, zrak i vodu.

S druge strane ovakve tehnologije moraju biti optimizirane ili zamijenjene, ako želimo smanjiti onečišćenje koje zahtijeva puno ljudskih napora i kompromisa kako bismo napustili zonu „komfora“ i pridonijeli boljoj sadašnjosti i sretnijoj budućnosti.

**Ključne riječi:** energetika, onečišćenje toplinom, fosilna goriva, elektrane



## THERMAL POLLUTION OF THE ENVIRONMENT

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Meeting modern human needs as well as those of economical and industrial development, requires large amount of energy. Energetics has major influence on other industries, transport, agriculture and economics in general, and environment. Energy manufacture still mostly employs methods of burning fossil fuels, coal, and lately in greater amounts-gas, but those are taking their toll on environment. Heat pollution mainly damages water ecosystems, and it comes from industry waste, thermonuclear and coal power plants, which use water for cooling purposes. Those industries have a lot of heat excess emitted into environment, air and water. Those technologies have to be optimized, or replaced, if we want to reduce pollution, but that mission also requires a lot of human effort and compromises to step out of our comfort zone and change the way we, together with our technology, affect our surroundings.

**Keywords:** power plants, heat pollution, energetics, fossil fuels



BIOTEHNIČKE ZNANOSTI / BIOTECHNICAL SCIENCES

## PAMETNO UPRAVLJANJE OTPADNOM HRANOM U ŠKOLSKIM KANTINAMA OSJEČKO-BARANJSKE ŽUPANIJE

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Prema podacima FAO-a iz 2011. godine gotovo jedna trećina ukupno proizvedene hrane namijenjene ljudskoj prehrani ostane neiskorištena tj. završi kao otpadna masa. Cilj ovoga rada je prikupljanje podataka o količini zaostale hrane nakon obroka u osnovnoškolskim kantinama na području Osječko-baranjske županije, te primjena dobivenih podataka u boljem upravljanju prehranom učenika. S obzirom na to da postoji više načina i varijabli kod odabira primjerene metode za kvantifikaciju ove vrste otpada, odabrana je trenutno najprikladnija metoda izračunavanja razlike masa hrane namijenjene prehrani i otpadne hrane. Prema podacima HZZ-a, u Osječko-baranjskoj županiji stopa nezaposlenosti iznimno je velika, a prosječna plaća niža od prosjeka većine hrvatskih županija. Financije predviđene za prehranu osnovnoškolske djece mogu biti bolje iskorištene kroz poboljšanje kvalitete obroka, a ne financiranje otpada. Prikupljeni podatci bili bi dobar temelj za podizanje svijesti o vrijednosti hrane kod djece osnovnoškolskoga uzrasta. Ranim edukacijama može se utjecati na stvaranje navika odgovornih ljudi koji će znati racionalno raspolagati hranom i prepoznati njezin utjecaj na ekonomska, socijalna i ekološka gledišta.

**Ključne riječi:** otpad, hrana, školska kantina, ekološka svijest



BIOTEHNIČKE ZNANOSTI / BIOTECHNICAL SCIENCES  
**SMART WASTE MANAGEMENT IN SCHOOL CAFETERIA  
IN OSIJEK-BARANJA COUNTY**

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According to data provided by FAO from 2011 almost one third of total food produced for human consumption remains unused and end up as waste mass. The aim of this research is to collect data on the amount of food left after meals in primary school canteens in the Osijek-Baranja County and to use the collected data to improve diet nutrition management. Considering several ways and variables in selecting the appropriate quantification method for this type of measurement, simple equation was used, difference between mass of the meal before the dining and mass of the leftovers. According to HZZ data, the unemployment rate in Osijek-Baranja County is exceptionally high and the average income is lower than the average of most Croatian counties. The provided finance for nutrition in primary schools can be better utilised to improve meal quality rather than financing waste. Collected data would be a good basis for raising awareness of the value of food in primary schools. Education at young age can help to raise responsible people who will have knowledge of their impact on economic, social and environmental aspects.

**Keywords:** waste, food, school canteen, ecological awareness



BIOTEHNIČKE ZNANOSTI / BIOTECHNICAL SCIENCES

## ANIMAL WELFARE AS A PRECONDITION FOR ENJOYABLE ANIMAL FARMING

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Stationary way of life did not only enable animal farming in smaller areas, but also the control over animal breeding, growth and evolution. Industrialization and introduction of intensive livestock farming have led to reduction of important primary animal needs, in order to increase the production and earnings. Maintaining animals in bad conditions resulted in a drop in product quality and reduction in yield for the producers. The enjoyment of common life shared by animals and humans has vanished due to the intensification of production. Numerous studies reveal higher consumer awareness on poor conditions for domestic animals that live on farms, as well as the animal rights activists growing success in making producers and competent authorities aware of those conditions. Laws and measures are being introduced to make agriculture more pleasant for cattle-breeding, both for animals and humans. In our presentation, we will show how successful the struggle regarding animal welfare has been to date and how much further we must progress in making animal breeding pleasant both for animals and humans.

**Keywords:** industrialisation, livestock farming, activists, welfare



BIOTEHNIČKE ZNANOSTI / BIOTECHNICAL SCIENCES  
**MOGUĆNOST UPRAVLJANJA BIOOTPADOM  
NA PODRUČJU GRADA BIHAĆA**

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Biootpad je otpad koji je pogodan za aerobnu ili anaerobnu razgradnju, kao što je hrana, vrtni otpad, papir i karton. Prema podacima o sastavu i strukturi komunalnoga otpada na području Unsko-sanskog kantona u proljetnom periodu, biootpad čini 31 % ukupnog otpada. Vođeni ovim podacima izvršili smo analizu sastava komunalnoga otpada pet kućanstava u našem okruženju. Analiziranjem i evidentiranjem sastava komunalnoga otpada, došli smo do saznanja da udio biootpada prosječne obitelji na području grada Bihaća iznosi 48,8 % ukupnog proizvedenog otpada.

S obzirom na velik udio biootpada, vidljivo je da postoji potreba za iznalaženjem mogućnosti upravljanja ovim otpadom. Ovim radom predstavljene su prednosti procesa kompostiranja, čija bi primjena riješila postojeći problem biootpada na području grada Bihaća.

**Ključne riječi:** biootpad, kompostiranje, Bihać, sastav otpada



BIOTEHNIČKE ZNANOSTI / BIOTECHNICAL SCIENCES

## THE POSSIBILITY OF MANAGING BIOWASTE IN THE AREA OF THE TOWN OF BIHAĆ

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Biowaste is a waste suitable for aerobic and anaerobic degradation like food, garden, paper and carton. According to the data of the composition and structure of household produced waste in the area of Una-Sana Canton in spring time, biowaste makes 31% of total waste. Guided by this data, we made an analysis of this kind of waste in five households in our area. Analyzing and recording the composition of household waste we have found that the share of biowaste produced by an average household in the town of Bihać is 48.8% of the total collected waste. Considering the large share of biowaste it is evident that there is a need to find out the possibility of managing this waste. This work presents the advantages of the composting process, the implementation of which would solve the current problem of biowaste in the area of the town of Bihać.

**Keywords:** biowaste, composting, Bihać, waste structure





BIOTEHNIČKE ZNANOSTI / BIOTECHNICAL SCIENCES  
**COLD PLASMA AS NEW GREEN TECHNOLOGY**

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Range of cold plasma applications covers many aspects of almost all major industries. Plasma technology is used in material science (e.g. textile engineering, polymer processing, electronics), agriculture (e.g. plant growth enhancement, insecticidal activity) and medicine (e.g. dentistry, wound healing). It has also shown its potential in food industry as new non-thermal technique for food decontamination, as well as in food packaging for material sterilization, surface etching and functionalization. Cold plasma reactors have been developed for several environmental applications, such as drinking and wastewater treatment, as well as for environmentally benign chemical processes. Plasma discharge directly in water, or in the gas above the water, has been demonstrated to produce many reactive species (e.g. hydrogen peroxide, free radicals, ozone) and to cause the formation of shock waves and UV light, which all together cause rapid and efficient degradation of many compounds such as phenols, aniline, benzene, pentachlorophenol, antibiotics, pesticides etc. The results have shown that degraded compounds and formed intermediates were less toxic than the parent substances. It can be concluded that cold plasma has a great potential as new green technology which can contribute in environmental protection.

**Keywords:** cold plasma, green technology, decontamination, waste water treatment



DRUŠTVENE ZNANOSTI / SOCIAL SCIENCES

## ZELENA EKONOMIJA – KONCEPTUALNA GLEDIŠTA RAZVOJA U REPUBLICI HRVATSKOJ

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Glavna svrha ovoga rada je promotriti razvoj zelenoga gospodarstva u Republici Hrvatskoj kao oblika gospodarstva kojemu je cilj održivi razvoj bez štete za okoliš i građane, posebno ističući poboljšanje blagostanja građana, izgradnju socijalne jednakosti, istodobno smanjujući rizike i slabosti u okolišu.

U radu se raspravlja u kojoj se mjeri primjenjuje koncept zelenoga gospodarstva i cirkularne ekonomije u Republici Hrvatskoj te ima li mjesta za napredak. Također se raspravlja što se čini po pitanju direktive Europske unije vezano uz primjenu klimatsko energetske ciljeva, odnosno „Inicijative 20/20/20“ i uspijeva li Republika Hrvatska u ostvarivanju zadanih ciljeva. Europska unija se u posljednje vrijeme bavi poticanjem zemalja članica na primjenu koncepta zelenoga gospodarstva zbog aktualnih svjetskih problema – očuvanja okoliša, zaštite voda i gospodarenja otpadom, upravo zbog energetske učinkovitosti i ekološke održivosti.

Također se istražuje primjenjuje li Republika Hrvatska propisane politike te kako se snalazi u prihvaćanju istih kao najmlađa zemlja članica Europske unije. Nadalje se proučava zastupljenost održivih izvora u načinu poslovanja hrvatskih proizvođača i poduzetnika te se razmatra mogućnost povećanja održivog, pametnog i uključivog rasta kroz strategiju „Europa 2020“.

**Ključne riječi:** zeleno gospodarstvo, cirkularna ekonomija, Inicijativa 20/20/20, održiv rast



DRUŠTVENE ZNANOSTI / SOCIAL SCIENCES

## GREEN ECONOMY - CONCEPTUAL ASPECTS OF DEVELOPMENT IN THE REPUBLIC OF CROATIA

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The main purpose of this paper is to examine the development of the green economy in the Republic of Croatia as a form of economy aimed at sustainable development without harm to the environment and citizens, especially by highlighting the improvement of the welfare of citizens, building social equality while reducing the risks and weaknesses in the environment.

This paper discusses to what extent the Republic of Croatia applies the concept of green economy and circular economy and is there room for progress. It also discusses what has been achieved in terms of EU directives regarding the application of climate-related energy objectives, or "Initiative 20/20/20" and whether Croatia succeeds in achieving these objectives. The European Union has recently been encouraging member states to apply the concept of green economy as an answer to current world problems - environmental protection, water protection and waste management, precisely because of energy efficiency and ecological sustainability.

It also investigates whether Croatia applies the prescribed policies and how is it managing to accept them as the youngest member of the European Union. Furthermore, it studies the presence of sustainable sources in business mode of Croatian producers and entrepreneurs, and also studies the possibility of increasing sustainable, smart and inclusive growth through the "Europe 2020" Strategy.

**Keywords:** green economy, circular economy, Initiative 20/20/20, sustainable growth



*DRUŠTVENE ZNANOSTI / SOCIAL SCIENCES*

## **UTJECAJ AKTIVNOSTI LOKALNIH I REGIONALNIH SUBJEKATA NA RAZVOJ KONTINENTALNOGA TURIZMA U SLAVONIJI I BARANJI**

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Perspektivne grane ekonomije neke zemlje utječu na pozitivno ostvarenje ekonomskih, socijalnih, kulturnih, demografskih i drugih rezultata koji u određenoj mjeri mogu biti nositelji razvoja cjelokupnoga gospodarstva zemlje. Jedna od takvih ekonomskih grana u Republici Hrvatskoj jest turizam. Iako je Republika Hrvatska površinom mala turistička zemlja, razvijenost turizma i broja dolazaka turista u Jadransku regiju bilježi višestruko veće brojke od turizma u kontinentalnoj regiji. Značajan doprinos u razvoju ove gospodarske grane imaju razni lokalni i regionalni subjekti, primjerice turističke zajednice, koji predstavljaju važnu ulogu u komunikaciji između samog turista i turističke destinacije. Međutim, postavlja se glavno pitanje: "Na koji način lokalni i regionalni subjekti značajni za turizam implementiraju aktivnosti koje doprinose ekološkoj, društvenoj i ekonomskoj održivosti promatrane regije Republike Hrvatske?". Na temelju istraživanja sinergije između postojećih turističkih aktivnosti i postignute razine razvijenosti turizma doprinosom istih, autori su prikazali moguća rješenja za ostvarenje potencijala u svrhu poboljšanja kontinentalnog turizma Slavonije i Baranje.

**Ključne riječi:** kontinentalni turizam, turističke zajednice, održivi razvoj



*DRUŠTVENE ZNANOSTI / SOCIAL SCIENCES*

## **THE EFFECT OF ACTIVITIES OF LOCAL AND REGIONAL ENTITIES ON THE DEVELOPMENT OF CONTINENTAL TOURISM IN SLAVONIA AND BARANJA**

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The prospective branches of a country's economy have impact on the positive realization of economic, social, cultural, demographic and other results that may, to a certain extent, be the carriers of the overall economy of the country. One of the mentioned economic branches in the Republic of Croatia is tourism. Despite being a small tourist country, the tourism development in Croatia and the number of tourist arrivals in the Adriatic region is higher than the number of tourism in the continental region. Significant contributions for the development of this branch have various local and regional entities, such as tourist boards, which play an important role in communicating between the tourists and the tourist destination. However, the main question is: "How can the local and regional stakeholders, that are important for tourism, implement activities that contribute to the ecological, social and economic sustainability of the observed region in the Republic of Croatia?" Based on the research of synergy between the existing tourism activities and the achieved level of tourism development, the authors provide possible solutions for realizing improvement of continental tourism of Slavonia and Baranja.

**Keywords:** continental tourism, tourist board, sustainable development



*DRUŠTVENE ZNANOSTI / SOCIAL SCIENCES*

## **EDUCATION FOR SUSTAINABLE DEVELOPMENT IN SCIENCE TEACHING IN CROATIA**

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Sustainable Development is very important for humanity awareness to grow into the responsible individuals from the earliest age. The period from the first to the fourth grade, primary education period, is particularly important for sustainable development in children's education. The core document we use in planning and programming is Curriculum, which contains suggestions for implementing activities that will take awareness of sustainable development.

Sustainable development with its components encompasses everything that surrounds us and implies ecological, sociocultural and economic issue of society. The purpose of this study is to observe qualitative and quantitative Sustainable Development components, which arise from the Curriculum through the Science lectures in Croatia. Our study shows almost the same level of environmental (30.21%) and social (25.00%) components of the Sustainable Development from the first to the fourth grade in Science in Croatian Curriculum. On the contrary, economic aspect of the Sustainable Development has the lowest number of themes (6.25%). We are giving the evidence of the sustainability themes in children's Science learning in primary education in Croatia.

**Keywords:** Science, primary education, Sustainable Development



## ODRŽIVI HOTELI – PROMICATELJI ODRŽIVA RAZVOJA U LOKALNOJ ZAJEDNICI

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Ključni izazov suvremenog društva je preoblikovanje postojećeg linearnog, neodrživog i nerijetko neodgovornog ekonomskog modela prema modelu odgovorne, kružne ekonomije, odnosno zatvorenom, uravnoteženom i integralnom procesu odgovornog korištenja resursa vodeći usklađenim s potrebama sadašnje i budućih generacija. Turizam, kao značajan i utjecajan društveno-ekonomski fenomen, ima značajnu ulogu u tom procesu tranzicije. Hoteli, kao ključni nositelji turističke ponude, suočavaju se s neprestanim i brzim promjenama, rastućom konkurentnosti i pritiscima različitih internih i eksternih dionika (dioničara, zaposlenika, turista, države, lokalne uprave, lokalne zajednice, civilnog sektora, itd.).

Iskustvo sve brojnijih hotela diljem svijeta pokazuje da implementacija koncepcije održivih hotela donosi niz poslovnih koristi: višu razinu zadovoljstva gostiju, lojalne, motivirane i kompetentne zaposlenike, niže troškove poslovanja, višu razinu konkurentnosti i dugoročnu profitabilnost. Takvi hoteli stvaraju brojne koristi u društvenoj zajednici u kojoj djeluju: pouzdan su poslovni partner, zapošljavaju stanovnike lokalne zajednice, ponudu većim dijelom temelje na lokalnim proizvodima, surađuju s lokalnom zajednicom na zajedničkim projektima te pridonose stvaranju imidža održive turističke destinacije. Održivi hoteli odgovorno se odnose prema okolišu kroz cijeli životni vijek poslovanja hotela.

Cilj rada bit će analizirati teorijske pretpostavke održivih hotela, analizirati primjere dobre prakse na međunarodnom turističkom tržištu te analizirati obilježja i značaj održivih hotela u Republici Hrvatskoj i njihov značaj u promicanju održivoga razvoja u lokalnoj zajednici.

**Ključne riječi:** održivi razvoj, dionici, održivi hoteli, Republika Hrvatska



*DRUŠTVENE ZNANOSTI / SOCIAL SCIENCES*

## **SUSTAINABLE HOTELS – PROMOTERS OF SUSTAINABLE DEVELOPMENT IN THE LOCAL COMMUNITY**

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The key challenge of the contemporary society is the transformation of the existing linear, unsustainable and frequently irresponsible economic model towards a model of responsible, circular economy, i.e. a closed, balanced and integral process of responsible use of resources harmonised with the needs of the present and future generations. Tourism, as a significant and influential socio-economic phenomenon, has an important role in this process of transition. Hotels, as key bearers of tourism supply, are faced with constant and quick changes, increased competitiveness and pressures from various internal and external stakeholders (shareholders, employees, tourist, the state, local administration, local communities, civil sector, etc.).

The experiences of numerous hotels all over the world indicate that the implementation of the concept of sustainable hotels result with many business benefits: higher level of customers' satisfaction; loyal, motivated and competent employees; lower costs; higher level of competitiveness and long-term profitability. Besides, such hotels create many benefits in the social community they operate in: they are reliable partners, employ local people, their offer is mainly based on local products, and they collaborate with the local community on joint projects and contribute to shaping the image of a sustainable tourism destination. Sustainable hotels are responsible towards the environment through their whole life-cycle.

The aim of the paper will be to study the theoretical presumptions of sustainable hotels, to analyse selected best-practice sustainable hotels on the international market and to analyse the features and significance of sustainable hotels in Croatia and their role in promoting sustainable development in the local community.

**Keywords:** sustainable development, stakeholders, sustainable hotels, Croatia





DRUŠTVENE ZNANOSTI / *SOCIAL SCIENCES*

## ZAKONODAVNI OKVIR KAO TEMELJ ODRŽIVOG PROMETA UNUTARNJIM PLOVNIM PUTOVIMA

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Promet kao gospodarska djelatnost zauzima značajan udio u ostvarenju nacionalnoga i međunarodnog gospodarskog rasta. Globalni gospodarski izazovi i sve veća potreba mobilnosti zahtijevaju i konkurentnu plovnost unutarnjih voda. Pri osiguravanju pretpostavki za povećanu prometnu konkurentnost ključno je i poštivanje prava okoliša. Inovativnim rješenjima osigurava se učinkovita, sigurna i održiva plovidba odnosno učinkovit promet bez štetnog utjecaja na okoliš. Cilj ovoga rada je ukazati na značaj nacionalnog i međunarodnog zakonodavnog okvira u svrhu smanjenja utjecaja štetnih posljedica prometa na klimu i okoliš. Također, analizom postojećeg zakonodavnog okvira unutarnje plovidbe i zaštite okoliša odgovara se na pitanje njihove uloge u razvoju boljeg, uključivog i sigurnog transportnog sustava.

**Ključne riječi:** promet, unutarnji plovni putovi, zakonodavni okvir, održivi razvoj, okoliš



*DRUŠTVENE ZNANOSTI / SOCIAL SCIENCES*

## **LEGISLATIVE FRAMEWORK AS THE FOUNDATION OF SUSTAINABLE INLAND WATERWAY TRANSPORT**

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Traffic as an economic activity occupies a significant share in the achievement of national and international economic growth. Global economic challenges and an increasing need for mobility also require competitive inland waterway transport. One of the important elements in ensuring the prerequisites for increased transport competitiveness is protection of the environmental law. Innovative solutions ensure efficient, safe and sustainable navigation and efficient traffic without any adverse environmental impact. The aim of this paper is to point out the importance of the national and international legislative framework, in order to reduce the negative impact of modern transport on the environment. Also, the analysis of the existing legislative framework for inland navigation and environmental protection is in line with the issue of their role in the development of a better, inclusive and safe transport system.

**Keywords:** traffic, inland waterways, legislative framework, sustainable development, environment



DRUŠTVENE ZNANOSTI / SOCIAL SCIENCES

## UČENIČKI RADOVI GRAFIČKOGA DIZAJNA I NJIHOVA POVEZANOST S RJEŠAVANJEM PROBLEMA DRUŠTVENE ZAJEDNICE

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Iako je Likovna kultura vrlo kreativan nastavni predmet, često se na satima protežu isti sadržaji i isti motivi. Izborne se teme uglavnom rijetko obrađuju. Jedno je od izbornih područja Likovne kulture i *Primijenjeno oblikovanje – dizajn*. Koliko učitelji osnovnih škola u Slavonskome Brodu obrađuju teme iz područja grafičkoga dizajna te koliko su njihovi učenici upoznati s tim područjem kao i što bi oni željeli raditi iz toga područja, pokazali su rezultati anketa. Prvi uzorak čini 51 učitelj, a drugi 62 učenika. Kako ne bi sve ostalo samo teorija, provedene su radionice u trima brodskim osnovnim školama (iz svake škole odabran je jedan 4. razred). Ideja je bila da učenici stvore proizvod grafičkoga dizajna, tj. plakat koji će biti izložen javnosti točno na Međunarodni dan rijeka koji se obilježava 14. ožujka. Da bi učenici stvorili svijest o važnosti očuvanja rijeka, posebno rijeke Save potičući na taj način promišljanje o problemu lokalne razine, bilo ih je potrebno educirati o tome. Zato je prvo održana radionica iz područja ekologije koja je povezala različite sadržaje, a nakon nje likovna radionica na kojoj su nastali plakati u kombiniranoj tehnici rađeni u paru. Izložba učeničkih plakata održana je u Galeriji umjetnina grada Slavnskoga Broda. Praćena je posjećenost izložbe.

**Ključne riječi:** grafički dizajn, Međunarodni dan rijeka, radionice, izložba



*DRUŠTVENE ZNANOSTI / SOCIAL SCIENCES*

## **SCHOOLCHILDREN'S GRAPHICAL DESIGN WORK AND THEIR CONNECTION WITH THE PROBLEM SOLVING OF SOCIAL COMMUNITY**

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Although Art is considered to be a creative school subject, the same contents and motifs tend to prevail in the lessons. One of the specific fields in Art that you can choose from is also Applied Design – Design. Teacher surveys have shown that the majority chooses topics in Graphic Design. The survey shows that the majority of schoolchildren choose posters among several topics in this area. To put it into practice, workshops in three primary schools in Slavonski Brod were conducted (in each school one 4th grade was chosen to participate). The idea was to create a graphic design product, that is a poster which would be presented in public on the International Day of Action for Rivers which is celebrated on March 14. There was a need for this type of education in order to raise pupils' awareness about the importance of preserving rivers, especially the Sava River, and in order to encourage critical thinking about the local problems. Therefore the first workshop on ecology was held, which included different contents, and afterwards an Art workshop was held where posters were made in pairs, in a combined Art technique. Each poster includes specially designed slogans made by schoolchildren, which invite audience to think about the problems of pollution and the Sava River. The exhibition of the posters was held in the Art Gallery of the City of Slavonski Brod. The attendance of the exhibition has been monitored.

**Keywords:** graphic design, the International Day of Action for Rivers, workshops, exhibition



DRUŠTVENE ZNANOSTI / SOCIAL SCIENCES

## **PRAVO ZAŠTITE OKOLIŠA I IMPELEMNTACIJA NJEGOVIH NORMI U USTAV REPUBLIKE HRVATSKE**

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U ovom smo radu stavili poseban naglasak na pravo zaštite okoliša. Posebno smo obradili njegov začetak i razvoj u Republici Hrvatskoj. Nakon toga smo se osvrnuli na probleme koji trenutno postoje kao što je aktualna situacija u Slavonskom Brodu. Na kraju rada smo se referirali na ustavne norme u Republici Hrvatskoj te na potrebu da se određene norme iz prava zaštite okoliša implementiraju u Ustav Republike Hrvatske.

**Ključne riječi:** pravo zaštite okoliša, Ustav Republike Hrvatske, ustavno pravo



*DRUŠTVENE ZNANOSTI / SOCIAL SCIENCES*

**THE RIGHT TO PROTECT THE ENVIRONMENT AND IMPLEMENT  
ITS NORMS IN THE CONSTITUTION OF THE REPUBLIC OF  
CROATIA**

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In this paper we have highlighted the right to protect the environment. We specially studied its beginnings and development in the Republic of Croatia. After that we looked back at problems that currently exist such as the current situation in Slavonski Brod. At the end of the paper we referred to the constitutional norms in the Republic of Croatia, and the need that certain norms from the right to protect the environment should be implemented into the Constitution of the Republic of Croatia.

**Keywords:** the right to protect the environment, Constitution of the Republic of Croatia, constitutional law



DRUŠTVENE ZNANOSTI / SOCIAL SCIENCES

## STUDENTS' ATTITUDES AND SKILLS ABOUT COMPONENTS OF SUSTAINABLE DEVELOPMENT AT TEACHER STUDY AT JURAJ DOBRILA UNIVERSITY OF PULA

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Education for Sustainable Development (SD) is becoming increasingly important at all levels of the educational system including higher education. However, little previous research exists on students' attitudes and skills towards SD at Teacher Study. This study is conducted with an aim of questioning Integrated undergraduate and graduate university teacher study students from Juraj Dobrila University of Pula, Croatia about the components of Sustainable Development during 2018. The questionnaire was made with a series of Likert Scale questions about students' attitudes and skills on SD from ecological, sociocultural and economic issues. The analysis reveals that students have generally moderate attitudes and skills for ecological (3.87) and economical (3.86) issues of SD, but higher understanding for the sociocultural (4.22) issue ( $p < 0.05$ ), respectively. Despite this, no difference was found between students' attitudes and skills on SD issues through all students' groups from Teacher Study. We emphasized factors in each issue that limit and enable students' skills for SD. These results could serve as an orientation in which our SD education in higher education should be directed to.

**Keywords:** ecological issue, economic issue, sociocultural issue, students' attitudes, Sustainable Development



## EKOLOGIJA KAO VAŽAN SEGMENT LOKALNE SAMOUPRAVE

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Cilj ovoga rada je upozoriti te skrenuti pozornost na potrebu zastupljenosti ekoloških stručnjaka u okviru upravnih ureda jedinica lokalne i područne (regionalne) samouprave. Lokalna samouprava definira se kao razina vladavine najbližija građaninu, s ulogom predstavljanja važnosti i stajališta lokalnog. Upravo ta razina koja je najbližija građaninu, omogućuje najkompetentniju brigu o kvaliteti i stilu života jedne zajednice. Ekologija je znanost koja u svom proučavanju objedinjava najvažnije elemente za čovjekov život kao što su zrak, voda, zemlja, okoliš, zdravlje, proizvodnja hrane, korištenje energija i sirovina. Ni jedna zajednica kao ni jedan ljudski život, bez takvih ekoloških čimbenika ne može funkcionirati te u njihovom nedostatku lako dolazi do nehumanih situacija koje su krajnje neprimjerene za suvremene europske demokracije, kao što se dogodilo u Slavonskom Brodu prilikom zagađenja vode u travnju 2018. godine. Ekološki stručnjaci na razinama lokalnih i područnih jedinica, sukladno svojoj kompetenciji, osigurali bi odgovarajuću kvalitetu upravo tih ekoloških čimbenika. Navedeni stručnjaci ne bi se bavili samo već postojećim ekološkim problemima kao što su zagađenje zraka i vode, već i zahtjevima koje Europska unija i budućnost postavljaju pred nas – održivi razvoj, ekološka proizvodnja, recikliranje. Uvođenjem ekoloških stručnjaka svakom građaninu bi se jamčio i omogućio kvalitetniji i zdraviji život.

**Ključne riječi:** ekologija, ekološki stručnjaci, lokalna samouprava, građani





*DRUŠTVENE ZNANOSTI / SOCIAL SCIENCES*

## **ECOLOGY AS AN IMPORTANT SEGMENT OF LOCAL SELF-GOVERNMENT**

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The goal of this paper is to warn and pay attention to the necessity of environmental experts within the administrative offices of local and regional self-government units. Local self-government is defined as the level of rule that is the closest to the citizens with the role of representing the most important things and aspect of local units. This level, which is the closest to the citizens, provides the most competent care of the quality and lifestyle of a community. Ecology is a science that unifies the most important elements for human life, such as air, water, soil, the environment, health, food production, the use of energy and raw materials. Neither one community, neither one human life, can function without such ecological factors and in cases of shortage ecological factors it can easily come to inhumane situations which are extremely inappropriate for modern European democracies, as it happened in Slavonski Brod in the case of water pollution in April 2018. Environmental experts at local and regional unit levels, in accordance with their competencies, would insure the appropriate quality of these ecological factors. The mentioned experts would not only deal with existing environmental problems such as air and water pollution, but also with the demands that the European Union and the future set up in front of us – sustainable development, ecological production and recycling. By introducing environmental experts every citizen would be guaranteed and enabled a better and healthier life.

**Keywords:** ecology, environmental experts, local self-government, citizens



HUMANISTIČKE ZNANOSTI / HUMANITIES

## THE SUBLIME AND LITERARY ENVIRONMENTALISM IN ROMANTICISM

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This paper looks at literature from the point of view of what could be called literary environmentalism, and what is now known in literary theory as ecocriticism. Broadly speaking, ecocriticism is the "the study of the relationship between literature and the physical environment". The paper focuses on Romanticism, literary movement of the 18<sup>th</sup> century originating in Europe. Romanticism is centered around emotion and individualism, but one of the main characteristics of this period is the glorification and apotheosis of nature. In respect to this, the focus of the paper will also be on the concept of the sublime. According to Edmund Burke, the sublime is an experience which is simultaneously terrifying and breathtaking or riveting. Romantic poets found the sublime in the grandeur of nature. Based on the examples from works by William Wordsworth, Edmond Burke, and Samuel Taylor Coleridge the paper will show that they can be seen as early environmentalists because of their fondness for nature and acute dissatisfaction with the changes brought about by the Industrial Revolution and the rising imbalance between nature and urban, industrial life.

**Keywords:** environmentalism, ecocriticism, Romanticism, Industrial Revolution, Sublime



HUMANISTIČKE ZNANOSTI / HUMANITIES

## ODRŽIVI OTOK – ANTROPOLOŠKI PRISTUP ODRŽIVOM RAZVOJU

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U radu *Održivi otok – antropološki pristup temi održivog razvoja* razmatra se antropološki pristup održivom razvoju, temi koja se sve više istražuje u okviru primijenjene antropologije. Antropološki pristup upućuje na važnost aktivne uključenosti lokalne zajednice kada je riječ o postupcima kojima se nastoji ostvariti održivi razvoj. Stajališta pripadnika lokalne zajednice o praksama kojima se postiže održivost, problemi koje oni sami prepoznaju te prijedlozi za djelovanje neizbježni su čimbenici koji pridonose uspješnosti postizanja održivosti. Autorice se u prvom redu fokusiraju na održivost otočnih zajednica, pritom razmatrajući koncept *otočnosti* kroz koji se može iščitati međudnos geografskih odrednica otočnog prostora te društvenog, kulturnog i ekonomskog konteksta lokalnih zajednica. Autorice u radu donose koncept antropološkog istraživanja na otoku Silbi, kao primjera otoka čija lokalna zajednica već godinama nastoji provesti aktivnosti kojima bi se postigla održivost te usmjeriti svoje privredne djelatnosti (u prvom redu turizam) k ekološki osviještenom djelovanju. Pritom, otvaraju pitanja na koji način rezultati antropoloških istraživanja mogu doprinijeti postizanju održivog razvoja.

**Ključne riječi:** održivi razvoj, antropološki pristup održivosti, održivi otok, otočnost, ekoturizam



HUMANISTIČKE ZNANOSTI / HUMANITIES

## **SUSTAINABLE ISLAND – ANTHROPOLOGICAL APPROACH TO THE SUSTAINABLE DEVELOPMENT**

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In the paper *Sustainable Island – Anthropological Approach to the Sustainable Development*, an anthropological approach to the sustainable development has been discussed, the topic that is being more commonly researched by applied anthropology. Anthropological approach highlights the importance of active participation of the local communities in sustainable development activities. Point of view of the local community about sustainable development activities, problems that they recognize and suggestions they have are inevitable factors that contribute to the successful achieving sustainability. Authors mainly focus on sustainability of island communities, while considering the concept of *islandness*, which directs attention on the interrelation of geographical features of the island area and social, cultural and economic context of the local community. In this paper authors present the concept of the research on the island of Silba, which is the example of the island whose local community strive for several years to carry out sustainable development activities and direct their economic activities (tourism in the first place) to environmentally conscious activity. As a part of that, questions about how the results of anthropological research can give a contribution to the achieving of sustainable development are asked.

**Keywords:** sustainable development, anthropological approach to the sustainability, sustainable island, *islandnes*, eco-tourism



HUMANISTIČKE ZNANOSTI / HUMANITIES

## KLIMATSKA POLITIKA I NOVA EKUMENA: O POTREBI ZA NOVIM PROSVJETITELJSTVOM

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Briga za okolinom, (izvanjsko) povratno, je briga za unutrašnje (dušu). U doba globalizacije odnos izvanjsko - unutrašnje prepušta se novom dinamizmu i prekomjernostima raznih vrsta. Veći format svijeta proizvodi veće i snažnije infekcije. Stoga smo zatečeni katastrofičnim paradoksom: je li moguće novo prosvjetiteljstvo ili tek nova klima?

Putem uvođenja autonomne etičke i filozofske misli kao važnih elemenata odgoja i obrazovanja, osigurava se briga za ono unutrašnje i temeljno ljudsko, koja postaje kontinuiranom brigom za okoliš i za život općenito. Poticanje samostalne etičke i filozofske misli u odgoju i obrazovanju ključno je s obzirom na etička pitanja današnjice, kada tehnički i znanstveni napredak nude mogućnost ljudskog utjecaja na sve razine života, od molekularne do planetarne, s dalekosežnim posljedicama.

Promišljajući o odabranim pojmovima Immanuela Kanta, Michela Foucaulta, Hanne Arendt te Giorgia Agambena, kao i elemenata etike Petera Singera, postaje vidljiva nemogućnost „tradicionalne“ etike da zadovoljavajuće odgovori na pitanja današnjice, te nedostaci institucija kao jedinih i apsolutnih moralnih autoriteta. Ova pitanja suvremenosti, čini se, zahtijevaju promjenu u mišljenju koja postavlja u centar ne čovjeka, već ono temeljno ljudsko; ona zahtijevaju svojevrsno „novo prosvjetiteljstvo.“

**Ključne riječi:** globalizacija, klima, etika, obrazovanje



HUMANISTIČKE ZNANOSTI / HUMANITIES

## CLIMATE POLITICS AND THE NEW ECUMENE: ABOUT THE NEED FOR A NEW ENLIGHTENMENT

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Care for the environment (the external) is in turn care for the internal (the soul). In the age of globalization the external-internal relation is given to a new dynamism and various excesses. A greater format of the world produces larger, more powerful infections. We are caught by a catastrophic paradox: is a new enlightenment possible, or merely a new climate?

By introducing autonomous ethical and philosophical thoughts as important elements of education, care for the internal and fundamentally human is ensured, which becomes a continuous care for the environment and life in general. Encouraging independent ethical and philosophical thought within education is key considering the ethical questions of today, when technical and scientific progress make human influence possible on all levels of life, molecular to global, with far-reaching consequences. By re-thinking certain terms of Immanuel Kant, Michel Foucault, Hannah Arendt, and Giorgio Agamben, as well as elements of Peter Singer's ethics, the inability of "traditional" ethics to satisfactorily answer today's questions becomes evident, alongside the shortcomings of institutions as sole and absolute moral authorities. These contemporary questions seemingly demand a change in thinking centered not on man, but on the fundamentally human; they demand a kind of a "new enlightenment."

**Keywords:** globalization, climate, ethics, education



## EKO-KULTURNI IDENTITETI GLOBALIZIRANOG DRUŠTVA

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Savremeno društvo obilježilo je *prostorni obrat* koji je nastao u okviru društvenih i humanističkih znanosti, a koji se potvrdio unutar prirodnih znanosti. Koliki je doprinos prostornoga obrata u povezivanju ovih znanosti kao i njihovih disciplina, u najvećoj mjeri pokazuju eko-kulturni identiteti, nastali na granici umreženih kultura čemu u najvećoj mjeri svjedoči južnoslavenska interliterarna zajednica. Rad se oslanja na već postojeći projekt na Odsjeku za južnoslavenske jezike i književnosti Filozofskoga fakulteta Sveučilišta u Zagrebu - *Eko-kulturni identitet južnoslavenskih književnosti* – bavi propitivanjem eko-kulturnih identiteta nastalih na granici između pojedinih južnoslavenskih kulturnih zajednica, a nastalih u fikcionalnim tekstovima, ali reprezentiranih različitim umjetničkim i medijskim sredstvima. Krajnji cilj rada jeste ukazivanje na posebnosti koje imaju zemlje središnjeg južnoslavenskog ekosistema re/prezentirane upravo kroz raznolike eko-kulturne identitete.

**Ključne riječi:** prostorni obrat, eko-kulturni identitet, južnoslavenske književnosti, južnoslavenske kulturne zajednice



HUMANISTIČKE ZNANOSTI / HUMANITIES

## ECO-CULTURAL IDENTITIES OF A GLOBALIZED SOCIETY

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Contemporary society was marked by a *spatial shift* that emerged within the social and humanistic domains, which was confirmed within natural sciences. What contributes to the spatial shift of linking these sciences and their disciplines to the greatest extent shows eco-cultural identities, created at the boundary of cross-cultural cultures, largely witnessed by the Southslavic interlitteral community. This work with reliance on a project of Department of Southslavic languages and literature at the Faculty of Philosophy, University of Zagreb – *Eco-cultural identity of Southslavic literature* – deals with the questioning of eco-cultural identities created at the border between particular Southslavic cultural communities, and those created in fictional texts, but represented by different artistic and media assets. The ultimate goal of the work is to point to the particularities that the countries of the central Southslavic ecosystem have re-presented through the diverse eco-cultural identities.

**Keywords:** spatial shift, eco-cultural identity, Southslavic literature, Southslavic cultural community





HUMANISTIČKE ZNANOSTI / HUMANITIES

## EKOTEOLOŠKI POTICAJI AMBIJENTALNE BIOETIKE ENCIKLIKE „LAUDATO SI“

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Beskrupuloznim iscrpljivanjem prirode, njezinim tehnološkim ovladavanjem i pristupom isključivo temeljenim na pragmatično-utilitarističkoj etici, suvremeni je čovjek pokušao despotski zauzeti dominirajuću ulogu nad Zemljom, zanemarujući svoju prvotnu ulogu odgovornog i brižnog zaštitnika uvjeta u kojima se odvija njegov život.

Kao posljedica ovakvoga pristupa, nastaje ekološka degradacija koja zahtijeva interdisciplinarni pristup u buđenju bio/etičke ekološke svijesti, značajno obogaćena brojnim intervencijama kršćanskoga crkvenog učiteljstva i filozofskih imperativnih poticaja načelom opreza, paradigmom održivoga razvoja i bioetičkom ekumenom.

Najnoviji poticaj osvješćivanja ekoloških rizika i buđenje moralne odgovornosti, dolazi nam od pape Franje, u enciklici, o brizi za zajednički dom, «Laudato si'» koja naglašava obnovu našeg odnosa s prirodom, unutarnjom promjenom čovjeka prožetog krjepostima solidarnosti i pravednosti iz perspektive prošlosti, gledajući prema sadašnjosti i budućnosti, izgradnje i održivosti harmoničnog svijeta, interdisciplinarnim nastojanjima.

**Ključne riječi:** ekološka / okolišna / ambijentalna bioetika, ekoteologija, ekološki rizici, moralna odgovornost, „održivi razvoj“, načelo opreza, bioetička ekumena



HUMANISTIČKE ZNANOSTI / HUMANITIES

## ECOTEOLOGICAL INCENTIVES OF ENVIRONMENTAL BIOETHICS ENCYCLICAL "LAUDATO SI"

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By unscrupulous exhaustion of the nature, through its technological mastery and approach solely based on pragmatic-utilitarian ethics, a contemporary man has attempted to despotically seize a dominant role over the Earth, neglecting his original role of a responsible and caring protector of the environmental conditions of his developing life.

As a consequence of such approach, ecological degradation is emerging, which requires an interdisciplinary approach into the awakening of a bio/ethical ecological consciousness, significantly enriched by numerous interventions of Christian ecclesiastical teaching and philosophical imperative incentives with the precautionary principle, paradigm of sustainable development and bioethical ecumenism.

The latest encouragement of awareness of ecological risks and the awakening of moral responsibility, comes from Pope Francis in the encyclical about caring for the common home, «Laudato si'», which emphasizes the renewal of our relationship with nature, the inner change of man pervaded by the virtues of solidarity and righteousness from the perspective of the past, looking at the present and the future, of the building and sustainability of the harmonious world by interdisciplinary efforts.

**Keywords:** ecological/environmental bioethics, ecology, ecological risks, moral responsibility, "sustainable development", precautionary principle, bioethical ecumenism



HUMANISTIČKE ZNANOSTI / HUMANITIES

## FIKCIONALNI I FAKCIONALNI PROSTOR IZMEĐU GRADA ZAGREBA I GRADA BANJA LUKE

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Reprezentacija fakcionalnih prostora u fikcionalnom diskursu postala je jednom od ključnih narativnih tehnika. Kako se fikcionalni tekstovi referiraju na stvarne, već postojeće, oni skupa tvore tzv. *treći prostor*, koji se može posmatrati iz najmanje tri ugla (sociološkog, antropološkog i imaginarnog), a osnovna zadaća mu je ukazati na to kako se čovjek (bilo u stvarnosti bilo imaginarnog preko protagonista) može ostvariti, u najvećoj mjeri, upravo u nekom neutralnom, hibridnom prostoru. Bosanskohercegovački pisac Irfan Horozović svoju prvu fazu književnog stvaralaštva započeo je u Zagrebu, što je književna kritika okarakterizirala kao zagrebačku fazu. U tom periodu nastala su djela koja tematiziraju prostor grada Zagreba i prostor zavičajne Banja Luke, te kako se protagonisti osjećaju i kreiraju *prostor između* ta dva grada. Rad će se fokusirati na djela iz te prve faze (posebno djelo „Kalfa“) s ciljem da ukaže na značaj tog i takvog prostora u odabranom opusu, ali i uopće za suvremeno globalizirano društvo koje na različitim razinama i s raznih gledišta re/konstruira i upražnjava *prostor između*.

**Ključne riječi:** čovjek, život, književnost, prostor



*HUMANISTIČKE ZNANOSTI / HUMANITIES*

## **FICTIONAL AND FACTIONAL SPACE BETWEEN THE CITY OF ZAGREB AND THE CITY OF BANJA LUKA**

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The representation of factional spaces in fictional discourse had become one of the key narrative techniques. As fictional texts refer to actual, already existing ones, they form together a so-called third space, which can be viewed from at least three angles (sociological, anthropological and imaginary), and its basic task is to point out that a man (in reality or imaginarily through the protagonist) can be realized, to a large extent, precisely in a neutral, hybrid space. Bosnian writer Irfan Horozović began his first stage of literary creation in Zagreb, which literary criticism characterized as the Zagreb phase. During this period, works that deal with the area of the city of Zagreb and the area of his hometown Banja Luka were created, and how the protagonists feel and create space between the two cities. This paper will focus on a work from the first phase (especially the work *Kalfa*) in order to point out the significance of that and such spaces in the chosen opus, but also for the contemporary society, which at different levels and from various aspects reconstructs and occupies the space between.

**Keywords:** man, life, literature, space



INTERDISCIPLINARNO / INTERDISCIPLINARY  
**GRUPNO FINANCIRANJE PROJEKATA ZELENE ENERGIJE**

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Kako bi Europska unija zadovoljila svoje potrebe za energijom, izbjegla korištenje fosilnih goriva, započela prilagodbu klimatskim promjenama i smanjila proizvodnju električne energije pomoću rizičnih nuklearnih pogona, pribjegli su širem korištenju lokalno dostupnih obnovljivih izvora energije. Ovaj će rad opisati razvoj poslovnih modela s naglaskom na grupno financiranje. Grupno financiranje je alternativni način financiranja kod kojeg grupa ljudi financira projekte, proizvode, usluge ili ideje pomoću internetskih platformi. Obnovljivi izvori energije najčešće su financirani modelom zajma kod kojeg velik broj sudionika malim iznosima doprinosi projektu, odnos sudionika i projekta definiran je ugovorom, pri kojem se isplaćuje prinos na pozajmljeni iznos. Ostali modeli grupnog financiranja su: grupno financiranje temeljeno na vlasničkim udjelima, grupno financiranje temeljeno na donacijama, grupno financiranje temeljeno na nagradama i hibridni modeli grupnog financiranja. Jedna od prvih EU internetskih platformi za grupno financiranje projekata obnovljivih izvora energije je Citizenergy. Platforma je razvila preko 54 projekata vrijednosti 36 milijuna € u 2016 - 2017. *Citizenergy* je krovna organizacija koja pomaže projekte obnovljivih izvora energije različitih zajednica kao što su: energetske zadruge, organizacije ili druge internetske platforme. Grupno financiranje je prilagodljiv model koji se odlično uklapa u lokalne projekte obnovljivih izvora energije povezivanjem različitih aktera.

**Ključne riječi:** grupno financiranje, obnovljivi izvori energije, energetska tranzicija



INTERDISCIPLINARNO/ I NTERDISCIPLINARY  
**CROWDFUNDING OF GREEN ENERGY PROJECTS**

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EU wants to use locally available renewable energy sources to meet its future energy needs, avoid the use of fossil fuels, start mitigation to climate change, and avoid using nuclear power plants. This paper will describe the development of different business models with an emphasis on crowdfunding. Crowdfunding is an alternative way of financing where a group of people funds projects, products, services, or ideas using Internet platforms. Renewable energy sources are most often financed by a lending model of crowdfunding where many participants contribute small amounts to the project. The ratio of the revenue and the invested amount is defined by contract. There are different types of crowdfunding models: crowd lending, equity crowdfunding, donation-based crowdfunding, reward-based crowdfunding and hybrid models of crowdfunding. One of first EU crowdfunding platforms for renewable energy projects is *Citizenenergy*. With over 54 projects and 36 million € collected during a period of 2016-2017. *Citizenenergy* has the experience to be an umbrella organization for other crowdfunding platforms. *Citizenenergy* encourages different communities as energy cooperatives and organizations to participate in renewable energy projects. Crowdfunding is an adjustable business model that successfully connects local RES projects with interested parties.

**Keywords:** crowdfunding, renewable sources of energy, energy transition



INTERDISCIPLINARNO / INTERDISCIPLINARY  
**ECOLOGY AND NATIONAL HERITAGE – A UNIQUE MASTER'S  
DEGREE COURSE IN PRE-SCHOOL EDUCATION IN CROATIA**

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The development of the system of various programmes of early and pre-school educations has become one of the priorities in the European Union in the last several years. One of such accepted programme is the course Ecology and national heritage within the Graduate university studies of early and pre-school education on the Faculty of Education of Josip Juraj Strossmayer University of Osijek. In Croatia there are five universities where upon completion of graduate university studies of early and pre-school education one is awarded a title of Master of early and pre-school education. Only on Faculty of Education in Osijek the course on ecology subjects is offered to undergraduate students. The values and specificities of this study programme among others are presented in this paper as well as its social significance.

**Keywords:** pre-school education, ecology, graduate university programme



INTERDISCIPLINARNO / INTERDISCIPLINARY  
**SVEMIRSKI OTPAD**

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Gotovo svakodnevno čitamo o novim zagađenjima Zemlje – kako površine, tako i morskih prostora. Međutim, ljudska civilizacija zadnjih 60-ak godina počela je raznim otpadom zagađivati i Svemir! Orbite oko Zemlje pune su starih satelita, dijelova raketa, dijelova opreme ili raznih manjih ili većih komada metala i drugih materijala nastalih slučajnim ili namjernim sudarima svemirskih letjelica.

Svemirski otpad postaje sve veći problem – radi velikih razlika u brzini (kinetička energija!), čak i mali komadi svemirskog otpada u stanju su ugroziti letjelice, pa i živote astronauta. Trošak praćenja svemirskog otpada, kako bi se izbjegle neželjene pa i opasne situacije postaje sve veći. Uza sve to, tehnički nije moguće pratiti manje komade otpada, koji također mogu biti opasni i prouzročiti akcidentne situacije. Zadnjih godina se razvijaju sustavi koji bi trebali pomoći smanjenju svemirskog otpada, pa čak i prikupljanju pomoću posebnih letjelica. Ovim započinje novo razdoblje u održivom gospodarenju otpadom.

U radu će se prezentirati pojam svemirskog otpada, opasnosti koje predstavlja i prijedlozi za sprječavanje nastanka otpada, mogućnosti njegove ponovne uporabe, recikliranja i uporabe, a sve u skladu s „hijerarhijom otpada“.

**Ključne riječi:** gospodarenje otpadom, svemirski otpad, prikupljanje otpada





INTERDISCIPLINARNO / INTERDISCIPLINARY  
**SPACE WASTE AND DEBRIS**

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Almost everyday we read about the Earth's pollution – both the area of the land surface and the area of the ocean surface. However, in the last sixty (60) years the human civilization has started to pollute the Space too! Earth Orbits are full of old satellites, and spent rocket stages, parts of equipment, including the fragments from their disintegration, erosion and debris of accidental and deliberate satellite collisions.

Space debris is becoming an increasing problem, due to the big differences in speed (kinetic energy), even the small debris is hazardous to spacecrafts, and even the lives of astronauts. To avoid unwanted and dangerous situations the cost of tracking space debris becomes bigger. Additionally, it is technically impossible to keep track of smaller debris, which can also be as dangerous, no matter the size, and which can cause the accidental situations. In the recent years, systems which should help reduce space debris and even collect it by using special spacecrafts are being developed. With this begins a new era in sustainable waste management. This paper presents the concept of space debris, the dangers it poses, and proposals for its prevention, and also the possibility of applying "space debris hierarchy".

**Keywords:** space waste management, space debris, waste collection



INTERDISCIPLINARNO / INTERDISCIPLINARY

## OBRAZOVANJE GLAZBOM: PJESMA KAO SREDSTVO BUĐENJA EKOLOŠKE SVIJESTI

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Kako bi promišljanje o pravilnom odnosu prema okolišu ušlo u naviku i postalo sastavni dio življenja, ekološku svijest potrebno je razvijati od najranije dobi. Za odgoj u tom smjeru presudni su roditelji, odgojitelji, ali i učitelji koji tijekom odgojno-obrazovnog procesa mogu utjecati na djecu i u tom smjeru poučavati. Nastava glazbene kulture putem pjesme, slušanja, sviranja i glazbene kreativnosti, može doprijeti do svih učenika.

S obzirom da se tekstom mogu prenijeti sadržaji pa tako i poruke ekološkog karaktera, autorice su za potrebe ovoga rada istraživale koje su sve pjesme ekološkog sadržaja uvrštene u udžbenike glazbene kulture u razrednoj nastavi te pjesme koje je snimio dječji Pjevački zbor *Zaro* iz Pule. Metode istraživanja koje se primjenjuju u ovome radu su analiza i sinteza te primjer dobre prakse (case study).

Prilikom istraživanja udžbenika, autorice su utvrdile da nema pjesama koje su tekstom direktno usmjerene prema zaštiti okoliša, dok se indirektno zaštita okoliša može povezati s pjesmama koje pjevaju o prirodi: životinjama, vodi, šumi i slično. Autorice stoga predlažu da se u nastavi glazbene kulture koriste dječje pjesme festivalskog tipa koje govore o ekološkoj problematici. Kao primjer dobre prakse predlažu *ekopjesme* Dječjeg zbora *Zaro* iz Pule.

**Ključne riječi:** glazbena pedagogija, interdisciplinarnost u nastavi glazbe, metodika glazbene kulture, obrazovanje glazbom, razredna nastava



INTERDISCIPLINARNO / INTERDISCIPLINARY  
**EDUCATION WITH MUSIC: THE SONG AS A MEANS  
OF AWAKENING ECOLOGICAL CONSCIOUSNESS**

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Ecological consciousness should be developed from the earliest age so that a proper relation towards the environment becomes a habit and an integral part of our living. For such upbringing, besides parents, educators, and teachers are also important who can influence children through teaching. Teaching a topic using music through song, listening, playing and musical creativity can reach all pupils.

For the purpose of this paper, the authors have researched which songs containing ecological messages are present in the textbooks of music culture in primary school, and which songs were recorded by the children's choir Zaro from Pula who are known for their eco-friendly songs. The research methods used in this paper were analysis, synthesis and case study.

While studying the textbooks, the authors found that there are no songs that are directly conveying the message towards environmental protection, only indirectly through songs whose lyrics are about nature (animals, water, woods and similar). Therefore, the authors suggest that children's songs of the festival type that talk about ecological problems are used in teaching music culture. As an example of good practice, the eco-songs of the children's choir Zaro from Pula are suggested.

**Keywords:** music pedagogy, eco-songs, interdisciplinary in teaching music, methodology of music culture, education with music, Music in primary school



INTERDISCIPLINARNO / INTERDISCIPLINARY

## MOGUĆNOSTI GOSPODARENJA OTPADOM PRILIKOM REMONTA ŽELJEZNIČKE PRUGE

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Prilikom remonta pruge nastaje otpadni kameni agregat, željeznički pragovi (drveni, betonski i čelični) te tračnice. Jedan od temeljnih principa u gospodarenju otpadom je primjena reda prvenstva odnosno „hijerarhija postupanja otpadom“. Sukladno navedenoj hijerarhiji priprema za ponovo korištenje ima prednost pred recikliranjem, a koje ime prednost pred oporabom, odnosno pred zbrinjavanjem. U radu se obrađuju vrste otpada nastalog prilikom remonta željezničke pruge i načini njegovog ponovnog korištenja, a sve u skladu s održivim gospodarenjem otpadom.

Nakon remonta pruga, otpadni kameni agregat, nastaje ručnim i strojnim rešetanjem zastora. Dobiveni otpadni kameni agregat razlikuje se po kvaliteti i svojstvima. Ukoliko je postojeća zastorna prizma manje onečišćena, moguće je 30 % izrešetanog postojećeg agregata zastorne prizme ugraditi u novi tamponski sloj ili reciklirati.

U željezničke pruge u Republici Hrvatskoj ugrađuju se: drveni, betonski i čelični pragovi. Zbog ograničenog trajanja pragova, nakon remonta pruga pragove je potrebno klasificirati na pragove koji se mogu ponovno ugraditi na prugama nižeg ranga i na pragove koji se ne mogu više ugrađivati i koji predstavljaju otpad.

Nakon remonta pruge ili pojedinačne zamjene tračnica prigodom redovitog održavanja kolosijeka, nastaju velike količine potrošenih tračnica koje nisu za daljnju uporabu i koje je potrebno predati ovlaštenim osobama na recikliranje.

**Ključne riječi:** gospodarenje otpadom, željeznički pragovi, kameni agregat, tračnice



INTERDISCIPLINARNO / INTERDISCIPLINARY  
**POSSIBILITY OF WASTE MANAGEMENT DURING  
THE OVERHAUL OF THE RAILWAY LINE**

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During the railway line overhaul, waste stone aggregates, railway sleepers (wooden, concrete and steel) and rails are formed. One of the fundamental principles in waste management is the application of the priority order or "waste management hierarchy". In accordance with this hierarchy, preparation for the waste to be reused has the priority over recycling the waste, which takes precedence over recovery or pre-care. This paper deals with types of waste generated during the railway track overhaul and the manner of its reuse, all in keeping with sustainable waste management. After the railway track overhaul, processing the ballast manually or by machines creates waste stone aggregate. The waste stone aggregate obtained is different in terms of quality and features. If the existing ballast bed is less contaminated, it is possible to install 30% of the existing ballast bed aggregate into a new tampon layer or recycle. The railway tracks in the Republic of Croatia are made of wood, concrete and steel railway sleepers. After the railway overhaul, because of the limited duration of the railway sleepers, it is necessary to classify the railway sleepers into those which can be re-installed into the lower level tracks and those which can no longer be used and present waste. After the railway track overhaul or the individual replacement of the tracks during the regular maintenance, large amounts of used rails are produced, which are not for further use and which need to be handed over to authorized recycling personnel.

**Keywords:** waste management, railway sleepers, stone aggregate, railway tracks



INTERDISCIPLINARNO / INTERDISCIPLINARY

## ODGOJNO-OBRAZOVNI PROGRAMI U ZAŠTIĆENIM PODRUČJIMA HRVATSKE – PRIMJERI IZ KRŠKIH PODRUČJA

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Krška područja su dijelovi reljefa sa specifičnim geomorfološkim i hidrogeološkim značajkama. Krški krajolik odlikuju brojni podzemni i nadzemni reljefni oblici i specifično kretanje vode u podzemlju. Jedan od važnih ciljeva Zakona o zaštiti prirode je očuvanje krša i krških oblika, biološke i krajobrazne raznolikosti krškog područja upravo s obzirom na njihovu specifičnost i jedinstvenost. U zaštićenim područjima zaštita prirode je primarna, ali kroz zaštitu se promiču i njihove znanstvene, kulturne, estetske, rekreativne te odgojno-obrazovne vrijednosti. Upravljanje zaštićenim područjima stoga uključuje obrazovne programe o vrijednostima i značajkama pojedinih ekosustava te edukaciju posjetitelja i lokalnog stanovništva o važnosti aktivne zaštite prirode za buduću, održivi razvoj. U radu su istraženi odgojno-obrazovni programi koji se provode u nekoliko zaštićenih područja u kojima dominira krški reljef: Parku prirode Velebit, Nacionalnom parku Paklenica i Pećinskom parku Grabovača. Posebno su analizirani postojeći programi koji se provode u Pećinskom parku Grabovača iz čega je razvidno da su ekološke radionice prilagođene različitim dobnim skupinama, već od vrtičke dobi do osnovnoškolske i srednjoškolske populacije. Radionice su usklađene s nastavnim planovima i programima, a cilj im je poučavanje o vrijednostima i potrebi zaštite krša i krških oblika i prirode uopće u cilju održivog razvoja.

**Ključne riječi:** krš, obrazovanje, zaštićena područja



INTERDISCIPLINARNO / INTERDISCIPLINARY  
**EDUCATIONAL PROGRAMS IN PROTECTED AREAS  
OF CROATIA – KARST AREAS EXAMPLES**

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Karst areas are parts of relief with special geomorphological and hydrological characteristics. Karst landscape is defined with many underground and landform karst features and specific subterranean water circulation. One of the important goals in the Nature Protection Act is preserving karst and karst features, biological and landscape karst diversity because of its specifics and uniqueness. In protected areas protection of the nature is the primary goal, but through protection the intention is to promote its scientific, cultural, estetical, recreative and educational values. Managing protected areas therefore include educational programs about values and characteristics of certain ecosystems, also visitors' and local population education about importance of nature protection for future sustainable development. In this article some educational programs that are implemented in few protected areas with dominant karst relief are analysed: Nature Park Velebit, Paklenica National Park and Cave Park Grabovača. Programs that are analysed, especially from Cave Park Grabovača, show that implemented workshops are adjusted for different groups of youth, from kindergarten to primary and secondary schools' children. These workshops are adjusted to national school programs with the main goal to educate about values and protection of karst relief, nature in general and sustainable development.

**Keywords:** karst, education, protected areas



INTERDISCIPLINARNO / INTERDISCIPLINARY

## KORELIRANJE SADRŽAJA NASTAVE PRIRODE I DRUŠTVA I GLAZBE: PROLJETNICE U DJEČJIM PJESMAMA

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Suvremene tendencije u pedagogiji ukazuju na važnost integriranog i projektnog pristupa nastavi, ističući da koreliranjem sadržaja različitih predmeta učenik uspješnije usvaja gradivo. Glazba je oduvijek bila dio školskoga kurikula, a istraživanja pokazuju da se može uspješno koristiti kao sredstvo za usvajanje sadržaja svih predmeta. Proljetnice, kao vjesnici proljeća, česta su tema u dječjim pjesmicama, a ujedno su i važan sadržaj nastave prirode i društva.

U ovom radu istražili smo učestalost pojavljivanja proljetnica u pjesmicama koje se nalaze u udžbenicima za glazbenu kulturu u prva tri razreda osnovne škole, te kako bi se te pjesmice mogle povezati sa sadržajima u nastavi prirode i društva.

Rad sadrži i prijedloge za realizaciju nastavnih sati prirode i društva s temom proljeća pomoću pjesmica o proljetnicama; po jedan za svaki od prva tri razreda.

**Ključne riječi:** korelacija nastavnih sadržaja, priroda i društvo, glazbena kultura, proljetnice, dječje pjesme





INTERDISCIPLINARNO / INTERDISCIPLINARY  
**CORRELATION OF TEACHING CONTENT IN NATURE AND  
SOCIETY EDUCATION AND MUSIC: SPRING FLOWERS IN  
CHILDREN SONGS**

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Contemporary tendencies in pedagogy point out the importance of integrated and project teaching approach, emphasizing that correlation of contents from different subjects enhances student success in learning them. Music has always been a part of school curricula, and research show that it can be successfully used as a tool in learning the contents of other school subjects. Spring flowers are, as heralds of spring, a common theme in children songs, and they are also an important content in nature and society education. In this paper, we have investigated the frequency of the appearance of spring flowers in children songs found in textbooks for music education in the first three grades of primary school, and how could these songs correlate with contents of nature and society education. The paper also contains suggestions for the execution of nature and society lessons with the theme of spring using the spring flowers themed songs; one for each of the first three grades.

**Keywords:** correlation of teaching content, nature and society education, music education, spring flowers, children songs



INTERDISCIPLINARNO / INTERDISCIPLINARY

## ZADARSKA GAŽENICA – INTERMODALNO PROMETNO ČVORIŠTE I MOGUĆNOSTI REGENERACIJE SKLADIŠNIH ZGRADA

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Pojam industrijske arheologije obuhvaća istraživanje industrijske i tehničke baštinske kulture, učestalo neiskorištene i beživotne u današnjem postindustrijskom dobu. Cilj je discipline osvijestiti vrijednost industrijskoga naslijeđa, spriječiti rušenje objekata koji su obilježili čitavo povijesno razdoblje te iskoristiti potencijal prostora za nove, suvremene funkcije.

Nastanak lučko-industrijskog kompleksa Gaženice, na zadarskom jugoistočnom rubu, vezan je uz oporavak gospodarstva i demografski rast potaknut izgradnjom željezničke pruge 1967. Premještanjem trajektne luke s poluotoka u zonu kompleksa priobalni pojas Gaženice danas postaje područje transformacije u suvremeno intermodalno čvorište, tj. mjesto povezivanja cestovnog, željezničkog i lučkog prometa, a u blizini luke zračnog prometa.

Međutim, njezino zaleđe, ispunjeno nekorištenim skladištima, nije predmet novih planova. Scenarije razvoja, i to oprečne, moguće je naći već u Republici Hrvatskoj. Šibenik Tvornicu elektroda i ferolegura, svjedoka nekadašnje gospodarske moći, sravnjuje sa zemljom, dok Rijeka imenovanje Europskom prijestolnicom kulture 2020. godine duguje oživljavanju industrijske baštine. Riječki Muzej moderne i suvremene umjetnosti u nedostatku sredstava seli u zapadno krilo nekadašnje tvornice Rikard Benčić, na izrazito ekonomičan način prilagođavajući postojeće prostore suvremenim potrebama. Londonska je termoelektrana također prenamijenjena u muzej, i to jedan od najposjećenijih na svijetu, Tate Modern. Napušteno i nezanimljivo može minimalnim sredstvima postati živo i bogato sadržajima, doprinos zadarskoj kulturnoj i turističkoj ponudi.

**Ključne riječi:** industrijska baština, postindustrijsko doba, lučko-industrijski kompleks, intermodalno čvorište, Zadar, Gaženica



INTERDISCIPLINARNO/INTERDISCIPLINARY  
**THE INDUSTRIAL ZONE OF THE CITY OF ZADAR – INTERMODAL  
HUB AND POSSIBILITIES IN WAREHOUSES' REGENERATION**

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The term industrial archaeology encompasses the systematic exploration of industrial heritage, frequently purposeless in postindustrial times. The discipline aims at raising awareness of the value of industrial buildings, at preventing their demolition, and reusing them for new purposes. Formation of Gaženica industrial complex, on Zadar's southeastern periphery, is linked to the economic and demographic growth brought about by railway in 1967. Recent dislocation of the ferry port from Zadar's historic center to Gaženica has resulted in transformation of its seafront area into an intermodal hub.

However, its hinterland, occupied by unused warehouses, has not been the object of new plans yet. Examples of other Croatian cities provide us with different, even contrasting scenarios of future development. Šibenik's Factory of Electrodes and Ferroalloys, witness of its once-great economic power, was torn down in the mid-1990s. In contrast, Rijeka wins The European Capital of Culture 2020 title owing to the regeneration of its industrial heritage, one example of which being the moving of the Museum of Modern and Contemporary Art into a former factory, Rikard Benčić. The abandoned and uninteresting can, with the minimum of means, be converted into full of life and contents, a contribution to Zadar's cultural and tourism offer.

**Keywords:** industrial heritage, postindustrial times, industrial complex, intermodal hub, Zadar, Gaženica



INTERDISCIPLINARNO / INTERDISCIPLINARY

## UTJECAJ USMJERENOSTI STRUKTURE NA SAVOJNI MODUL ELASTIČNOSTI DRVA HRASTA U LONGITUDINALNOM SMJERU

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Modul elastičnosti je važno mehaničko svojstvo i pokazuje otpornost materijala prema elastičnoj deformaciji. Vrijednosti modula elastičnosti različitih drvnih vrsta značajno se razlikuju, a velike razlike mogu biti i unutar iste vrste. Vrijednosti modula elastičnosti ovise o orijentaciji mikrostrukture i značajno se razlikuju za tri glavne osi: longitudinalne, radijalne i tangencijalne. Kod nekih drvnih vrsta savojni modul elastičnosti u longitudinalnom smjeru također ovisi o kutu između savojne sile i smjera godova.

U radu su prikazani rezultati ispitivanja savojnog modula elastičnosti hrasta lužnjaka u longitudinalnom smjeru. Kut između smjera savojne sile i smjera godova iznosio je 0°, 45° i 90°. Pokazalo se da položaj savojne sile u odnosu na smjer godova utječe na vrijednost modula elastičnosti u longitudinalnom smjeru. Najveće vrijednosti modula elastičnosti dobivene su za kut od 0°, a vrijednosti za 45° i 90° su vrlo slične.

Rasipanje i varijabilnost rezultata opisana je dvoparametarskom Weibullovom razdiobom. Pokazalo se da je ista prikladna za statističku analizu dobivenih rezultata.

**Ključne riječi:** savojni modul elastičnosti, hrast, usmjerenost mikrostrukture



INTERDISCIPLINARNO / INTERDISCIPLINARY  
**EFFECTS OF MICROSTRUCTURAL ORIENTATION ON BENDING  
MODULUS OF ELASTICITY OF OAK TRUNKS IN THE  
LONGITUDINAL DIRECTION**

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Modulus of elasticity (MOE) defines an important mechanical property which expresses the resistance of a material to elastic deformation. MOE values are significantly different for each wood species and they vary within the same wood species. The values of the modulus of elasticity depend on the orientation of wood microstructure in regard to three principal axes: longitudinal, radial and tangential. For some wood species, the bending MOE in the longitudinal direction depends on the angle between the direction of loading and annual growth rings.

The paper presents the results of the research of the bending modulus of elasticity of penduculate oak trunks (*Quercus robur*) in the longitudinal direction. The angles between the direction of load and the annual growth ring orientation were 0°, 45° and 90°. The study showed that the annual growth ring orientation affects the MOE of penduculate oak wood in the longitudinal direction. The highest values were obtained at the angle of 0°, and the values for 45° and 90° were very similar.

The heterogeneity and variability of the results was described with the two-parameter Weibull distribution and they follow the Weibull distribution.

**Keywords:** bending modulus of elasticity, penduculate oak, microstructural orientation



INTERDISCIPLINARNO / INTERDISCIPLINARY

## UMJETNA INTELIGENCIJA I KLIMATSKE PROMJENE

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Posljednjih godina područje zaštite okoliša privlači sve veću pozornost dobivajući određenu količinu potpore, koja između ostalog uključuje istraživanje tehnologije i traženje novih metoda za rješavanje problema u tom području. Među novim tehnologijama pojavio se inovativni način gledanja na znanost o okolišu kroz perspektivu umjetne inteligencije. U radu je objašnjena primjena umjetne inteligencije u rješavanjima problema vezanih za klimatske promjene. Nove tehnologije pametne neuronske mreže posjeduju izniman potencijal za primjenu u mnogim područjima ljudskih djelatnosti zbog čega se svakodnevno unaprjeđuju. Važni čimbenici koji utječu na rješavanje raznih pitanja u području klimatskih promjena su vrijeme i novac, kako bi se u što kraćem vremenu odabrale što bolje raspoložive tehnologije. Prikazani su neki od razvojnih projekata smanjenja utjecaja klimatskih prilika na okoliš.

**Ključne riječi:** umjetna inteligencija, klimatske promjene, razvojni projekti



INTERDISCIPLINARNO / INTERDISCIPLINARY  
**ARTIFICIAL INTELLIGENCE AND CLIMATE CHANGE**

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Over the last few years, the area of environmental protection has attracted an increasing attention by gaining a certain amount of support including the technology research and finding new methods for solving problems in this area. Among the new technologies, an innovative way of looking at environmental science through the perspective of artificial intelligence has emerged. This paper explains the use of artificial intelligence in solving climate change problems. New smart neuron network technologies have significant application potential in many fields of human activities, because of which they are constantly developing. Important factors for solving climate change issues are time and money, to make the right further choice from available technologies. Some of the development projects for reducing the impact of climate change on the environment are presented.

**Keywords:** artificial intelligence, climate change, developing projects



INTERDISCIPLINARNO / INTERDISCIPLINARY  
**HEALTHY URBAN DEVELOPMENT**

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There has never been before such a large percentage of humanity removed from nature. Hundred of researches determine significant positive effects of nature on human body, immune function, stress hormones, concentration, activation natural killer cells, which attack on the cancer cells. Visiting forest for relaxation and recreation while breathing in volatile substances, called phytoncides. Production of phytoncides has been discovered at coniferous and deciduous trees. Challenge for urbanists and landscape architects is to protect and improve green spaces in urban landscape and build up new green areas, providing a healthy environment for people by using benefits of nature. Incorporating bigger green areas into the city or near the city is substantial in 21st century and also in future. By the year 2050, 70% of people will live in urban areas.

**Keywords:** phytoncides, urban landscape, healthy environment





INTERDISCIPLINARNO / INTERDISCIPLINARY

## HOW WOULD NATURE REMOVE MICROPLASTIC FROM MARINE ENVIRONMENT: CROBIN SOLUTION

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Plastic pollution in marine environment has been exacerbated in the last several decades due to accumulation of micro and nano particles in water, sediment and marine species. Based on the recent scientific data, micro-plastic has been detected throughout the marine food webs from zooplankton to shellfish, fish and marine mammals. In addition, seafood eaters ingest about 11,000 pieces of micro-plastic particles ( $\leq 5$  mm) per year. Students at UNIZD participate in the biomimicry livinglabs for practical education and learning about nature-based solutions aiming to address local issues. CroBin (*morska kanta*) is a such solution designed and built by two students with a main goal to remove microplastic from coastal marine areas, making them more resilient and healthy. The key technological principle is to pump in situ seawater by using solar energy and move it through a filter to remove microplastic particles. The first prototype was successfully tested in Jazine marine in Zadar, while the next steps include an interdisciplinary research to improve the CroBin design and its technology based on green chemistry and biomimicry principles.

**Keywords:** biomimicry LivingLabs, microplastic pollution, nature-based solutions, green chemistry, marine environment



INTERDISCIPLINARNO / INTERDISCIPLINARY  
**GRADSKO VRTLARENJE – CJELOVIT PRISTUP**

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Svjedoci smo intenzivnog razvoja gradskog vrtlarenja. Ova činjenica otvara pitanje: Je li gradsko vrtlarenje moda, utopija ili naša budućnost? Namjera ovog rada je istražiti teoriju i praksu, poštujući cjelovit pristup, kako bismo pronašli odgovore na gore navedeno pitanje. Naš je cilj usporediti ta tri gledišta gradskoga vrtlarenja i otkriti njihov značaj.

U empirijskom dijelu istraživanja sudjelovali su stručnjaci iz područja biologije, kemije i geografije, a metodologija, koja je korištena u ovom radu, temelji se na World Café Metodi. Uvažavajući interdisciplinarni pristup, naši rezultati istraživanja pokazuju da budućnost gradskog vrtlarenja ima primarnu i dominantnu ulogu, iako modna gledišta i utopije daju zanimljive poticaje za dodatno istraživanje. Doprinos našeg rada je višedimenzionalan. Na teorijskoj razini pruža pregled gradske poljoprivrede i gradskog vrtlarenja. Na empirijskoj razini naš rad odražava kompleksnost gradskog vrtlarenja i njegovu važnost za budućnost. Na obje razine, na teorijskoj i empirijskoj, naš rad pridonosi širenju svijesti o održivosti.

**Ključne riječi:** gradska poljoprivreda, održivost, world café metoda, interdisciplinarni pristup



INTERDISCIPLINARNO / INTERDISCIPLINARY  
**URBAN GARDENING - AN INTEGRATIVE APPROACH**

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We are witnesses of intensive urban gardening development. This fact opens up a question: is urban gardening the fashion, utopia or our future? The aim of this paper is to explore literature and practice to find the answers to the question above by respecting an integrative approach. Our goal is to compare those three aspects of urban gardening searching for the most dominant one. The methodology used in this paper is based on the World Café Method with participants who are experts from the fields of biology, chemistry and geography.

Our research results show that the future aspect of urban gardening has a primary and dominant role, although aspects of fashion and utopia deliver interesting impulses provided by this interdisciplinary approach. The contribution of our paper is multidimensional. On the theoretical level it provides the overview about urban agriculture and gardening. On the empirical level our paper reflects complexity of urban gardening and its importance for the future. On both levels our paper contributes to widening of the awareness about sustainability.

**Keywords:** urban agriculture, sustainability, world café method, interdisciplinary approach



**Posterska priopćenja / *Poster presentations***



## THE ROLE OF METALLOTHIONEINS IN DETOXIFICATION AND OXIDATIVE STRESS

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Metallothioneins (MTs) are low-molecular weight, metal-binding proteins, rich in cysteine residues, present in virtually all living organisms. They are localized mainly in the cell cytoplasm, but can also be present in lysosomes, mitochondria and nuclei. MT molecule is a single polypeptide chain with more than one-third of amino acids being Cys residues, which can act as metal binding domains. Therefore, the key role of MTs is maintaining the homeostasis of essential metals like Zn, but they also have high affinity for binding toxic metals like Cd, Hg and Pb. Due to their potent metal-binding and redox capabilities, important biological functions of MTs include heavy-metal detoxification, free radicals scavenging and protection of cells against the oxidative stress. Metal ions can induce MTs expression which can be used as a biomarker indicating environmental contamination with toxic metals. MTs regulate levels of free radicals, shortly lived chemical particles containing one or more unpaired electrons generated by radiation and various biological processes. It was shown that MT can act as scavengers of superoxide and hydroxyl radicals or as Zn donor for enzymes participating in repairing processes and cell protection.

**Keywords:** metallothionein, toxic metals, free radicals, oxidative stress



## ISPITIVANJE OKSIDO-REDUKCIJSKIH SVOJSTAVA L-HISTIDINA

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Histidin je esencijalna aminokiselina koja štiti stanice od oksidativnog stresa, a između ostaloga nalazi se i u krvnom serumu gdje služi kao jedan od nosioca bakra između krvi i tkiva. Pronalaskom kompleksa bakra (II) i L-histidina u krvi, povećao se interes znanstvenika za istraživanje L-histidna i njegovih kompleksa.

U ovom su radu ispitivana oksido-redukcijska svojstva L-histidina u pH području od pH = 4 do pH = 10 uporabom voltametrijskih tehnika. Istraživanja su provedena u troelektrodnoj elektrokemijskoj ćeliji gdje je kao radna elektroda korištena elektroda od staklastog ugljika, kao referentna Ag/AgCl elektroda te kao protuelektroda platinska žica. Rezultati cikličke voltametrije su pokazali da L-histidin nije elektroaktivan u ispitivanom pH području, dok su rezultati diferencijalne pulsne voltametrije pokazali oksidacijski strujni vrh L-histidina, koji odgovara oksidaciji imidazolnog prstena, samo pri pH = 10. Utvrđen je porast struje oksidacijskog strujnog vrha L-histidina s povećanjem njegove koncentracije u ispitivanoj otopini, a uočena je i adsorpcija oksidacijskog produkta L-histidina na površinu radne elektrode. Ispitivan je i nastanak kompleksa L-histidna i nekoliko prijelaznih metala voltametrijskim tehnikama i UV/VIS spektroskopijom te je utvrđen nastanak kompleksa L-histidina i metalnog iona ( $Mn^{2+}$ ,  $Ni^{2+}$ ,  $Fe^{3+}$  i  $Co^{2+}$ ) u omjeru 1:1.

**Ključne riječi:** prirodne znanosti / natural sciences, elektrokemija, L-histidin, metalni kompleksi



## STUDY OF OXIDO-REDUCTION PROPERTIES OF L-HISTIDINE

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Histidine is an essential amino acid which protects human cells against oxidation stress. Among all, histidine is present in blood serum where it carries copper between blood and tissue. Discovery of copper (II)-L-histidine complex in blood increased interest of scientist to investigate L-histidine and its complexes.

In this work oxido-reduction properties of L-histidine in pH range from pH = 4 to pH = 10 were studied by voltammetry. Experiments were conducted in three electrode cells with a working glassy carbon electrode, reference Ag/AgCl electrode and a counter electrode platinum wire. Results of cyclic voltammetry have shown that L-histidine is not electroactive in the studied pH range, while results of differential pulse voltammetry have shown oxidation peak of L-histidine's imidazole ring at pH = 10. It has been found that the oxidation peak current of L-histidine increased with the increase of its concentration in solution. Adsorption of oxidation product of L-histidine on a working glassy carbon electrode surface was also detected. Formation of L-histidine complexes with transition metals were studied by voltammetry and UV/VIS spectroscopy. It has been found that L-histidine-metal ion ( $Mn^{2+}$ ,  $Ni^{2+}$ ,  $Fe^{3+}$  and  $Co^{2+}$ ) complexes in 1:1 ratio were formed.

**Keywords:** natural sciences, electrochemistry, L-histidine, metal complexes





## RAD I DJELOVANJE "EKO ZVU" GRUPE

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Studentski zbor Zdravstvenog veleučilišta u Zagrebu na inicijativu studenata, te uz suglasnost Stručnog vijeća Veleučilišta, u proljeće 2013. godine osniva EKO ZVU grupu Studentskoga zbora čiji djelokrug rada uključuje biološka i ekološka istraživanja, suradnju s udrugama iz djelokruga zaštite prirode i okoliša, organizaciju terenske istraživačke nastave i različite oblike edukacijskih aktivnosti poput javnih predavanja, tribina, radionica, konferencija i slično. U sklopu projekta grupe i u suradnji s Udrugom „Lijepa naša“, a koristeći se pritom metodologijom ISO 14:001, Veleučilište u svibnju 2015. godine prima međunarodno priznanje „eko-škole“ i zelenu zastavu te tako postaje prva visokoškolska ustanova s tim priznanjem. EKO ZVU grupa u novije vrijeme ostvaruje suradnju sa BIOM-om, BIUS-om, Hrvatskim institutom za biološku raznolikost i drugima te provodi razne tematske edukacije, radionice i projekte od kojih su u tijeku projekti „Odvajamo zajedno“ koji se bavi problematikom plastičnog otpada na Zdravstvenom veleučilištu te projekt „Upoznavanje s močvarnim područjima Republike Hrvatske“. Ciljevi EKO ZVU grupe su promicanje prirodnih znanosti, informiranje i podizanje svijesti studenata i djelatnika Zdravstvenog veleučilišta i javnosti o bioraznolikosti, ugroženosti vrsta i staništa, održivom razvoju i zaštiti prirode i okoliša te popularizacija osviještenog stava o svijetu koji nas okružuje kojim zajedno možemo graditi bolju i zeleniju budućnost.

**Ključne riječi:** EKO ZVU grupa, eko-škola, projekt, zaštita prirode i okoliša



## WORK AND ACTIVITY OF "EKO ZVU" GROUP

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The Student Union of the University of Applied Health Sciences in Zagreb on the initiative of students and with the approval of the University's Expert Council has in the spring of 2013 established the "EKO-ZVU" group of the Student Union, the work domain of which consists of biological and ecological researches, collaboration with associations within the same domain of protection of the nature and environment, organization of terrain researches and different kinds of educational activities as public lectures, practical workshops, conferences and similar. Within the group project and in the cooperation with association "Lijepa naša", and while using ISO 14:001 methodology, the University in May of 2015 received the international recognition of "Eco-school" and green flag and this way it became the first university institution with such recognition. Recently, the "EKO-ZVU" group has accomplished a cooperation with BIOM and BIUS organizations, the Croatian institute for biological diversity and others. The "EKO-ZVU" group also carries out different theme lectures, practical workshops and projects. The current projects are "Upoznavanje s močvarnim područjima Republike Hrvatske" (Introduction with the swamp areas of Croatia) and "Odvajamo zajedno – We separate together", which deals with the issue of plastic waste within the area of the University. The main goal of the "EKO-ZVU" group is promotion of the natural sciences, informing and raising awareness of students and staff within the University and general public about biodiversity, endangerment of the species and habitat, sustainable development and protection of the nature and environment, making the conscious attitude about the world that surrounds us popular, with whom we can together build better and greener future.

**Keywords:** EKO ZVU group, eco school, project, nature and environment protection



## IMPACT OF SOLVENT AND TEMPERATURE ON SOLUBILITY AND VISCOSITY OF EXPANDED POLYSTYRENE (EPS)

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*Expanded polystyrene (EPS)* is a lightweight, rigid and tough, closed-cell thermoplastic foam material. *EPS* is used for many applications e.g. in isolation, protecting, storing and serving many different food products. In this paper, the solubility and viscosity of EPS in the chloroform ( $\text{CHCl}_3$ ) and benzene ( $\text{C}_6\text{H}_6$ ) have been studied. We have seen a significant impact of polarity of solvents on the solubility of EPS and consequently very pronounced difference of viscosity of EPS in these solvents. This behaviour of EPS in different solvents is very attractive to study because it plays an important role in polystyrene recycling. These results indicate that it could be an alternative to incineration and mechanical recycling because it is the cheapest and one of the most efficient ways for EPS recycling.

**Keywords:** solubility, viscosity, expanded polystyrene, recycling



## ISPITIVANJE SADRŽAJA VITAMINA C U RAZLIČITO TRETIRANOM VOĆU I POVRĆU

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Vitamin C jedan je od najvažnijih organskih spojeva za jačanje imuniteta koji se svakodnevno unosi u organizam kroz namirnice prirodnog i sintetskog porijekla. Sastavni je dio voća i povrća, prvenstveno paprike, limuna, naranče i brokule. Kao aktivni čimbenik sudjeluje u najmanje šest enzimskih reakcija, među kojima je nekoliko reakcija sinteze kolagena, čija se disfunkcionalnost pokazuje simptomima karakterističnim za skorbut. Obrada hrane koja sadrži vitamin C ima značajan utjecaj na njegov udio u njima.

Cilj ovoga rada jeste usporediti sadržaj vitamina C u različito tretiranom voću i povrću. U tu svrhu odabrano je pet vrsta voća (jabuka, kivi, naranča, limun i banana) i povrća (kupus, paprika, paradajz, mrkva i tikvica) koji su podvrgnuti zamrzavanju i kuhanju. U cilju komparacije sadržaja vitamina C u navedenim namirnicama, rezultati su upoređeni s rezultatima svježe analiziranog voća, odnosno povrća. Ispitivanja su provedena titracijom s otopinom joda, dok se škrob koristio kao indikator.

Rezultati su pokazali da svježe i kuhano voće i povrće sadrže najviše vitamina C, dok se njegov sadržaj značajno smanjuje kod zamrznutih uzoraka. Najviše vitamina C prisutno je u paprici, limunu i naranči. Najmanji sadržaj ovog vitamina utvrđen je kod mrkve, banane i rajčice.

**Ključne riječi:** askorbinska kiselina, voće, povrće, titracija, kuhanje, zamrzavanje



PRIRODNE ZNANOSTI / NATURAL SCIENCES

## INVESTIGATION OF THE VITAMIN C CONTENT IN DIFFERENTLY TREATED FRUITS AND VEGETABLES

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Vitamin C is one of the most important organic compounds for strengthening the immunity that is daily introduced into the body through food of natural and synthetic origin. It is an integral part of fruits and vegetables, primarily peppers, lemons, oranges and broccoli. As a cofactor, it participates in at least six enzymatic reactions, among which there are several reactions of collagen synthesis, whose dysfunctionality is manifested with symptoms characteristic of scurvy. Food processing has a significant impact on the proportion of vitamin C found in these foods. The aim of this study is to compare the amounts of vitamin C in foods that were processed in different ways. Five kinds of fruits have been selected (apple, kiwi, orange, lemon and banana) and vegetables (cabbage, pepper, tomato, carrot and zucchini) which underwent freezing and cooking.

In order to compare the content of vitamin C in these foods, the results are compared with the results of freshly analyzed fruits or vegetables. The tests were carried out by titration with iodine solution, while starch was used as an indicator. The results showed that fresh and cooked fruits and vegetables contain the largest amount of vitamin C, while its content is significantly reduced in frozen samples. The largest content of vitamin C is present in pepper, lemon and orange. The smallest content of this vitamin is determined in carrot, banana and tomato.

**Keywords:** ascorbic acid, fruits, vegetables, titration, cooking, freezing



## MIKROBIOLOŠKA ANALIZA IZVORSKE VODE NA PODRUČJU PAPUKA

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Područje planine Papuk, koja se prostire u istočnoj Hrvatskoj, obiluje mnoštvom prirodne izvorske vode. Cilj je ovog istraživanja bio odrediti prisustvo koliformnih bakterija na nekoliko odabranih izvora te shodno tomu procijeniti je li voda prikladna za piće. Također je ispitano preživljavanje namjerno dodanih koliformnih bakterija u mikrokozmičkim laboratorijskim uvjetima. Uzorci vode prikupljeni su 18. veljače 2018. godine s izvora Jankovac, Kokočak (Vučenović), Muška voda i Žervanjska. Određen je ukupan broj bakterija na hranjivoj podlozi, kao i broj koliformnih bakterija na endoagaru. Također je određen pH i konduktivitet vode. Rezultati istraživanja su pokazali da je voda iz izvora Kokočak sadržavala povećan ukupan broj mikroorganizama te koliformne bakterije, te kao takva nije prikladna za piće. Ostala ispitana izvorišta su prema ispitivanim parametrima prikladna za ljudsku upotrebu. S druge strane, inokulirani koliformi su uspješno preživjeli devetodnevnu inkubaciju u mikrokozmosima u svim uzorcima izvorske vode osim u vodi s izvora Muška voda. Stoga se može zaključiti da Muška voda ima najveću kvalitetu vode s obzirom na ispitivane parametre te najmanju mogućnost perzistencije koliforma u slučaju zagađenja izvora. Također, s obzirom da ovi rezultati pružaju samo dio uvida u kakvoću izvorske vode potrebno je provesti dodatne analize kako bismo sa sigurnošću mogli utvrditi njezinu zdravstvenu ispravnost.

**Ključne riječi:** izvorska voda, bakterije, Papuk



## MICROBIOLOGICAL QUALITY OF NATURAL SPRING WATER IN THE PAPUK AREA

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The Papuk area, extending in the eastern part of Croatia, is abundant with natural spring waters. The purpose of this study was to determine the presence of coliform bacteria in several selected springs and therefore assess whether water is suitable for drinking. Survival of intentionally added coliform bacteria in microcosmic laboratory conditions was also investigated. Water samples were collected on February 18, 2018. from the springs Jankovac, Kokočak (Vučenović), Men's Wwater and Žervanjska. The total number of bacteria on the nutrient agar was determined as well as the number of coliform bacteria on the endoagar. Also, pH and water conductivity were determined. The results of the research have shown that the water from the Kokočak contained an increased total number of microorganisms and coliform bacteria, and as such was not suitable for drinking. Other tested springs were, according to the examined parameters, suitable for human use. On the other hand, inoculated coliforms survived successfully a nine-day incubation in microcosmos in all samples of the spring water except in the water from the Men's Water. Therefore, it can be concluded that Men's Water has the highest water quality with respect to the examined parameters and the smallest possibility of coliform persistence in case of spring pollution. Also, given that these results provide only one part of the insight into the quality of spring water, it is necessary to carry out additional analyses.

**Keywords:** spring water, bacteria, Papuk



## ISOLATION OF NON-RHIZOSPHERIC WHEAT GROWTH PROMOTING BACTERIA

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Rhizosphere bacteria are of great importance for the development of the plants. On the other hand, one gram of soil contains up to  $10^9$  bacteria, therefore that abundance of bacteria could contain many non-rhizosphere bacteria which potentially can have a beneficial effect on plant growth and development. The aim of this investigation was to isolate pure bacterial cultures from different ecosystems (forests, fields, reed beds, aquatic ecosystems) and treat the wheat with them during the first week of development. Wheat has been grown in conditions of sufficient humidity for undisturbed development and under dry conditions. Out of the 39 isolates, the four of them were statistically significantly stimulated, and nine of them had a destimulated development of the wheat at both experimental conditions. Stimulators of wheat development were more often isolated from forest soils and aquatic ecosystems, while inhibitors from agricultural fields and reed beds. Such results demonstrate the potential of non-rhizosphere bacteria to stimulate the initial development of the important agricultural crop. They also point to a possible further direction of the research with the aim of isolating new non-rhizosphere bacteria that could stimulate the development of the wheat.

**Keywords:** bacteria, wheat, water, soil, growth promoters





PRIRODNE ZNANOSTI / NATURAL SCIENCES

## INFLUENCE OF ENVIRONMENTAL VARIABLES ON ZOOPLANKTON DEVELOPMENT IN THE DANUBE RIVER

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The influence of different limnological parameters on zooplankton development was studied in the Danube River following the change of season. Samples were collected monthly during 2011. As expected, the maximum abundance of crustacean zooplankton was recorded in summer (1.12 ind/L), while minimum abundance was recorded in autumn (0.58 ind/L). In total, two cladoceran species: *Bosmina longirostris* (O.F. Müller, 1785) and *Sida crystallina* (O.F. Müller, 1776); three copepod species: *Acanthocyclops vernalis* (Fisher, 1853), *Cyclops vicinus* (Sars, 1863) and *Thermocyclops crassus* (Fisher, 1853) and juvenile copepod stages were recorded. Pearson's correlation coefficients were used to test the significant variables for development of investigated zooplankton groups. Overall, major environmental variables influencing crustacean zooplankton were water temperature, nitrogen concentration and conductivity. Water temperature that oscillated according to seasonal change was the most significant variable for copepodite and cladoceran development during warmer months. In autumn, adult crustaceans significantly correlated with nitrate ion and total nitrogen concentrations, when their concentrations increased. All zooplankton groups (except nauplii) positively correlated with conductivity values but at different times of the year. Our results suggest that in a river ecosystem, depending on the seasonal change, measured environmental variables have a significantly different effect on growth and structure of an individual zooplankton group.

**Keywords:** Cladocera, Copepoda, seasonal variability, river ecosystem



## CULTURAL - ECOLOGICAL POTENTIALS OF URBAN GARDENS

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The main aspect of the researched work was focusing on the potentials and results of the realization of urban gardens within the urban environment. Also, it highlighted the main values of urban gardens that are inseparable from the multicultural environment and tradition of edible plant species cultivation. The following characteristics of urban gardens were analyzed: the representation of these gardens all over the world, their historical characteristics and significances, and then the focus was concentrated on resolving the question of how such cultural, artistic and traditional values could be promoted through the realization of urban gardens on the territory of the Balkans. The very important and certainly indispensable character of urban gardens is their ecological potential - solving the problem of urban pollution, improving the ecological situation in the cities and socialization, more precisely, the social benefits and benefits of the population that would enjoy such an urban solution. However, the urban gardens are not just an ecological solution. It is above all a reflection and an indication of a deep, bright and rooted tradition in culture - an incentive of deep respect for nature and understanding of its significance.

**Keywords:** urban garden, sustainable development, health, edible plant species, communities



## GNIJEŽĐENJE VRANE GAČAC (*Corvus frugilegus* L. 1758) U ISTOČNOJ SLAVONIJI

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Vrana gačac (*Corvus frugilegus* L. 1758) redovna je gnjezdarica u Republici Hrvatskoj. Međutim, do 1927. godine bila je poznata samo kao zimski gost u hrvatskoj ornitofauni. Cilj istraživanja je utvrđivanje broja i rasprostranjenosti gnjezdeće populacije vrane gačac na području istočne Slavonije. Prebrojavanje jedinki izvršeno je metodom brojanja za vrijeme zime prije odlaska na spavalište, a prebrojavanje gnjezda i parova u kolonijama izvršeno je tijekom proljeća dok na stablima nema lišća. Prikupljeni su podatci za sezonu 2016./2017. i 2017./2018. na području istočne Slavonije. Obradom podataka s terenskih istraživanja, tijekom 2017. godine, utvrđeno je 16 malih kolonija (do 50 parova), 6 srednje velikih

(50 - 100 parova) i 9 velikih kolonija (više od 100 parova), dok je za 2018. godinu utvrđeno 15 malih kolonija, 5 srednje velikih te 8 velikih kolonija. Najveće gnjezdeće kolonije nalaze se u Kneževu, Osijeku i Požegi gdje se prosječno gnjezdi 567 parova. Rezultati dugoročnih istraživanja pokazuju da je trend gnjezdeće populacije gačaca u blagom padu. Glavni razlog tome je stalno uznemiravanje i protjerivanje za vrijeme gnjezdeće sezone kao i rušenje gnjezda, iako je to protivno Zakonu o zaštiti prirode Republike Hrvatske.

**Ključne riječi:** vrana gačac, *Corvus frugilegus*, gnježđenje, istočna Slavonija



## BREEDING OF ROOKS (*Corvus frugilegus* L. 1758) IN EASTERN SLAVONIA

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Rook (*Corvus frugilegus* L. 1758) is the common breeding bird in Croatia. But until 1927 it was known just as a winter guest in Croatian ornithofauna. The aim of this research was to determine the number and prevalence of wintering and breeding population of the rook in the areas of eastern Slavonia. Nests and couples in the colonies were counted during the spring, when there are no leaves on trees. The data was collected for seasons of 2016/2017 and 2017/2018 in the areas of eastern Slavonia. In total, in 2017 there were 16 small colonies (less than 50 couples), 6 medium large colonies (50-100 couples) and 9 large colonies (more than 100 couples). In the year of 2018, 15 small, 5 medium large and 8 large colonies were counted. The biggest nesting colonies were registered in Kneževo, Osijek and Požega with the average of 567 nesting couples. The results of long term research show the trend of mild decrease in the nesting populations of the rook. The main reason for that is constant harassment and banishment in the time of nesting season as well as anthropogenic demolition of the nests, although it is against the Croatian Nature Protection Act.

**Keywords:** rook, *Corvus frugilegus*, breeding, eastern Slavonia



## ODNOS KONCENTRACIJA O<sub>3</sub> I NO<sub>x</sub> U PRIZEMNOM SLOJU ATMOSFERE IZNAD ZAGREBA, OSIJEKA I DUBROVNIKA

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U proteklih nekoliko desetljeća smanjene su emisije brojnih onečišćivača zraka, ali njihove koncentracije još uvijek su visoke i problemi kvalitete zraka nisu riješeni. Dušikovi oksidi, NO<sub>x</sub> i prizemni ozon, O<sub>3</sub> smatraju se onečišćujućim tvarima koje najviše utječu na zdravlje ljudi i okoliš.

U ovom istraživanju analizirani su podatci o satnim koncentracijama O<sub>3</sub> i NO<sub>x</sub> u Zagrebu, Osijeku i Dubrovniku tijekom 2016. te su uspoređivani s meteorološkim parametrima (temperatura, relativna vlažnost zraka, brzina vjetrova i atmosferski tlak). Izmjerene vrijednosti koncentracija O<sub>3</sub> pokazuju tipičan dnevni hod za gradove. Dolazi do lokalnog stvaranja ozona od strane zagađivala, uglavnom podrijetlom iz lokalnog prometa i prirodnih emisija hlapljivih ugljikovodika, koji utječu na podnevni maksimum i jutarnji minimum koncentracije O<sub>3</sub>. Također, za sve mjerne postaje, postoji proljetni i ljetni maksimum koncentracije O<sub>3</sub> što ukazuje na postojanje godišnjeg ciklusa. Najviše koncentracije O<sub>3</sub> izmjerene su tijekom proljeća, što je karakteristično za Zemljinu sjevernu polutku. Analizom podataka utvrđeno je da nastanku O<sub>3</sub> pogoduju povišene temperature te manje O<sub>3</sub> nastaje kada je prisutno mnogo vlage u zraku, dok se NO<sub>x</sub> različito ponašaju. Promatrane koncentracije O<sub>3</sub> i NO<sub>x</sub> međusobno negativno koreliraju. Ovo su očekivani rezultati s obzirom na kemizam nastajanja promatranih onečišćivača.

**Ključne riječi:** kvaliteta zraka, prizemni ozon, dušikovi oksidi



## THE RELATION BETWEEN O<sub>3</sub> AND NO<sub>x</sub> IN THE ATMOSPHERIC BOUNDARY LAYER IN THE ZAGREB, OSIJEK AND DUBROVNIK

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In the last few decades emissions of air pollutants have decreased, but their concentrations are still high and problems concerning air quality haven't been resolved. Nitrogen oxides, NO<sub>x</sub> and ground level ozone, O<sub>3</sub> are considered as pollutants which mostly affect the health of mankind and the environment.

In this research, data on hourly concentrations of O<sub>3</sub> i NO<sub>x</sub> in Zagreb, Osijek and Dubrovnik during 2016 were analysed and compared with meteorological parameters (temperature, relative air humidity, wind speed and atmospheric pressure). The measured concentrations of O<sub>3</sub> show a typical diurnal course for those cities. Localised formation of ozone by pollutants occurs, mostly coming from local traffic and natural emissions of volatile hydrocarbons, which affect noon maximum and morning minimum of O<sub>3</sub> concentrations. Likewise, a spring and summer maximum of O<sub>3</sub> concentrations exists for all measurement stations, what indicates the existence of a yearly cycle. The highest O<sub>3</sub> concentrations have been measured during springtime, which is characteristic for the Northern Hemisphere. By analysis of data, it has been confirmed that the formation of ozone is facilitated by higher temperatures and that a lower amount of O<sub>3</sub> is formed when the air is more humid, while nitrogen oxides behave differently. Observed amounts of O<sub>3</sub> i NO<sub>x</sub> are in a negative correlation. This is to be expected, taking into account the chemism of formation of the observed pollutants.

**Keywords:** air quality, ground level ozone, nitrogen oxides



## FONTANE KAO IZVORI BIOLOŠKE RAZNOLIKOSTI URBANIH BIOTOPA

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Trzalci (Chironomidae, Diptera), su jedna od najbrojnijih i najraširenijih skupina kukaca te se pojavljuju na svim kontinentima i naseljavaju sve tipove vodenih i semi-terestričkih staništa. Jedan od ekstremnijih tipova staništa kojeg trzalci naseljavaju su gradske fontane, koje predstavljaju kombinaciju lotičkog i lentičkog vodenog tijela te često sadrže specifične zajednice organizama koje se teško mogu naći u prirodnim vodenim ekosustavima. Cilj našega istraživanja je bio utvrditi raznolikost trzalaca u fontanama i obližnjim vodenim tijelima. Na području Varaždina, u razdoblju od travnja do lipnja 2016., prikupljeni su uzorci svlakova trzalaca u gradskoj fontani, Dravi i obližnjem bajeru, pomoću mrežice s promjerom pora 300  $\mu\text{m}$ . U laboratoriju su trajni mikroskopski preparati svlakova pripremljeni njihovim uklapanjem u „Berlese“ medij i determinirani do najniže taksonomske kategorije pomoću mikroskopa i ključeva za determinaciju. U istraživanom razdoblju je zabilježeno 38 vrsta i 15 svojti koje su svrstane u četiri potporodice: Tanytopodinae(4), Diamesinae(1), Orthocladiinae(18) i Chironominae(31). Najveći broj vrsta je zabilježen u Dravi (27), dok je u fontani zabilježeno 8 vrsta, od kojih su tri vrste zabilježene samo u fontani (*Orthocladius rubicundus*, *Orthocladius glabripennis* i *Cricotopus sylvestris*), što pokazuje da fontane nisu samo odraz faune vodenih tijela koja ih okružuju, već i same mogu pridonijeti biološkoj raznolikosti nekog područja.

**Ključne riječi:** Chironomidae, Urbana ekologija, Kolonizacija, “Vodeni otoci”



## FOUNTAINS AS A SOURCE OF BIODIVERSITY IN URBAN BIOTOPES

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Chironomidae (Diptera), represent one of the most abundant and widespread insect groups, appearing on all continents, and inhabiting all types of aquatic and semi-terrestrial habitats. One of the extreme habitat types colonized by chironomids are city fountains, a combination of lotic and lentic water-bodies, and are often inhabited by specific invertebrate communities, which differ from those in natural ecosystems. The aim of our research was to determine the diversity of chironomids in fountains and nearby water-bodies. Samples of pupal exuviae were collected by a hand net (300  $\mu\text{m}$  mash) in the fountain, Drava, and a nearby pond in Varaždin, from April to June 2016. Exuviae were mounted on slides in „Berlese“ media and determined to the lowest taxonomic level using identification keys and a microscope. In total, 38 species and 15 taxa of four subfamilies were recorded: Tanypodinae(4), Diamesinae(1), Orthocladiinae(18), and Chironominae(31). The highest number of species was recorded in Drava (27), and 8 species were recorded in the fountain, of which three were recorded only in the fountain (*Orthocladius rubicundus*, *Orthocladius glabripennis*, *Cricotopus sylvestris*), what indicates that fountains are not just a reflection of the fauna of surrounding water-bodies, but they themselves can contribute to the biodiversity of a certain area.

**Keywords:** Chironomidae, Urban Ecology, Colonisation, “Aquatic islands”





PRIRODNE ZNANOSTI / NATURAL SCIENCES

## FLORA STEPOLIKOG TRAVNJAKA U BISTRINCIMA (ISTOČNA HRVATSKA)

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Stepolika travnjačka površina u Bistrincima (istočna Hrvatska) predstavlja vrlo rijedak tip staništa na području Republike Hrvatske te je uvrštena na popis prioriternih staništa ekološke mreže Natura 2000 pod brojem HR2000730. Istraživanja vaskularne flore na stepolikoj travnjačkoj površini provedena su tijekom vegetacijske sezone 2017. i u rano proljeće 2018. godine. Utvrđene su ukupno 132 biljne svojte iz 42 porodice. Najveći broj svojti (19) pripadao je porodici Fabaceae te porodicama Rosaceae (13 svojti), Poaceae (11 svojti) i Asteraceae (11 svojti). Prema životnom obliku, biljne svojte su najvećim dijelom hemikriptofiti (70 svojti), terofiti (26 svojti) i geofiti (17 svojti) kojima pogoduju slabo bazična do neutralna, suha tla. Među utvrđenim biljnim svojtima jedna je vrsta strogo zaštićena (*Dichanthium ischaemum* (L.) Roberty), 26 su zaštićene, a tri vrste (*Reynoutria japonica* Houtt., *Ailanthus altissima* (Mill.) Swingle i *Phytollaca americana* L.) su invazivne. Utvrđena relativno velika raznolikost flore i prisutnost vrijednih biljnih vrsta ukazuju na važnost očuvanja i daljnjeg praćenja stanja ovog jedinstvenog i rijetkog staništa.

**Ključne riječi:** stepoliki travnjak, Istočna Hrvatska, florni sustav



## FLORA OF STEPPE-LIKE GRASSLAND AREA IN BISTRINCI (EAST CROATIA)

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Steppe-like grassland in the village of Bistrinci (East Croatia) represents a very rare type of habitat in the Croatian territory and is included in the list of priority habitats of the Natura 2000 Ecological Network under the number HR200730. The research of the grassland flora was conducted during vegetation period in 2017 and early spring 2018. A total of 132 vascular plant taxa from 42 families were recorded. The highest number of taxa belonged to the families Fabaceae (19 taxa), Rosaceae (13 taxa), Poaceae (11 taxa) and Asteraceae (11 taxa). Life form spectrum analysis showed that hemicryptophytes were dominant (70 taxa), followed by therophytes (26 taxa) and geophytes (17 taxa) which prefer poorly basic to neutral, dry soil. Among the identified taxa, 26 are protected, one species, *Dichanthium ischaemum* (L.) Roberty, is strictly protected and three species (*Reynoutria japonica* Houtt., *Ailanthus altissima* (Mill.) Swingle and *Phytolacca americana* L.) are invasive. The relatively large diversity of flora and the presence of valuable plant species point to the importance of conservation and further condition monitoring of this unique and rare habitat.

**Keywords:** steppe-like grassland, east Croatia, flora



PRIRODNE ZNANOSTI / NATURAL SCIENCES

## APPLICATION OF PERLITE AS A SUBSTRATE FOR SOIL PROPERTIES IMPROVEMENT FOR ENVIRONMENTAL PROTECTION

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Perlite is a generic name for an amorphous volcanic alumina-silicate rock that expands 4-20 times when rapidly heated to 700 – 1000 °C. Expanded perlite has several attractive physical properties for commercial applications, including, low bulk density, low thermal conductivity, high heat resistance, low sound transmission, high surface area, and chemical inertness. Perlite supplies the ideal balance between air and water. Perlite is sterile, inert, non-toxic, non-decomposable and easy to handle with, enhanced water retention and aeration capacity. In recent years, special attention has been given to the development of sustainable agriculture using environmentally friendly substances. Today environment is more than ever faced with problems of pollution and degradation. Because of this, the perlite is ecologically pure, its use does not adversely affect the ecosystem, it is healthy, it does not contain heavy metals and other substances that can be harmful to human health. The purpose of this study is to present and discuss the experimental results of perlite as a substrate that does not pollute the environment and has a role to improve the water-physical properties of the soil. Results of total porosity (%), water porosity (%) and air porosity (%) of perlite and soil WRB, 2016 (VertisoL), with different ratios of 10/90, 30/70, 50/50, to determine the effect of perlite on the soil, will be given.

**Keywords:** perlite, soil, porosity, environmental protection



## EVALUATION OF ANTIOXYDANT POTENTIAL OF PHENOLIC COMPOUNDS PRESENT IN BLACK ELDERBERRY, *SAMBUCUS NIGRA* L.

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Native to Europe and North America, black elderberries (*Sambucus nigra* L.) have long been used in traditional medicine. The purple-black fruits of elderberries are one of the richest sources of phenolic compounds that exhibit a wide range of health benefits, such as reduced risk of coronary heart disease and stroke, anticarcinogenic activity, anti-inflammatory and immunostimulatory properties. Extracts of black elderberry have also demonstrated strong antioxidative properties. The aim of this work was to evaluate the antioxidant potential of phenolic compounds present in black elderberry fruits (flavonoids, phenolic acids, flavonols) *in silico* using Gaussian 09 DFT approach. Geometry optimizations and frequency calculations were carried out using the M5-2X/6-311++G(d,p) level of theory, in conjunction with the SMD solvation model. Studied mechanisms of free radical scavenging were hydrogen atom transfer (HAT) and sequential proton loss electron transfer (SPLET), single and double processes. Obtained thermodynamic results indicate that studied phenolic compounds possess high free radical scavenging potency and are able of deactivating various free radicals ( $\text{HO}^\bullet$ ,  $\text{HOO}^\bullet$ ,  $\text{CH}_3\text{O}^\bullet$ , etc.). Obtained results indicate second HAT and second SPLET processes as less energy demanding than the first ones.

**Keywords:** antioxidant activity; elderberry; phenolic acids, density functional theory (DFT)



## UTJECAJ OBORINSKIH VODA NA ABUNDANCIJU BAKTERIJA U DUBROVAČKOM AKVATORIJU

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Mikrobiološko praćenje mora za kupanje pruža važne spoznaje o njegovoj kakvoći. U laboratorijima Zavoda za javno zdravstvo provode se testiranja na kulture bakterija *Escherichia coli* i crijevnih enterokoka pri čemu se uzorci ne uzimaju za vrijeme vremenskih nepogoda. U ovom se radu istražuje abundancija bakterija *E.coli*, crijevnih enterokoka i ukupnih koliforma na trima dubrovačkim plažama za vrijeme zimsko-proljetnih kiša. Tri popraćene plaže Porporela, Banje i Excelsior najposjećenije su gradske plaže za vrijeme turističke sezone u Dubrovniku. Uzorci su uzimani u predkišnom, kišnom i postkišnom periodu i to u površinskom sloju, na dubini od 0,5 m i 1 m te obrađeni metodom membranske filtracije. Očekivani porast broja kolonija za vrijeme najvećeg otjecanja oborinskih voda bio je najizraženiji na plaži Banje gdje su ukupni koliformi ostvarili porast u prosjeku od čak 15,80 puta, dok je na plaži Excelsior broj kolonija *E.coli* porastao za 12 puta. Na plaži Porporela tek blagi porast ostvaruju crijevni enterokoki od 6,66 puta. Prema podacima Zavoda za javno zdravstvo u Dubrovniku, plaže su uglavnom ocjenjivane izvrsnim ocjenama ( $\leq 200$  bik) pogotovo od 2003. kada je reguliran kanalizacijski odvod u starogradskom području. Trenutni učinak oborinskih voda dokazan je smanjenjem broja kolonija za 99,80 % u prosjeku za sve bakterije nakon kiše.

**Ključne riječi:** bakterije, more za kupanje, oborinske vode



## RAINFALL INFLUENCE ON THE ABUNDANCE OF BACTERIA IN DUBROVNIK MARINE WATERS

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Microbiological monitoring of the sea gives us great knowledge about its quality for swimming. Tests are carried out regularly in the laboratories of the Public Health Institute to monitor *E. coli* colonies and intestinal enterococci whereas no sampling is carried out during bad weather conditions. In this paper we studied the fluctuations in the abundance of *E. coli* colonies, intestinal enterococci and total coliforms on three beaches in Dubrovnik during the rainfall periods in winter and spring. Three monitored beaches Porporela, Banje and Excelsior are the most visited city beaches during the summer season. The samples were taken before, during and after the rainfall on the surface, in the depth of 0.5 m and 1 m. Membrane filtration was used for sample treatment. Expected increase in the abundance of colonies is shown most on the Banje beach where the total coliforms increased 15.80 times while on the Excelsior beach *E. coli* colonies increased 12 times during the rainfall. On the Porporela beach there was a mild increase of intestinal enterococci colonies for 6.66 times. According to the data of the Public Health Institute of Dubrovnik-Neretva County the beaches were mostly marked with grades "excellent" ( $\leq 200$  CFU) especially since 2003 after the sewers had been regulated in the Dubrovnik Old Town. The instant effect of rainfall water was proved by the reduction of the number of all colonies for 99.80% in all three locations.

**Keywords:** bacteria, sea for swimming, rainfall



## CLADOCERANS (CRUSTACEA: CLADOCERA) SEASONAL DYNAMICS AT SNR "OBEDSKA BARA"

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The Cladocera are an order of small Crustaceans which are widespread in inland aquatic habitat of variety of aquatic ecosystems. They have an important role in food chains, as a filter feeding macroplankton and, as a most desirable food form for younger fish and amphibians. Also the Cladocerans presence in freshwater ecosystems is important because of their ability to convert phytoplankton and decaying matter into a more usable form. The Cladocerans species and spatial diversity, abundance and seasonal dynamics are parameters which could be used for sensitive and accurate assessment of the aquatic ecosystems conditions, eutrophication and pollution. The aim of this study was to obtain an insight in Cladocerans species status and their seasonal dynamics at special nature reserve SNR "Obedska bara".

**Keywords:** Cladocera, aquatic ecosystem, seasonal dynamic



## PRIMJENA KITOZANA U ZAŠTITI OKOLIŠA

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Kitozan je prirodni polimer koji zahvaljujući svojim kemijskim i biološkim karakteristikama pronalazi ulogu u gotovo svim područjima ljudske djelatnosti, od medicine i farmacije do očuvanja okoliša. Kitozan je kopolimer dobro topljiv u vodi, izgrađen od dvije vrste ponavljajućih monomernih jedinica: *N-acetil-2-amino-2-deoksi-D-glukopiranoza* i *2-amino-2-deoksi-D-glukopiranoza*. Kemijskim putem nastaje N-deacetilacijom hitina, dok ga se u prirodi može pronaći kod određenih tipova gljivica. Nadalje, kitozan karakterizira visok stupanj netoksičnosti, biokompatibilnosti i biorazgradivosti te upravo zahvaljujući tim osobinama pronašao je svoju ulogu u očuvanju okoliša; vrlo je koristan kelirajući agens teških metala otpadnih voda i lebdećih čestica. Teški metali su često prisutni u zraku u lebdećim česticama, u čiji sastav još ulaze i sulfati, nitrati, amonijak, organski spojevi, soli te čestice vode.

Kitozan je vrlo koristan u pripravi polimernih nanovlakana. Kitozanska polimerna nanovlakna mogu na sebe vezati određene zagađivače zraka. Kitozanska polimerna nanovlakna metodom elektroispredanja mogu se oblikovati u mrežu polimernih nanovlakana koja se kao takva mogu koristiti u filterima za filtraciju onečišćenog zraka. Kitozan se može sintetizirati iz egzoskeleta člankonožaca; prvo se izolira hitin, a nakon toga u procesu deacetilacije se dobiva kitozan, koji je primjenjiv kao polazna sirovina za kemijsku sintezu određenih produkata korisnih u zaštiti okoliša.

**Ključne riječi:** kitozan, sinteza kitozana, zaštita okoliša





## USE CHITOSAN IN ENVIRONMENT PROTECTION

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Chitosan is a natural polymer which, due to its chemical and biological characteristics, has a role in almost all areas of human activity, from medicine and pharmacy to environment protection. It is a water-soluble copolymer, composed of two types of repetitive monomeric units: *N-acetyl-2-amino-2-deoxy-D-glucopyranose* and *2-amino-2-deoxy-D-glucopyranose*. It can be produced by N-deacetylation of the chitin using chemical processes, and it can be found in nature with certain types of fungi. Furthermore, chitosan is characterized by a low level of toxicity and high levels of biocompatibility and biodegradability. Due to these properties, chitosan has found its role in environment protection; it is a very useful chelating agent for heavy metals in wastewaters and particulate matter (PM). Heavy metals are often present in air in PM which can also have sulfates, nitrates, ammonia, organic compounds, salts and water particles.

Chitosan is very useful in the preparation of polymer nanofibers. Chitosan polymeric nanofiber can bind certain air pollutants. The chitosan polymeric nanofibers can be formed, using electrospinning, into a network of polymer nanofibers that can be used as such in filters for filtering contaminated air. Chitosan can be synthesized from the exoskeleton of the arthropod; first, the chitin is isolated, and then in the process of deacetylation chitosan is obtained. It can be then used as a starting material in chemical synthesis of certain products used in environment protection.

**Keywords:** chitosan, chitosan synthesis, environment protection



## ZELENE ORGANSKE SINTEZE LIJEKOVA

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U današnje je vrijeme uporaba lijekova svakodnevna pojava u skoro svakom domaćinstvu. Konzumirajući razne lijekove, ni ne razmišljamo koliko je zapravo otpada nastalo prilikom njihove sinteze. Povećanjem potrošnje lijekova, povećana je i njihova proizvodnja, a samim time raste i količina otpada (otapala, nusprodukti) koja nastaje tijekom sinteze. Osim što je zbrinjavanje takvog otpada financijski problem, također predstavlja i veliki problem za okoliš te je u današnje vrijeme osviještena potreba za njegovim ekološkim zbrinjavanjem. Unaprjeđenje sinteza lijekova ide u smjeru smanjenja nastajanja nusprodukata, smanjenja količine otapala i upotrebe toksičnih spojeva tako da ih zamjenjuju otapala koja se mogu reciklirati te biokatalizatori, a nastoje se izbjeći i nepoželjni nusprodukti.

U ovom radu prikazane su stare, tradicionalne i nove, „zelenije“ sinteze lijekova koji su danas u širokoj uporabi. Kada se takve „zelenije“ sinteze primjene na industrijskoj razini, količina otpada znatno se smanjuje. U tim sintezama primjenjeni su principi zelene kemije s ciljem dobivanja ekološki povoljnijih procesa. Lijekovi čije su sinteze opisane u radu su: ibuprofen, sertralin, sildenafil citrat i saxagliptin.

**Ključne riječi:** zelena kemija, lijekovi, organska sinteza



## GREEN ORGANIC SYNTHESIS OF DRUGS

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Nowadays, the use of medicaments is common in almost every household. By consuming various drugs, we are mostly unaware of how much waste is being produced during their synthesis. By increasing drug consumption, its production will also increase, and the amount of waste (solvents, by-products) that is generated during the synthesis is growing. Apart from the fact that the disposal of such waste is a financial problem, it is also a major environmental problem, and today there is a growing need for its ecological care. Improvement of drug synthesis is directed to reducing byproduct formation, reducing the amount of solvents, and using toxic compounds by replacing the recyclable solvents and biocatalysts, while also avoiding unwanted byproducts.

This paper presents old, traditional and new, "green" synthesis of drugs that are today widely used. When such "green" synthesis is applied at an industrial level, the amount of waste is significantly reduced. In these syntheses, the principles of green chemistry were applied to obtain ecologically more favorable processes. The drugs whose syntheses are described in the paper are ibuprofen, sertraline, sildenafil citrate and saxagliptin.

**Keywords:** green chemistry, drugs, organic synthesis



## DETERMINATIONS OF TWELVE RARE EARTH ELEMENTS IN THE HAIR SAMPLES OF INHABITANTS OF EASTERN CROATIA (ICP-MS)

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In this study special attention is paid to the concentrations of rare earth elements (REEs), an often neglected group of elements in environmental and toxicological studies. During the past years, application of rare earth elements has been extensively reported in various fields including: electronics, fuel additives, modern biomedicine and agriculture. The concentrations of: Ce, Dy, Er, Eu, Gd, Ho, La, Nd, Pr, Sm, Tm and Yb in Slavonia (eastern part of Croatia) were measured for the first time in 390 hair samples of residents at five localities: Vladislavci, Čepin, Dalj, Našice and Osijek.

In comparison with the rare published data the maximum values of Ce (0.33-28.57  $\mu\text{g g}^{-1}$ ), Eu (0.020-0.81  $\mu\text{g g}^{-1}$ ), Gd (0.009-4.16  $\mu\text{g g}^{-1}$ ), La (0.08-0.50  $\mu\text{g g}^{-1}$ ), Nd (0.035-29.14  $\mu\text{g g}^{-1}$ ) and Tm (<0.001-0.275  $\mu\text{g g}^{-1}$ ) in our study are much higher than those reported in available literature. Also, the average values of Ce, Eu and Sm in Vladislavci village are higher than the reported data, and reach as high as several times that of the published values. The parallel analyses showed that the exposure of the local population to rare earth elements through water and soil was generally low, thus, geological factors and water are not responsible for the higher rare earth elements content in the hair samples in this study.

**Keywords:** rare earth elements, water, soil, hair, ICP-MS



## SPECIFIČNOST ODNOSA VEKTOR-PARAZIT

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Svaki je parazit kojeg prenose hematofazi povezan s ograničenim brojem vektorskih vrsta. Čak i organizmi koji se mehanički prenose (poput myxoma virusa), pokazuju određeni stupanj specifičnosti pri povezivanju s vektorom, dok su odnosi u kojima je parazit biološki ovisan o vektoru znatno specifičniji. Nekoliko je načina na koji se može postići specifičan odnos između parazita i pripadnog vektora. Primjerice, važan faktor koji determinira vektor-parazit odnos je izbor domadara, na koji utječu geografski, ekološki, morfološki, bihevioralni i drugi čimbenici. Budući da paraziti ostavljaju jako malo ili nimalo fosiliziranih ostataka, svi pokušaji da se opišu evolucija i razvoj odnosa vektor-parazit, temelje se na spekulaciji. Tako primjerice za porodicu Trypanosmatidae (koja ima dva važna roda, *Leishmania* i *Trypanosoma*) razlikujemo dva pretpostavljena suprotstavljena evolucijska puta. Jedna teorija pretpostavlja da su prvobitno paraziti bili povezani s beskrležnjacima, a s kralježnjacima tek onda kada je razvijena trajna veza beskrležnjaka i kralježnjaka. Druga teorija smatra da su izvor parazita bili kralježnjaci s kojih su se paraziti prenijeli na beskrležnjake u onom trenutku kada su se vektori počeli hraniti krvlju kralježnjaka. U ovom radu dan je kratki pregled argumenata za i protiv obje teorije, kao i kratki pregled porijekla i specifičnosti vektor-parazit odnosa na nekoliko primjera.

**Ključne riječi:** paraziti, domadar, vektori, hematofazi



## THE SPECIFICITY OF VECTOR-PARASITE RELATIONSHIP

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Parasites transmitted by hematophagous insects are associated with a number of vectors. Mechanically transmitted organisms, such as the myxoma virus, show a certain degree of vector association specificity, while relationships in which parasite is biologically dependent on vector are significantly more specific. Vector-parasite relationship can become specific in several ways, for instance by the choice of host, which depends on geography, ecology, morphology, behaviour and other factors. Since parasites leave few if any fossils, all attempts to study and analyse origin and development of vector-parasite relationship are based on speculation. For example, for the family Trypanosomatidae (*Leishmania* and *Trypanosoma*) two possible conflicting origins and development paths have been suggested. In one, parasites are originally associated with invertebrates, and become associated with vertebrates after a continuous vertebrate-invertebrate interaction has developed. In second, vertebrates are defined as the origin of parasites, and are associated with invertebrates only after the vector developed hematophagous life style. In this work, we analysed arguments for both theories, and gave a short overview and few examples of the origin and specificity of vector-parasite relationship.

**Keywords:** parasites, hosts, vectors, hematophagous insects



## UPOTREBA AUTOHTONIH PASMINA U ORGANSKOJ POLJOPRIVREDI PRI RAZVOJU NERAZVIJENIH PODRUČIJA

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Pola litre ekološkog punomasnog mlijeka (ili ekvivalent unosa masnoće iz ostalih mliječnih proizvoda, kao što su maslac ili sir) pruža procijenjeno 16 % (39 mg) preporučenog dnevnog unosa vrlo dugačkog lanca omega-3 kiselina, dok konvencionalno mlijeko pruža 11 % (25 mg). Također, opažene su i više razine masnih topivih vitamina, kao što su vitamin E i karotenoidi te 40 % više CLA u ekološkom mlijeku. Konvencionalno mlijeko, u odnosu na organsko, ima veći prosječni udio jednostruko nezasićenih masnih kiselina. Buša je jedna od najmanjih pasmina na svijetu, u laktaciji daje od 1000 do 2000 litara mlijeka sa 4 do 6 % masti. Meso je izuzetne kakvoće. Domaća balkanska rogata koza uglavnom se susreće u nižim i višim područjima golog i pokrivenog krša BiH (ravničarski i planinski tip). Tjekom 5 - 6 mjeseci laktacije proizvede 100 - 150 litara mlijeka. U odnosu na plemenitije pasmine, otpornije su na lošije uvjete držanja i nisu izbirljive u ishrani. Pramenka je pojam koji označava primitivnu ovcu, slabih fizioloških svojstava, koja je nastala u oskudnim uvjetima ishrane i njege, a na koje se kroz duži niz godina dobro prilagodila. Razvoj organske poljoprivrede doprinosi očuvanju prirodnih resursa, posebno vode i zemljišta, izravno utječe na razvoj niza dopunskih djelatnosti u ruralnim područjima, a najviše doprinosi razvoju ruralnog turizma.

**Ključne riječi:** organsko mlijeko, konvencionalno mlijeko, laktacija, buša, domaća balkanska rogata koza, pramenka



## USAGE OF AUTOCHTHONOUS BREEDS IN ORGANIC AGRICULTURE IN THE DEVELOPMENT OF UNDERDEVELOPED AREAS

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Half liter of organic whole milk (or an equivalent of fat from other milk products like butter or cheese) provides estimated 16% (39 mg) of the recommended daily intake of a very long chain of omega-3 acids, while conventional milk provides 11% (25 mg). A higher level of fatty soluble vitamins, such as vitamin E and carotenoids, and 40% more CLA in organic milk have also been observed. Conventional milk has a higher average proportion of single unsaturated fatty acids compared to organic. Bush is one of the smallest breeds in the world, lactating from 1000 to 2000 liters of milk with 4-6% fat. The meat is of exceptional quality. The domestic Balkan horned goat is mostly encountered in the lower and higher regions of the naked and covered karst of Bosnia and Herzegovina (flat and mountainous type). During 5-6 months lactation it produces 100-150 liters of milk. In comparison to the more noble breeds, they are more resistant to poorer conditions of keeping and are not picky in the nutrition. Pramenka is a term that denotes a primitive sheep with weak physiological properties, which was created in the scarce conditions of nutrition and care, and which has been well adapted for many years. The development of organic agriculture contributes to the preservation of natural resources, especially water and land, directly influencing the development of a range of additional activities in rural areas, and most of all contributes to the development of rural tourism.

**Keywords:** organic whole milk, conventional milk, lactation, Bush, the domestic Balkan horned goat, Pramenka





PRIRODNE ZNANOSTI / NATURAL SCIENCES

## NEW METHODS FOR BIOMATERIAL PREPARATION: MECHANOCHEMICAL SYNTHESIS OF CALCIUM OXALATE MONOHYDRATE

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Frequent occurrence of kidney stones caused by the changes in living and eating habits, especially in developing and industrialized countries, has led scientists to study the mechanisms of kidney stones genesis. Calcium oxalate crystallizes in three hydrated forms: thermodynamically stable calcium oxalate monohydrate (COM), metastable dihydrate (COD) and trihydrate (COT). COM is the most commonly found in kidney stones and therefore, most of the studies put the emphasis on this form of oxalate.

This study shows the environmentally friendly, mechanochemical synthesis of calcium oxalate in a planetary ball mill, with and without the presence of a small amount of solvent. Unlike previous investigations that were mainly focused on the solution synthesis, this type of preparation will bring a new knowledge about the synthesis of calcium oxalate crystals caused by the influence of mechanical energy.

The main goal is the synthesis, identification and characterization of COM synthesized from calcium salts (chloride, sulfate and nitrate), using a mill speed of 750 rpm while monitoring the reaction progress as a function of the synthesis time. Structural and thermal properties of the samples were examined by FT-IR spectroscopy and thermogravimetric analysis, and crystal morphology was characterized by optical microscopy.

**Keywords:** Natural Sciences, Mechanochemistry, calcium oxalate monohydrate, kidney stones



## ŽCGO MARIŠĆINA - PRAĆENJE KVALITETE ZRAKA U RAZDOBLJU 2012. - 2016. GODINE

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Županijski centar za gospodarenje otpadom Marišćina (ŽCGO) je središnji dio integriranog sustava za gospodarenje otpadom unutar Primorsko-goranske županije. Osim centra, sustav obuhvaća postrojenje za mehaničko-biološku obradu (MBO) nesortiranog komunalnog otpada te pretovarne stanice.

Mjerna postaja Viškovo-Marišćina je industrijska postaja na području Općine Viškovo. Institucija odgovorna za postaju je Nastavni zavod za javno zdravstvo Primorsko-goranske županije. Onečišćujuće tvari koje se mjere su: sumporov dioksid, sumporovodik, dušikov dioksid, amonijak, ozon, ugljikov monoksid, benzen, lebdeće čestice (< 10 µm). Osim njih prate se brzina i smjer vjetra, vlažnost, temperatura zraka te tlak zraka, kao meteorološki parametri. Mjerenje se vrši automatskim analizatorom koji prati trenutnu koncentraciju onečišćujućih tvari i meteoroloških parametara. Kvaliteta zraka za postaju Viškovo-Marišćina u periodu 2012. - 2016. godine, svrstava se u I. kategoriju, osim u 2012. godini kada je prema parametru O<sub>3</sub> svrstana u II. kategoriju. Razlog tome je transport i akumulacija ozona iz drugih onečišćenih područja u čista područja na višim nadmorskim visinama prilikom čega je došlo do prekoračenja dnevne granične vrijednosti koncentracija O<sub>3</sub> u periodu od 30 dana tijekom 2012. godine.

Jedini problem ŽCGO Marišćina jesu neugodni mirisi nastali anaerobnim i aerobnim razlaganjem otpada. Iako, kvaliteta zraka na ŽCGO Marišćina pripada I. kategoriji, postojani odbojni mirisi narušavaju kvalitetu života na tom području.

**Ključne riječi:** ŽCGO Marišćina, IVO-koncept, kvaliteta zraka



## CWMC MARIŠĆINA – AIR QUALITY MONITORING IN THE PERIOD FROM 2012 TO 2016

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The Marišćina County Waste Management Centre (CWMC) is the central part of an integrated waste management system within the Primorsko-Goranska County. In addition to the center, the system includes mechanical biological treatment of unsorted municipal waste and waste transfer stations.

The Viškovo-Marišćina air quality measurement station is an industrial station in the area of Viškovo Municipality. The Institution responsible for the station is Teaching Institute of Public Health of Primorsko-Goranska County in Rijeka. The measured pollutants are: sulfur dioxide, hydrogen sulfide, nitrogen dioxide, ammonia, ozone, carbon dioxide, benzene and particulate matter less than 10 microns. Besides them, wind speed and wind direction, relative humidity, air temperature and air pressure are monitored as meteorological parameters. The current concentration of pollutants and meteorological parameters are measured with automatic analyser. For measured values of pollutants, there was no exceedance of the limit value or assessment threshold occurred during the period of 2012 to 2016 (category I) except for 2012 when according to parameter O<sub>3</sub> a limit value has been exceeded for 30 days (category II). The reason for this is transport and accumulation of ozone from other polluted areas in clean areas at higher altitude.

The only problem with CWMC Marišćina is the unpleasant odors created by anaerobic and aerobic waste disposal. Although air quality belongs to category I, persistent repulsive odors impair the quality of life in this area.

**Keywords:** The Marišćina County Waste Management Centre, air quality



## DEGRADATION OF CONGO RED (CR) CATALYZED BY NANOSTRUCTURED CERIA

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Nanostructured  $\text{CeO}_2$  is a promising catalyst in many applications because it is one of the most reactive rare earth metal oxides. It plays a vital role in technologies for environmental and energy related applications, such as heterogeneous catalysis. Nanostructured ceria with various morphologies exhibits excellent physicochemical properties. In this thesis, nanostructured  $\text{CeO}_2$  has been synthesized by previously published surfactant-assisted green chemical precipitation method. As a cationic surfactant CTAB (cetyltrimethylammonium bromide) was used and as a cerium precursor cerium chloride hexahydrate. Synthesized compounds were characterized by powder X-ray diffraction (PXRD), transmission electron microscopy (TEM), Fourier transform infrared spectroscopy (FTIR). The catalytic activity of the nanostructured  $\text{CeO}_2$  was tested towards the degradation of Congo Red (CR) synthetic dye in different shapes (spherical, nanorods and mixture of both). The results show excellent removal capacity of this organic pollutant and therefore it can be a promising candidate for wastewater treatment.

**Keywords:** nanostructured ceria, congo red, catalysis



BIOMEDICINA I ZDRAVSTVO / BIOMEDICINE AND HEALTH  
**FIZIKALNO-KEMIJSKA KVALITETA VODE ZA PIĆE NA PODRUČJU  
SREDNJOBOSANSKOG KANTONA U 2017. GODINI**

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Uvod: Zdravstveno ispravna voda za piće je voda koja treba imati fizikalne, kemijske i biološke osobine koje ne mogu imati negativne posljedice za zdravlje ljudi. Kvaliteta vode za piće propisana je Pravilnikom o zdravstvenoj ispravnosti vode za piće („Službeni glasnik BiH“, br. 40/10, 43/10, 30/12, 62/17).

Cilj je rada predstaviti rezultate fizikalno-kemijskih analiza vode za piće na području deset općina Srednjobosanskog kantona u 2017. godini.

Metode: U radu su korišteni podatci iz arhive Zavoda za javno zdravstvo Srednjobosanskog kantona o rezultatima ispitivanja fizikalno-kemijskih parametara uzetih uzoraka vode iz gradskih i lokalnih vodovoda u 2017. godini.

Rezultati: U periodu od jedne godine na području Srednjobosanskog kantona ukupno je uzeto 932 uzorka vode za piće na fizikalno-kemijsku analizu, i to 564 uzorka iz gradskih vodovoda i 368 uzoraka iz lokalnih vodnih objekata. Od toga je utvrđeno ukupno osam (0,86 %) neispravnih uzoraka, pet (0,88 %) neispravnih uzoraka iz gradskih vodovoda i tri (0,81 %) neispravna uzorka iz lokalnih vodovoda.

Zaključak: Rezultati ispitivanja fizikalno-kemijskih parametara vode za piće pokazali su da je postotak neodgovarajućih uzoraka bio nizak, a najčešći uzrok odstupanja odnosio se na mutnoću vode.

**Ključne riječi:** voda za piće, kvaliteta, fizikalno-kemijska analiza



BIOMEDICINA I ZDRAVSTVO / BIOMEDICINE AND HEALTH

## PHYSICOCHEMICAL QUALITY OF DRINKING WATER IN CENTRAL BOSNIA CANTON IN 2017

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The quality of drinking water refers to water that should have physical, chemical and biological properties that can not have negative consequences for human health. Quality standards of water intended for human consumption are prescribed by national Regulation on health safety of drinking water ("Official Gazette of Bosnia and Herzegovina", no. 40/10, 43/10, 30/12 and 62/17). The aim of this paper is to present the results of the physicochemical analysis of drinking water in 10 municipalities in Central Bosnia Canton in 2017. The data from the Public Health Institute of Central Bosnia Canton on the results of testing physico-chemical parameters of taken samples of water from urban and local water supply systems in 2017 were used.

In the period of one year in the area of Central Bosnia Canton, 932 samples of drinking water were collected for physicochemical analysis, 564 samples from urban water supply systems and 368 samples from local water facilities. According to all samples, a total of eight (0.86%) samples were inadequate, five (0.88%) defective samples from urban water supply systems and three (0.81%) defective samples from local water supply systems were found. The results of the analysis of physicochemical parameters of drinking water showed that the percentage of inadequate samples was low, and the most frequent cause of deviation was related to water turbidity.

**Keywords:** drinking water, quality, physicochemical analysis



## WINE AND HEALTH: MERLOT SUPPRESS INFLAMMATION AND OXIDATION PROCESSES

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Numerous reports confirmed that moderate consumption of red wine could contribute to the overall well-being, mostly due to antioxidant, neuroprotective, anti-inflammatory, anti-cancer and antithrombotic effects of present phenolic compounds. Since oxidative stress and inflammation are important elements in progression of different diseases, such as atherosclerosis, the aim of this study was to evaluate anti-inflammatory and anti-oxidant potential of Merlot wine from Fruška Gora region. Antioxidant activity was examined by nitric oxide ( $\cdot\text{NO}$ ) scavenger capacity and  $\text{Fe}^{2+}$ /ascorbate induced lipid peroxidation (LP) assays. Antiinflammatory activity was tested in an *in vitro* system: inflammation in macrophages (derived from human U937 monocytic cell line) was induced by lipopolysaccharide and the content of prostaglandine  $\text{E}_2$  ( $\text{PGE}_2$ ) and thromboxane  $\text{A}_2$  ( $\text{TXA}_2$ ) was evaluated by LC-MS/MS technique. Examined wine exhibited good activity in all applied assays ( $\text{IC}_{50}(\text{NO}) = 73.5$  trolox equivalent (TE),  $\text{IC}_{50}(\text{LP}) = 0.25$  TE, 30% inhibition of  $\text{TXA}_2$  and 10% of  $\text{PGE}_2$  production). UV-VIS HPLC technique was applied for quantitative analysis of 21 phenolics. Dominant compounds were malvidine-3-*O*-glucoside (66.5 mg/L), catechine (23.7 mg/L) and gallic acid (20.45 mg/L). Obtained results suggest that examined Merlot wine could be regarded as good antioxidant, as well as anti-inflammatory agent.

**Keywords:** wine, health, inflammation, antioxidants, polyphenols



BIOMEDICINA I ZDRAVSTVO / BIOMEDICINE AND HEALTH

**MOGUĆNOST UDOMLJAVANJA NAPUŠTENIH PASA  
S TJELESNIM OŠTEĆENJIMA**

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U urbaniziranim područjima velik problem čini populacija napuštenih pasa. Način pristupanja problemu zbrinjavanja uvjetovan je nacionalnim i regionalnim okvirima. „Noina arka“ udruga je zaštitnika životinja koja s Gradom Zagrebom ima razvijen službeni program zbrinjavanja ranjenih životinja bez vlasnika.

Kako je poznato da postoje teško udomljive kategorije pasa, cilj našeg rada je istražiti utjecaj tjelesnih oštećenja nakon izlječenja na mogućnost udomljavanja napuštenih pasa.

Kroz razdoblje od 7 godina u arhivu Udruge Noina Arka evidentiran je 541 ozlijeđeni pas (61 % mužjaka i 39 % ženki). Prema izjavama nalaznika (svjedoka) i vrstama ozljeda određene su 4 vrste nastanka ozljeda: stradavanje u prometu (64 %), posljedice zanemarivanja (16 %), interakcije među životinjama (7 %) te ozljede kojima je način nastanka nemoguće utvrditi (13 %). Tjelesna oštećenja ostala su prisutna kod 68 (12,56 %) pasa, od toga 16 % iz skupine stradalih u prometu. U vremenskom periodu do 2 godine udomljeno je 98,53 % pasa, u prosječnom vremenu od 4,5 mjeseci.

Suprotno očekivanjima, podatci pokazuju da u usporedbi sa zdravim jedinkama psi s tjelesnim oštećenjima imaju blagu prednost u pronalasku udomitelja, s neznatno dužim prosječnim vremenom boravka u skloništu do udomljenja. Moguća objašnjenja za to su lakši razvoj empatije prema takvim psima ili ranije iskustvo posjedovanja životinje s tjelesnim nedostatkom.

**Ključne riječi:** napušteni psi, ozljede, tjelesna oštećenja, udomljavanje





BIOMEDICINA I ZDRAVSTVO / BIOMEDICINE AND HEALTH

## THE POSSIBILITY OF ADOPTING ABANDONED DOGS WITH PHYSICAL HANDICAP

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The population of abandoned dogs is a big problem in urbanized areas. The way of approaching the problem of care for those dogs is conditioned by national and regional frameworks. "Noina Arka" is an association for animal protection who has developed an official program for emergency rescue and treatment of wounded animals without owners. As it is known that there are several categories of dogs who find it harder to find a foster home, the aim of our work is to investigate the effect of physical handicap after treatment to the possibility of adopting abandoned dogs.

Over a period of 7 years, 541 injured dogs (61% males and 39% females) were recorded in Noina Arka database. According to the statements of the witnesses and the types of injuries, four types of trauma causes were identified: vehicles trauma (64%), consequences of neglect (16%), injuries in which the cause could not be confirmed (13%) and animal interactions (7%). Physical handicap were present in 68 (12.56%) dogs, of which 16% were in the group of injured in traffic. In a time period of up to 2 years, 98.53% of dogs found a foster home, with an average of 4.5 months.

Contrary to expectations, the data show that compared to healthy individuals, dogs with physical disabilities have a slight advantage in finding a foster home, with a slightly longer average length of staying in the shelter by the time they are adopted. Possible explanations for this are the easier development of empathy towards such dogs or earlier experience of possessing an animal with a physical handicap.

**Keywords:** abandoned dogs, injuries, physical handicap, adopting



BIOMEDICINA I ZDRAVSTVO / BIOMEDICINE AND HEALTH

## DUKTALNI SALIVARNI KARCINOM PAROTIDE - PRIKAZ BOLESNIKA

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Duktalni salivarni karcinom parotide je rijedak tumor visokog stupnja malignosti. Patohistološki ovaj tumor pokazuje veliku sličnost s duktalnim karcinomom dojke zbog čega se i opisuje kao „salivary duct carcinoma“. To je epitelijalna neoplazma koja se sastoji od struktura koje sliče proširenim salivarnim duktusima. Incidencija pojavnosti, ovisno o studijama iznosi oko 0,2 % svih epitelijalnih tumora slinovnica. Više od 85 % tumora zahvaća parotidne žlijezde, a približno dvije trećine pacijenata su muškarci. Klinički se najčešće manifestira oteklinom parotide, a u 25 % pacijenata prvi simptom može biti disfunkcija (pareza/paraliza) živca.

Duktalni salivarni karcinom je jedan od najagresivnijih tumora slinovnica i karakteriziran je lokalnom invazijom, limfogenim i hematogenim širenjem te lošom prognozom.

Prikazujemo muškarca I.A. starog 53 godine, s duktalnim salivarnim karcinomom parotide čije stanice histokemijski pokazuju difuzno pozitivnu reakciju na HER2/neu (+++). Navodno unazad 15 godina ima oteklinu u lijevoj parotidnoj žlijezdi radi čega je učinjena obrada i 3. 10. 2011. godine totalna parotidektomija. PHD: Ca metastaticum - tumorsko tkivo negativno na estrogen, progesteronske receptore te HER2/neu pozitivan, a pozitivan na GCDF15 i androgene receptore-invanzivni duktalni karcinom žlijezda slinovnica. 12. 7. 2012. godine učinjena je radikalna diskekcija vrata, nakon čega je započeta terapija Trastuzumabom (Herceptin) kroz tri ciklusa.

**Ključne riječi:** duktalni salivarni karcinom, onkologija, ORL



BIOMEDICINA I ZDRAVSTVO / BIOMEDICINE AND HEALTH

## SALIVARY DUCT CARCINOMA OF THE PAROTID GLAND - CASE REPORT

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Salivary duct carcinoma of the parotid gland is an uncommon tumor, highly aggressive. Pathomorphologically, these tumors shows great similarities to ductal carcinoma of the female breast, that is why they have described this tumor as "salivary duct carcinoma". It is an epithelial neoplasm that consists of structures that are similar to extended salivary ducts. Salivary duct carcinoma is a rare tumor accounting for 0.2% of all epithelial salivary gland tumors. More than 85% of the tumor affects the parotid gland, and approximately two-thirds of the patients are men. Clinically, it is most commonly manifested by swollen parotid gland, and in 25% of the patients the first symptom may be a dysfunction (paresis / paralysis) of the nerve. Salivary duct carcinoma of the parotid gland is one of the most aggressive salivary gland neoplasms and is characterized by local invasion, lymphatic and hematogenous metastasis and high mortality.

We present a case of male I.A. patient, 53 years old, with salivary duct carcinoma of the parotid gland whose cells histochemically demonstrate a diffuse positive response to HER2 / neu (+++). For 15 years, patient had swollen left parotid gland because of that after proper medical examination we have done 3.10.2011. total parotidectomy.

PHD:Ca metastaticum -tumor tissue is negative to estrogen, progesterone receptors and HER2/neu positive and positive to GCDF15 and androgen receptors-invasive ductal carcinoma of the parotid gland. 12.7.2012. a radical dissection of the neck was performed, followed by Trastuzumab (Herceptin) therapy in three cycles.

**Keywords:** ductal salivary parotid carcinoma, oncology, otorhinolaryngology



BIOMEDICINA I ZDRAVSTVO / BIOMEDICINE AND HEALTH

**KRIJE LI SE U BAKTERIJAMA RJEŠENJE ZA RAZGRADNJU  
PLASTIČNOG OTPADA?**

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U svijetu se svake godine proizvede više od 300 milijuna tona plastičnog otpada. Ako nastavimo tako, predviđa se kako će do 2050. godine težina navedenog otpada u oceanima premašiti ukupnu težinu ribe u istima. Sintetički polimer polietilen tereftalat (PET) je najčešće korištena vrsta plastike te njezina otpornost na prirodnu razgradnju predstavlja veliku ugroženost za sav živi svijet, osobito u morskom okolišu. Kako je plastici potrebno jako puno vremena da bi se razgradila, evidentno je da smo zatrpani gomilama plastičnog otpada koji će se u prirodi zadržati stotinama godina. No, možda ipak nije tako? Izolacijom bakterije *Idonella sakaiensis* u tvornici za reciklažu PET boca u Japanu, otkriven je novi način razgradnje PET-a. Gram negativna i aerobna bakterija *Idonella sakaiensis* 201-F6 koristi PET kao svoj primarni izvor energije i ugljika. Pod djelovanjem dva enzima, PETaza i MHETaza pri optimalnoj temperaturi od 30 °C bakterija razgrađuje PET na tereftalnu kiselinu i etilen glikol, dva kemijska spoja manje opasna po okoliš. Otkriće enzima koji ima sposobnost razgradnje osim PET-a i polietilen-2,5-furandikarboksilata (PEF), pruža nove i još brže mogućnosti za biorazgradnju plastike.

**Ključne riječi:** bakterije, PET, biorazgradnja, enzimi



## DOES BACTERIA HIDE THE SOLUTION FOR DEGRADATION OF PLASTIC WASTE?

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More than 300 million tons of plastics are produced annually worldwide. If we continue, it is anticipated that by 2050 the weight of plastic in the oceans will exceed the total weight of the fish. Synthetic polymers poly(ethylene terephthalate) (PET) are the most commonly used type of plastic. Their resistance to natural degradation presents a serious, growing risk to flora and fauna, particularly in marine environments. Since plastics take a great deal of time to degrade, it is evident that we are crowded with the masses of plastic waste that will remain in nature for hundreds of years. But maybe not so? Recently a new PET degradation system has been identified from bacteria *Idonella sakaiensis* isolated from a PET bottle-recycling factory in Japan. A Gram-negative and aerobic bacteria *Idonella sakaiensis* 201 F6 is able to use PET as its major energy and carbon source. With two enzymes; PETase and MHETase at temperature of 30°C bacteria degrades PET on terephthalic acid and ethylene glycol, two environmentally benign monomers. This enzyme discovery demonstrates PET degradation capacity that it can also degrade PET replacement, polyethylene-2.5-furandicarboxylate, providing new opportunities for biobased plastics recycling.

**Keywords:** bacteria, PET, biodegradation, enzymes



BIOMEDICINA I ZDRAVSTVO / BIOMEDICINE AND HEALTH

## ZNAČAJ ISPITIVANJA PRISUSTVA REZIDUA ANTIBIOTIKA U OKOLIŠU

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U posljednjih trideset godina istraživanja o učincima kemijskoga onečišćenja okoliša su usmjerena gotovo isključivo na konvencionalne zagađivače. Međutim, postoje i kemijski spojevi koji mogu biti potencijalni zagađivači okoliša, a pridaje im se relativno malo pozornosti. To su lijekovi koji se koriste u humanoj medicini i veterini. Prečišćavanjem se samo u slučaju nekih lijekova smanjuju njihove koncentracije prije ispuštanja u vodotokove, tako da je veliki dio urbane kanalizacije kontaminiran lijekovima ili njihovim metabolitima.

Posebnu pozornost pri ispitivanjima treba posvetiti reziduama antibiotika jer one mogu uzrokovati rezistenciju mikroorganizama koja postaje globalni problem. Postoje brojne metode za određivanje rezidua antibiotika od kojih su neke nedovoljno osjetljive i specifične dok su druge često nedostupne zbog svoje visoke cijene. U radu je provedeno preliminarno ispitivanje antibiotika iz grupe tetraciklina i fluorokinolona u površinskoj otpadnoj vodi. Postupak se zasnivao na ekstrakciji na čvrstim fazama (SPE) i hromatografiji na tankom sloju (TLC). Limit detekcije korištene metode je bio 50 ng. Analizom uzoraka vode nije detektovano prisustvo ispitivanih antibiotika u koncentraciji 50 ng ili više.

**Ključne riječi:** rezidue antibiotika, okoliš, kromatografija na tankom sloju (TLC)



## THE SIGNIFICANCE OF DETERMINATION OF THE ANTIBIOTIC RESIDUES PRESENCE IN THE ENVIRONMENT

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In the last thirty years, the study of chemical pollution impacts on the environment is mainly focused on conventional pollutants. However, there are chemical compounds that can be potential environmental pollutants, but little attention is given to them. These substances are medicines used in human and veterinary medicine. Only in the case of some particular drugs, their concentration is reduced prior to discharge into the environment. Therefore, most of the urban saweage is contaminated with drugs or their metabolites. A special attention, during the research, should be paid to the antibiotic residuals, since they can cause resistance to microorganisms, which becomes a global problem.

There are numerous methods for determining antibiotics residuals. Some of them are not sufficiently sensitive and specific, while others are often unavailable due to high costs. In this work, preliminary testing of antibiotics from the tetracycline and fluoroquinolone groups, in surface wastewater, was conducted. The procedure was based on solid phase extraction (SPE) and thin layer chromatography (TLC). Detection limit of the used TLC method was 50 ng. In the tested water sample, were not detected residues of tetracycline and fluoroquinolone antibiotics at concentrations of 50 ng or more.

Analysis of the water samples did not detect the presence of antibiotics tested in concentrations of 50 ng or more.

**Keywords:** antibiotic residuals, the environment, thin layer chromatography (TLC)



BIOMEDICINA I ZDRAVSTVO / BIOMEDICINE AND HEALTH

**DISTRIBUCIJA INZULINSKOG RECEPTORA U HIPOKAMPUSU  
GENETIČKI IZMIJENJENOG MIŠA *B4Galnt1***

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**Uvod:** Hipokampus je dio mozga zadužen za stvaranje dugoročno pamćenje i emocije, a za funkciniranje mu je neophodan inzulin, koji svoje djelovanje ostvaruje preko receptora. Receptori se u periferiji nalaze u lipidnim splavima, čiji su glavni organizatori gangliozidi.

**Ciljevi:** Odrediti ekspresiju inzulinskog receptora u hipokampusu genetički izmijenjenog miša *B4Galnt1* s poremećajem u sintezi kompleksnih gangliozida.

**Materijali i metode:** U istraživanju su korišteni miševi divljeg tipa (WT) i genetički izmijenjeni miševi (KO). Utvrđen je genotipa, nakon čega su životinje žrtvovane, a mozgovi izolirani, fiksirani i krioprotektirani. Kako bi se utvrdila distribucija inzulinskog receptora, napravljena je imunohistokemijska analiza tkiva. Korištena su protutijela IR- $\alpha$  na kriostatskim rezovima debljine 35  $\mu$ m metodom slobodno-plutajućih rezova. Rezultati su analizirani svjetlosnim mikroskopom, slikani kamerom, a slike su analizirane u programu Fiji. Statistika je napravljena u programu Statistica 12.

**Rezultati:** Najveća ekspresija IR- $\alpha$  uočena je u CA3 području oba miša. U KO mišu distribucija je smanjena u sva tri područja u odnosu na WT. Razlika je u područjima CA3 i DG statistički značajna, dok u CA1 razlika postoji, ali nije statistički značajna.

**Zaključak:** Kompleksni gangliozidi imaju značajnu ulogu u formiranju lipidnog okruženja inzulinskog receptora u hipokampusu. Kod genetički izmijenjenog miša *B4Galnt1* pokazano je kako se ekspresija inzulinskog receptora smanjuje.

**Ključne riječi:** gangliozidi, hipokampus, inzulinski receptor, lipidne splavi





BIOMEDICINA I ZDRAVSTVO / BIOMEDICINE AND HEALTH  
**DISTRIBUTION OF INSULIN RECEPTOR IN THE HIPPOCAMPUS OF  
GENETICALLY MODIFIED MOUSE *B4Galnt1***

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The hippocampus is part of the brain responsible for creating long-term memory and emotions. For its unhindered function it is necessary for the insulin to function through receptors. The receptors in the periphery are found in the lipid rafts, whose main organizers are gangliosides. The aim of this study is to determine the expression of insulin receptor in hippocampus of the genetically modified *B4Galnt1* mouse with disorder in the synthesis of the complex gangliosides. Wild type mice (WT) and genetically modified mice (KO) were included in the research. The genotype was determined then after that the animals were sacrificed, and the brains were isolated, fixed and cryoprotected. To determine the distribution of the insulin receptor, immunohistochemical analysis of hippocampus tissue was performed. High-specific anti-IR- $\alpha$  on 35  $\mu\text{m}$  thick cryostat cuts by free-floating cuts method were used. The results were analyzed using a light microscope, photographed by camera and created images were analyzed in *Fiji*. Statistics were made in the *Statistics 12* program.

The results show that the highest expression of IR- $\alpha$  was observed in the CA3 area of both mice. In KO mouse, the distribution was reduced in all three domains in relation to WT mouse. The difference in CA3 and DG area is statistically significant while the difference in CA1 exists but is not statistically significant.

Complex gangliosides have a significant role in the formation of the lipid environment of the insulin receptor in the hippocampus. In the genetically modified mouse *B4Galnt1* it is shown that expression of the insulin receptor decreases.

**Keywords:** gangliosides, hippocampus, insulin receptor, lipid rafts



BIOMEDICINA I ZDRAVSTVO / BIOMEDICINE AND HEALTH

**UTJECAJ KLOROKINA, RAPAMICINA I VORTMANINA NA  
PREŽIVLJAVANJE I RAZMNOŽAVANJE BAKTERIJA *LEGIONELLA*  
*PNEUMOPHILA* I *FRANCISELLA NOVICIDA* UNUTAR AMEBE  
*DICTYOSTELIUM DISCOIDEUM***

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Autofagija ili autofagocitoza je evolucijski očuvan katabolički proces koji uključuje degradaciju citoplazmatskih komponenti. Tijekom infekcije različiti mikroorganizmi različito reguliraju proces autofagije. Istraživanja su pokazala da *L. pneumophila* i *F. novicida* u nekim stanicama potiču autofagiju, a u drugim suprimiraju proces autofagije u korist unutarstanične replikacije. Najveći broj istraživanja proveden je u stanicama sisavaca, a vrlo malo se zna o utjecaju autofagije prilikom infekcije stanica ameba s bakterijama *Francisella* i *Legionella*. Klorokin i vortmanin imaju ulogu da blokiraju autofagiju, dok rapamicin inhibiranjem mTOR receptora potiče autofagiju. Cilj ovog istraživanja bio je utvrditi utjecaj klorokina, rapamicina i vortmanina na preživljavanje i razmnožavanje *L. pneumophila* i *F. novicida* unutar amebe. Rezultati su pokazali kako dodatak inhibitora autofagije, klorokina i vortmanina, negativno utječe na preživljavanje i razmnožavanje bakterija. Međutim, prilikom dodatka rapamicina, induktora autofagije, bakterije se bolje razmnožavaju unutar amebe. Također, iz toga se može zaključiti kako fomiranje autofagične vakuole pomaže bakterijama *L. pneumophila* i *F. novicida* prilikom preživljavanja i razmnožavanja unutar amebe.

**Ključne riječi:** *L. pneumophila*, *F. novicida*, klorokin, rapamicin, vortmanin



BIOMEDICINA I ZDRAVSTVO / BIOMEDICINE AND HEALTH

**THE INFLUENCE OF CHLOROQUINE, RAPAMYCIN AND  
WORTMANNIN ON THE SURVIVAL AND REPLICATION OF  
BACTERIA *LEGIONELLA PNEUMOPHILA* AND *FRANCISELLA  
NOVICIDA* WITHIN *AMOEBAE DICTYOSTELIUM DISCOIDEUM***

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Autophagy or autophagocytosis is an evolutionally preserved catabolic process that involves the degradation of cytoplasmic components. During infection, various microorganisms regulate the autophagy process differently. Studies have shown that *L. pneumophila* and *F. novicida* in some cells stimulate autophagy, and in others suppress the autophagy process in favor of intracellular replication. Most of the studies were performed in mammalian cells, and very little is known about the autophagy process in the amoeba cell after infection with *Francisella* and *Legionella*. Chloroquine and wortmannin plays a role in blocking the autophagy, while rapamycin in iducing the autophagy by inhibiting mTOR receptor. The aim of this study was to determine the influence of chloroquine, rapamycin and wortmannin on survival and replication of *L. pneumophila* and *F. novicida* within *Dyctiostelium discoideum*. The results have shown that treatment of cells with autophagy inhibitors, chloroquine and wortmannin has a negative effect on survival and replication of *Legionella* and *Francisella*. In contrast, induction of autophagy in amoebae cells results of hight number of intacellular bacteria. We can conclude that the formation of an autophagic vacuole support the intracellular replication of *L. pneumophila* and *F. novicida* in *Dictyostelium discoideum*.

**Keywords:** *L. pneumophila*, *F. novicida*, chloroquine, rapamycin, wortmannin, *Dyctiostelium discoideum*



BIOMEDICINA I ZDRAVSTVO / BIOMEDICINE AND HEALTH

**BISFENOL A I FTALATI – UTJECAJ NA LJUDSKO ZDRAVLJE**

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Bisfenol A (BPA) i ftalate ubrajamo u kemikalije koje se najviše proizvode i ispituju u svijetu. U posljednje se vrijeme često u medijima naglašava problem specifične migracije BPA i ftalata posebice iz plastične ambalaže u hranu, ali i okoliš. BPA je reaktivan spoj s dvije fenolne skupine koje su polazne sirovine za dobivanje epoksidnih smola, poli-sulfona, polikarbonata, a isto se tako koristi i kao antioksidans i stabilizator. Ftalati su esteri ftalne kiseline i alifatskih alkohola koji se dodaju u plastične mase da bi se poboljšala njihova mekoća, savitljivost i rastezljivost. Pretpostavlja se da se najznačajniji toksikološki učinak BPA i ftalata, očituje njihovim djelovanjem kao endokrini disruptori, odnosno da remete ravnotežu hormona, a to u konačnici može dovesti do feminiziranosti i smanjenog tipičnog muškog ponašanje kod dječaka, uz razne malformacije spolnih žlijezda te alergije i poremećaje u živčanom i endokrinom sustavu ljudi. Zbog prethodno navedenih negativnih učinaka na ljudsko zdravlje, nužna je učestala kontrola svih materijala i proizvoda od uvoza u Republiku Hrvatsku pa do stavljanja istih na tržište i u promet uključujući predmete opće uporabe i široke potrošnje koji dolaze u kontakt s kožom i sluznicom, a koji bi u svom sastavu potencijalno mogli sadržavati BPA i ftalate.

**Ključne riječi:** bisfenol A, ftalati, endokrini disruptori



## BISFENOL A AND PHTHALATES – IMPACT ON HUMAN HEALTH

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Bisphenol A (BPA) and phthalates are among the most studied and produced chemicals in the world. Recently, the topic of discussion is specific migration of BPA and phthalates especially from plastic packaging into food, and environment. BPA is compound with two phenol groups, which are a raw material for production of epoxy resins, polysulfones and polycarbonates, it is also used as antioxidant and stabilizer. Phthalates are esters of phthalic acid and aliphatic alcohols which are added to plastic masses to improve their softness, flexibility, and extensibility. It is assumed that the highest toxic impact of the above mentioned, is manifested as their ability to react as endocrine disruptors, meaning they disrupt hormonal balance, which can lead to feminization and reduction of typical male behaviour in adolescents, also a variety of sexual glands malformations, allergies, nerve and endocrine system disorders can occur. Because of all the negative impacts mentioned on human health, frequent control of materials and products is needed, from import into the Republic of Croatia, to the placing on to the market, including objects of general use and consumption which come in close contact with skin and mucosa, and can potentially have BPA and phthalates in their composition.

**Keywords :** bisphenol A, phthalates, endocrine disruptors



TEHNIČKE ZNANOSTI / TECHNICAL SCIENCES

## ANALIZA ZASTUPLJENOSTI TEMA PRIRODE I EKOLOGIJE NA POŠTANSKIM MARKAMA REPUBLIKE HRVATSKE

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Autori rada polaze od pretpostavke da su poštanske marke kao i drugi filatelistički proizvodi (prigodni žigovi, omotnice prvog dana i dr.) i danas prepoznatljiv te tražen proizvod koji je pogodan za prijenos različitih korisnih društvenih informacija od kojih se, u današnje vrijeme, razvoj ekološke svijesti pokazuje kao sve značajniji.

U radu su izdvojene različite tematske skupine poštanskih maraka koje je Hrvatska pošta do sada (od 1991. godine naovamo) izdala, a koje su povezane s temom prirode i ekologije (flora, fauna, priroda i turizam, društvena osviještenost, dječji svijet, znanost, svjetske teme i sl.). Analizira se zastupljenost relevantnih motiva te vezanih filatelističkih proizvoda po godinama tijekom promatranog razdoblja. Istovremeno se analiziraju i njihove tehničke specifičnosti (kao što su: oblici, dimenzije, namjene, nominale i sl.).

Hrvatska pošta, kroz različite promotivno-edukativne radionice i aktivnosti, promiče ljubav prema poštanskim markama kao nositeljima i čuvarima nacionalne i svjetske baštine. U tom smislu je razvijena i suradnja s brojnim obrazovnim institucijama među koje se nedavno uključio i Fakultet prometnih znanosti Sveučilišta u Zagrebu.

**Ključne riječi:** poštanska marka, priroda, ekologija, promet, filatelija



TEHNIČKE ZNANOSTI / TECHNICAL SCIENCES

## ANALYSIS OF NATURE AND ECOLOGY THEMES REPRESENTATION ON CROATIAN POSTAGE STAMPS

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The starting assumption of the authors of this paper is the fact that postage stamps, including other philatelic products, are even today recognizable and desired items. As such they are able to transfer various, useful social information among which, in recent times, development of ecological awareness seems to be more and more important.

The paper analyses different thematic groups of postage stamps which were issued by the Croatian Post since 1991 until nowadays and which are related to nature or ecology aspects (theme groups to be found are flora, fauna, nature and tourism, social awareness, pets, science, global themes, anniversaries, etc.). The authors analyse distribution and representation of relevant themes, i.e. the number of the issued stamps or the number of relevant themes over a period of 28 years.

The Croatian Post, as a producer of Croatian postage stamps, through different promotional-educational workshops and activities, promotes and encourages the affection towards postage stamps as carriers and guardians of the national and the world heritage. In this respect, modes of cooperation were established with numerous educational institutions to which the Faculty of Traffic Sciences from University of Zagreb has recently joined.

**Keywords:** postage stamp, nature, ecology, traffic, philately



TEHNIČKE ZNANOSTI / TECHNICAL SCIENCES

## RAZVOJ I VAŽNOST SKLADIŠTENJA ENERGIJE S GLEDIŠTA INTEGRACIJE OBNOVLJIVIH IZVORA

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U današnje vrijeme bilježimo porast korištenja obnovljivih izvora energije za proizvodnju električne energije. Kako su količine proizvedene električne energije iz obnovljivih izvora energije promjenjivi i nepredvidivi, jedan od većih problema jest njihovo skladištenje te korištenje električne energije iz baterija, akumuliranog oblika električne energije. U ovom radu objasnit ćemo razvoj i važnost skladištenja energije u obnovljivim izvorima. Opisat ćemo različite načine pohrane električne energije, njihove principe rada te njihove prednosti i nedostatke. Dotaknut ćemo se početaka skladištenja energije, razvoja kroz povijest te ćemo se osvrnuti na nove tehnologije koje se razvijaju u današnje vrijeme.

**Ključne riječi:** skladištenje energije, baterije, obnovljivi izvori, električna energija





TEHNIČKE ZNANOSTI / *TECHNICAL SCIENCES*

## THE DEVELOPMENT AND IMPORTANCE OF ENERGY STORAGE IN RESPECT TO INTEGRATION OF RENEWABLE ENERGY

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Nowadays there is an increase in the use of renewable energy sources for electricity production. As the quantity of electricity produced from renewable energy sources are variable and unpredictable, one of major problems is their storage and use of electricity from batteries. In this article we will explain the development and importance of energy storage with focus on renewable energy sources. We will describe different ways of storing electricity, their working principles, advantages and disadvantages. The beginnings of energy storage, development through history will be presented, and we will present new technologies that are developing today.

**Keywords:** energy storage, batteries, renewable energy sources, electricity



TEHNIČKE ZNANOSTI / TECHNICAL SCIENCES

## MANAGEMENT OF WATER RESOURCES IN R.MACEDONIA: A REVIEW

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Globally increased industrial production, increased activity in agriculture as well as domestic consumption in the last century, have led to increased use of water resources. This, on the other hand, leads to an increased rate of wastewater production, thereby polluting immediate entities (surface water and groundwater). The sustainable use of water resources and their protection, the quality of water and the goals of achieving sources of healthy drinking water and basic hygiene, have become an increasingly debated topic in the international and regional legal instruments. Responses to the reduction of the quantity and the quality of water sources in the future are also being raised in the European Union (EU), where water should be one of the main themes of the political agenda that will be embedded in all policies. When the water resources of a country are explored, one should first review the geographical location of the country and its demographic and socioeconomic status. The Republic of Macedonia is a landlocked country on the southern part of the Balkan Peninsula, located between mountains and hills. This article will provide an analysis of the wastewater management status and the wastewater purification status in Macedonia. It will address issues such as: types of wastewater treatment plants that are given a green light adapted to Macedonian conditions, the responsibilities of the institutions and the local self - governments in terms of financial and administrative capacity to accept the responsibility of the new Law on Water, which asks for a great commitment from the key figures to function properly.

**Keywords:** wastewater, treatment plants, characteristics, water pollution, Law on Water and legal legislation



## UTJECAJ KISELIH KIŠA NA OKOLIŠ

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Kisele kiše posljedica su zagađenja zraka te predstavljaju jedan od najvećih problema današnjice za okoliš. Uzroci su oslobađanje oksida sumpora i dušika, koji uz određene kemijske reakcije, prelaze u sulfate i nitate. Vrijednost pH (kiselost oborina) diferencira čiste te kisele kiše, a granica se nalazi na 5,5, pri čemu se od te vrijednosti na niže nalaze kisele kiše. Iz same definicije vidljivo je kako su kisele kiše zapravo posljedica ljudskog djelovanja. Naime, do onečišćenosti atmosfere došlo je zbog naglog industrijskog razvoja. O kiselosti voda određenih područja prvi put se govori još 1920. u Norveškoj. Tek se 30-ak godina poslije počinje pretpostavljati veza između kiselih voda i pH oborina. Od tada pa do danas pronađen je niz negativnih posljedica kiselih kiša. Jedna od najčešće spominjanih je uništavanje organizama koji žive u vodi slatkovodnih ekosustava gdje problemi započinju već kod  $\text{pH} < 6$ . Osim toga, posljedice su vidljive u jezerima, rijekama, na životinjskom i biljnom pokrovu, ali također i na građevinama. U Republici Hrvatskoj onečišćenje zraka i oborina prati Državni hidrometeorološki zavod od 1971. godine. Ne postoji jednostavan odgovor na to kako spriječiti kisele kiše, no ono na čemu svakako treba raditi je: proširiti znanje o kiselim kišama, odrediti osjetljivost na zakiseljavanje, monitoring kemijskog sastava oborina i voda, neutralizacija, kontrola emisije i dušikovog oksida.

**Ključne riječi:** kisele kiše, okoliš, onečišćenje



## INFLUENCE OF ACID RAINS ON THE ENVIRONMENT

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Acid rain is a consequence of air pollution and represents one of the biggest environmental problems. The causes are the release of sulfur and nitrogen oxides, which, with certain chemical reactions, converge to sulfate and nitrate. The pH value (acidity precipitation) differentiates pure and acidic rain, and the limit is 5.5, with the acid rain below. From the definition it is evident that acid rains are actually a consequence of human activity. Namely, the pollution of the atmosphere was due to the sudden industrial development. The acidity of water in certain areas was first mentioned in Norway in 1920. Only 30 years later, the connection between acidic water and pH precipitation began was assumed. Since then, a number of negative consequences have been found in acid rains. One of the most commonly mentioned is the destruction of organisms living in freshwater ecosystems where problems start at  $\text{pH} < 6$ . In addition, the consequences are visible in lakes, rivers, animal and plant cover, but also on buildings. In Croatia, air pollution and rainfall has been monitored by the National Hydrometeorological Institute since 1971. There is no simple answer how to prevent acid rain, but what is needed is to extend acid rain knowledge, determine acidity sensitivity, monitor chemical precipitation and water, neutralize, control emissions and nitrogen oxides.

**Keywords:** acid rain, environment, pollution



TEHNIČKE ZNANOSTI / TECHNICAL SCIENCES

## BIORAZGRADNJA BISFENOLA A

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Bisfenol A (BPA) je osnovna građevna jedinica u proizvodnji polikarbonata, epoksi smola, stomatoloških potrepština te drugih materijala. Najviše se koristi u proizvodnji plastike i time ulazi u život svakog čovjeka. Bisfenol A je sveprisutan kemijski spoj u okolišu, unatoč njegovom kratkom životnom vijeku, zbog konstantnog otpuštanja u okolinu. Do otpuštanja BPA u okolinu, odnosno u tlo i vode, može doći tijekom kemijske proizvodnje, transporta ili prerade. BPA negativno utječe na životinjski svijet i ljudsko zdravlje te ga je potrebno ukloniti iz okoliša. Biorazgradnja BPA u vodenim sustavima može se provesti primjenom različitih mikroorganizama koji imaju sposobnost razgradnje BPA.

U ovom radu provedena je biorazgradnja BPA u vodenoj otopini s bakterijskom kulturom *Pseudomonas aeruginosa* u šaržnim uvjetima rada. *Pseudomonas aeruginosa* izolirana je iz biootpada i ima sposobnost razgradnje organskih, toksičnih spojeva. Ispitani su različiti čimbenici koji utječu na proces biorazgradnje, poput pH-vrijednosti (5, 6 i 7), koncentracije BPA (0 do 15 mg/L), temperature (25, 35 i 45 °C) i koncentracije biomase *P. aeruginosa* (0,1; 0,2; 0,3). Prema dobivenim rezultatima najviše se BPA razgradilo pri temperaturi od 35 °C, pH-vrijednosti 7 i optičkoj gustoći od 0,3. U vremenu od dva sata razgradilo se 50 % BPA, a najintenzivnija biorazgradnja je bila unutar 30 minuta.

**Ključne riječi:** Biorazgradnja, Bisfenol A, *Pseudomonas aeruginosa*, utjecaj *T*, pH-vrijednosti, optičke gustoće



## BIODEGRADATION OF BISPHENOL A

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Bisphenol A (BPA) is a basic unit of polycarbonates, epoxy resins, dental and other materials. BPA is mostly used in plastic industry and because of that, it is present in human life. BPA is ubiquitous organic compound despite its short half-life. The reason it is constant release in the environment. Release of BPA can occur during chemical manufacture, transport and processing. Because of BPA's negative effect on human health and animals, it has to be removed from the environment. Biodegradation of BPA, in water solutions, can occur in the presence of various microorganisms that have the ability to degrade BPA.

In this paper, a biodegradation of BPA in water was conducted with bacterial culture *Pseudomonas aeruginosa* BSW in batch conditions. *Pseudomonas aeruginosa* BSW was isolated from biowaste and it has the ability to degrade toxic organic compounds. Experiments were performed under different pH-values (5, 6, 7), different BPA concentration (0 - 15 mg dm<sup>-3</sup>), different temperatures (25, 35 and 40°C), and different biomass concentration of *P. aeruginosa* (0.1; 0.2; 0.3). According to the experimental results the highest amount of BPA (initial concentration 15 mg dm<sup>-3</sup>) was degraded at 35°C, pH-value 7 and at optical density of 0.3. *Pseudomonas aeruginosa* BSW showed the best results at initial BPA concentration of 5 mg dm<sup>-3</sup>. In two hours 50% of



BPA was biodegraded and the most intensive biodegradation was within 30 minutes.

**Keywords:** biodegradation, Bisphenol A, *Pseudomonas aeruginosa*, influence of temperature, pH-values, optical density



TEHNIČKE ZNANOSTI / TECHNICAL SCIENCES

## KINETIKA BIOREMEDIJACIJE FARMACEUTSKE OTPADNE VODE POMOĆU BIOAUGMENTIRANOG AKTIVNOG MULJA

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Farmaceutska industrija bilježi značajni porast proizvodnje te nastaju otpadne vode koje mogu predstavljati opasnost za okoliš. Bioremedijacija, kao održiva alternativa konvencionalnim tehnologijama za obradu otpadnih voda, iskorištava mikroorganizme za razgradnju i/ili detoksifikaciju prisutnih onečišćujućih tvari. Bioaugmentacija, kao strategija za povećanje učinkovitosti procesa biorazgradnje, podrazumijeva inokulaciju egzogenih mikroorganizama u sustav obrade otpadnog toka. U ovome radu istraživana je bioremedijacija farmaceutske otpadne vode pomoću aktivnog mulja bioaugmentiranog bakterijskom kulturom *Pseudomonas putida*. Proces biorazgradnje proveden je u šaržnim uvjetima tijekom 24 sata s početnom koncentracijom supstrata  $S_0=5,0 \text{ g L}^{-1}$  i različitim početnim koncentracijama bioaugmentiranog aktivnoga mulja,  $X_0=3,7-5,8 \text{ g L}^{-1}$ . Tijekom procesa praćena je koncentracija otopljenoga kisika i pH-vrijednost, a mikroskopskom analizom kakvoća pahuljica bioaugmentiranog aktivnog mulja. Endo-Haldaneov kinetički model korišten je za opis procesa biorazgradnje. Procijenjene vrijednosti biokinetičkih parametara  $\mu_{max}$ ,  $K_s$ ,  $K_i$ ,  $Y$  i  $k_d$  iznosile su  $0,44 \text{ h}^{-1}$ ;  $65,53 \text{ g L}^{-1}$ ;  $143,63 \text{ g L}^{-1}$ ;  $0,45 \text{ g g}^{-1}$ ;  $0,0071 \text{ h}^{-1}$ . Učinkovitost uklanjanja supstrata iznosila je 80 %.

**Ključne riječi:** farmaceutska otpadna voda, bioremedijacija, bioaugmentacija, *Pseudomonas putida*





## BIOREMEDIATION KINETICS OF PHARMACEUTICAL WASTEWATER WITH BIOAUGMENTED ACTIVATED SLUDGE

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The pharmaceutical industry is experiencing a significant increase in production and resulting in waste water that can pose a hazard to the environment. Bioremediation, as a viable alternative to conventional wastewater treatment technologies, exploits microorganisms for the degradation and/or detoxification of present pollutants. Bioaugmentation, as a strategy for increasing the efficiency of the biodegradation process, implies inoculation of exogenous microorganisms into the wastewater treatment system. In this study, bioremediation of pharmaceutical wastewater by activated sludge, which was bioaugmented with bacterial culture *Pseudomonas putida*, was investigated. The experiment was conducted during 24 hours in batch reactor at initial concentration of substrate  $S_0=5,0 \text{ g L}^{-1}$  and different initial concentrations of bioaugmented activated sludge,  $X_0=3,7-5,8 \text{ g L}^{-1}$ . During the process, concentration of dissolved oxygen and pH-value were monitored. The quality of bioaugmented activated sludge flocs was monitored by microscopic analysis. The Endo-Haldan kinetic model was used for performing the biodegradation of pharmaceutical wastewater. Estimated values of biokinetic parameters  $\mu_{max}$ ,  $K_s$ ,  $K_i$ ,  $Y$  and  $k_d$  were  $0,44 \text{ h}^{-1}$ ;  $65,53 \text{ g L}^{-1}$ ;  $143,63 \text{ g L}^{-1}$ ;  $0,45 \text{ g g}^{-1}$ ;  $0,0071 \text{ h}^{-1}$ . The efficiency removal of substrate was 80%.

**Keywords:** pharmaceutical wastewater, bioremediation, bioaugmentation, *Pseudomonas putida*



## COMMUNITY EDUCATION FOR CULICIDAE CONTROL

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Culicidae are considered a disease of the XXI re-emerging century and cause major public health problems in the world, not only because it affects thousands of people, since the mosquito *Aedes aegypti* tends to reproduce in homes but also because it is considered one of the most important viral diseases transmitted by animals. In health surveillance Environmental Health Tracking of the environment, and its mission is to analyze, prevent and correct the health risks, which are environmental or potential. It is in this sense that environmental health is as important to end this disease, and in the meantime to prevent that it does not affect human health. In the study the method used was plating the presence of mosquitoes and larvae that can cause contamination and diseases originating from mosquitoes, the analysis of these data and the other allows us to see the need for prophylactic care to have in our country, for its location and climate can foster the emergence of these.

Results: climate change that crosses can cause the onset of mosquito vectors of carriers, so you want to public education for preventive measures can combat the proliferation of mosquitoes mosquito carriers.

The reached conclusion in this paper is that despite the fact that there are no mosquitoes, public needs to be educated about mosquito prevention measures. Thus, this study provides a number of solutions to minimize the proliferation mosquito vectors.

**Keywords:** culicids, environmental health, culicid prevention



TEHNIČKE ZNANOSTI / TECHNICAL SCIENCES

## GREEN ROUTINE FOR BIODIESEL PRODUCTION FROM WASTE COFFEE GROUNDS

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Biodiesel can be produced from different types of feedstock. The quality of feedstock influences the quality of biodiesel as well as the quality of exhaust gases. When low quality feedstock is used for base catalysed transesterification, feedstock needs to be purified since only high quality oil or fat will assure production of high quality biodiesel. Waste coffee grounds are proven to be an excellent feedstock for biodiesel production. In this work coffee oil was extracted from dried waste coffee grounds. Since the total acid number was too high, the concentration of free fatty acids was reduced by means of liquid-liquid extraction with deep eutectic solvents based on potassium carbonate. Biodiesel was then synthesised by chemical transesterification in the presence of a homogeneous base catalyst (NaOH) at different reaction conditions (time and quantity of catalyst). Impurities present in crude biodiesel were extracted with a deep eutectic solvent (choline chloride:ethylene glycol, 1:2.5). The feasibility of the proposed methodology was evaluated by extraction efficiency. Optimal extraction time, temperature and mass ratio solvent/biodiesel was selected.

**Keywords:** biodiesel, deep eutectic solvents, liquid-liquid extraction, waste coffee grounds



TEHNIČKE ZNANOSTI / TECHNICAL SCIENCES

## KAKO SE KLASIFICIRA ZELENA INFRASTRUKTURA GRADA OSIJEKA - ANALIZA ZELENIH POVRŠINA GRADSKO ČETVRTI GORNJI GRAD

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Zelena infrastruktura ima sve veće značenje unutar ekosustava i u pružanju zaštite biološke raznolikosti za pravilno funkcioniranje gradova. Pogodnosti koju nude zelena područja u gradovima poput gospodarskih, ekoloških i društvenih temelje se na razumijevanju prednosti koje pruža mreža prirodne infrastrukture za koju je dokazano da doprinosi kvaliteti života i zdravlju. Definicije zelene infrastrukture dinamične su kroz vrijeme i pomaknule su se od osnovnih prirodnih značajki prema funkcionalnim i uslužnim te društvenim, kulturnim i ekonomskim osnovama. Cilj rada je na osnovi literature koja raspravlja o definiciji, klasifikaciji i tipologiji zelene infrastrukture ponuditi okvir za evidentiranje i valoriziranje zelene infrastrukture na razini gradske četvrti. Za prostor gradske četvrti Gornji grad u Osijeku prikazat će se udio zelenih površina prema tipologiji koja služi upravljanju na razini grada i udio zelenih površina iskazan prema broju stanovnika. U radu će se usporediti postojeća i predložena tipologija za osječku gradsku četvrt Gornji grad. Rezultati analize jasno ukazuju da je prostor grada Osijeka intenzivno pokriven zelenim površinama što upućuje na potrebu pravilne kategorizacije za učinkovitije upravljanje.

**Ključne riječi:** zelena infrastruktura, klasifikacija zelenila, Osijek, Gornji grad



TEHNIČKE ZNANOSTI / TECHNICAL SCIENCES

## HOW TO CLASSIFY THE GREEN INFRASTRUCTURE OF THE CITY OF OSIJEK - THE ANALYSIS OF THE GREEN AREAS OF THE CITY DISTRICT UPPER TOWN

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Green infrastructure has an increasing importance within the ecosystem as well as in providing biodiversity for the good quality of living in cities. Benefits provided by green areas in cities regarding economic, ecological and social issues are based on positive effects caused by the network of natural within the built infrastructure. The definitions of green infrastructure are dynamic over time and the core of the term has shifted from basic natural features to functional, service, social, cultural and economic grounds. The main aim of the research is to provide a framework for valorisation of green infrastructure at the level of the city district on the basis of a literature review that discusses the definition, classification and typology of green infrastructure. There will be presented results of statistical analysis of land use regarding green infrastructure for the area of the Osijek city district of Upper Town. The results will present the share of green areas according to the green infrastructure typology used by the city management at the city level and the share of green areas according to the number of inhabitants. The results will present comparison of the existing and proposed typology for the Osijek city district Upper Town. The results of the analysis clearly indicate that the city area of Osijek is intensely covered by green areas, indicating the need for proper categorization for more efficient management.

**Keywords:** green infrastructure, green classification, Osijek, Upper Town



## OTPADNO JESTIVO ULJE

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Otpadno jestivo ulje koje nastaje u ugostiteljskim objektima je veliki resurs obnovljivih izvora energije. Iako postoji sve veća globalna zainteresiranost za njegovo zbrinjavanje i ponovnu upotrebu nakon korištenja, u Bosni i Hercegovini još uvijek ne postoji zakonski pravilnik o regulaciji gospodarenja otpadnog jestivog ulja. Anкета pod nazivom „Otpadna jestiva ulja iz ugostiteljskih objekata“ je provedena u 30 manjih ugostiteljskih objekata (do 50 zaposlenih) u Bosni i Hercegovini. Od ukupnog broja ispitanih 18 ih poznaje HACCP sustav, ali ih svega 13 dostavlja izvještaj koji se odnosi na održavanje HACCP sustava. Otpadno ulje se posebno skladišti u 17 ugostiteljskih objekata, a u 13 ne skladišti. Od 17 ugostiteljskih objekata koji predaju ulje ovlaštenom skupljaču, 5 ih popunjava prateći listić, a 12 ih ne popunjava. U ostatku restorana (13) se ulje ne predaje ovlaštenom skupljaču. U Bosni i Hercegovini treba težiti povećanju svijesti o važnosti zbrinjavanja ulja i njegovoj obradi te mogućnosti ponovne upotrebe. Međutim, rezultati su pokazali nisko poznavanje HACCP sustava, metoda obrade otpadnog jestivog ulja, te drugih mjera zaštite okoliša.

**Ključne riječi:** gospodarenje otpadnim jestivim uljem, HACCP sustav, anketno istraživanje, restorani, zaštita okoliša



## WASTE COOKING OIL

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Waste cooking oil produced in restaurants is a large resource of renewable energy sources. Although there is growing global interest in its disposal after use, there is still no legal regulation regarding waste cooking oil management in Bosnia and Herzegovina. The questionnaire named "Waste cooking oil from restaurants" was made in 30 smaller restaurants (up to 50 employees) in Bosnia and Herzegovina. Of the total number of people questioned, 18 are familiar with the HACCP system, but only 13 of them report the HACCP system. There are special containers of waste cooking oil in 17 restaurants, and 13 of them do not store it. Out of 17 restaurants that surrender waste oil to a licensed collector, 5 of them fill in a leaflet and 12 do not. In the rest of the restaurants (13) the oil is not surrendered to a licensed collector. In Bosnia and Herzegovina, efforts should be made to raise awareness of the importance of waste oil disposal and its handling and the possibility of reuse. However, the results showed poor knowledge of the HACCP system, the method of waste cooking oil processing, and other environmental protection measures.

**Keywords:** waste cooking oil management, HACCP system, survey, restaurants, environmental protection



TEHNIČKE ZNANOSTI / TECHNICAL SCIENCES

## MORPHOLOGICALLY CONTROLLED ZNO NANOSTRUCTURES FOR IMPROVED PHOTOCATALYTIC ACTIVITY

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Photocatalytic degradation of an organic dye, as a model pollutant, was studied in aqueous solutions using nanosized zinc oxide photocatalyst. Zinc oxide is well known as a material that forms various morphologies at the micro- and nanoscale, which exhibit different functional properties. Photocatalysts are required to have large specific surface areas, because chemical reactions induced by suitable irradiation take place by contact between their surface and fluid. We designed and synthesized one-dimensional (sticks and wires) and two-dimensional (leaves) nanostructures of zinc oxide that should fulfill this requirement. We also expected that nanostructuring will enhance semiconducting features of zinc oxide. Nanostructures were grown from solution and their morphology was controlled by varying the precursors and the growth and post-growth conditions. Detailed characterization of their structure and porosity on the micro- and nanoscale was performed by scanning electron microscope and X-ray scattering measurements. All nanostructures exhibited good photocatalytic activities. Mesoporous nanostructures in form of wires and leaves exhibited improved photocatalytic activity, even in sunlight.

**Keywords:** photocatalyst, zinc oxide, nanostructure





## POKAZATELJI ODRŽIVOSTI VODNIH RESURSA

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Održivost ili održivi razvoj je jedan od osnovnih koncepata očuvanja prirodnih resursa (vodnih resursa) i vrijednosti okoliša. Osnovni dokument o upravljanju vodnim resursima prema načelima održivog razvoja u Europi su Smjernice o vodama Europske unije. Za analizu održivosti vodnih resursa potrebno je odrediti pokazatelje. Pokazatelji predstavljaju reprezentativne vrijednosti nastale na temelju niza sakupljenih i analiziranih podataka nekog promatranog sustava. Teorijsko – metodološka osnova za uspostavu pokazatelja održivosti koju preporučuje Europska agencija za okoliš je Drivers – Pressures – State – Impact – Responses DPSIR okvir (pokretači, pritisci, stanje, utjecaj, odgovori). Pokretači su prateće pojave i posljedice društvenog i gospodarskog razvoja koje stvaraju pritiske na okoliš čije se stanje mijenja, zbog čega dolazi do negativnih utjecaja na zdravlje ljudi i ekosustave što u konačnici zahtijeva odgovore društva. Neki od pokazatelja kojima se može analizirati održivost vodnih resursa pojedinog vodnog područja su stanje površinskih i podzemnih voda koje se definira kakvoćom i količinom, potrošnja vode, izvori onečišćenja. U ovom radu će se na temelju DPSIR okvira dati pokazatelji održivosti vodnih resursa dunavskog vodnog područja Republike Hrvatske.

**Ključne riječi:** održivost; vodni resursi, pokazatelji, DPSIR okvir, dunavsko vodno područje



## INDICATORS OF SUSTAINABILITY OF WATER RESOURCES

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Sustainability or sustainable development is one of the basic concepts of preserving natural resources (water resources) and environmental values. The basic document on water resources management according to the principles of sustainable development in Europe is the EU Water Framework Directive. For the analysis of water resource sustainability it is necessary to determine the indicators. Indicators represent representative values based on the number of collected and analyzed data of a observed system. Theoretical-methodological basis for establishment sustainability indicators recommended by the European Environment Agency is Drivers - Pressures - State - Impact - Responses The DPSIR framework. The initiators are the accompanying phenomena and consequences of social and economic development that create pressures on the environment whose state of affairs changes, resulting in adverse impacts on human health and ecosystems, which ultimately requires societal responses. Some of the indicators that can be used to analyze the sustainability of the water resources of the catchment area are the state of surface and groundwater that is defined by the quality and quantity, water consumption, sources of pollution. In this paper, the DPSIR framework will provide indicators of water resource sustainability of the Danube River Basin District of the Republic of Croatia.

**Keywords:** Sustainability, water resources, indicators, DPSIR framework, The Danube River Basin District



TEHNIČKE ZNANOSTI / TECHNICAL SCIENCES

## OPTIMIZATION OF ULTRASOUND-ASSISTED EXTRACTION OF OIL FROM WHITE MUSTARD SEED

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In the present work, in order to maximize the yield of total extract from white mustard seed (*Sinapis alba* L.) by using ethanol (96% vol.), the effects of two operating parameters (extraction time and extraction temperature) were investigated by implementation of one modern (ultrasound-assisted extraction) extraction technology. The main goals were to develop the kinetic and optimization model through application of response surface methodology (RSM) optimization. Ultrasound-assisted extraction was carried out at 25, 30 and 35°C in duration of 30, 60 and 90 min under constant agitation by ultrasound with frequency of 40 kHz and solvent to sample ratio 33.333:1 raw material. In *Statgraphics Centurion XV*, software optimization is made to determine the influence of the working parameters on the size of the yield [%] of extracted oil. The created software model provided adequate fitting of experimental data with a high correlation coefficient  $R^2=98.4483$ . It was found that the extraction temperature is more important of the extraction time. The maximum of yield of total extract for UAE were 14.0893 at the optimum temperature and extraction time of 35°C and 90 min.

**Keywords:** white mustard seed, ultrasound-assisted extraction, operating parameters, RSM optimization.



## RECIKLIRANJE ODBAČENIH BATERIJA

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Baterije su sastavni dio različitih prijenosnih električnih i elektroničkih uređaja koje koristimo u svakodnevnom životu da su postale gotovo nevidljive. Procijenjena količina odbačenih baterija 2015. godine u svijetu iznosila je oko 15 milijardi komada, a samo 10 % njih je na pravilan način odloženo i zbrinuto. Odbačene baterije zbog svoje neupotrebljivosti jer su potrošene, nužno je reciklirati iz više razloga. Svakako je najvažniji razlog zaštita okoliša jer elektrokemijske ćelije u sebi sadrže različite štetne i opasne tvari kao što su: živa, olovo, kadmij, nikal, cink i kobalt. Pravilnikom o baterijama i akumulatorima i otpadnim baterijama (NN 111/2015) definirane su smjernice koje doprinose udjelu smanjenja opasnog otpada u baterijama i njihovom pravilnom zbrinjavanju, kao i uvjeti koji se moraju poštovati pri prikupljanju dotrajalih baterija, evidenciji i skladištenju. U radu su prikazana dva tehnološka postupka recikliranja različitih vrsta odbačenih baterija koji za cilj imaju smanjenje primarne proizvodnje materijala i energenata te emisije žive, olova i kadmija u okoliš.

**Ključne riječi:** odbačene baterije, recikliranje, materijali, zaštita okoliša



## RECYCLING OF DISCARDED BATTERIES

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The batteries are an integral part of the various portable electrical and electronic devices that we use in everyday life which became almost invisible. Estimated amount of discarded batteries in 2015 was around 15 billion units worldwide, and only 10% of them were properly disposed of. Discarded batteries because of their non-usability is necessary to recycle for several reasons. Regulations on batteries and accumulators and waste batteries (Official Gazette No. 111/2015) define guidelines that contribute to the share of hazardous waste reduction in batteries and their proper disposal, as well as the conditions that must be met when collecting overage batteries, records and storage. This paper presents two technological processes for the recycling of different types of discarded batteries aimed at reducing the primary production of materials and energy sources, as well as the emission of mercury, lead and cadmium into the environment.

**Keywords:** Discarded batteries, recycling, materials, environment protection



TEHNIČKE ZNANOSTI / TECHNICAL SCIENCES

## QUALITATIVE AND QUANTITATIVE CHARACTERISTICS OF DRINKING WATER SPRINGS FOR THE CITY OF SKOPJE

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Water supply with chemical and microbiological healthy water is essential for the survival of man in urban areas and in general. The resources that meet these criteria are limited and under great pressure from urbanization, industrial activities, assigning objects of all kinds. Failure to respect the basic principles of environmental protection can significantly jeopardize the quality of a resource that is used or would be used for water supply to the population. The conditions, the impacts, the degree of resistance to one resource for water supply are determined by a series of hydrological, hydrogeological, geological, lithological, meteorological and other parameters that collected in one should characterize the resource or in our case the spring Rasche. In order to implement the measures arising from complex research, protection zones are created that should guarantee the population safety of water supply. This involves respecting and implementing certain measures and activities in accordance with the characteristics previously defined by the research. The bottom line is to maintain the quality and security of the source now and in future periods. It is therefore necessary to consistently implement the prescribed rules and procedures in accordance with the protection zones. It does not mean that the quality and quantity of the source should not be monitored. On the contrary. This is the primary task in order to be able to determine the situation accurately and if necessary, propose new protection measures, which ultimately includes the revision of the protection zones, in order to maintain the existing status with the quality and quantity of the source. Water distribution system to the user public water supply and guaranteeing quality is regulated by rules on the quality and safety of water.

In addition to rules which lays down the law but there are rules of the profession, especially when it comes to exceptions in terms of both importance and water supply in a region. Approach to determining the number and location sites, sampling frequency, number of parameters, methods and equipment for the determination of: anions, cations, heavy metals and total organic carbon is presented in this written work. The obtained values measured physical and chemical parameters are shown as minimum, maximum and mean values at the level of annual observations.

**Keywords:** protection zones, hydrology, hydrogeology, quality, water supply, anions, cations, heavy metals



BIOTEHNIČKE ZNANOSTI / BIOTECHNICAL SCIENCES

## OPTIMIZATION OF ULTRASOUND-ASSISTED EXTRACTION OF PHENOLIC COMPOUNDS FROM RASPBERRY (*RUBUS IDAEUS* L.)

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Phenolics are compounds possessing one or more aromatic rings with one or more hydroxyl groups, generally involved in defense against ultraviolet radiation or aggression by pathogens, parasites and predators, as well as contributing to plants' colors. Raspberry is a functional natural fruit that is widely cultivated worldwide. Raspberries are rich in polyphenols. Ultrasonic-assisted extraction is an environmentally friendly method characterized by high efficiency, low energy consumption, and no involvement of high temperature or pressure. Ultrasound-assisted extraction (UAE) was employed for highly efficient extraction of polyphenols from raspberries. Concentration of ethanol described as green solvent, sonication time and extraction temperature was investigated for optimization of extraction of polyphenol compounds. Verification experiments were carried out under optimal conditions, and good agreement was found between estimated values and experimental values.

**Keywords:** raspberry, ultrasonic-assisted extraction (UAE), polyphenol compounds



BIOTEHNIČKE ZNANOSTI / BIOTECHNICAL SCIENCES

## KVALITETA KOMPOSTA DOBIVENOG KOMPOSTIRANJEM BIOOTPADA

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Jedan od načina korisnog zbrinjavanja otpada je kompostiranje. Biootpad je kuhinjski otpad (ostaci od pripreme hrane) i vrtni ili zeleni otpad. Vrijedna je sirovina za proizvodnju kvalitetnog biokomposta. Kompostiranje znači aerobnu razgradnju biootpada pri čemu nastaju ugljikov dioksid, voda, toplina i kompost. U procesu kompostiranja ključnu ulogu imaju mikroorganizmi, koji uz odgovarajući stupanj vlažnosti i kisika, prerađuju organsku tvar u kompost.

U radu su prikazane osnove metoda kompostiranja, dan je pregled polaznog materijala (sirovina) za kompostiranje, osnovne karakteristike proizvoda komposta. Kompostiranjem biootpada, u kontroliranim se uvjetima odvija razgradnja organske tvari u stabilno stanje u kojemu dobivamo koristan proizvod, koji može poslužiti kao poboljšivač tla. Za vrijeme istraživanja, u spremnik „Organko“ odlagani su ostaci voća, povrća, ostaci hrane, čajne vrećice, uvenulo cvijeće, sir, jaja, ribe. Tijekom ovoga procesa nema truljenja niti neugodnih mirisa, budući da je sadržaju dodavan posip za biološki otpad, bogat mikroorganizmima. Nadalje, analizirana je fermentacijska tekućina / procjedna voda svakih sedam dana, kroz mjesec dana. U okviru ovog rada analizirana su fizikalna, kemijska i biološka svojstva komposta dobivenog kompostiranjem biootpada, kao i procjedne tekućine.

Iz navedenog se da zaključiti da je višestruka korist kompostiranja biorazgradivog otpada i da je neophodno postupno uvođenje procesa kompostiranja u svakom individualnom kućanstvu.

**Ključne riječi:** biootpad, kompostiranje, upravljanje otpadom





BIOTEHNIČKE ZNANOSTI / BIOTECHNICAL SCIENCES

## THE QUALITY OF THE COMPOST OBTAINED BY BIOWASTE COMPOSTING

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One of the ways to use waste is composting. Biowaste is kitchen waste (food preparation residues) and garden or green waste. It is a valuable raw material for the production of high quality biofuels. Composting means aerobic biodegradation by forming carbon dioxide, water, heat and compost. In the process of composting, the microorganisms which, with the appropriate degree of moisture and oxygen, convert the organic substance into the compost play a key role. The paper presents the basics of the composting method, an overview of the starting material (raw material) for composting, the basic characteristics of compost products. By composting the biowaste, under controlled conditions, the degradation of the organic substance is carried out in a stable state in which we obtain a useful product which can serve as soil improvers. During the research, in the "Organko" cartridge deposited were remnants of fruit, vegetables, food remains, tea bags, roasted flowers, cheese, eggs and fish. During this process there is no rupture or no odor, since the the biowaste stream rich in microorganisms have been added to the contents. Furthermore, fermentation fluid/brewing water was analysed every seven days within one month. In this paper, the physical, chemical and biological properties of the compost obtained by composting the biowaste as well as the liquid are analyzed.

From the above it can be concluded that there is a multiple benefit of composting biodegradable waste and the gradual introduction of the composting process in each individual household is indispensable.

**Keywords:** biowaste, composting, waste management



BIOTEHNIČKE ZNANOSTI / BIOTECHNICAL SCIENCES

## “PLAVA REVOLUCIJA” – NOVI KORAK PREMA ODRŽIVOJ BUDUĆNOSTI

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Konstantni porast svjetske populacije pridonosi rastućem iskorištavanju prirodnih resursa, sto uključuje i riblji fond, te se postavlja pitanje hoće li doći do „Šestog izumiranja” ili smo sposobni odgovornom upotrebom biotehnoških postignuća osigurati održivu budućnost. Posljednjih nekoliko desetljeća započinje „Blue revolution”, nagli razvitak akvakulture, grane koja postaje najbrže rastući sektor proizvodnje hrane. Uz nagli porast potrebe za hranom i očuvanjem okoliša, raste i potreba za mijenjanjem dizajna uzgojnih sustava. Cilj je primjenom inovativnih sustava minimizirati utjecaj na okoliš, povećati učinkovitost proizvodnje uzgajanih organizama uz što učinkovitiju uporabu vodenih resursa te pri tome zadovoljiti potrebe za hranom i trend zdrave prehrane. Nažalost, brojne države još uvijek koriste ili uvoze zastarjele tehnologije koje onečišćuju okoliš. Osvještenje o primjeni održivih sustava može osigurati ekološki zbrinutu i profitabilnu budućnost. Primjere održivih akvakulturnih sustava predstavljaju integrirana multi-trofička akvakultura (IMTA), suvremeni zatvoreni recirkulacijski sustav (RAS) te akvaponija – povezivanje RAS-a s uzgojem biljaka u jedan održivi sustav. Zbrinjavanje ribljeg otpada je veliki problem i loše upravljanje istim može dovesti do znatnih ekoloških problema. Uz inovativne tehnologije, od otpada možemo proizvoditi bioplin, biodizel, aktivne tvari za farmaceutsku i kozmetičku industriju ili kompost. U radu su opisani osnovni dizajni nekoliko sustava koji jamče ekonomsku, okolišnu, socijalnu i energetske održivost.

**Ključne riječi:** održiva akvakultura, plava revolucija, zbrinjavanje ribljeg otpada, obnovljivi izvori energije



BIOTEHNIČKE ZNANOSTI / BIOTECHNICAL SCIENCES  
“BLUE REVOLUTION” - A NEW STEP TOWARDS  
SUSTAINABLE FUTURE

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There is a logical correlation to the effect human population growth has on the depletion of natural resources. Many resources are strained by this spiraling process, but fresh water, oceans and fish stock stand to benefit from biotechnological achievements capable of staving off the proverbial “Sixth Extinction” and securing a sustainable future. The growing need for food and the preservation of the environment dictates an increasing exigency for changing designs of cultivation systems. Over the past few decades, the growing need for food and environmental preservation led to the “Blue Revolution”, and as a result, aquaculture became the fastest growing branch in the food production sector. The aim is to improve breeding of farm-raised products, continuously grow food, consume less water, and use processes that both enhance the environment and satisfy the demand for healthy and safe food sources. Some examples of sustainable systems are integrated multitrophic aquaculture (IMTA), which combines modern closed recirculation systems (RAS) and hydroponics to cultivate fish and plants within a sustainable aquaponics system. With the use of innovative technologies and proper management, byproducts of food production and waste mitigation can be used to produce biogas, biodiesel, substances for the pharmaceutical and cosmetic industries, while increasing the financial stability and profitability of the business. This paper describes the basic designs of several systems that could guarantee socioeconomic, environmental, and energy sustainability.

**Keywords:** sustainable aquaculture, blue revolution, fish waste mitigation, renewable energy sources



BIOTEHNIČKE ZNANOSTI / BIOTECHNICAL SCIENCES

## THE IMPACT OF PRETREATMENTS ON PRODUCTION OF BIOACTIVE PROTEIN HYDROLYSATES FROM PLUM OIL CAKE

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Stones from plum have a high content of proteins and lipids but they are mostly underused and undervalued. Plum cake, which remains after oil extraction from seed has protein content of about 50%. Hence, isolation of proteins from plum cake is a way of utilization of this by-product. Hydrolysis of proteins by commercial protease is an effective method for production of hydrolysates with desirable bioactive properties. The different treatments on proteins before enzymatic hydrolysis could improve hydrolytic process helping in protein unfolding and increasing accessibility of enzymes to peptide bonds. Methods used in this purpose include heat (HT), hydrostatic pressure (HP), ultrasound (US), microwave (MW) and pulsed electric field (PEF) treatments.

This work investigates the impact of heat (HT) and ultrasound (US) pretreatments on enzymatic hydrolysis of plum cake protein isolate for production of bioactive products. Two enzymes were employed in hydrolytic process: alcalase and flavourzyme. Antioxidant and ACE inhibitory activity of obtained hydrolysates were determined. Results show that both treatments improved the enzymatic process and increase the antioxidant and potential antihypertension activity of obtained hydrolysates. Moreover, HT treatment was more effective than US.

**Keywords:** plum by-product, protein isolate, enzymatic hydrolysis, bioactive peptide



BIOTEHNIČKE ZNANOSTI / BIOTECHNICAL SCIENCES  
**REGIONALNA PREPOZNTLJIVOST AUTOHTONIH  
POLJOPRIVREDNO-PREHRAMBENIH PROIZVODA  
SLAVONIJE I BARANJE**

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Autohtoni proizvodi su oni proizvodi koji konkuriraju svojom kvalitetom i posebnosti ostalim proizvodima na globalnom tržištu zbog svojih tehnoloških, prehrambenih te organoleptičkih posebnosti. Izuzetno su važni za održivi ruralni razvoj, očuvanje tradicije i identiteta pojedinog kraja. Područje Slavonije i Baranje poznato je po svojim autohtonim proizvodima kao što su slavonski kulen, baranjski kulen i slavonski med. Osim toga, ovo područje u svojim autohtonim proizvodima često kao temeljni sastojak koristi meso od također autohtone pasmine, crne slavonske svinje, koja je također zaštićena. Budući da su upravo ovakvi proizvodi temelj za budući razvoj ruralnog područja Slavonije i Baranje kao i cjelokupne poljoprivredne djelatnosti, potrebno je raditi na regionalnoj prepoznatljivosti ovoga dijela Republike Hrvatske kroz autohtone proizvode, a prilika je vidljiva u povezivanju „zelene“ i „plave“ Hrvatske. Cilj je rada bio utvrditi postoji li vidljivost (prepoznatljivost) autohtonih proizvoda Slavonije i Baranje, kroz empirijsko istraživanje provedeno na području Dalmacije.

**Ključne riječi:** autohtoni poljoprivredno-prehrambeni proizvodi, ruralni razvoj, slavonski kulen, baranjski kulen, slavonski med



BIOTEHNIČKE ZNANOSTI / BIOTECHNICAL SCIENCES

## REGIONAL RECOGNIZABILITY OF INDIGENOUS AGRICULTURAL AND FOOD PRODUCTS OF SLAVONIA AND BARANJA

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Indigenous or autochthonous products are those products that due to their quality and uniqueness compete with other products on the global market. They are competitive on the global market due to the uniqueness of their technological, nutritional and organoleptic features. Indigenous products are extremely important for sustainable rural development, the preservation of tradition and identity of a particular region. The region of Slavonia and Baranja is well known for its indigenous products such as Slavonian Kulen, Baranjski Kulen and Slavonian Honey. In addition, this region, in its autochthonous products, often, as a main ingredient, uses meat from autochthonous Slavonian black pigs - which are also protected. Since such products are the foundation for the future development of the Slavonia and Baranja rural areas as well as the entire agricultural activity, it is necessary to work on the regional recognizability of this part of the Republic of Croatia through indigenous products. Opportunity could be seen in connecting "green" and "blue" Croatia. The aim of the seminar paper, that was carried by empirical research in region of Dalmatia, was to determine whether there is recognition of Slavonia and Baranja's indigenous products.

**Keywords:** autochthonous food products; rural development; Slavonian Kulen; Baranjski Kulen, Slavonian Honey



## NITRATES DIRECTIVE AND THE INFLUENCE OF NITRATES ON THE ENVIRONMENT

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Today's attention is focused on the problem of environmental pollution and groundwater nitrates. In the areas of intensive agricultural production, the highest concentrations of nitrates are present in groundwater, and represent the greatest threat to their pollution. In Croatia, a limit value for the concentration of nitrate in groundwater is prescribed in the Regulations about safety of drinking 50 mg/L. Nitrates are mostly attributed to toxicity due to their light reduction in nitrite. Oral microflora reduces about 20% of nitrate to nitrites then entering the stomach and the small intestine where they are absorbed. Long-term consumption of high levels of nitrate was associated with the development of carcinogenic diseases. Approximately 20% of the input nitrate comes from water, while 80% comes from food. The proportion of nitrates in vegetables depends largely on the use of fertilizers in breeding, breeding conditions and processing. Nitrate is a stable and highly soluble ion with low deposition and adsorption potential. These features make it difficult to remove him for conventional water purification technology. Methods for removing nitrates from water should be harmless, efficient and simple so that the water at the end of the process complies with the Regulations on compliance parameters and water analysis methods for human consumption. Currently used methods for water purification is ion exchange, membrane processes, electrodialysis, phytoemediation, biological denitrification.

**Keywords:** nitrates, nitrate directive, agriculture, health



BIOTEHNIČKE ZNANOSTI / BIOTECHNICAL SCIENCES

## PRIMJENA INFRACRvene TERMOGRAFIJE U DETEKCIJI VODNOG STRESA BILJAKA

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Infracrvena termografija je beskontaktna metoda mjerenja i bilježenja temperature i njezine raspodjele na površinama objekata koje se bilježe infracrvenom kamerom. Nakon mjerenja ostaje trajan zapis o izmjerenim veličinama - termogram. Termografija i suvremeni termografski uređaji postigli su zavidnu brzinu razvoja i pružaju nove mogućnosti mjerenja temperature koja se mogu primjeniti u različitim područjima proizvodnje biljaka koja su povezana s promjenama temperature unutar ploda i krošnje. Upravo ta činjenica omogućuje primjenu infracrvene termografije u određivanju vodnog stresa u biljkama. U ovome radu provedeno je istraživanje na uzorcima presadnica industrijske rajčice (*Lycopersicon esculentum* Mill.) i paprike (*Capiscum annuum* L.). Mjerenja temperature su provedena termoparovima i infracrvenom termografskom kamerom. Analizirana je promjena temperature i indeksa vodnog stresa usjeva (CWSI) tijekom dana. Zaključeno je da je uz korištenje metode automatskog termografskog snimanja koja proizvodi termograme dovoljno visoke kvalitete, automatska obrada termograma za izračun CWSI pouzdano primjenjiva.

**Ključne riječi:** infracrvena termografija, navodnjavanje, vodni stres





BIOTEHNIČKE ZNANOSTI / BIOTECHNICAL SCIENCES

## APPLICATION OF INFRARED THERMOGRAPHY FOR DETECTION OF PLANT WATER STRESS

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Infrared thermography is a contactless method of measuring and recording temperature and its distribution on the surfaces of objects, detected by infrared camera. After the measurement, a permanent record of the measured quantities - thermogram remains. Thermography and modern thermographic devices have achieved an enviable developmental speed and provide new temperature measurement capabilities that can be applied in different plant production abstractions that are associated with changes in temperature within the fruit and the tree crown. This fact enables the use of infrared thermography in determining water stress in plants. Research was conducted on samples of tomato (*Lycopersicon esculentum* Mill.) and bell pepper (*Capsicum annuum* L.) seedlings. Temperature measurements were carried out using thermocouples and an infrared thermal imaging camera. An analysis of the change of temperature and crop water stress index (CWSI) during the day was conducted. It was concluded that if an automatic thermal imaging method which produced thermal images of sufficiently high quality is used, then the automatic method for the calculation of CWSI developed here is confidently applicable.

**Keywords:** infrared thermography, irrigation, water stress



BIOTEHNIČKE ZNANOSTI / BIOTECHNICAL SCIENCES

## EVALUATION OF VERMICOMPOSTED WASTE FROM GREEN PUBLIC AREA

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Vermicompost (lumbripost, biohumus) is an organic fertilizer produced by biodegradation of various organic substances, most commonly manure, using the digestive system of *Eisenia foetida*. Vermicomposting can be more environmentally friendly and cost-effective than conventional methods for waste disposal because organic waste by decomposition turns into a useful product. In this study was presented the evaluation of fertilization value and ecological suitability of vermicompost produced from residues of maintenance of green public area. The low conductivity of the vermicompost were determined as a very favorable property, but the vermicompost characteristics that indicate that the maturation process was not completed were slightly increased C/N ratio and  $\text{NH}_4\text{-N}/\text{NO}_3\text{-N}$  ratio (0.4) and respiration intensity (3.4 mg  $\text{CO}_2/\text{g}/\text{day}$ ). These values indicate that vermicompost has not reached the highest stability class and that the nitrification has not been completed. Nevertheless, the estimated fertilization value of vermicompost is moderate to high, with a moderate concentration of N and P. However, the environmental suitability of vermicompost is very high because the determined concentrations of heavy metals and toxic elements are very low, significantly lower than the maximum allowed concentrations, and vermicompost can be used without limitation as an organic fertilizer, as a component for substrate production, but also as a substrate for seedlings growth.

**Keywords:** fertilization value, heavy metals, environmental suitability, substrate



BIOTEHNIČKE ZNANOSTI / BIOTECHNICAL SCIENCES  
**EVALUATION OF SOIL SUITABILITY FOR  
ORGANIC AGRICULTURE**

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The agrochemical soil properties are very important for determining fertility and suitability of soil for conventional and organic agricultural production. The aim of this study was to evaluate the suitability of the analyzed soil of eastern Croatia for organic agricultural production based on agrochemical soil properties. In this study is an evaluation of the soil suitability on the example of arable land and orchard based on selected agrochemical soil properties: pH reaction, SOM and mineralization potential, macro and microelement availability and total heavy metal content. Most of the agrochemical properties of the soil were found to be very favorable, analyzed soils had a medium mineralization potential, slightly alkaline to slightly acidic pH, poorly available phosphorus, potassium, manganese and poor to medium available zinc. Basic soil properties (especially the availability of phosphorus and microelements) is possible to improve by regular application of organic fertilizers. It is convenient to use composts, green fertilizer and other organic fertilizers with increased phosphorus content. Very low concentration of almost all essential and toxic heavy metals, especially the most detrimental Hg, Cd and Pb are very significant favorable properties of analyzed soils showing high suitability for organic agricultural production.

**Keywords:** soil pH, mineralization, available nutrients in soil, heavy metals



BIOTEHNIČKE ZNANOSTI / BIOTECHNICAL SCIENCES

## VEGETABLE BY-PRODUCTS AS NEW AND CHEAP SOURCES OF FUNCTIONAL PROTEIN ISOLATES

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The cultivation and consumption of vegetable generated tons of by-products (stems and leaves) during the harvest every year. Stockpiling or dumping them cause environmental pollution due to their high organic matter and moisture contents. By-products of vegetable such as broccoli, cabbage, cauliflower, beetroot can be good source of leaf proteins. Hence the protein exploitation from this source could be a way to increase the value of this agricultural by-product. Therefore, this study was conducted to extract protein from broccoli, cabbage, cauliflower and beetroot leaves and investigate its functional properties for discovering its potential in the food industry.

The protein isolates were obtained after alkaline extraction (at pH 11) of chopped and squeezed leaves followed by isoelectric-precipitation of the proteins at pH 4. Protein contents were in the range of 53.5 - 72%. Gel electrophoresis indicated similar composition in all proteins with major subunits of the 40 kDa and 14 kDa polypeptides. Results showed that the extracted proteins had a good solubility in strong acidic and alkaline solutions. Minimum solubility was observed at pH 4, confirming the isoelectric point of most plant proteins. All proteins exhibited favourable emulsifying abilities, foaming, fat and water absorption capacities.

These results indicated that these proteins due to their good functional properties could be used as potential ingredient of functional-health-promoting foods and cosmetics products.

**Keywords:** vegetable by-products, green leaves protein isolates, functional properties



## UKLANJANJE ORGANSKIH TVARI IZ VODE PRIMJENOM AKTIVNIH UGLJENA NA BAZI LJUSKI LJEŠNJAKA I ORAHA

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Prehrambena industrija tijekom proizvodnih procesa često stvara značajne količine otpada, a posljednjih nekoliko godina sve je veće zanimanje za iznalaženje novih načina njegove ponovne upotrebe. Jedan od njih je i proizvodnja jeftinih adsorbensa tzv. „low-cost“ materijala koji se mogu proizvesti od otpada nastalog u procesu prerade voća i povrća. Navedeni adsorbensi najčešće imaju primjenu u procesima prerade vode za piće ili procesima pročišćavanja otpadnih voda. Do danas su tako proizvedene različite vrste aktivnih ugljena dobivene pirolizom ljuski kokosa, šećerne trske, ljuskica riže, kore naranče i sličnih materijala koje karakterizira visoki udio ugljika, a mnogobrojne studije su ispitale njihova adsorpcijska svojstva i učinkovitost uklanjanja različitih tvari koje narušavaju kakvoću vode.

Prirodne organske tvari (NOM) čini kompleksna smjesa organskih tvari u kojoj prevladavaju huminske tvari, a često se u podzemnim i površinskim vodama pojavljuju u povišenim koncentracijama. Pojava povišenih koncentracija NOM u vodi uzrokuje pojavu žućkastog obojenja vode, a ukoliko se takva voda dezinficira klorom, mogu nastati kancerogeni trihalometani. U ovom radu ispitana je učinkovitost uklanjanja prirodnih organskih tvari iz vode primjenom aktivnih ugljena dobivenih pirolizom ljuski lješnjaka i oraha. Učinkovitost uklanjanja ispitana je u ovisnosti o masi adsorbensa, pH vrijednosti vode, vremenu kontakta te početnoj koncentraciji NOM-a u vodi.

**Ključne riječi:** prirodne organske tvari, prerada vode, adsorpcija, „low-cost“ adsorbensi



BIOTEHNIČKE ZNANOSTI / BIOTECHNICAL SCIENCES

## REMOVAL OF NATURAL ORGANIC MATTER FROM WATER ON NUTSHELL-BASED ACTIVATED CARBONS

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During the food production process, the industry generates significant amounts of by-product and during the last few years, there is growing interest among the scientist for its reuse. Among the other, one of the possibility is production of so-called "low-cost" adsorbents. Those adsorbents are mostly produced from by-product material generated during the fruit and vegetables processing, and used in drinking water or wastewater treatment processes. Various types of activated carbons have been produced by pyrolysis. Mostly of them are based on coconut shell, sugar cane, rice scraps, orange peels or similar materials that are characterized by a high carbon content. Their adsorption properties and the effectiveness in contaminants removing from water have been tested and reported via many research studies.

Natural organic matter (NOM) is a broad term for the complex mixture of thousands of organic compounds that can be present in groundwaters or surface waters. The appearance of elevated concentrations of NOM in water causes yellowish coloration of water, and if such water is disinfected with chlorine, harmful trihalomethanes (THMs) can be produced.

This paper examines the efficiency of NOM removal from water using activated carbon produced by nutshells and walnuts pyrolysis. The removal efficiency of obtained activated carbons was tested as a function of the mass dosage, pH, contact time, and initial concentration of NOM in water.

**Keywords:** natural organic matter, water treatment, adsorption, „low-cost” adsorbents



BIOTEHNIČKE ZNANOSTI / BIOTECHNICAL SCIENCES

## BREEDING OF THE BLACK SLAVONIAN PIG

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Ecological agriculture is a system of sustainable agriculture management that includes animal breeding and plant cultivation, raw material and food production, and is designed to protect soil, air, animal and plant genetic resources, that it is not harmful to the environment and it is economically viable. The Black Slavonian pig, which was created in the 19th century on the estate of Pfeffera on Orlovnjak near Osijek, was created with the aim of being early maturing, more fertile and with a higher yield of meat, and also had to retain for the properties of resistance and adaptability to keeping outdoors. She was a cross between the mangulica and the Bekshire pig breeds, and then crossed over with the Poland China. It is grown extensively in free-standing environments, where the animal lives in pastures or forests. It is fed with grains, pumpkins, clover, maize ect. Recently, for the specificity of meat, the pigs are fed with oak nut. This way of breeding pigs, in harmony with the nature and needs of the animals, results in high-quality raw material being processed into high-quality cured meat products such as Slavonian kulen, pork rind and sausage

**Keywords:** ecological agriculture, Black Slavonian pigs, products



BIOTEHNIČKE ZNANOSTI / BIOTECHNICAL SCIENCES

## HOUSEPLANTS IMPACT ON AIR QUALITY AND OVERALL WELL-BEING

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Quality of air is an important factor for determining a level of well-being. Besides relative humidity (%RH) and temperature, volatile organic compounds (VOC) have major influence on air quality. The precise mechanisms of plant's ability to remove or reduce VOC's in indoor air are still not defined, and current knowledge is based on the results made in controlled conditions. This paper is based on the need for creating a system that will improve the air quality and overall well-being of the user, but not harm the environment. In order to investigate the influence of ornamental houseplants on air quality and overall well-being of the user, we have placed 8 *Sansevieria trifasciata* var. 'Laurentii' in 12 m<sup>2</sup> bedroom which is used by elderly woman with various health conditions. Air quality parameters, %RH, temperature and VOC were measured with Extech SD800 and designed device based on Arduino Uno. Overall well-being of the user was examined by a questionnaire. Measured results in this paper show that under uncontrolled environments it is still not possible to find the unique botanical system for air purification, although there are certain evidence that plants have positive impact on air quality, which subjective opinion of the user confirms.

**Keywords:** *Sansevieria trifasciata*, relative humidity, VOC, temperature, ornamental plants





## ZAŠTO ME NEKRETANJE RADUJE?

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U 18. stoljeću dr. Tisso je rekao: „Kretanje i fizička aktivnost mogu zamijeniti mnoge lijekove, ali nijedan lijek ne može zamijeniti redovnu fizičku aktivnost.“. Iako znamo da je previše sjedenja loše, koliko nas poduzme nešto kako bismo smanjili sate sjedenja? Danas najviše ljudi u svijetu umire od kardiovaskularnih bolesti, a posljedica su nekretanja i loših prehrambenih navika. Ako sjedimo više od 6 sati, a krećemo se manje od 2 sata nakon posla, škole ili fakulteta, bez obzira jesmo li vježbali ta dva sata, pripadamo rizičnoj skupini. Dakle, glavni problem je broj sati provedenih u aktivnosti, a ne intenzitet treninga. No, u ovom ćemo radu promatrati populaciju studenata. Provest ćemo istraživanje koje će biti usmjereno na razloge nekretanja, odnosno što studente sprječava u fizičkoj aktivnosti. Jedan je student rekao: „Nakon što dnevno provedem sate slušajući predavanja i doživim psihički umor, osjećam se kao da sam trčao 8 sati. Jedino kretanje za koje sam tada sposoban je dolazak do kreveta.“. Potrebno je pronaći nove strategije koje će pokrenuti mlade ljude i oblikovati bolje iduće generacije. „Promjena stava prema tjelesnom vježbanju u novijim uvjetima života koji su zahvaćeni masovnom pojavom hipokinezije, mogu drastično promijeniti rezultate zdravstvenoga statusa pojedinca.“

**Ključne riječi:** fizička aktivnost, nekretanje, sjedilački način života



DRUŠTVENE ZNANOSTI / SOCIAL SCIENCES

## WHY INACTIVITY MAKES ME HAPPY?

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In the 18th century dr. Tisso said: "Movement and physical activity can replace many drugs, but no drug can replace regular physical activity.". Even though we know that too much sitting is bad, how many of us do something to reduce the time of sitting? Nowadays, most people around the world die of cardiovascular diseases, which are result of inactivity and bad eating habits. If we sit longer than 6 hours and are active less than 2 hours after work, school, or college, regardless of whether we work out for these 2 hours, we belong to the risk group. Thus, the main problem is the amount of time spent on activities, not the intensity of training. However, in this paper we will observe the student population. We will conduct a research that will be focused on the causes of inactivity, that is, what prevents the students from being physically active. One student said: "After spending hours listening to various lectures and experiencing mental fatigue on a daily basis, I feel like I have been running for 8 hours. The only movement I could at that time was to get to the bed.". There is a need to find new strategies that will trigger new people and shape the next generation. "Changing the attitude towards physical exercise in recent life conditions affected by the massive phenomena of hypokineses can drastically alter the health outcomes of an individual."

**Keywords:** physical activity, inactivity, sitting



DRUŠTVENE ZNANOSTI / SOCIAL SCIENCES

## UTJECAJ KONCEPTA PAMETNIH GRADOVA NA GOSPODARSTVO – PRIMJER GRADA ŠIBENIKA

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Pametni gradovi svojim inovativnim rješenjima omogućavaju kvalitetniji život svojim stanovnicima. Koristeći svoje resurse pametni gradovi postaju poželjna mjesta za život i poželjne turističke destinacije. Brojne su mogućnosti kako grad može postati „pametan“: implementacijom novih i zelenih tehnologija, učinkovitim upravljanjem gradskom infrastrukturom, kreativnošću u idejama, upravljanjem gradom koje koristi inovaciju, povezivanje lokalnog i globalnog, inovacijama u poduzetništvu, kulturnim sadržajima, socijalnom kohezijom itd. Učinkovito upravljanje na razini gradske uprave predznak je konkurentne prednosti grada. Programom EU Strategija Europa 2020 naglašava se pametan i održiv rast, a u sklopu strategije osmišljeni su operativni programi pomoću kojih se mogu financirati unaprjeđenje lokalne uprave, gospodarski rast i konkurentnost. Grad Šibenik u svojoj prošlosti nije bio poznat kao turističko odredište, ali koristeći pametna rješenja i svoje resurse je postao poželjna turistička destinacija. Aplikirajući na projekte financirane iz fondova EU-a u koje su implicirana pametna rješenja, grad Šibenik se pretvorio u pametni grad.

U radu je prikazan teorijski pristup pojmu pametnog grada, istraženi su ostvareni projekti i projekti u tijeku koji sadrže pametna rješenja te njihovi učinci na gospodarstvo grada Šibenika koji su posebice vidljivi u turizmu.

**Ključne riječi:** pametni gradovi, Strategija Europa 2020, grad Šibenik, projekti, gospodarstvo



## THE INFLUENCE OF THE CONCEPT OF SMART CITIES ON ECONOMY - CASE STUDY CITY OF ŠIBENIK

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Smart cities with their innovative solutions enable a better quality of life for their citizens. When using their resources, smart cities have become desirable places to live and also desirable tourist destinations. There are plentiful of possibilities for a city to become a "smart" city: in the course of implementing new and green technologies, more efficient management of a city infrastructure, by influx of creative ideas, managing the innovations introduced to the city, establishment of local and global connectivity, by presenting an entrepreneurial innovations, cultural contents, social cohesion, etc. Efficient management at the level of the city administration is a sign of the competitive advantages of the observed city. The EU Strategy for Europe 2020 emphasizes on smart and sustainable growth, and within the framework of the strategy, operational programs are designed to help improve financial promotion and better efficiency of the local government, economic growth and competitiveness. In the past, the City of Šibenik was not recognised as a tourist destination, but once it started using smart solutions and its own resources, Šibenik has become a desirable tourist destination. By applying the projects that were financed from the EU funds that involved smart solutions; the City of Šibenik has turned into a smart city.

In this paper is presented a theoretical approach to the smart city concept of solutions, the realised projects were explored and also the current projects that encompassed the smart solutions and their impact on the City of Šibenik economy, what is predominantly visible in the tourist sector.

**Keywords:** smart cities, The EU Strategy for Europe 2020, the city of Šibenik, projects, economy



DRUŠTVENE ZNANOSTI / *SOCIAL SCIENCES*

## USPOREDNA ANALIZA PROIZVODNJE SUNCOKRETA, SOJE I ŠEĆERNE REPE NA TERITORIJI AUTONOMNE POKRAJINE VOJVODINE

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U radu su prikazani osnovni ekonomski i proizvodni rezultati važnijih industrijskih usjeva na području Autonomne pokrajine Vojvodine (APV). Cilj je rada sagledati osnovne pokazatelje proizvodnje suncokreta, soje i šećerne repe, kao i prosječan nivo isplativosti spomenutih proizvodnji na poljoprivrednim gospodarstvima AP Vojvodine u desetogodišnjem periodu (2008. - 2017). Prosječna proizvodnja suncokreta je 430.750 t, s tendencijom rasta od 1,79 %; soje 407.858 t, s tendencijom rasta od 3,06 %; šećerne repe 2.763.276 t, i ima tendenciju rasta od 0,31 %. Najveća marža pokrića ostvarena je u proizvodnji šećerne repe (148.987 RSD/ha), a najveći koeficijent ekonomičnosti (2,69) i stopa profitabilnosti (62,8 %) ostvareni su u proizvodnji soje. Analizom ovih indikatora može se ocijeniti koji je usjev najisplativiji za proizvodnju i preporučiti ga za što veću zastupljenost na gospodarstvu.

**Ključne riječi:** proizvodnja, ekonomičnost, rentabilnost



*DRUŠTVENE ZNANOSTI / SOCIAL SCIENCES*

## **ECONOMIC EFFECTS OF INDUSTRIAL PLANTS PRODUCTION IN VOJVODINA**

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The paper discusses the basic economic and production results of important industrial crops on agricultural farms in Vojvodina. The aim of the research is to evaluate the most important parameters of cost-effectiveness of the mentioned production, and propose measures to improve the existing situation on farms in Vojvodina in ten-year period (2008-2017). Average sunflower production is 430.750 t, with a tendency of growth rate 1.79% per year, soybean 407.858 t, with a tendency of growth 3.06% per year, sugar beet 2.763.276 t, with a tendency of growth 0.31% per year. Sugar beet production gives the largest coverage margin (148.987 RSD/ha). The highest coefficient of economy (2.69) and profitability rate (62.8%) are reached in soybean production. Since these are very profitable productions, with stable and growing demand, we can expect further growth their representation in sowing structure.

**Keywords:** production, coefficient of economy, profitability



## POTREBNI SMO ZEMLJI KOLIKO I ONA NAMA

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Čovječanstvo u 21. stoljeću nalazi se u tehnološki naprednom društvu, no shodno napretku, raste zagađenost zemlje čemu pridonosi i globalizacija. Stoga, prva i osnovna čovjekova zadaća je zaštita i briga o zemlji.

Tehnologijom se doskočilo nebrojenim nevoljama, posebice na području medicine, inženjerstva i telekomunikacija. Briga o zemlji nikad nije bila „lakša“ upravo zbog svih tih pomoći, ali istovremeno i zahtjevnija.

Posterskim priopćenjem želja je bila prikazati Zemlju u terminalnoj fazi na bolničkom krevetu, ali i nadu te skrb koju nam može pružiti znanost za ljepši i bolji svijet. Ova slika, dakle, ima namjeru izraziti zabrinutost i iskrenu brigu za ono što se danas događa našem planetu, zato je cijelo čovječanstvo pozvano na radikalnu promjenu svijesti u načinu potrošnje, proizvodnje i iskorištavanja Zemljinih dobara.

Upravo enciklika pape Franje „Laudato Si’“ svjedoči nam kako su „znanost i tehnologija divni plod ljudskog stvaralaštva koje je Božji dar“. Stoga, na tragu te misli moramo si posvijestiti kako smo odgovorni pred Zemljom i kao bića urešena razumom moramo poštivati zakone i ravnotežu svega stvorenoga te koristiti znanost i tehnologiju za opće dobro svih nas i svakog sljedećeg naraštaja.

**Ključne riječi:** znanost, tehnologija, zaštita, skrb, čovjek



HUMANISTIČKE ZNANOSTI / HUMANITIES

## THE EARTH NEEDS US AS MUCH AS WE NEED HER

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The Humanity of the 21st century is situated in a technologically advanced society. In spite of this progress, there is more pollution on the Earth because of globalisation. Therefore, the first and the elementary duty of a human being is the protection and care of the Earth. Thanks to technology, many problems have been resolved, especially in the fields of medicine, engineering and communications. The care for Earth never was easier but at the same time more demanding.

Our intention is to describe the Earth in a terminal stage on the sick-bed, but also a hope and a care that comes from the science towards a better world. The intention of this picture is to show concern and honest care for everything to do with our planet Earth. Therefore, all human kind is invited to do radical change of conscience in spending, production and exploitation of the possessions.

The Papal encyclical "Laudato si'" of Pope Francis proves that "science and technology are wonderful products of god-given human creativity". Consequently, in the pursuit of this we must enlighten that we are responsible before Earth and, as a human being with intellect, we must respect the laws and balance of everything created. In addition, we must use science and technology for the common good of us all and for the next generation to come.

**Keywords:** science, technology, protection, care, human being





HUMANISTIČKE ZNANOSTI / HUMANITIES

## KAKAV UTJECAJ IMAJU GENETIČKI MODIFICIRANI USJEVI NA OKOLIŠ?

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Kakav utjecaj imaju genetički modificirani (GM) usjevi na okoliš? Odgovor na ovo pitanje dobit ćemo različito, ovisno o tome kome ga postavimo. Za pristaše GM-a odgovor je da su GM usjevi neophodni za prehranu svjetskog stanovništva i ključni u rješavanju okolišnih problema. Potpuno suprotan stav imaju kritičari GM usjeva, koji upozoravaju na pogubne posljedice od prekomjerne upotrebe pesticida, preko deforestacije do pojave superkorova i super štetnika. Tragom istraživanja u radu će biti pojašnjeno što je ekološka poljoprivreda, a što intenzivna, te kako biotehnološke korporacije pomoću patentiranog genetički modificiranog sjemena i prapadajućih herbicida destruktivno djeluju na okoliš, dovode do biološke i kulturne entropijom, te krše ljudskih prava u siromašnim zemljama.

**Ključne riječi:** genetički modificirani usjevi, ekološka poljoprivreda, bioraznolikost



HUMANISTIČKE ZNANOSTI / HUMANITIES

## WHAT IS THE IMPACT OF GENETICALLY MODIFIED CROPS ON THE ENVIRONMENT?

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The answer to the question on what kind of impact of genetically modified (GM) crops there is on the environment will vary depending on who we address it to. The answer by GM supporters is that GM crops are essential for the world's nutrition and key factor in addressing environmental problems. A completely opposite attitude is taken by GM crop critics who are warning of the devastating consequences of excessive use of pesticides, from deforestation to the emergence of superweeds and superpests. Through this research, a clarification will be given about what is an ecological agriculture and what is an intense farming, and how the biotechnological corporations using patented genetically modified seeds and associated herbicides have a destructive effect on the environment, lead to biological and cultural entropy and cause human rights violations in poor countries.

**Keywords:** genetically modified crops, ecological agriculture, biodiversity



INTERDISCIPLINARNO / INTERDISCIPLINARY  
**PERMACULTURE ZONE PLANNING BY THE  
TRIANGULAR METHOD**

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Permaculture is a multifaceted, integrated and ecologically harmonious method of designing human centered landscapes. Ideal Permaculture system serves human or community needs in efficient and sustainable manner. One of the key elements in planning the Permaculture systems is Zone planning. Zone planning is a method where the locations of system elements are determined by two factors: the number of times human needs to visit the plant, animal or the structure, which corresponds to using the element, and the number of times the plant, animal or structure needs to be visited by human, which corresponds to servicing the element. These two criteria are fundamentally the same to criteria used in production system planning. In Permaculture the criteria are linked to interactions between human and environment elements while in production systems that is number of transports between system elements (machines or departments). The goal of the technical production systems planning is also the same, and it is determination of the most favorable spatial arrangement of the system elements. The goal of this paper is to present the possible application of technical production planning method for Permaculture Zone planning. The design is based on the material flow according to the minimum transport distance criterion. The technical method whose application will be presented in Permaculture Zone planning is Bloch-Schmigalla triangular method.

**Keywords:** Permaculture, Zone planning, production planning, layout, Triangular method



INTERDISCIPLINARNO / INTERDISCIPLINARY

## THE ATTITUDES AND MOTIVATION OF STUDENTS OF THE UNIVERSITY OF OSIJEK CONCERNING FOODSELECTION AND EATING HABITS

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Choosing food is an everyday decision which can be affected by many different variables that include sensory, nutritional and socioeconomic aspects. The aim of this study was to investigate the influence of sex, BMI, opinions about health, nutrition, emotions and price on food selection in the student population. This on-line, anonymous questionnaire study was done during April 2018 by the use of specially designed questionnaire which contained Food Choice Questionnaire and questions regarding the demographic data.

Results: There were 18.1% (41/227) males and 81.9% (186) females. Their income ranged from 1-2000kn 10.1% (23/227), 2001-5000kn 23.3% (53/227), 5001-8000kn 23.8% (54/227), 8001-11000kn 21.1% (48/227), 11001-14000 10.1% (23), more than 14001kn 11.5% (26/227).

Regarding their BMI 4.4% (10/227) were underweight, 72.2% (164/227) normal weight, 18.5% (42/227) overweight, 4.8% (11/227) obese, BMI median was 22.04, minimum 16.73, maximum 36.05. The study has shown that females choose their food based on natural content ( $p=0.028$ ), price ( $p=0.011$ ), weight control ( $p=0.031$ ). The study also revealed that students with higher BMI tend to choose food which affects their weight control ( $p=0.032$ )

Conclusion: Food choice in student population is affected mainly by weight control, price and natural content of the food.

**Keywords:** university students, eating habit, food selection, questionnaire, Croatia



INTERDISCIPLINARNO / INTERDISCIPLINARY  
**OD OTPADNOG MATERIJALA DO PRAKTIČNE  
PRIMJENE: SLUČAJ KITOZANA**

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Ribarska industrija, osobito rakovi, proizvode mnogo otpadnoga materijala. Nakon što se meso iz rakova izolira oko 50 - 60 % originalnog materijala se odbacuje. Upravo zbog toga, danas se pojavio novi trend koji pokušava koristiti takav otpadni materijal. Dio otpadnoga materijala koristi se radi dobivanja funkcionalnih materijala za farmaceutsku, kozmetičku i prehrambenu industriju. Jedan od načina zbrinjavanja otpada jest ekstrakcija hitina iz oklopa rakova i daljnja modifikacija do kitozana. Hitin se iz oklopa rakova ekstrahira na sljedeći način: nakon mljevenja, slijedi demineralizacija za razrijeđenom otopinom HCl, a zatim deproteinizacija s razrijeđenom otopinom NaOH. Nadalje, reakcijom s koncentriranom NaOH uz povišenu temperaturu izvodi se reakcija deacetilacije i dobiva se kitozan. Kitozan se uvelike primjenjuje u posljednjih nekoliko godina u mnogim područjima poput ekologije, biomedicine, polimerne kemije, ispostava lijekova, i sl. Fokusirajući se na područje medicine, dokazano je da kitozan posjeduje aktivna svojstva, poput primjerice antibakterijskih svojstava. Danas se kitozan primjenjuje u farmaceutskoj industriji za zacjeljivanje rana (komercijalno dostupan) te kao razne varijacijske formulacije lijekova koji se teško primjenjuju oralno budući da kitozan pruža prednost odgode otpuštanja lijeka i zaštitu lijeka od razgradnje prilikom prolaska kroz crijeva. Stoga je važno uzeti kitozan kao primjer kako je otpadni materijal iz ribarske industrije pronašao značajnu industrijsku primjenu.

**Ključne riječi:** otpad, kitozan, hitin, riblja industrija, biomedicina



INTERDISCIPLINARNO / INTERDISCIPLINARY

## FROM WASTE MATERIAL TO PRACTICAL APPLICATION: THE CASE OF CHITOSAN

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The fish industry, in particular crabs, produces a lot of material waste. In fact, after the meat is extracted, around 50-60% of the original material is wasted. There is a new trend that tries to use the waste material. Some waste material is used as fertilizers or further elaborated to get more functional materials.

One way to deal with this is to extract chitin from crabs waste and further modify it to chitosan. Chitin is extracted from crabs in the following way: first the material is milled, followed by demineralization with diluted HCl. Afterwards the deproteinisation process takes place with diluted NaOH. Furthermore, the reaction with concentrated NaOH by higher temperatures leads to the deacetylation process thus leading to chitosan.

Chitosan is being extensively used in the last few years in many fields such as ecology, biomedicine, polymer chemistry, drug delivery, etc. Focusing on the medical field, chitosan has been proven to have some active properties per se, such as antibacterial properties. Nowadays it is used in the pharmaceutical industry/biomedicine in wound healing (already commercially available) and in various formulations for drugs that are difficult to administer orally as it offers the advantage of sustained drug release and protection of the drug from degradation as it crosses the gut.

Therefore it is important to take chitosan as an example of how a material that would be wasted from the fishing industry can find its way to important uses.

**Keywords:** waste material, chitin, chitosan, fishery, biomedicine



INTERDISCIPLINARNO / INTERDISCIPLINARY  
**ZELENA KOMUNIKACIJA - KOMUNICIRAMO STAZAMA PRIRODE**

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„Stabla nose nebo. Ako šume nestanu, nebeski će se krov nad našim planetom urušiti. Tada će priroda i ljudi zajedno poginuti.“ Drevna je ovo indijska poslovice koja nas uvodi u priču o projektu Zelene knjižnice Fakulteta za odgojne i obrazovne znanosti Osijek.

Zelena knjižnica je projekt u organizaciji Društva bibliotekara Istre koji je pokrenut 2011. godine. Projektu su se uz knjižnice Istarske županije, kasnije pridružile i knjižnice ostalih županija, te Hrvatsko knjižničarsko društvo. Knjižnica Fakulteta za odgojne i obrazovne znanosti uključena je u projekt od travnja 2017. godine. Kroz ekološke radionice, aktivnosti i priče, djelatnice knjižnice u suradnji sa studentima sveučilišnog preddiplomskog studija Ranoga i predškolskog odgoja i obrazovanja, sveučilišnog diplomskog studija Ranoga i predškolskog odgoja i obrazovanja, integriranoga preddiplomskoga i diplomskog sveučilišnog Učiteljskog studija, te dječjim vrtićima i školama grada Osijeka podižu svijest o očuvanju okoliša te obrazuju mlađe naraštaje o konceptu održivoga razvoja.

Za poticanje i razumijevanje ekološke pismenosti treba iskoristiti svaku povoljnu priliku koja se ukaže. Izazovi koje pred nas stavljaju važni međunarodni i nacionalni datumi o okolišu, vode k jačanju i osnaživanju programa odgoja i obrazovanja za održivi razvoj te osjetljivost djece na ekološke teme.

**Ključne riječi:** zelena knjižnica, eko radionice, djeca, odgoj i obrazovanje, ekologija



INTERDISCIPLINARNO / INTERDISCIPLINARY  
**GREEN COMMUNICATION - WE COMMUNICATE VIA  
THE PATHS OF NATURE**

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"The trees carry the sky. If forests disappear, the heavenly roof of our planet will collapse. This is when nature and people will die together." This is an ancient Indian proverb that introduces us to the story of the Green Library project of the Faculty of Education in Osijek.

The Green Library is a project organized by the Society of Librarians of Istria, which was launched in 2011. In addition to the libraries of the Istria county, the libraries of other counties and the Croatian Library Association were later included in the Project too. The Faculty of Education's library was included in April 2017. Through ecological workshops, activities and stories, in cooperation with the students of both undergraduate and graduate university studies of early and preschool education, the students of integrated undergraduate and graduate university class teacher studies as well as the kindergartens and schools of Osijek, the librarians raise awareness on environment protection and educate younger generations on the concept of sustainable development.

Every single beneficial opportunity should be used to encourage and understand ecological literacy. Challenges that are placed before us by important international and national environmental dates, lead us towards better capacitated and strengthened education programmes for sustainable development and raised sensibility of children to ecological issues.

**Keywords:** green library, eco-workshops, children, education and ecology





INTERDISCIPLINARNO / INTERDISCIPLINARY

## GREEN JOBS - POTENTIALS AND OPPORTUNITIES IN THE SOUTH-EAST REGION OF THE REPUBLIC OF MACEDONIA

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A green job is any job or self-employment that genuinely contributes to a more sustainable world. A green job can be with business, nonprofit organizations, government or education. Small business, self-employment and entrepreneurship is very much a part of the new green economy. Some green jobs require specific 'green' skills or education, such as a solar engineer, an environmental educator, or an organic gardener. Many people are both concerned and motivated about the environment and would love to focus their energies around green work full-time. Not every job or company that calls itself green, actually is genuinely green or sustainable. The subject of research in this paper will be focused on analyzing the effects of the possibility of creating a green jobs in the South-East Region of the Republic of Macedonia. The theoretical part of the paper will give an overview of the basic notions related to green jobs and an explanation of the most common possible reasons for createing a green jobs. The practical part of the paper will focus on conducting research to understand if the population in the South-East Region of the Republic of Macedonia desiare to work on this grean positoins.

**Keywords:** green jobs, entrepreneurship, environment



INTERDISCIPLINARNO / INTERDISCIPLINARY

## ACHIEVING SUSTAINABLE DEVELOPMENT IN SPECIAL NATURE RESERVE KOVILJ-PETROVARADIN WETLAND

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Sustainable development can be considered as an essential part of the preservation and conservation of natural environment and resources. Furthermore, the importance of this concept is emphasized when dealing with protected nature areas with the unique values, such as Kovilj-Petrovaradin wetland (Northern Serbia). Thus, ecotourism and sustainable tourism should be the basis for successful development of protected swamp and marsh areas. The problem of preserving the nature can be observed from a point of tourism progress and its influence on it. Even though, ecotourism is a good concept of nature preservation and a strong starting point, there are many obstacles to overcome in the process. Therefore, the purpose of this study is determination of current situation and future possibilities of ecotourism improvement in the given area. Kovilj-Petrovaradin wetland is located in southeastern part of Bačka Region (Northern Serbia), encompassing area of approximately 59 km<sup>2</sup>. The best progress in the development of ecotourism concept of the Kovilj-Petrovaradin wetland is made in Sremski Karlovci municipality.

**Keywords:** sustainable development; Kovilj-Petrovaradin wetland, ecotourism



## DUŠA DRAVE

Saša Došen

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Kratki film (17'). Prema priči Lorne Kalazić.

Kolektivna realizacija: Lorna Kalazić, Rahela Šajinović, Tončica Knez, Davor Molnar, Neda Ilijević, Danira Matošić Matičević.

Mentori: Saša Došen, Davor Šarić, Hrvoje Seršić, Ivana Živković.

*Duša Drave* je kratki film, autorski rad studenata diplomskog sveučilišnog studija Oblikovanje i tehnologija lutke i diplomskog studija Scenografija pri Umjetničkoj akademiji u Osijeku. Realiziran u formi teatra sjena, film je poetska, estetski sofisticirana i vješto izvedena priča o Čovjeku i njegovom neodgovornom odnosu prema prirodi. Uzimanje prirode i svih elemenata zdravo za gotovo, gubitak ikakvog poštovanja za jedno kojega smo svi tek maleni dio, poprimilo je globalne razmjere. Ovo je upozorenje o onome što bi se moglo dogoditi ukoliko nastavimo zagađivati, zapostavljati i zlostavljati svoju planetu. Osobni stav studenata prema sveopćem zagađenju utjelovljuje lik djevojčice Drave koja je jedina u doticaju s primarnim elementom vode kojega osjeća i čuje poput unutarnjega glasa koji je nagoni u potragu za velikom vodom koja je, odavna, zatrpana smećem koje smo mi sami nagomilali tijekom vremena. Jedino čistoća Dravinog srca, njezina ustrajnost i hrabrost mogu osloboditi veliku vodu ispod naslaga smeća te joj pomoći da iznova poteče i pročistiti Zemlju.



## THE SPIRIT OF DRAVA

Saša Došen

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A short film (17'). According to the story written by Lorna Kalazić.  
Collective realization: Lorna Kalazić,, Rahela Šajinović, Tončica Knez, Davor Molnar, Neda Ilijević, Danira Matošić Matičević.  
Mentors: Saša Došen, Davor Šarić, Hrvoje Seršić, Ivana Živković.

*The Spirit of Drava* is a short film realized by the MA students of Puppetry design and technology and Set design at the Academy of Arts in Osijek. Realized in the form of shadow theatre, the film is a poetic, aesthetically sophisticated and skillfully executed story of Man and his irresponsible relationship to the Nature. Taking the Nature and all the Elements for granted, losing all the respect for the One that we are all just a tiny part of has taken on a global scale. This is a warning of what might happen should we continue to pollute, neglect and abuse our Planet. Students' personal attitude towards the overall pollution is embodied in the character of a small girl named Drava who is the only one still in touch with the primary element of Water that she feels and hears as an inner voice that drives her on the quest in search of the Great Water that has been, long ago, buried by all the trash that we ourselves have piled up over the time. Only the pureness of Drava's heart, her perseverance and courage, can release the Great Water from underneath the piled up trash, and help it to gush anew and purify the Earth.

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