

# 56. hrvatski i 16. međunarodni simpozij agronoma: zbornik sažetaka

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## 09

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**Agroekologija,  
ekološka poljoprivreda  
i zaštita okoliša**

**01**

**Agroecology,  
Organic Agriculture  
and Environment  
Protection**



## Distribution of TEs in urban soils: Zagreb city case study

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### Summary

In Croatia soil monitoring is a legal obligation comprised of monitoring not just the soil, but as well other environmental media, primarily water and air. However, monitoring of urban soils' quality is more complex because of the diverse soil usage. In Zagreb, soil monitoring is associated with sustainable drinking water supply, health aspects of direct intake, proximity to landfills or sources of industrial pollution, food production in urban areas, recreational and sports areas, and aesthetic effects in city parks due to contamination or salinization of the soil along roads. Thus, urban soils' quality monitoring programme in Zagreb commenced in 2015. Within the programme 150 soil samples were collected throughout the city along pre-determined transects, 36 soil samples from 3 localities located near landfills or sources of industrial pollution, and 20 soil samples at 2 localities near high frequency roads. Main chemical soil properties, trace elements, PAH and PCB were determined. The values obtained were compared with available data from Croatian government regulation on the protection of the agricultural land from pollution, as with Central Croatia soil data, soil worldwide and average continental crust composition. Furthermore, soil quality was assessed by applying statistics and geostatistics. TEs and PAH deviate from baseline concentrations, while distribution of the trace metal concentrations interpreted as anthropogenically polluted and/or naturally enriched soil.

**Key words:** urban soils, monitoring, TEs, spatial heterogeneity, anthropogenic and natural factors

## Urban gardening: managing soil, water and vegetable crops quality

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### Summary

Cities throughout Croatia are turning to urban gardening thereby providing low-cost agri-products, social interactions and healthier lifestyles. The City of Zagreb started the Urban Gardens project in 2013, and today it has a total of 13 urban gardens, all included in urban soils quality monitoring programme aiming to prevent harmful effect of potentially toxic elements in the soils of urban gardens. Therefore, as part of the latter project, the quality of soil (pH, EC, P<sub>2</sub>O<sub>5</sub>, K<sub>2</sub>O, C<sub>org</sub>, Cd, Cr, Cu, Hg, Ni, Pb, Zn, PAHs and PCBs), irrigation water (pH, EC, NH<sub>4</sub>-N, NO<sub>3</sub>-N, NO<sub>2</sub>-N, PO<sub>4</sub>-P, Cl<sup>-</sup>); vegetable crops (dry matter, Ca, Fe, K, Mg, Na, P and S) is being tested. The monitoring sites were spatially referenced using GPS and the results were stored in different GIS layers. The results were examined applying uni- and multivariate statistical analyses. Large differences of soil quality and fertility indicators were found between, but also within each urban garden. Such variations of soil quality are result of combination of inherent soil state and recent agricultural practices. Despite the wide concentration range of some soil TE and PAH concentrations, they do not exceed maximal permissible concentrations as defined by the Croatian government regulation. Furthermore, results of water quality analysis showed that there is no limitation to use groundwater for irrigation. Also, macro- and micronutrient concentrations determined in vegetables are within the recommended ranges for healthy plants.

**Key words:** urban gardens, monitoring, quality, soil, water, vegetable crops

## Utjecaj agroklimatskih čimbenika na stupanj razvoja CO<sub>2</sub> iz tla tijekom uzgoja soje

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### Sažetak

U kopnenim ekosustavima, tla mogu djelovati kao ponori ili izvori ugljika, ovisno o načinu gospodarenja i klimatskim uvjetima. Disanje tla predstavlja jedan od glavnih izvora ugljikovog dioksida (CO<sub>2</sub>). Stupanj razvoja CO<sub>2</sub> iz tla ovisi o mnogim čimbenicima, a jedan od njih su agroklimatski elementi. Da bi se utvrdio utjecaj temperature i vlage tla na stupanj razvoja CO<sub>2</sub> iz tla, praćeno je disanje tla odnosno emisija C-CO<sub>2</sub> iz tla u kontinentalnom dijelu Hrvatske u blizini grada Zagreba tijekom 2019. godine. Emisija C-CO<sub>2</sub> iz tla mjerena je metodom zatvorenih statičkih komora u vegetaciji soje (*Glycine max* L.). Disanje tla povećavalo se s razvojem usjeva, i bilo je najviše u srpnju a najmanje u listopadu prije žetve soje. Disanje tla kretalo se u rasponu od 4,5-31,2 kg ha<sup>-1</sup> dan<sup>-1</sup>, s godišnjim prosjekom od 15 kg ha<sup>-1</sup> dan<sup>-1</sup>. Temperatura i vlaga tla kretale su se u rasponu od 7,7-37,1 °C, odnosno 17,3-39,8 %, s godišnjim prosjekom od 19,6 °C, odnosno 29,1 %. Vlaga tla imala je veći utjecaj na disanje tla u odnosu na temperaturu tla. S obzirom da je disanje tla pod utjecajem složenih interakcija nekoliko čimbenika; preporuča se daljnje proširenje istraživanja i na druge kontrolirajuće čimbenike.

**Ključne riječi:** disanje tla, temperatura tla, vlaga tla, soja, Hrvatska



## Effect of agroclimate elements on soil CO<sub>2</sub> evolution rate during soybean cultivation

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### Summary

In terrestrial ecosystems, soils can act as carbon sinks or sources depending on land-use management and climate conditions. Soil respiration is one of the main sources of carbon dioxide (CO<sub>2</sub>). Soil CO<sub>2</sub> evolution rate depends on many factors and one of them are agroclimate elements. In order to determine the effect of soil temperature and soil moisture on soil CO<sub>2</sub> evolution rate, soil respiration i.e. soil C-CO<sub>2</sub> emissions have been studied in 2019 in continental part of Croatia near Zagreb city. Soil C-CO<sub>2</sub> emissions were measured with *in situ* closed static chamber method during soybean (*Glycine max* L.) growing season. Soil respiration increased with crop development, and was the highest in July and the lowest in October before the soybean harvest. Soil respiration was in the range of 4.5-31.2 kg ha<sup>-1</sup> day<sup>-1</sup>, with yearly average of 15 kg ha<sup>-1</sup> day<sup>-1</sup>. Soil temperature and soil moisture were in the range of 7.7-37.1°C and 17.3-39.8% respectively, with the yearly average of 19.6°C and 29.1% respectively. Soil moisture had greater influence on soil respiration compared to the soil temperature. As soil respiration is influenced by complex interactions of several factors; the further study should include also other controlling factors.

**Key words:** soil respiration, soil temperature, soil moisture, soybean, Croatia

## Control of Colorado potato beetle with spinosad and metaflumizone – one of the few insecticides available on the market in Croatia

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### Summary

Colorado potato beetle (CPB) is a serious pest of potato worldwide, which became difficult to control due to resistance developed to many classes of insecticides. In Croatia, resistance to organophosphorus insecticides and pyrethroids was established in mid 1990s, and recent research has shown that it has developed resistance to newer generation insecticides (e.g. neonicotinoids) in some areas. Due to the resistance development and restrictions on the registration and use of plant protection products in the EU as well as in Croatia, the spectrum of available insecticides for CPB control is limited. Efficacy of spinosad and metaflumizone was investigated in laboratory bioassays on 35 populations collected from 2017-2019 in Croatia. Efficiency of recommended dose, half, 1/5 and 1/10 of the recommended dose were determined. Populations were classified according to IRAC method No. 1132 into five categories based on the efficacy. Efficacy data were subjected to Probit analysis to generate LC<sub>50</sub> estimates for each insecticide and population 48 and 72 hours after the treatment. Results have showed that all populations are susceptible or highly susceptible to spinosad and metaflumizone. However, the differences among populations in LC<sub>50</sub> have been established, indicating that at some locations resistance development is in progress. Due to the limited availability of insecticides for CPB control, spinosad and metaflumizone could be recommended in areas where CPB developed resistance to other classes of insecticides. But, the monitoring of the resistance development to these active ingredients is required.

**Key words:** bioassay, *Leptinotarsa decemlineata*, metaflumizone, resistance, spinosad

## Elementarna analiza u različitim poljoprivrednim i šumarskim kontekstima

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### Sažetak

Postoje mnogi aspekti poljoprivredne i šumarske industrije koji se oslanjaju na poznavanje prehrambenih ili kaloričnih svojstava srodnih tla, biljaka ili otpada. Elementar nudi široku paletu instrumenata koji su vrlo pogodni za ove svrhe. Instrumenti se kreću od analizatora za simultano određivanje nekoliko elemenata do onih namijenjenih brzom mjerenju pojedinog elementa. Ne samo da se mogu izmjeriti mali, homogeni uzorci, već se mogu izmjeriti i uzorci tla do 5 g, smanjujući potrebnu količinu pripreme uzoraka. Primjene uključuju mjerenje sadržaja dušika u gnojivu, sadržaja CHNS-a u tlu, sadržaja CHNS-a u bio-ulju i biomasi i sadržaja CHNS-a u biljnim materijalima. Preciznost ovih mjerenja rutinski pada ispod  $\pm 0,05$  % apsolutne koncentracije. Granica detekcije ovih mjerenja nalazi se u opsegu ppm i pogodna je za razne svrhe, što ilustrira sposobnost određivanja sadržaja proteina u škrobu. Veliki apsolutni kapacitet sustava za hvatanje produkata izgaranja/trapping omogućuje velike uzorke, do 500 mg apsolutnog sadržaja ugljika. Radeći prema Dumasovom principu visokotemperaturnog izgaranja praćenog redukcijom, ovi su instrumenti i sami primjeri zelene kemije, ne proizvodeći otrovni otpad. Također su vrlo održivi s opcijama za rad s ugljičnim dioksidom ili argonom kao plinovima nosačima, za razliku od često korištenog helija, koji je ograničen resurs.

**Ključne riječi:** biomasa, elementarna analiza, gnojivo, analiza proteina, tlo

## Elemental Analysis in a Variety of Agricultural and Forestry Contexts

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### Summary

There are many aspects of the agricultural and forestry industries that rely on knowing the nutritional or caloric properties of related soils, plants, or wastes. Elementar offers a wide variety of instruments well suited to these purposes. Instruments range from analyzers for simultaneous determination of several elements to those dedicated to the rapid measurement of a single element. Not only can small, homogeneous samples be measured, but soil samples up to 5 g can also be measured, reducing the amount of sample preparation necessary. Applications include measuring the nitrogen content of fertilizer, the CHNS content of soil, the CHNS content of bio-oil and biomass, and the CHNS content of plant materials. The precision of these measurements routinely falls below  $\pm 0.05\%$  absolute concentration. The detection limit of these measurements is in the ppm range and is well-suited to a variety of purposes, as illustrated by the ability to determine the protein content of starch. The large absolute capacity of the trapping mechanism allows for large samples, up to 500 mg absolute carbon content. Operating according to the Dumas principle of high-temperature combustion followed by reduction, these instruments are themselves examples of green chemistry, producing no toxic wastes. They are also highly sustainable with options to operate with carbon dioxide or argon as carrier gases, as opposed to the commonly-used helium, which is a limited resource.

**Key words:** biomass, elemental analysis, fertilizer, protein analysis, soil

## Utjecaj gospodarenja tlom na svojstva tla i plošnu eroziju mjerenu kišnim simulacijama u nasadu lijeske

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### Sažetak

Cilj istraživanja je odrediti utjecaj različitih vrsta malčeva na smanjenje erozije tla u nasadu lijeske na nagibu u Zmajevcu (Hrvatska). Tri tretmana su proučavana: obrađeno (golo tlo); malčirano drvnom sječkom (2 t/ha) i malčirano slamom (2 t/ha) na kambisolu. Svaki tretman se sastoji od 10 plotova (ponavljanja), gdje su provedene kišne simulacije za određivanje površinskog otjecanja, gubitka tla i hraniva, te fizikalne i kemijske analize tla. Rezultati su pokazali kako nema značajne razlike između volumne gustoće između tretmana, dok se trenutna vlaga tla značajno razlikuje na obrađenom tretmanu u odnosu na tretmane s malčirano drvnom sječkom i slamom. Kapacitet tla za vodu, srednja veličina strukturnih agregata i udio vodostabilnih agregata se također ne razlikuju među tretmanima. Više vrijednosti vremena do površinskog stagniranja, početka otjecanja i infiltracija, zabilježeni su na obrađenom tretmanu, dok je najveća koncentracija sedimenta zabilježena na tretmanu malča s drvnom sječkom, a najveće površinsko otjecanje i gubitak sedimenta su značajno bili veći na obrađenom tretmanu. Rezultati pokazuju kako je slama imala najbolji utjecaj na sprječavanje erozije, iz tog razloga što direktno usporava vrijeme otjecanja i smanjuje gubitak sedimenta.

**Ključne riječi:** korištenje pokrova tla, površinsko otjecanje, degradacija tla, ublažavanje

**Zahvala:** Rad je financiran od strane Hrvatske zaklade za znanost kroz projekt „Erozija i degradacija tala Hrvatske“ (UIP-2017-05-7834) (SEDCRO). Autori su zahvalni na potpori OPG-a Domagoj Dropulić iz Kneževih Vinograda.

## **Soil management impact on soil properties and initial soil erosion obtained by rainfall simulation experiments in hazelnut orchard**

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### **Summary**

This study aims to assess the impacts of different mulch types on reducing soil erosion in hazelnut orchard on a slope in Zmajevac (Croatia). Three treatments were studied: tilled (bare soil); wood chips mulch (2 t/ha) and straw mulch (2 t/ha) on Cambisol. Each treatment consists from 10 plots (replicates) where rainfall simulation experiments, soil physical and chemical analyses were carried out to determine runoff, sediment and nutrient losses. The results showed that there was no significant difference in bulk density between treatment's while soil water content was significantly different on tilled treatment compared to treatment with wood chips and straw. Water holding capacity, mean weight diameter, and water-stable aggregates also indicate that there is no significant difference between treatments. Higher values were recorded for ponding time, time to runoff, and infiltration rate on tilled treatments. Sediment concentration was highest on treatments with wood chips, the runoff and sediment loss were significantly higher on tilled treatment. The results indicate that straw mulch had the best effect on erosion control because it immediately slows down runoff initiation and reduces sediment losses.

**Key words:** soil management system, overland flow, soil degradation, mitigation

**Acknowledgements:** This work was supported by the Croatian Science Foundation through the project "Soil erosion and degradation in Croatia" (UIP-2017-05-7834) (SEDCRO). The authors are grateful for the support of Family farm Domagoj Dropulić from Kneževi Vinogradi.

## Effects of Nitrogen Fertilization on lignotuber development and sprouting of *Arbutus unedo* L.

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### Summary

Strawberry tree (*Arbutus unedo* L.) is an important species for nature. It is resistant to fire and drought. It is one of the species which can survive the increasing temperatures in global climate change and this makes it an important species need to propagate. Lignotubers develop over the years in the lower part of *Arbutus* trunks. These structures that accumulate carbon are they are storage organs. Lignotuber size vary between 41cm to 3068 cm<sup>2</sup> size that they are the source of new meristems. After forest fire ended, plant re-grow from meristem of lignotubers. These structures that accumulate carbon are they are storage organs. Lignotuber size vary between 41cm<sup>2</sup> to 3068 cm<sup>2</sup> size that they are the source of new meristems. After forest fire, over grazing or rejuvenation cutting of forest, plant re-grow from meristem of lignotubers. In this study plant development and lignotuber formation was evaluated in the first 5 years after plantation in plastic tunnel condition in Kocaeli City of Turkey. One year seed propagated plants were established in high plastic tunnel. After plantation 40, 80, 120, 160 and 240 ppm N fertilization was applied to the saplings with irrigation water. There are 7 plants in each treatments. The results was evaluated after 2 years for plant development and after 5 years for lignotuber formation. The number of new sprouting was recorded 120 and 160 ppm N application formed the most new sprouts from lignotubers. Lignotubers diameter and size was increased by doses of N fertilizationbut decreased after 200 ppm doses. Fruit size also increased by the application of N. All doses increased plant development according to control plant. The results obtained from the studies will be of great benefit in terms of breeding studies and supply knowledge for manage the global climate change in future.

**Keywords:** *Arbutus unedo* L., nitrogen fertilizer, lignotuber, germination

## Cherry laurel (*P. laurocerasus* L.) flower characteristics, fertilization and fruit set

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### Summary

Cherry laurel (*Prunus laurocerasus* L.) is an evergreen shrub or small tree that can grow up to 6 m high. It is native to the regions bordering the Black Sea in most part of Europe and also in Southwestern Asia. It is naturally grow in the northern part of Turkey and very common in the Kocaeli. There are many cultivars as sources of germplasm, provide rich parental material for breeding studies. It is consumed as fresh fruit in Turkey. The fruit is traditionally known for its rich medicinal properties against diabetes and kidney stones. It is an integral part of the life of the people of the Black sea region where it is known as amazing fruit for their life circle. Cherry laurel gardens have been recently planted. In this study flower characteristics was investigated and pollination requirements was discussed. Fruit set was evaluated on “black” and “cherry” cherry laurel cultivars. All observation was made on three replicates. One tree was taken as a replicate and 15 flower stalk per tree. Fruit color, size and quality was changed with pollen source. Fruit set was increased with different pollen resources compare with open pollination. There was not fruit in self-pollinated flowers. Results of the study gave pollination biology of cherry laurel that very useful for plantation of modern orchards. We propose that, in future, it can be grown in small-scale conventional farms.

**Keywords:** Cherry laurel, flower, fruit set, socio-economic evaluation, breeding



## Utvrđivanje prisutnosti entomopatogenih nematoda (Nematoda: Rhabditida) u Republici Hrvatskoj

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### Sažetak

Entomopatogene nematode (EPN) paraziti su kukaca. Pripadaju porodicama Steinernematidae i Heterorhabditidae, a pojedine vrste se proizvode i koriste za biološko suzbijanje štetnih kukaca. Zbog povlačenja mnogih insekticida s tržišta sredstava za zaštitu bilja, radi njihovih ekotoksikološki nepovoljnih karakteristika, u svijetu je zabilježen porast istraživanja vezanih uz pronalaženje i komercijalizaciju novih vrsta EPN. S ciljem ubrzanja agroekološke tranzicije, zajedničku deklaraciju "Towards a Chemical Pesticide - free Agriculture" potpisale su 2020. g. 24 istraživačke ustanove iz 16 europskih država. Cilj ovoga istraživanja bio je utvrditi prisutnost EPN te izolirati endemske vrste na poljoprivrednim površinama u Republici Hrvatskoj. U periodu 2017 - 2020, na 36 lokaliteta u sedam županija, prikupljeno je ukupno 180 uzoraka tla. Korištenjem metoda „Insect baiting“ i „White trap“ te molekularne dijagnostike, vrste roda *Steinernema* izolirane su iz tri uzorka tla prikupljena na lokalitetima Karane, Đeletovci i Luka. Učestalost pojave EPN (broj uzoraka tla pozitivnih na prisutnost EPN/ ukupan broj uzoraka tla) u istraživanju iznosila je 1.7 %. Udio lokaliteta pozitivnih na prisutnost EPN u odnosu na ukupan broj uzorkovanih lokaliteta iznosio je 8.3 %. Prisutnost EPN u tlima Republike Hrvatske ukazuje da su uvjeti za njihov razvoj povoljni te bi njihova primjena u biološkom suzbijanju štetnika trebala biti učinkovita. Isto je potrebno utvrditi daljnjim istraživanjima.

**Ključne riječi:** poljoprivredne površine, biološko suzbijanje štetnika, EPN, endemske vrste, *Steinernema*

## A survey of entomopathogenic nematodes (Nematoda: Rhabditida) in the Republic of Croatia

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### Summary

Entomopathogenic nematodes (EPNs), small parasitic roundworms, are specialized to feed on insects. EPNs belong to families Steinernematidae and Heterorhabditidae, members of which are commercially produced and used for biological control of insect pests. Because of the removal of many chemical pesticides from the market due to the ecotoxicological issues, increasing trend in research of EPNs has been observed throughout the world. In order to accelerate the agroecological transition, the joint declaration “Towards a Chemical Pesticide-free Agriculture” was signed by 24 research organisations from 16 European countries in 2020. The aim of this survey was to determine the occurrence of EPNs and to isolate endemic species in agricultural land in Croatia. In period 2017-2020 a total of 180 soil samples were collected at 36 localities in 7 Croatian counties. Using “Insect baiting technique”, “White trap” and molecular biology analysis, *Steinernema* sp. was recovered from three soil samples taken at the localities Karane, Đeletovci and Luka. The recovery frequency of EPNs in four-year survey was 1.7 %. The abundance (number of localities positive for EPNs/ total number of localities) of EPNs in Croatian soils was 8.3 %. The presence of EPNs in Croatia suggests that conditions for their development are favorable, and that their use for biological control of insect pests may be successful, what should be confirmed in further research.

**Key words:** agricultural land, biological pest control, EPNs, native species, *Steinernema*

## Biodostupnost Mg, Fe i Zn iz soka zelenog lisnatog povrća

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### Sažetak

Zeleno lisnato povrće bogato je vlaknima, klorofilom, vitaminima, mineralima i aminokiselinama. Zbog visoke nutritivne vrijednosti često se koristi za pripremu svježih sokova u kojima se najčešće kombinira sa svježim voćem. Cilj ovog istraživanja bio je ispitati bioraspoloživost Mg, Fe i Zn iz svježeg soka blitve, listova celera i kupusa te utvrditi kako dodatak limunovog soka utječe na bioraspoloživost navedenih elemenata. Bioraspoložive koncentracije utvrđene su u uzorcima nakon simulacije probave *in vitro*, a izmjerene su, kao i ukupne koncentracije, pomoću ICP-MS tehnike. Najviše ukupne koncentracije Mg ( $413,45 \pm 5,41 \text{ mg kg}^{-1}$ ) i Fe ( $27,82 \pm 0,16 \text{ mg kg}^{-1}$ ) utvrđene su u soku celera dok je najviša koncentracija Zn utvrđena u soku celera u koji je dodan limunov sok ( $4,23 \pm 0,028 \text{ mg kg}^{-1}$ ). Najniže koncentracije Mg ( $45,64 \pm 1,85 \text{ mg kg}^{-1}$ ), Fe ( $2,27 \pm 0,067 \text{ mg kg}^{-1}$ ) i Zn ( $1,38 \pm 0,003 \text{ mg kg}^{-1}$ ) utvrđene su u svježem soku kupusa. Dodatak limunovog soka značajno je povećao bioraspoloživost (%) Mg ( $t = 7,27$ ;  $p < 0,01$ ), Fe ( $t = 5,55$ ;  $p < 0,01$ ) i Zn ( $t = 12,15$ ;  $p < 0,01$ ) u soku od kupusa. U sokovima blitve i celera nije utvrđen utjecaj dodatka limuna na povećanje postotak bioraspoloživosti ispitivanih elemenata. Sokovi blitve, celera i kupusa se značajno razlikuju s obzirom na bioraspoloživost Mg, Fe i Zn, a najniža bioraspoloživost (%) sva tri elementa utvrđena je u soku celera. Općenito Mg ima najveću bioraspoloživost, dok je najniža bioraspoloživost utvrđena za Fe.

**Ključne riječi:** bioraspoloživost, mikronutrijenti, simulacija probave

## Bioaccessibility of Mg, Fe and Zn in green leafy vegetable juice

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### Summary

Green leafy vegetables are rich in fibre, chlorophyll, vitamins, minerals, and aminoacids. Due to the high nutritional value, green leafy vegetable is often used for the preparation of fresh juices in which it is usually combined with fresh fruit. The aim of this research was to evaluate bioaccessibility of Mg, Fe, and Zn in fresh Swiss chard, celery, and cabbage juice and determine the effect of lemon juice addition on bioaccessibility of Mg, Fe, and Zn. Total and bioaccessible concentrations (after simulation of *in vitro* digestion) are determined by the ICP-MS technique. The highest total concentrations of Mg ( $413.45 \pm 5.41 \text{ mg kg}^{-1}$ ) and Fe ( $27.82 \pm 0.16 \text{ mg kg}^{-1}$ ) are determined in celery juice, while the highest Zn concentration was determined in a mixture of celery and lemon juice ( $4.23 \pm 0.028 \text{ mg kg}^{-1}$ ). The lowest Mg ( $45.64 \pm 1.85 \text{ mg kg}^{-1}$ ), Fe ( $2.27 \pm 0.067 \text{ mg kg}^{-1}$ ) and Zn ( $1.38 \pm 0.003 \text{ mg kg}^{-1}$ ) concentrations were found in fresh cabbage juice. Addition of lemon juice significantly increased bioaccessibility (%) of Mg ( $t = 7.27$ ;  $p < 0.01$ ), Fe ( $t = 5.55$ ;  $p < 0.01$ ) and Zn ( $t = 12.15$ ;  $p < 0.01$ ) in fresh cabbage juice. The effect of lemon addition on the increase of the bioavailability (%) of the tested elements was not determined in the case of chard and celery juice. Swiss chard, celery, and cabbage juices are significantly different regarding the bioaccessibility of Mg, Fe, and Zn. The lowest bioaccessibility (%) of all elements was found in celery juice. In general, regardless of vegetable juice, Mg has the highest, while Fe has the lowest, bioaccessibility.

**Key words:** bioavailability, micronutrients, simulation of digestion

## Provedba agrotehničkih mjera u Republici Hrvatskoj u 2019. godini

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### Sažetak

Zakonom o poljoprivrednom zemljištu (NN 20/18, 115/18, 98/19.) propisane su ovlasti jedinica lokalne samouprave u pogledu uređenja i održavanja poljoprivrednih površina. Na temelju zakona donesen je Pravilnik o agrotehničkim mjerama (NN 22/19). Pravilnik o agrotehničkim mjerama propisuje agrotehničke mjere koje moraju provoditi vlasnici i posjednici poljoprivrednog zemljišta prilikom obrade poljoprivrednog zemljišta kako se ne bi umanjila njegova bonitetna vrijednost. Izvješće o primjeni propisanih mjera za 2019. godinu od 556 jedinica lokalne samouprave Hrvatskoj agenciji za poljoprivredu i hranu – Centru za tlo dostavilo je 106 jedinice lokalne samouprave (19,1 %). Prema dostavljenim podacima praćenje provedbe propisanih agrotehničkih mjera provedeno je na ukupno 403 502 ha. Najviše nadzora i postupanja vezano je za primjenu slijedećih agrotehničkih mjera: minimalna razina obrade i održavanja poljoprivrednog zemljišta povoljnim za uzgoj biljaka, sprječavanje zakorovljenosti i obrastanja višegodišnjim raslinjem, suzbijanje biljnih bolesti i štetnika. Najmanje nadzora i postupanja vezano je za primjenu agrotehničkih mjera: postupanje s biljnim ostacima, održavanje organske tvari i humusa u tlu, održavanje povoljne strukture tla te mjera gnojidba mineralnim i organskim gnojivima, odvodnja i navodnjavanje. Najčešći problemi u provedbi agrotehničkih mjera su neriješeni imovinsko-pravni odnosi, iseljavanje domicilnog stanovništva i zapuštenost njihovih posjeda, staračka domaćinstva koja ne mogu održavati zemljište, neusklađenost podataka katastra i gruntovnice i dr. Na kraju pregleda provedbe agrotehničkih mjera želimo naglasiti važnost njihove primjene na području Republike Hrvatske. Kontinuirana skrb jedinica lokalne samouprave i gradova o provođenju agrotehničkih mjera na svom području ključan je subjekt kvalitetne i prosperitetne poljoprivredne proizvodnje te zdravog, čistog i urednog okoliša za sve nas.

**Ključne riječi:** agrotehničke mjere, održavanje poljoprivrednog zemljišta, nadzor, poticanje provedbe agrotehničkih mjera

## Implementation of agro-technical measures in the Republic of Croatia in 2019.

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### Summary

The Agricultural Land Act (NN 20/18, 115/18, 98/19) prescribes the jurisdiction of local self-government units regard to the arrangement and maintenance of agricultural land. Based on the law, the Ordinance on agro-technical measures was adopted (NN 22/19). The Ordinance on agro-technical measures prescribes agro-technical measures that must be implemented by owners and possessors of agricultural land when cultivating agricultural land in order not to reduce its worthiness. The report on the application of prescribed measures for 2019 from 556 local self-government units was submitted to the Croatian Agency for Agriculture and Food - Soil Center by 106 local self-government units (19,1%). According to the submitted data, the monitoring of the implementation of the prescribed agro-technical measures was carried out on 403 502 ha. The most supervisions and actions are related to the application of the following agro-technical measures: the minimum level of cultivation and maintenance of agricultural land favorable for plant cultivation, prevention of weeds and perennial overgrowth, control of plant diseases and pests. The least supervisions and actions are related to the application of the following agro-technical measures: humus in the soil, maintaining a favorable soil structure, and measures fertilization with mineral and organic fertilizers, drainage and irrigation. The most common problems in the implementation of agro-technical measures, and are unresolved property-legal relations, emigration of the domicile population and neglect of their property, elderly households that cannot maintain land, inconsistency of cadastre and land registry data, etc. At the end of the review of the implementation of agro-technical measures, we would like to emphasize the importance of their application in the territory of the Republic of Croatia. Continuous care of local self-government units and cities for the implementation of agro-technical measures in their area is a key subject of quality and prosperous agricultural production and a healthy, clean and tidy environment for all of us.

**Keywords:** agro-technical measures, agricultural land maintenance, supervision, encourage the implementation of agro-technical measures

## Kemijska svojstva tala i tumačenje klasa opskrbljenosti

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### Sažetak

Sukladno važećem Pravilniku o metodologiji za praćenje stanja poljoprivrednog zemljišta, 5 ovlaštenih laboratorija u RH referentnom laboratoriju za ispitivanje plodnosti tla dostavljaju izvješća što za 2019. godinu uključuje rezultate analiza 10.825 uzoraka tla provedenih u referentnom ili ovlaštenim laboratorijima. Analizom 9.868 uzoraka oraničnog sloja tla utvrđeno je da je 59 % uzoraka kisele supstitucijske reakcije, od čega 21,7 % jako kiselih, 22,8 % kiselih i 14,5 % slabo kiselih tala. Alkalnih je tala 26,9 %, a neutralnih samo 14,1 %. i hidrolitska kiselost ukazuje na značajnu zastupljenost kiselih tala jer je kalcizacija neophodna za 25,3 % analiziranih tala ( $H_y > 4 \text{ cmol kg}^{-1}$ ), a bila bi korisna za još 21,3 % tala. Humoznost analiziranih tala je vrlo niska jer 90 % tala ima  $< 3$  % humusa, a čak je u 55,4 % tala sadržaj humusa  $< 2$  % (klase A, B i C). Iako je prosječan sadržaj humusa u svim analiziranim uzorcima 2,12 % uz median 1,93 %, prosječan sadržaj humusa u slabohumoznim tlima (55,4 % tala) je samo 1,63 %, a prosječan sadržaj humusa u tlima s do 3 % humusa (90 % analiziranih tala) je samo 1,91 %. Raspoloživost fosfora nedostatna je u 37,3 % analiziranih tala (klase A i B vrlo slabo i slabo opskrbljenih tala), dobro je opskrbljeno 30,1 % tala (klasa C), a bogato 32,6 % tala (klase D i E bogatih i vrlo bogatih tala). Raspoloživim kalijem je dobro opskrbljeno 55,4 % tala (klasa C), slabo je opskrbljeno 19,3 %, a bogato je 25,4 % tala. Rezultati kemijskih analiza tala nedvojbeno ukazuju da je najveći problem humoznost tala i da je najvažnija strateška agrotehnička mjera organska gnojidba i gospodarenje organskom tvari, čiji značaj dodatno naglašava 25-47 % prekiselih i 37,3 % fosforom siromašnih tala.

**Ključne riječi:** kemijska svojstva tala, tumačenje rezultata, klase opskrbljenosti, humoznost, pH tla

## Soil chemical properties and interpretation of supply classes

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### Summary

According to the current Ordinance on the methodology for monitoring the condition of agricultural land, 5 authorized laboratories in the Republic of Croatia submit reports to the reference laboratory for soil fertility testing, which for 2019 includes the results of analyzes of 10,825 soil samples carried out in the reference or authorized laboratories. The analysis of 9,868 samples of arable layer of soil has been found that 59% of the samples were acidic substitution reactions, of which 21.7% were highly acidic, 22.8% were acidic and 14.5% were weakly acidic soils. Alkaline soils was 26.9%, and neutral only 14.1%. Hydrolytic acidity also indicates a significant presence of acid soils because calcification is necessary for 25.3% of the analyzed soils ( $H_y > 4 \text{ cmol kg}^{-1}$ ), and would be useful for another 21.3% of soils. Analyzed soil humus content is very low because 90% of soils have  $< 3\%$  humus, and even in 55.4% of soils the humus content is  $< 2\%$  (classes A, B and C). Although the average humus content in all analyzed samples was 2.12% with a median of 1.93%, the average humus content in low-humus soils (55.4% of soils) was only 1.63%, and the average humus content in soils with up to 3% humus (90% of the analyzed soils) was only 1.91%. The availability of phosphorus is insufficient in 37.3% of analyzed soils (class A and B of very poorly and poorly supplied soils), 30.1% of soils (class C) are well supplied, and 32.6% of soils rich and very rich soils (class D and E). 55.4% of soils (class C) are well supplied with available potassium, 19.3% are poorly supplied and 25.4% of soils are rich with available potassium. Chemical analyzes of soils clearly indicate that the biggest problem is soil humus content and that the most important strategic agrotechnical measure is organic fertilization and organic matter management, whose importance is further emphasized by 25-47% of acidified soils and 37.3% of phosphorus-poor soils.

**Keywords:** soil chemical properties, interpretation of results, supply classes, humus content, soil



## Krajobrazne vrijednosti Voćina – identifikacija i valorizacija

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### Sažetak

Cilj rada je prikazati i valorizirati krajobrazne vrijednosti Voćina. Valorizacija prirodnih krajobraznih vrijednosti uključuje poznate metode fizičke i ekološke valorizacije krajobraza što uključuje analize klime, tla, reljefa i pokrova, elemente subjektivnih parametara (vizualne i ambijentalne vrijednosti). Analiza povijeno značajnih arhitektonskih vrijednosti i vrijednosti krajobrazne arhitekture, prikazat će se kroz detaljnu inventarizaciju. Biofizička komponenta je osnova procjene krajobraza. Biofizičke sastavnice Voćina detaljno su opisane i kao zaključak one mogu biti dio prostorno planske dokumentacije Voćina sa smjernicama mogućeg razvoja mjesta u smjeru buduće zelene gradnje.

**Ključne riječi:** povijesno nasljeđe, obnova, zelena gradnja

## The Landscape Values of Voćin—Identification and Valorization

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### Summary

The aim of this paper is to present and valorize the landscape values of Voćin. The valorization of natural landscape values involves the known methods of physical and ecological landscape assessment, which partakes the analyses of climate, soil, relief and cover, i.e., the elements of subjective parameters (visual and ambient values). The analysis of historically significant architectural values and the values of landscape architecture will be presented through a detailed inventory. A biophysical component is the basis of landscape assessment. The biophysical components of Voćin are described in detail and, as a conclusion, they can be a part of the spatial planning documentation of Voćin, with the guidelines for possible development of the place in a direction of future green construction.

**Keywords:** historical heritage, renewal, green building

## Rezultati provođenja programa posebnog nadzora *Xylella fastidiosa* i vektori u Hrvatskoj

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### Sažetak

Bakterija *Xylella fastidiosa* na području Europske unije regulirana je kao karantenski štetnik. Predstavlja vrlo ozbiljnu prijetnju i rizik hrvatskoj poljoprivredi, naročito u regiji Primorska Hrvatska. Bakterija se može prenijeti trgovinom zaraženim sadnim materijalom ili kukcima vektorima. Program posebnog nadzora *X. fastidiosa* i vektori provodi se u Republici Hrvatskoj od 2014. U sklopu nadzora svake godine od 2014. do 2021. godine redovito se provede aktivnosti koje uključuju vizualne preglede, uzimanje uzoraka biljaka domaćina, te sakupljanje kukaca vektora. Nadzor je proveden u voćnjacima, okućnicama, vrtovima, javnim zelenim površinama, prirodnoj vegetaciji i vrtnim centrima. U nadzoru su sudjelovali Centar za zaštitu bilja – Hrvatska agencija za poljoprivredu i hranu i fitosanitarna inspekcija. Tijekom sedam godina ukupno je provedeno 3466 vizualnih pregleda, te sakupljeno i analizirano 4433 uzoraka od toga 3217 uzoraka biljnog materijala i 1216 uzoraka kukaca vektora. Programom posebnog nadzora *X. fastidiosa* i njenih vektora osigurava se provođenje Uredbe (EU), te se dobiva potvrda o statusu štetnog organizma. Štetni organizam *X. fastidiosa* nije utvrđen niti u jednom analiziranom uzorku. U slučaju pozitivnog nalaza razradit će se i provesti prikladne fitosanitarne mjere u svrhu sprječavanja širenja štetnog organizma. Program posebnog nadzora potrebno je nastaviti redovno provoditi na području republike Hrvatske.

**Ključne riječi:** *Xylella fastidiosa*, nadzor, uzorci, vektori, Hrvatska

## Results of the implementation of the special surveillance program *Xylella fastidiosa* and vectors in Croatia

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### Summary

The bacterium *Xylella fastidiosa* in the European Union is regulated as a quarantine pest. Present a very serious threat and risk to Croatian agriculture, especially in the Coast Region. The bacterium can be transmitted by trade with infected planting material or by insect vectors. The program of special surveillance *X. fastidiosa* and vectors has been implemented in the Republic of Croatia since 2014. As part of the surveillance every year from 2014 to 2021, activities are regularly carried out and include visual inspections, sampling host plants and collecting insect vectors. Surveillance is implemented in orchards, backyards, gardens, public areas, natural vegetation and garden centers. The Center for Plant Protection - Croatian Agency for Agriculture and Food and Phytosanitary Inspection are participated in the supervision. During the seven years of the program, a total of 3466 visual inspections were conducted, and a total of 4433 samples were collected and analyzed, of which 3217 samples of plant material and 1216 samples of insect vectors. The special supervision program *X. fastidiosa* and vectors ensures the implementation of the Regulation (EU) and obtains a confirm of the status of the harmful organism. The harmful organism *X. fastidiosa* has not been identified in any of the analyzed samples. In the case of a positive finding, appropriate phytosanitary measures will be developed and implemented in order to prevent the spread of the harmful organism. The special surveillance program needs to be further regularly implemented in the territory of the Republic of Croatia.

**Key words:** *Xylella fastidiosa*, surveillance, samples, vectors, Croatia

## Učinkovitost bakterija roda *Pseudomonas* sp. za otapanje fosfora na različitim hranjivim podlogama

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### Sažetak

Fosfor je esencijalni makroelement važan za rast i razvoj bilja. Iako ga u tlu ima u dovoljnim količinama, većina ovog elementa se nalazi u biljci nepristupačnom obliku. Stoga, sve se više koriste mikrobiološki preparati koji sadrže mikroorganizme s mogućnošću otapanja fosfora. Cilj ovog istraživanja bio je utvrditi učinkovitost bakterija roda *Pseudomonas* sp. za otapanje fosfora na različitim hranjivim podlogama. Korištene su bakterije *P. putida* (ATCC12633), *P. rhizosphaerae* (DSM16299) i *P. fluorescens* (ATCC13525) te dvije mikrobiološke hranjive podloge različitih koncentracija fosfora. Pikovskaya's Agar (PIK), gotova podloga koja sadrži 5 g L<sup>-1</sup> fosfora u obliku trikalcij fosfata te pripravljena podloga (FOP) koja sadrži 2 g L<sup>-1</sup> fosfora u istom obliku. Pri završetku inkubacije ustanovljena je učinkovitost pojedinih bakterija za otapanje fosfora pomoću mjerenja promjera prozirne površine podloge koji je nastao usljed otapanja fosfora. Na podlozi s većom koncentracijom fosfora (PIK) utvrđena je statistički značajna razlika učinkovitosti otapanja fosfora između pojedinih vrsta bakterija roda *Pseudomonas* sp. Učinkovitost bakterije *P. putida* za otapanje fosfora iznosila 26,7 mm, *P. fluorescens* 18,7 mm, dok je učinkovitost bakterije *P. rhizosphaerae* iznosila 10,3 mm. Na podlozi s manjom koncentracijom fosfora (FOP) nisu ustanovljene statistički značajne razlike učinkovitosti otapanja fosfora, a učinkovitost bakterije *P. putida* za otapanje fosfora iznosila 29,3 mm, *P. fluorescens* 29,0 mm, dok je učinkovitost bakterije *P. rhizosphaerae* iznosila 23,7 mm. Na osnovi dobivenih rezultata možemo zaključiti kako je u svrhu naših istraživanja pogodnije koristiti gotovu podlogu, odnosno Pikovskaya Agar.

**Ključne riječi:** otapanje fosfora, *Pseudomonas fluorescens*, *Pseudomonas putida*, *Pseudomonas rhizosphaerae*

## Efficiency of some *Pseudomonas* species for dissolving phosphorus on different growing media

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### Summary

Phosphorus is an essential macronutrient important for plant growth and development. Although it is present in sufficient quantities in the soil, most of this element is found in an unavailable form for plant uptake. Therefore, microbiological preparations containing microorganisms with the ability to dissolve phosphorus are increasingly used. The aim of this study was to determine the effectiveness of some *Pseudomonas* species to dissolve phosphorus on various growing media. Bacteria *P. putida* (ATCC12633), *P. rhizosphaerae* (DSM16299), *P. fluorescens* (ATCC13525) and two microbiological growing media containing different phosphorus concentrations were used. Pikovskaya's Agar (PIK), a prepared growing media containing 5 g L<sup>-1</sup> phosphorus in the form of tricalcium phosphate and a non-prepared growing media (FOP) containing 2 g L<sup>-1</sup> phosphorus in the same form. At the end of incubation period, the effectiveness of individual bacteria for dissolving phosphorus was established by measuring the diameter of the transparent surface of the media resulting from the dissolution of phosphorus. On the media with higher phosphorus concentration (PIK), a statistically significant difference in the efficiency of phosphorus dissolution was found between individual species of bacteria of the genus *Pseudomonas* sp. The efficiency of *P. putida* for dissolving phosphorus was 27.7 mm, *P. fluorescens* 18.7 mm, while the efficiency of *P. rhizosphaerae* was 10.3 mm. No statistically significant differences in phosphorus dissolution efficiency were found on the media with lower phosphorus concentration (FOP), and the efficiency of *P. putida* for phosphorus dissolution was 29.3 mm, *P. fluorescens* 29.0 mm, while the efficiency of *P. rhizosphaerae* was 23.7 mm. Based on the obtained results, we can conclude that for the purpose of our research it is more convenient to use the Pikovskaya Agar.

**Key words:** phosphorus dissolution, *Pseudomonas fluorescens*, *Pseudomonas putida*, *Pseudomonas rhizosphaerae*

## Polimorfizam pojedinačnog nukleotida – metoda u istraživanju rezistencije kukuruzne zlatice

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### Sažetak

Kukuruzna zlatica, (*Diabrotica virgifera virgifera* LeConte) najvažniji je štetnik kukuruza na području SAD-a i Europe. Već više od desetljeća populacijska genetika koristi se za evaluaciju učinkovitosti provedenih mjera suzbijanja ovoga štetnika u Hrvatskoj, a pokazala se korisnim i u razumijevanju invazijskog širenja štetnika kroz Hrvatsku i u druge susjedne države. Provedena genetska istraživanja kukuruzne zlatice utvrdila su osnovne informacije vezane uz njene alele i haplotipove u SAD-u i Europi. Polimorfizam pojedinačnog nukleotida (SNP, od engl. single nucleotide polymorphism) novija je metoda analize cijelog genoma utvrđivanjem polimorfizma. Primjena SNP-ova u nemodelnim organizmima postala je pristupačno i lako dostupno sredstvo za generiranje važnih podataka o brojnim vrstama što bi inače bilo nemoguće zbog visokih troškova i često nedostatka stručnosti laboratorijskog osoblja. Zbog velikog broja SNPs-a (od tisuće do milijuna) koji se lako generiraju u jednom slijedu, nadmašili su mikrosatelite u izboru istraživačkog alata kada je u pitanju utvrđivanje populacijske genetike neke vrste. S obzirom na najnoviju tehnologiju u sekvenciranju i sada već rutinsku upotrebu genotipizacije sekvenciranjem SNPs-a, analizirali smo veći broj uzoraka iz više populacija kako bi dobili bolje rezultate koji bi detektirali promjenu genoma kukuruzne zlatice na malim (intra-populacijski) i velikim (inter-populacijski) geografskim površinama. U radu će biti prikazani preliminarni rezultati SNP analize te genetska struktura, diferencijacija i protok gena unutar i između populacija kukuruzne zlatice.

**Ključne riječi:** *Diabrotica virgifera virgifera*, rezistencija, SNP, anti-resistentna strategija

## Single nucleotide polymorphisms (SNPs) – novel application to investigate pest resistance in the Western Corn Rootworm

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### Summary

The Western Corn Rootworm, WCR (*Diabrotica virgifera virgifera* LeConte) is the worst pest of maize in North America and Europe. For over a decade, population genetic monitoring has been used to inform the effective control and ongoing integrated management of invasive WCR in Croatia. It has proven useful in understanding the WCR invasion of Croatia and neighboring countries too. Genetic monitoring of WCR undertaken since 2009 has established baseline allelic and haplotype information for WCR in the USA and much of Europe. Recently SNPs, Single Nucleotide Polymorphisms, have become the marker of choice in studying the population genetics of non-model organisms. SNPs are single base substitutions found at a single genomic locus. SNPs have lower allele diversity and provide less statistical power to discriminate unique genotypes but have a denser and uniform distribution within genomes which make them a powerful marker for population and mapping studies. SNPs have become an affordable and readily accessible means of generating large amounts of genomic data for a species. Using SNPs, as a low-cost high-throughput marker genotyping platform, we analyzed population genomic data to understand WCR movement patterns on small (intra population) and large (inter population) geographic scales. In this work I will present preliminary results of SNPs and genetic diversity, structure and gene flow of WCR overall and by-population.

**Key words:** *Diabrotica virgiferaa virgifera*, resistance, SNPs, anti-resistance strategy



## Zaštitna uloga sumporovodika i svena kod pšenične trave (*Triticum aestivum* L.) pri temperaturnom stresu

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### Sažetak

Zbog sličnih elektrokemijskih svojstava, biljke selen i sumpor često asimiliraju preko istih membranskih prijenosnika. Selen je benefician element za biljke koji se uključuje u puteve asimilacije sumpora te može zamijeniti sumpor u organskim spojevima bez negativnog utjecaja na njihovu fiziološku funkciju. Također, za oba elementa je poznato da su od iznimne važnosti u odgovoru biljke na abiotski i biotski stres. Cilj ovog istraživanja bio je odrediti utjecaj otopine natrijevog hidrogen sulfida (NaHS), natrijevog selenata ( $\text{Na}_2\text{SeO}_4$ ) te njihove kombinacije na sadržaj kloroplastnih pigmenata, fenola, flavonoida, vitamina C, prolina i razinu lipidne peroksidacije kod tri sorte pšenične trave (*Triticum aestivum* L.), uzgajane pri 10, 20 i 30 °C. Značajno veći sadržaj fenola i flavonoida je utvrđen kod biljaka pšenične trave uzgajane pri temperaturi 10 °C. Kod sorte Katarina, najviši sadržaj vitamina C i prolina utvrđen je u varijanti primiranja sjemena kombinacijom otopina  $\text{Na}_2\text{SeO}_4$  i NaHS. Najviša razina lipidne peroksidacije je utvrđena u varijanti primiranja vodom. Kod sorte Osječka 20 najveći sadržaj vitamina C je utvrđen kod biljaka primiranih vodom, a kod sorte Super Žitarka u varijanti primiranja s NaHS-om. Rezultati istraživanja dokazuju zaštitnu ulogu oba ispitivana elementa pri temperaturama uzgoja izvan granica optimuma za pšeničnu travu jer utječu na sintezu zaštitnih molekula i signalnih komponenti u biljnom metabolizmu. Također, dokazano je da postoji genetska specifičnost pšenične trave u odgovoru na varijante primiranja sjemena pri različitim temperaturama uzgoja.

**Ključne riječi:** fenoli, kloroplastni pigmenti, prolin, vitamin C

## Protective role of hydrogen sulphide and selenium in wheatgrass (*Triticum aestivum* L.) under temperature stress

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### Summary

Due to similar electrochemical properties, the plants often assimilate selenium and sulfur through the same membrane transporters. Selenium is a beneficial element for plants that is involved in sulfur assimilation pathways and can replace sulfur in organic compounds without the adverse effects on their physiological function. Also, both elements are known to be extremely important in plants' response to abiotic and biotic stress. The aim of this study was to determine the effect of sodium hydrogen sulfide (NaHS) solution, sodium selenate (Na<sub>2</sub>SeO<sub>4</sub>) and their combinations on the content of chloroplast pigments, phenols, flavonoids, vitamin C, proline and the level of lipid peroxidation in three cultivars of wheat grass (*Triticum aestivum* L.), grown at 10, 20 and 30°C. Significantly higher contents of phenols and flavonoids were found in wheatgrass plants grown at 10°C. Regarding the cultivar Katarina, the highest content of vitamin C and proline was determined in the variant of seed priming by the combination of Na<sub>2</sub>SeO<sub>4</sub> and NaHS solutions. The highest level of lipid peroxidation was found in the hydro-priming variant. In the cultivar Osječka 20, the highest content of vitamin C was found in plants developed from hydro-primed seeds, and in the case of cultivar Super Žitarka this was seen in the NaHS-priming variant. The results of this research confirm the protective role of both tested elements at growing temperatures outside the optimum limits for wheatgrass, because they affect the synthesis of protective molecules and signaling components in plant metabolism. Also, it has been proven that there is a genetic specificity of wheat grass in response to seed priming variants at different growing temperatures.

**Key words:** phenols, chloroplast pigments, proline, vitamin C

## Planiranje upravljanja i obnova suhih travnjaka Dinare za očuvanje biološke raznolikosti i podršku održivom razvoju

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### Sažetak

Početkom 2020. godine je započet trogodišnji projekt „Dinara back to LIFE“ kojem zadatak planiranje upravljanja i obnova suhih travnjaka Dinare u cilju očuvanja biološke raznolikosti i podrške održivom razvoju. U projektu sudjeluju Udruga Biom, Hrvatske šume d.d., Lokalna akcijska grupa „Cetinska krajina“ i Sveučilište u Zagrebu Agronomski fakultet. Projekt uključuje stručne konzervacijske aktivnosti za restauriranje suhih travnjaka kroz krčenje, kontrolirano paljenje i uspostavu održivih modela napasivanja kao i istraživačke aktivnosti koje se odnose na utvrđivanje produktivnosti inventarizaciju i kartiranje travnjaka. U sklopu inventarizacije travnjaka provedena su floristička istraživanja kojim su utvrđeni travnjački stanišni tipovi i popisane biljne vrste te su prikupljeni uzorci biljne mase s travnjaka za procjenu produktivnosti i njihovog pašnjačkog potencijala. Ustanovljeno je 238 biljnih vrsta te je mjereno proljetni i ljetni prinos travnjaka. Utvrđen široki raspon produktivnosti travnjaka koja može dosezati i 3,8 t ha<sup>-1</sup> suhe tvari. Osim flore istraživane su i ptice ovisne o dinarskom tipu staništa kao što su vrtna strnadica (*Emberiza hortulana*), kratkoprsta ševa (*Calandrella brachydactyla*) i ćukavica (*Burhinus oedicnemus*) čija je pojavnost kartirana. Ovim istraživanjem su dobiveni preliminarni podaci koji će biti ugrađeni u završne rezultate projekta koji će u konačnici pomoći izradi smjernica za upravljanje travnjacima i njihovim održivim korištenjem na području Dinare.

**Ključne riječi:** Dinara, pašnjaci, LIFE, bioraznolikost, ptice

## Management planning and restoration of Dinara dry grasslands to save biodiversity and support sustainable development

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### Summary

At the beginning of 2020, the three-year project "Dinara back to LIFE" was started, with the task of planning the management and restoration of dry grasslands of Dinara in order to preserve biodiversity and support sustainable development. The participants in the project are the Association Biom, Hrvatske šume d.d., Local Action Group "Cetinska krajina" and the University of Zagreb, Faculty of Agriculture. The project includes expert conservation activities for the restoration of dry lawns through clearing, controlled burning and the establishment of sustainable grazing models as well as research activities related to determining productivity, grassland inventory building and mapping. As part of the grassland inventory, floristic surveys were conducted to determine grassland habitat types and list plant species, and to collect plant mass samples from grasslands to assess productivity and their grazing potential. In the research 238 plant species were identified and spring and summer grassland yields were measured showing a wide range of productivity that can reach up to 3.8 t ha<sup>-1</sup> of dry mater. In addition to flora, birds dependent on the Dinaric habitat type, such as ortolan bunting (*Emberiza hortulana*), short-toed lark (*Calandrella brachydactyla*) and stone-curlew (*Burhinus oedicephalus*), whose occurrence was mapped. This research provided preliminary data that will be incorporated into the final results of the project, which will ultimately help develop guidelines for grassland management and their sustainable use in the Dinara area.

**Key words:** Dinara, pastures, LIFE, biodiversity, birds

## Ekološki prihvatljivo suzbijanje kukaca primjenom biorazgradivih mikrosfera na bazi apitoksina

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### Sažetak

Uporaba agrokemikalija u poljoprivredi ima znatne posljedice na onečišćenje okoliša. Sve je manje aktivnih tvari na tržištu zbog nepovoljnih toksikoloških svojstava, što dodatno otežava uobičajenu zaštitu bilja. Osim toga uslijed dugogodišnje i nepravilne uporabe sredstva za zaštitu bilja često dolazi do razvoja rezistentnosti brojnih vrsta kukaca. Nužno je istražiti nove formulacije i nove ekološki prihvatljive aktivne tvari. Jedna od mogućih novih ekološki prihvatljivijih formulacija su mikrosfere. Alternativa i zamjena sintetičkim kemikalijama mogu biti prirodni toksini koje proizvode brojni člankonošci kao što je apitoksin. Cilj ovoga istraživanja bio je utvrditi učinkovitost apitoksina u suzbijanju štetnih kukaca. Istraživanje je provedeno na tri različite vrste kukaca u odraslom i ličinačkom razvojnom stadiju (*Leptinotarsa decemlineata*, *Tenebrio molitor*, *Sitophilus granarius*). Procedure su optimizirane te je utvrđeno želučano i kontaktno djelovanje apitoksina. Mikrosfere s apitoksinom imaju dugo početno i rezidualno djelovanje, zbog sporog otpuštanja apitoksina iz mikrosfere. U istraživanju je utvrđeno značajno bolje želučano u usporedbi s kontaktnim djelovanjem na kukce. Podaci istraživanja pridonijeti će ukupnom znanju o primjeni i razvoju inkapsuliranih formulacija, a mikrosfere apitoksina imaju potencijal da postanu alternativa u ekološkoj i visoko dohodovnoj proizvodnji.

**Ključne riječi:** apitoksin, inkapsulacija, mikrosfere, mortalitet, učinkovitost, štetnici

## Environmentally friendly pest management using biodegradable apitoxin based microspheres

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### Summary

The use of agrochemicals in agriculture has significant implications for environmental pollution. Fewer active substances are available on the market due to their adverse toxicological properties. In addition, due to the long-term and improper use of plant protection agents, there has been a development of pest resistance. It is necessary to explore new formulations and new environmentally friendly active substances. Microspheres are one of possible new environmentally friendly formulations. Alternatives and replacements for synthetic chemicals can be natural toxins produced by numerous members of the arthropods such as apitoxin. The main goal of this study was to determine the effectiveness of apitoxins formulated as microspheres on harmful insects. The research was carried out on three different pest species in adult and larval developmental stages (*Leptinotarsa decemlineata*, *Tenebrio molitor*, *Sitophilus granarius*). Procedures were optimized and apitoxin microspheres' stomach and contact efficacy have been tested. Apitoxin microspheres have a long initial and residual action, due to the slow release of apitoxin from the microsphere. Results shown that apitoxin has a harmful effect especially after insect digestion. Research data will contribute to overall knowledge of the application and development of encapsulated formulations, and apitoxin microspheres have the potential to become an alternative control method in organic and high-income production.

**Key words:** apitoxin, encapsulation, microspheres, mortality, efficiency, pest

## Procjena izvedbe leta invazivne vrste *Cydalima perspectalis* (Walker) korištenjem mlina za letenje

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### Sažetak

*Cydalima perspectalis* (Walker) (Lepidoptera: Pyralidae) invazivni je moljac porijeklom iz istočne Azije. U Hrvatskoj je prisutan od 2012. godine. Gusjenice su vrlo proždrljive i nanose štetu hraneći se lišćem i korom biljaka iz roda *Buxus*. Mlade ličinke teško je primijetiti jer se hrane zaštićene između dva uvrnuta lista zbog čega mjere zaštite u pravo vrijeme često izostanu. Jaki napad dovodi do sušenja i odumiranja biljaka. Trgovina živim biljkama najvjerojatniji je put unosa u nova područja. Brzina širenja šimširovog moljca do 10 km godišnje posebno je zabrinjavajuća. Prirodno prisutne vrste šimšira, kao i one koje predstavljaju kulturnu baštinu, ozbiljno su ugrožene ovim štetnikom. Cilj istraživanja bio je koristiti mlin za letenje, jednostavnu i jeftinu metodu, u procjeni izvedbe leta šimširovog moljca. Pomoću četiri mlina za letenje i u prirodnim uvjetima praćene su karakteristike leta populacije šimširovog moljca poput trajanja i broja letova te brzine i udaljenosti pojedinih letova. Poznavanje izvedbe leta vrste *C. perspectalis* od velike je važnosti za procjenu potencijalne štete, posebno zbog relativno visokog prirodnog potencijala širenja te činjenice da u našim uvjetima može razviti do tri generacije godišnje.

**Ključne riječi:** brzina širenja, karakteristike leta, prirodni potencijal širenja, šimširov moljac

## Flight mill in assessment of invasive *Cydalima perspectalis* (Walker) flight propensity and performance

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### Summary

*Cydalima perspectalis* (Walker) (Lepidoptera: Pyralidae) is an invasive moth originating from East Asia. It is present in Croatia since 2012. Its larvae are highly voracious and causing damages by feeding on the leaves and the bark of *Buxus* plants. Young larvae are hard to notice since they feed sheltered between two spun leaves. As a result, protection measures at the right time are often lacking. Severe infestation leads to drying and death of plants. Trade of live plants is the most likely route of introduction into new areas. Its natural dispersal velocity of up to 10 km per year is of particular concern. Naturally present *Buxus* species as well as those that represent the cultural heritage are seriously endangered by this pest. Aim of this research was to use the flight mill, an easy and cheap method, in testing flight propensity and performance of box tree moth. Flight characteristics such as duration and number of flights as well as velocity and distance of individual flights were monitored by four flight mills in *C. perspectalis* population under naturally occurring conditions. Knowledge of *C. perspectalis* flight propensity is of great importance for estimation of the potential damage especially when having in mind that *C. perspectalis* has up to three generations per year and relatively high self-spread potential.

**Keywords:** box tree moth, dispersal velocity, flight characteristics, self-spread potential



## Najznačajnije biljne svojte planine Dinare

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### Sažetak

Dinara je planinski masiv koji se odlikuje mediteranskom, submediteranskom i kontinentalnom klimom. Istraživanje flore provedeno je tijekom 2018. i 2019. godine. Utvrđeno je 30 stenoendemičnih i subendemičnih svojti koje imaju usku rasprostranjenost, kao što su između ostalih: dinarska oštrica (*Oxytropis dinarica* ssp. *velebitica*), dinarska prženica (*Knautia dinarica*), hrvatska bresina (*Micromeria croatica*), dalmatinska žutilovka (*Genista sylvestris* ssp. *dalmatica*), dalmatinski crni bor (*Pinus nigra* ssp. *dalmatica*), velecvjetni rožac (*Cerastium grandiflorum*), Arduinov dubačac (*Teucrium arduinii*), modro lasinje (*Moltkia petraea*), vriskova čestoslavica (*Veronica saturejoides*), krutolisna majčina dušica (*Thymus striatus*) i druge. Ustanovljeno je da su 22 svojte suočene s rizikom i opasnošću od izumiranja te imaju neku od IUCN-ovih kategorija ugroženosti. Na području Dinare rastu i svojte koje se navode u Prilozima II, IV i V Direktive o zaštiti prirodnih staništa i divlje faune i flore: dinarski rožac (*Cerastium dinaricum*), Skopolijeva gušarka (*Arabis scopoliana*), livadski procjepak (*Chouardia litardierei*), nerazgranjeni srpac (*Serratula lycopifolia*) i bodljikava veprina (*Ruscus aculeatus*). Istražene svojte rastu na staništima kamenjarskih kraških područja i vrhovima planine gdje su izolirane, stoga je velika njihova ekološka važnost u zaštiti vegetacije i tla planinskih livada i pašnjaka važnih u kontekstu tradicionalnog stočarstva.

**Ključne riječi:** biljna raznolikost, ugrožene biljke, endemične biljke, Dinara

## The most important plant taxa of the Dinara mountain

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### Summary

Dinara is a mountain massif characterized by a mediterranean, sub-mediterranean and continental climate. The study of flora was conducted during 2018 and 2019, and 30 stenoendemic and subendemic taxa with a narrow distribution were identified, such as among others: *Oxytropis dinarica* ssp. *velebitica*, *Knautia dinarica*, *Micromeria croatica*, *Genista sylvestris* ssp. *dalmatica*, *Pinus nigra* ssp. *dalmatica*, *Cerastium grandiflorum*, *Teucrium arduinii*, *Moltkia petraea*, *Veronica saturejoides*, *Thymus striatus* and others. It was found that 22 taxa face the risk and danger of extinction and have one of the IUCN endangerment categories. On the Dinara area, also the species listed in Annexes II, IV and V of the Directive on the Protection of Natural Habitats and Wild Fauna and Flora grow: *Cerastium dinaricum*, *Arabis scopoliana*, *Chouardia litardierei*, *Serratula lycopifolia* and *Ruscus aculeatus*. The investigated taxa grow in the habitats of rocky karst areas and mountain peaks where they are isolated, therefore they have a great ecological importance in the protection of vegetation and soil of the mountain meadows and pastures area important in the context of traditional livestock.

**Key words:** plant diversity, endangered plants, endemic plants, Dinara

## **Preliminarna analiza erozije vodom na poljoprivrednim površinama Istarske županije RUSLE metodom, daljinskim istraživanjima i GISom**

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### **Sažetak**

Različite prakse obrade tla primjenjivane u procesu poljoprivredne proizvodnje, u kombinaciji s ostalim čimbenicima, pod utjecajem oborina dovode do erozije površinskog dijela tla različitog intenziteta. Erozijski intenzitet uvjetovan je raznim čimbenicima, a na poljoprivrednom zemljištu ističu se intenzitet oborina, reljefna svojstva područja, vegetacijski pokrov, fizikalna svojstva tla te smjer obrade tla. Cilj ovog rada je integrirano primijeniti daljinska istraživanja s RUSLE (Revised Universal Soil Loss Equation) metodologijom pri utvrđivanju intenziteta oborinske erozije na poljoprivrednim površinama na području Istarske županije. Korištenjem daljinskih istraživanja temeljenih na Sentinel 1 i 2 satelitskim snimkama, analizom digitalnog modela reljefa i oborinskih parametara te terenskim prikupljanjem uzoraka tla za određivanje njegovih fizikalnih svojstava, čimbenici oborinske erozije na poljoprivrednim površinama obrađeni su putem GIS programskih alata te kvantificirani putem RUSLE metodologije. Dobiveni rezultati ukazuju na različite razine intenziteta erozijskih procesa koji se mogu utvrditi primjenom metoda daljinskih istraživanja i predstavljaju ishodište za buduća istraživanja erozije tla oborinskom vodom u Republici Hrvatskoj. Dobiveni podaci doprinijet će donošenju pravovremenih mjera očuvanja poljoprivrednog tla i sprječavanju nepovratnih gubitaka tla.

**Ključne riječi:** erozija, daljinska istraživanja, RUSLE metoda, poljoprivredno tlo

## **Preliminary analysis of water erosion in agricultural areas of Istria County by RUSLE method, remote sensing and GIS**

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### **Summary**

Different tillage practices applied in the process of agricultural production, in combination with other factors, lead to different intensity of surface soil erosion under the influence of precipitation. The erosion intensity is conditioned by various factors, and on the agricultural land the most important ones are the intensity of precipitation, relief properties of the area, the vegetation cover, the physical properties of the soil and the direction of cultivation. The aim of this paper is to integrate remote research with RUSLE (Revised Universal Soil Loss Equation) methodology in determining the intensity of precipitation erosion on agricultural land in the Istria County. Using remote sensing based on Sentinel 1 and 2 satellite images, analysis of digital relief model and precipitation parameters and field collection of soil samples to determine its physical properties, precipitation erosion factors on agricultural land were processed using GIS software tools and quantified using RUSLE methodology. The obtained results indicate different levels of intensity of erosion processes that can be determined by applying the method of remote sensing and represent the starting point for future research of soil erosion by rainwater. The obtained data will contribute to the adoption of timely measures for the preservation of agricultural soil and the prevention of irreversible soil losses.

**Key words:** Erosion, Remote sensing, RUSLE method, agricultural soil

## Mogući model obnove Banove Jaruge s ciljem oblikovanja modernog sela

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### Sažetak

Svakodnevno mediji govore o odlasku mladih sa sela, napuštanju ruralnih područja u potrazi za boljim životom. Ruralna područja danas su zapuštena, neperspektivna i razlog odlaska mladih. Takvo selo je Banova Jaruga. Odnos lokalnih samouprava prema selu i ruralnim područjima općenito, odnosno kratkotrajni i dugoročno neodrživi projekti ulaganja u sela, jedan su od uzroka napuštanja istih. Ni jedno hrvatsko selo nema zaokruženu proizvodnu strukturu. Prema načelima održivog razvoja, selo bi moralo stajati u centru političkih i gospodarskih programa u Republici Hrvatskoj. Osnovni cilj ovog rada je pružiti model „Pametnog sela“ kako prilagoditi razvoj sela suvremenim načinima življenja, zadovoljiti potrebe stanovništva, zaustaviti odlazak mladih ljudi u gradove i riješiti sve gore navedene probleme na primjeru kibuca Geva u Izraelu. Model se oslanja se na prirodne resurse i njihovu zaštitu, tj. kontrolirano iskorištavanje i na moderne tehnologije zelene gradnje i obnovljivih izvora energije. To podrazumijeva prodaju na veliko i malo i zatvoren ciklus potreba dnevne košarice stanovnika za hranom prema principima održivog razvoja, ekološke poljoprivredne proizvodnje, zelene gradnje i korištenja obnovljivih izvora energije. U radu je prikazan izgled zaokruženog urbanog ruralnog prostora te ekonomski samoodrživog ciklusa proizvodnje, prerade i plasmana poljoprivrednih proizvoda prikazanih cjelina. Unutar ovog rada prikazana je povijesna geneza Banove Jaruge, te njen identitet prema K. Lynchu i Godronu i Formanu.

**Ključne riječi:** moderno selo, kibuc, povijesna geneza

## **A Potential Reconstruction Model of Banova Jaruga, with the Aim of a Modern Village Formation**

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### **Summary**

Every day, the media speak about younger population leaving the countryside and leaving the rural areas looking for the sake of a better life. These rural areas are left deserted, offer no perspective, and become the reason because of which the young generations leave. This is the case with Banova Jaruga. The local government's attitude toward the village and rural areas in general, i.e., long- and short-term unsustainable projects, are one of the main reasons for the young people to leave. There is no single Croatian village that has an actual rounded production structure. According to the sustainable development norms, a village should be in the center of Croatia's political and economic programs. The main goal of this paper is to present a model a "smart village" and of an adjustment to the modern living, satisfying the population's needs, keeping younger generations interested, and solving all problems already stated above, as done in the kibbutz of Geva, Israel. This model relies on the natural resources and their protection, i.e., on a controlled exploitation, modern green building technologies, and renewable energy sources. This entails wholesale and retail sales, and a closed cycle of the populations' daily food needs, according to the sustainable development norms, eco agriculture, green building, and the usage of renewable energy sources. This paper shows a rounded urban, rural space and an ecological self-sustaining production cycle, incorporating the processing and placement of agricultural products in the shown parts. The historic genesis of Banova Jaruga is shown, as well as its identity, according to K. Lunch and Godron and Forman.

**Keywords:** modern village, kibbutz, historical genesis

## Cyanobacterial blooming in the Fehérvárcsurgó reservoir, Hungary

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### Summary

Cyanobacteria are prokaryotic photosynthetic organisms known to uncontrollably proliferate in water ecosystems characterized by poor water quality and eutrophication. During their proliferation (cyanobacterial blooming), cyanobacteria are known to enter secondary metabolism and start producing toxic compounds - cyanotoxins. Therefore, regular monitoring of freshwater ecosystems is needed. During our research on the Fehérvárcsurgó reservoir (Hungary) during 2018, we have observed a blooming event characterized by the presence of a large number of cyanobacterial cells (up to 2.8 million cells/ml). The most dominant species were *Aphanizomenon flos-aquae*, *Microcystis flos-aquae* and *Microcystis wesenbergii*. In July and September the microcystin-synthetase encoding gene *mcyE* and the saxitoxin-synthetase encoding gene *sxtG* were amplified in the biomass samples. A very low concentration of a common cyanotoxin – microcystin-RR was detected in the water sample in July, however, no accumulation of this toxin was observed in the tissues of *Abramis brama* and *Carassius gibelio* caught from the reservoir. Certain histopathological alterations in the livers, kidneys and gills of these fish were observed. Obtained results suggest that cyanobacterial blooming is occurring in the Fehérvárcsurgó reservoir, therefore, further monitoring is necessary to determine the potential adverse effects of blooming and presence of cyanotoxins in this multipurpose freshwater ecosystem.

**Key words:** cyanobacteria, cyanotoxins, fish histopathology, freshwater ecosystem, monitoring

## Utjecaj tipa i primjene malča na sadržaj vode u tlu

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### Sažetak

Malčiranje je agrotehnička mjera kojom se pokriva tlo s osnovnim ciljem zaštite od temperaturnih ekstremna, širenja korova i gubitka vode iz tla. Dva su osnova tipa malča, organski i sintetički koji pored osnovnih uloga također poboljšavaju strukturu tla, smanjuju mogućnost erozije te stvaranje pokorice. Na taj način malčevi direktno ili indirektno utječu na sadržaj i dinamiku vode u tlu što je analizirano ovim radom. Malč ublažava udarce krupnijih kapljica te na taj način sprječava stvaranje pokorice, odnosno sprječava sporu infiltraciju vode u tlo. Nadalje, organski malč koji se u tlu razgrađuje popravlja strukturu tla, aeraciju te vodozračne odnose. Umanjuje se gubitak vode putem evaporacije jer štiti tlo od pretjeranog zagrijavanja tijekom ljetnih mjeseci. Važno je odabrati najpovoljniji tip i način primjene malča u smislu debljine sloja, ovisno o uzgajanoj kulturi i preostaloj agorethnici. Kod navodnjavanja metodom kišenja, dolazi do sniženja prinosa radi spore infiltracije na pregusto postavljenom malču koji sam po sebi ima mogućnost upijanja i zadržavanja vode. Stoga je preporuka kod metode kišenja da interval navodnjavanja ne bi trebao biti učestaliji od šest do sedam dana. Pojedini literaturni navodi ne prave razliku između tipa malča već ističu važnost debljine sloja malča. Što se tiče optimalnog odnosa između zadržavanja i propuštanja vode od strane malča, preporuka je upotrebljavati sjeckanu koru te organski malč.

**Ključne riječi:** tip malča, primjena, voda u tlu



## The impact of mulch type and application on soil water content

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### Summary

Mulches are layers of different materials placed on a soil surface to protect the soil from temperature extremes, weed spreading, and to conserve soil water. In general, there are two types of mulch, organic and inorganic mulches that in addition to its main purpose, also improve soil structure, reduce erosion, and soil crusting. For that reason, the mulches have a direct or indirect impact on soil water content which is discussed in this manuscript. Mulch decreases the negative impact of water droplets on the soil surface and so reduces the soil crust, meaning it prevents slow water infiltration. Organic mulch that decomposes in soil improves soil structure and air/water capacity. Water losses caused by the process of evaporation are reduced due to the protection of the soil from high air temperatures during the summer months. Also, it is important to choose the right type and mulch application for specific crop management. For example, in head irrigation systems mulch reduces soil infiltration by absorbing irrigation water and therefore causes yield losses. Hence the recommendation for head irrigation is to keep an irrigation interval between six to seven days. Literature review suggest that there are no differences between the type of mulch but emphasize the importance of mulch layer thickness. As for optimum ratio between water holding capacity and infiltration rate, it is recommended to use wood chip and organic mulch.

**Key words:** mulch type, application, soil water

## Istodobna biofortifikacija ozime pšenice cinkom i željezom

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### Sažetak

Agronomska biofortifikacija predstavlja najjednostavniji i najbrži način povećanja koncentracije Zn i Fe u zrnu. Ciljevi istraživanja su utvrditi utjecaj sorte i istodobne aplikacije mikroelementima Zn i Fe na povećanje koncentracije Zn i Fe u zrnu. Poljski pokus s 4 ozime sorte proveden uz 7 različitih tretmana aplikacije Zn i Fe: 1. kontrola, 2. aplikacija Zn u tlo u jesen, 3. Fe u jesen, 4. folijarna prihrana Zn, 5. folijarno Fe, 6. Zn + Fe u tlo i 7. Zn + Fe folijarno. Najveću koncentraciju Zn u zrnu ostvarila je sorta Divana (48,598 mg kg<sup>-1</sup>). Najveća koncentracija Zn u zrnu ostvarena je nakon folijarne aplikacije Zn (43,356 mg kg<sup>-1</sup>), te folijarne aplikacije Fe+Zn (41,298 mg kg<sup>-1</sup>). Značajno veću koncentraciju Fe u zrnu ostvarila je sorta Divana (47,377 mg kg<sup>-1</sup>) u odnosu na preostale tri sorte. Najveća koncentracija Fe (47,103 mg kg<sup>-1</sup>) u zrnu pšenice je rezultat folijarne aplikacije Fe, zatim folijarne aplikacije Fe + Zn (45,703 mg kg<sup>-1</sup>). Folijarna aplikacija Zn i Fe značajno povećava koncentraciju Zn i Fe u zrnu. Najveća koncentracija Zn u zrnu ostvarena je nakon folijarne aplikacije Zn ili Fe+Zn. Najveća koncentracija Fe je ostvarena nakon folijarne aplikacije Fe. Sorte i biofortifikacija Zn i Fe su značajno utjecali na koncentraciju Zn i Fe u zrnu.

**Ključne riječi:** pšenica, mikroelementi, agronomska biofortifikacija, sortna specifičnost, folijarna aplikacija

## Simultaneous Biofortification of Winter Wheat with Zinc and Iron

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### Summary

Agronomic biofortification is the simplest and fastest way to increase the concentration of Zn and Fe in the grain. The objectives of this research were determining the influence of cultivar and simultaneous application of microelements Zn and Fe into the soil and/or foliar on the increase of Zn and Fe concentration in wheat grain. A field experiment with 4 varieties of winter wheat was conducted with 7 different treatments of Zn and Fe application: 1. control, 2. application of Zn to the soil in autumn, 3. Fe to the soil, 4. foliar fertilization of Zn, 5. foliar Fe, 6. Zn + Fe in soil and 7. Zn + Fe foliar. The highest Zn concentration in the grain was gained by the cultivar Divana (48.598 mg kg<sup>-1</sup>). The highest Zn concentration in the grain was gained after foliar application of Zn (43.356 mg kg<sup>-1</sup>), and foliar application of Fe + Zn (41.298 mg kg<sup>-1</sup>). Significantly higher Fe concentration in the grain was gained by the cultivar Divana (47.377 mg kg<sup>-1</sup>) compared to the other three cultivars. The highest Fe concentration (47.103 mg kg<sup>-1</sup>) in wheat grain is the result of foliar Fe application, followed by foliar Fe + Zn application (45.703 mg kg<sup>-1</sup>). Foliar application of Zn and Fe significantly increases the concentration of Zn and Fe in the grain. The highest concentration of Zn in the grain was achieved after foliar application of Zn or Fe + Zn. The highest concentration of Fe was achieved after foliar application of Fe. Varieties and biofortification with Zn and Fe also significantly affected the concentration of Zn and Fe in the grain.

**Key words:** wheat, microelements, agronomic biofortification, cultivar diversity, foliar application

## Hlapive tvari masline – mogući atraktanti štetnika masline

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### Sažetak

Godinama je zaštita masline (*Olea europea* L.) od štetočinja, kod nas i u svijetu, bila usmjerena samo na uporabu pesticida, što je u zadnjih nekoliko desetljeća rezultiralo negativnim učinkom na okoliš. Očuvanje biološke ravnoteže i cjelokupnog agroekosustava, ključni je problem današnjice. Intenzivne agrotehničke mjere narušavaju sklad biocenoze maslinika, stoga se danas u maslinarstvu sve više pribjegava integriranom ili ekološki prihvatljivom sustavu proizvodnje u kojima je ograničena uporaba pesticida. Dosadašnja istraživanja pokazuju da prirodne hlapive tvari, uključujući feromone, hlapive tvari biljke domaćina, kvasaca i bakterija imaju utjecaj na ponašanje različitih vrsta kukaca. Cilj ovog istraživanja je izolacija i identifikacija hlapivih tvari masline te pronalazak onih koje bi mogle biti odgovorne za privlačenje najvažnijih štetnika masline. U sklopu istraživanja izolirane su i identificirane biljne hlapive tvari cvijeta, ploda i lista. Oblice u različitim fazama zrelosti ploda pomoću HS-SPME/GC-MS uređaja. Identificirano je više od 40 hlapivih tvari koji većinski pripadaju skupinama estera, zasićenih ugljikovodika, aldehida, alkohola, terpena i seskviterpena. Rezultati istraživanja mogli bi dati odgovore na mnoge nedoumice o uzajamnom odnosu maslina/štetnik, koji bi rezultirali velikim doprinosom u zaštiti bilja RH, ali i u svijetu.

**Ključne riječi:** zaštita bilja, integrirana zaštita bilja, ponašanje kukaca, hlapive tvari, *Olea europea* L.

## Olive volatiles - possible attractants of olive pests

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### Summary

For many years, olive (*Olea europea* L.) pest management has been based only on the use of pesticides, of which the result was negative affect on the environment. The preservation of biological balance and the entire agro-ecosystem is the biggest challenge of today. Intensive agriculture is responsible for imbalance of olive grove biocenosis and for that reason integrated and organic management is widely applied nowadays since they limit the use of pesticides. Current studies show that different insect species are attracted by volatile natural compounds, including a female-produced pheromone, and host-plant, yeasts and bacterial volatiles. The aim of the research was isolation and determination of olive volatile compounds and moreover identification of those that could be responsible for attracting the most important olive pests. Thus, plant volatile compounds of the flower, fruit and leaf were isolated and identified using a HS-SPME/GC-MS. More than 40 volatile compounds have been identified, mostly belonging to the groups of esters, saturated hydrocarbons, aldehydes, alcohols, terpenes and sesquiterpenes. The results of the research could provide answers to many doubts about the relationship between olive and pest that would be valuable result for the world plant protection.

**Key words:** plant protection, integrated pest management, insect behavior, volatile compounds, *Olea europea* L.

## Utjecaj navodnjavanja na alelopatski potencijal salate (*Lactuca sativa* L.)

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### Sažetak

Cilj istraživanja bio je utvrditi utjecaj vodnog stresa odnosno različitih normi navodnjavanja na alelopatski potencijal salate (*Lactuca sativa* L.). Pokus je proveden u Petrijevim zdjelicama prema potpuno slučajnom planu s tretmanima u šest ponavljanja u kontroliranim laboratorijskim uvjetima. Alelopatski potencijal vodenih ekstrakata pripremljenih od listova salate uzgajane pri različitim normama navodnjavanja (45 mm, 90 mm i 135 mm) testiran je u tri koncentracije (2,5 %, 5 % i 10 %) na klijavost sjemena i rast klijanaca rotkvice. Alelopatski utjecaj procijenjen je mjerenjem klijavosti sjemena, duljine korijena i izdanka, te svježe mase klijanaca rotkvice. Alelopatski potencijal vodenih ekstrakata salate ovisio je o normi navodnjavanja i koncentraciji. Povećanjem koncentracije vodenih ekstrakata povećavao se negativni alelopatski utjecaj, te je zabilježeno potpuno inhibitorno djelovanje (100 %) na klijavost i rast klijanaca rotkvice u tretmanima s ekstraktima najviše koncentracije. Vodni stres uzrokovao je veći negativni alelopatski potencijal. Vodeni ekstrakti koncentracije 5 % pripremljeni od salate uzgajane pri dvije niže norme navodnjavanja od 45 mm i 90 mm imali statistički značajno jače inhibitorno djelovanje od ekstrakata salate uzgajane pri normi navodnjavanja od 135 mm na sve mjerene parametre.

**Ključne riječi:** alelopatija, vodni stres, norma navodnjavanja, salata, rotkvica

## Effect of irrigation on allelopathic potential of lettuce (*Lactuca sativa* L.)

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### Summary

The aim of this study was to determine the influence of water stress i.e. different net irrigation water on the allelopathic potential of lettuce (*Lactuca sativa* L.). The experiment was conducted in Petri dishes as a completely randomized design with treatments in six replicates under controlled laboratory conditions. Allelopathic potential of water extracts prepared from lettuce grown at three different net irrigation water (45 mm, 90 mm and 135 mm) was tested in three concentrations (2.5%, 5% and 10%) on seed germination and seedling growth of radish. Allelopathic effect of water extracts was evaluated through seed germination, root and shoot length and fresh weight of radish seedlings. The allelopathic potential of lettuce water extracts depended on the net irrigation and concentration. Negative allelopathic effect increased with the increase of water extracts concentration, and a complete inhibitory effect (100%) on germination and seedlings growth of radish was observed in treatments with extracts of the highest concentration. Water stress caused a higher negative allelopathic potential. Water extracts at 5% concentration prepared from lettuce grown at two lower net irrigation treatments of 45 mm and 90 mm had a statistically significantly stronger inhibitory effect than extracts from lettuce grown at net irrigation treatment of 135 mm on all measured parameters.

**Key words:** allelopathy, water stress, net irrigation, lettuce, radish

## Ozon u kapljicama i maglici u inhibiciji patogene mikrobiote

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### Sažetak

Ozon je jak antimikrobni agens zbog progresivne oksidacije staničnih komponenti mikroorganizama. Ozon je učinkovit protiv širokog spektra gram-pozitivnih i gram-negativnih bakterija i mikroskopskih gljivica. Međutim, puno je faktora koji mogu utjecati na rezultate istraživanja kao što je vrsta i biomasa mikrobnog kulture te koncentracija ozona koji se aplicira. Osnovni cilj ovog istraživanja bio je utvrditi utjecaj ozona otopljenog u vodi na patogeni mikrobiotu koja izaziva bolesti kod ljudi, životinja i biljaka. Ukupno je bilo testirano deset različitih potencijalnih patogena kao i djelovanje dvije koncentracije ozona (4 i 2 ppm) apliciranog u obliku kapljica i maglice. Ozon otopljen u vodi pokazao je izrazito inhibitorno djelovanje na patogene bakterije kada je apliciran u obliku kapljica, neovisno o korištenoj koncentraciji. Efikasnost redukcije brojnosti testiranih bakterija iznosila je 89,71-99,99 % pri koncentraciji 4 ppm i 89,35-99,99 % pri 2 ppm. Aplikacija ozona u obliku maglice pokazuje nižu efikasnost (10,19-99,70 %) u odnosu na aplikaciju u obliku kapljica (44,91-99,99 %). Suprotno, aplikacija ozona u obliku maglice je efikasnija u suzbijanju rasta plijesni *Botrytis cinerea*. Koncentracija ozona od 4 ppm aplicirana u obliku kapljica pokazala se najefikasnijom u inhibiciji mikrobnog rasta bakterija, dok se ista koncentracija ozona aplicirana u obliku maglice pokazala najefikasnijom u suzbijanju rasta plijesni.

**Ključne riječi:** ozon, patogene bakterije i plijesni, inhibicija mikrobnog rasta



## Ozone in droplets and nebula in inhibition of pathogenic microbiota

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### Summary

Ozone is a strong antimicrobial agent due to the progressive oxidation of cellular components of microorganisms. Ozone is effective against a wide range of gram-positive and gram-negative bacteria and microscopic fungi. However, there are many factors that can affect the results of investigation such as the type and biomass of the microorganism and the concentration of ozone applied. The main objective of this study was to determine the effect of ozone dissolved in water on a pathogenic microbiota that causes disease in humans, animals and plants. A total of ten different potential pathogens as well as the action of two concentrations of ozone (4 and 2 ppm) applied in the form of droplets and nebulae were tested. Ozone dissolved in water showed a pronounced inhibitory effect on pathogenic bacteria when applied in the form of droplets, regardless of the concentration used. The reduction efficiency of the number of tested bacteria was 89.71-99.99% at a concentration of 4 ppm and 89.35-99.99% at 2 ppm. The application of ozone in the form of a nebula shows lower efficiency (10.19-99.70%) compared to the application in the form of droplets (44.91-99.99%). In contrast, the application of ozone in the form of a nebula is more effective in suppressing the growth of *Botrytis cinerea* molds. A ozone concentration of 4 ppm applied in the form of droplets proved to be the most effective in inhibiting the microbial growth of the tested bacteria, while the same concentration of ozone applied in the form of a nebula proved to be the most effective in suppressing mold growth.

**Key words:** ozone, pathogenic bacteria and molds, inhibition of microbial growth

## Agronomska biofortifikacija suncokreta i soje cinkom

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### Sažetak

Nedostatak koncentracija mikroelemenata u hrani rezultira pothranjenošću koju je moguće riješiti agronomskom ili genetskom biofortifikacijom. Cilj istraživanja bio je utvrditi utjecaj folijarne aplikacije mikroelemenata na akumulaciju cinka (Zn) u zrnu suncokreta (*Helianthus annuus* L.) i soje (*Glycine max* L.). Pokus suncokreta postavljen je na jednom lokalitetu (Tenja), dok je pokus soje postavljen na dva lokaliteta (Tenja i Rakitovica) u istočnoj Hrvatskoj. Agronomska biofortifikacija suncokreta i soje provedena je folijarnom aplikacijom otopine ZnSO<sub>4</sub> (100gZn/l) u fenofazi cvatnje u količini od 3 kg/ha Zn i 6 kg/ha Zn. Folijarna aplikacija Zn nije utjecala na povećanje prinosa zrna suncokreta i soje, ali je povećala koncentraciju Zn u zrnu. Folijarna aplikacija Zn u količini od 3 kg/ha povećala je koncentraciju Zn u zrnu suncokreta za 63,4 % i koncentraciju Zn u zrnu soje za prosječno 17,5 %. Folijarna aplikacija Zn u većoj koncentraciji od 6 kg/ha Zn povećala je koncentraciju Zn u zrnu suncokreta za 61 % i koncentraciju Zn u zrnu soje za prosječno 17,8 %. U kontrolnom tretmanu u suncokretu je utvrđena koncentracija 39,47 mg/kg Zn, a nakon folijarne aplikacije s 3 kg/ha Zn 64,50 mg/kg Zn i sa 6 kg/ha Zn 63,56 mg/kg Zn. Kontrolni tretman u soji prosječno je imao koncentraciju 42,51 mg/kg Zn, a nakon folijarne aplikacije s 3 kg/ha Zn 49,95 mg/kg Zn i sa 6 kg/ha Zn 50,08 mg/kg Zn. Pokus je pokazao učinkovitost folijarne aplikacije cinkovim sulfatom na obogaćivanje biljnog materijala cinkom i opravdao postupak agronomske biofortifikacije s 3 kg/ha Zn dok aplikacija 6 kg/ha Zn nije dodatno povećala koncentraciju Zn.

**Ključne riječi:** folijarna aplikacija, zrno, suncokret, soja, cinkov sulfat

## **Agronomic biofortification of sunflower and soybean with zinc**

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### **Summary**

Insufficient concentration of microelements in food results in malnutrition that can be solved by agronomic or genetic biofortification. The aim of this study was to determine the effect of foliar application of microelements on the accumulation of zinc in sunflower (*Helianthus annuus* L.) and soybean (*Glycine max* L.) grain. The sunflower experiment was conducted in Tenja, while the soybean experiment was set up in Tenja and Rakitovica in eastern Croatia. Agronomic biofortification of sunflower and soybean was carried out by foliar application of zinc sulfate (ZnSO<sub>4</sub>) solutions (100g Zn/l) in the flowering phenophase with 3 kg Zn/ha and 6 kg Zn/ha. Foliar application of Zn did not affect on the yield of sunflower and soybean grains, whereas concentration of Zn in the grain was increased. Foliar application of 3 kg Zn/ha increased the concentration of Zn in sunflower grain by 63.4% and the concentration of Zn in soybean approximately by 17.5%. Foliar application of Zn at a higher concentration of 6 kg Zn/ha increased the concentration of Zn in sunflower grain by 61% and the concentration of Zn in soybean by an average of 17.8%. In the control treatment in sunflower, the concentration was determined to be 39.47 mg Zn/kg, and after foliar application with 3 kg Zn/ha was 64.50 mg Zn/kg and with 6 kg Zn/ha 63.56 mg/kg Zn. The control treatment had an average concentration of 42.51 mg Zn/kg, and after foliar application with 3 kg Zn/ha 49.95 mg Zn/kg and with 6 kg Zn/ha 50.08 mg Zn/kg. The experiment showed the efficiency of foliar application with zinc sulfate on the increase of zinc in the plant tissue, and justified the process of agronomic biofortification with 3 kg Zn/ha while the application of 6 kg Zn/ha did not further increase the concentration of Zn.

**Key words:** foliar application, grain, sunflower, soy, zinc sulfate

## Utvrđivanje fitotoksičnosti mliječne i maslačne kiseline testom klijavosti

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### Sažetak

Organske karboksilne kiseline fitotoksičnim učinkom mogu inhibirati rast biljaka, posebice u najranijim fazama. Cilj provedenog istraživanja bio je testom klijavosti kres salate i krastavca utvrditi fitotoksičnost različitih koncentracija mliječne i maslačne kiseline. Testom klijavosti analizirano je 7 različitih koncentracija kiselina (0,10 mM; 0,25 mM; 0,50 mM; 1,00 mM; 2,00 mM; 4,00 mM; 8,00 mM) uključujući i deioniziranu vodu kao kontrolni tretman (0,00 mM). Maslačna i mliječna kiselina nisu smanjile klijavost krastavca dok su klijavost kres salate značajno smanjile samo 3 najveće koncentracije maslačne kiseline (2,00 mM, 4,00 mM i 8,00 mM). Obje kiseline smanjile su duljinu korijena krastavca uz fitotoksični učinak mliječne kiseline u koncentracijama  $\geq 0,50$  mM i maslačne kiseline u koncentracijama  $\geq 4,0$  mM. Istovrsni fitotoksični učinak na korijen kres salate utvrđen je za mliječnu kiselinu samo u najvećoj koncentraciji (8 mM), a za maslačnu kiselinu već u koncentracijama  $\geq 2,0$  mM. Međutim, za razliku od krastavca, na korijen kres salate utvrđen je i fitostimulativni učinak niskih koncentracija maslačne kiseline (0,1 mM; 0,25 mM i 0,50 mM) i gotovo svih istraživanih koncentracija ( $\leq 4,0$  mM) mliječne kiseline. Indeks klijavosti krastavca također je bio indikator fitotoksičnog učinka mliječne (koncentracije  $\geq 0,50$  mM) i maslačne kiseline (koncentracije  $\geq 1,00$  mM), dok je indeks klijavosti kres salate bio u rasponu od fitostimulativnog (mliječna  $\leq 4,0$  mM i maslačna  $\leq 0,25$  mM) do fitotoksičnog učinka (mliječna 8,0 mM i maslačna  $\geq 2,0$  mM). Provedena istraživanja ukazuju da je krastavac bolji indikator fitotoksičnosti mliječne i maslačne kiseline, a kres salata otpornija na fitotoksičnost uz fitostimulativnu reakciju na niže koncentracije kiselina.

**Ključne riječi:** indeks klijavosti, krastavac, kres salata

## Evaluation of phytotoxicity of lactic and butyric acids using the seed germination bioassay

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### Summary

Organic carboxylic acids can inhibit plant growth with a phytotoxic effect, especially in the earliest stages. The aim of the study was to determine the phytotoxicity of different concentrations of lactic and butyric acid by the germination test with watercress and cucumber. The germination test included 7 increasing acid concentrations (0.10 mM; 0.25 mM; 0.50 mM; 1.00 mM; 2.00 mM; 4.00 mM; 8.00 mM) including deionized water as a control treatment (0.00 mM). Butyric and lactic acid did not reduce the germination of cucumber while the germination of watercress was significantly reduced by only the 3 highest concentrations of butyric acid (2.00 mM, 4.00 mM and 8.00 mM). Both acids reduced cucumber root length with a phytotoxic effect of lactic acid at concentrations  $\geq 0.50$  mM and butyric acid at concentrations  $\geq 4.0$  mM. A similar phytotoxic effect on watercress root was found for lactic acid only in the highest concentration (8 mM), and for butyric acid in concentrations  $\geq 2.0$  mM. However, in contrast to cucumber, the phytostimulative effect of low concentrations of butyric acid (0.1 mM; 0.25 mM and 0.50 mM) and almost all investigated concentrations ( $\leq 4.0$  mM) of lactic acid was found on the root of watercress. The germination index of cucumber was also an indicator of the phytotoxic effect of lactic (concentration  $\geq 0.50$  mM) and butyric acid (concentration  $\geq 1.00$  mM), while the germination index of watercress was in the range of phytostimulative (lactic  $\leq 4.0$  mM and butyric  $\leq 0.25$  mM) to phytotoxic effect (lactic 8.0 mM and butyric  $\geq 2.0$  mM). Studies indicate that cucumber is a better indicator of phytotoxicity of lactic and butyric acid, and watercress is more resistant to phytotoxicity with a phytostimulative reaction to lower acid concentrations.

**Key words:** germination index, cucumber, watercress

## Fly bioash accelerates dissipation dynamics of the herbicide terbuthylazine in the aquatic matrix

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### Summary

Pesticides often become emergent chemicals in aquatic systems shortly after application. As one of the widely used broad-spectrum herbicides, terbuthylazine (TBL) has been frequently detected in all types of natural waters. TBL is a lipophilic compound that tends to adsorb to organic matter in soil and has a high runoff potential to surface waters, where it dissipates very slowly under natural conditions. To date, remediation of TBL-contaminated surface waters has relied on challenging and variably effective processes such as physical adsorption to activated carbon, photocatalytic degradation by titanium oxide, ozonation, and bioremediation. Therefore, there is an economic need to explore the effectiveness of remediation of contaminated matrices using less expensive agents, especially industrial by-products such as biomass ash. In-depth characterization of wood fly ash (FA, from a modern cogeneration power plant facility), using state-of-the-art *in situ* approaches (Scanning Electron Microscopy, X-ray diffraction) raised the hypothesis that highly developed nano-microstructure and alkaline Ca/Mg/Si-enriched mineralogy of FA could be effectively used for removal of TBL from the watercourse. This study showed that FA addition at 1% w/v rate to the watercourse sample reduced the half-life of TBL from 14 days to 9 h vs. the control (distilled water) treatment. TBL was not detected in the alkaline (pH 12.4) treatment 48 h after the addition of FA, while in the control TBL remained at nearly 80% of its initial amount. These results show a promising starting point for the development of novel FA-based polymers, targeted for decontamination of aquatic ecosystems loaded with TBL and similar contaminants.

**Key words:** Pesticides, Wood fly ash, Water decontamination, Degradation, Scanning Electron Microscopy, X-ray diffraction

## Učinkovitost prirodnih polifenola u suzbijanju invazivne stjenice *Halyomorpha halys*

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### Sažetak

*Halyomorpha halys* invazivni je štetnik koji napada veliki broj biljnih vrsta, a ujedno je i neugodan molestant u urbanim sredinama. U svrhu suzbijanja vrste *H. halys* proučavana je učinkovitost mnogih pesticida, ali sintetske kemikalije mogu imati negativan utjecaj na korisne člankonošce, mogu uzrokovati povećanje populacije štetnika i razvoj rezistentnosti. S obzirom na navedeno, posebna pozornost pridaje se integriranom sustavu suzbijanja vrste *H. halys* koji je siguran i za kućnu uporabu. Glavni ciljevi ovog istraživanja bili su formulirati mikrokapsule na bazi ekstrakata lišća stevije i aronije, te utvrditi kontaktnu i želučanu učinkovitost. Pronađeni su optimalni parametri ekstrakcije, a fizikalno-kemijska svojstva mikrokapsula pokazala su toksične učinke na vrstu *H. halys*. Mikrokapsule na bazi stevije iskazale su vrlo dobru pesticidnu učinkovitost, posebno na ličinke štetnika nakon kontaktne i želučane primjene. Mikrokapsule na bazi aronije iskazale su slabiju učinkovitost, ali su ipak pokazale toksičnost nakon kontaktne primjene. Ovi rezultati pružaju prvi uvid u insekticidni učinak mikrokapsuliranih formulacija ekstrakata stevije i aronije na vrstu *H. halys* i mogu biti obećavajući alat u suzbijanju, posebno u urbanim područjima te u kućnoj upotrebi.

**Ključne riječi:** vodeni ekstrakti, *Stevia rebaudiana* Bertoni, *Aronia melanocarpa* (Michx.) Elliott 1821, insekticidni učinak, *Halyomorpha halys*

## **Efficacy of natural polyphenols in controlling the invasive brown marmorated stink bug *Halyomorpha halys***

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### **Summary**

*Halyomorpha halys* is an invasive pest that infests a large number of plant species and is also a human nuisance pest. The effectiveness of many pesticides in controlling *H. halys* has been studied, but synthetic chemicals can have a negative impact on beneficial arthropods, can cause an increase in pest outbreaks and resistance development. All this was the reason to investigate the potential control of *H. halys* in respect to integrated pest control practices and safe home use. The main objectives of this study were to formulate microcapsules loaded with extracts of stevia and black chokeberry leaves, and the evaluation of their contact and digestive toxicity. Optimal extraction parameters were found, and the physico-chemical properties of the microcapsules showed effects on *H. halys*. Stevia-based microcapsules have a very good pesticidal efficacy, especially in the larval stage after contact and digestive treatment. Microcapsules based on black chokeberry are less effective but still showed toxicity after contact application. These results provide first insights into the effect of microencapsulated formulations of stevia and black chokeberry extracts on the suppression of *H. halys* and could be a promising tool for the control of this species, especially in urban areas and in home use.

**Key words:** water extracts, *Stevia rebaudiana* Bertoni, *Aronia melanocarpa* (Michx.) Elliott 1821, insecticidal effect, *Halyomorpha halys*



## Pilot study of natural formulation activity in the protection of stored wheat and barley against stored-product insects

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### Summary

Stored-product insects are one of the major causes of losses in stored cereals. Most of the control measures still rely on the synthetic pesticide usage but due to their negative side effects on goods, human health and environment, there is an urgent need for alternative control. We developed natural formulation based on diatomaceous earth (DE) SilicoSec<sup>®</sup> enhanced with botanicals (essential oil lavender, corn oil and bay leaves dust) and silica gel. The aim of the study was to test the activity of developed formulation as a postharvest protectant of seed wheat and barley against *Sitophilus oryzae* (L.), *Rhyzopertha dominica* (F.) and *Tribolium castaneum* (Herbst). As a reference comparative value, DE SilicoSec<sup>®</sup> was used. After six months of storing under the simulated warehouse conditions, formulation completely suppressed initial population development of all three tested insect species both in wheat and barley. In wheat, complete suppression was detected at the dose of 500 ppm, against *T. castaneum*, and 600 ppm, against both *R. dominica* and *S. oryzae*. In barley, complete suppression was detected at the doses of 500 ppm, 400 ppm and 600 ppm against *R. dominica*, *T. castaneum* and *S. oryzae*, respectively. Overall, the results of this study indicate that developed natural formulation based on DE, botanicals and silica gel, was highly effective against three major stored product insect species providing long-term safe storage of wheat and barley seeds.

**Key words:** diatomaceous earth, botanicals, stored-product insects, long-term protectant, stored cereals

## Biofortifikacija soje i kukuruza selenom

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### Sažetak

Selen kao važan mikronutrijent ima značajnu ulogu u fiziološkim procesima kod ljudi, životinja, biljaka i mikroorganizama. Biofortifikacijom biljaka selenom povećava se njegova koncentracija u biljci, a u generativnoj fazi veliki dio selena bude translociran u zrno. Biofortifikacija kukuruza i soje selenom obavljena je folijarnom aplikacijom na tri lokaliteta: lokalitet 1 - Tenja, lokalitet 2 - Tenja i lokalitet 3 - Rakitovica. Cilj istraživanja bio je istražiti utjecaj folijarne aplikacije otopine natrijevog selenata na koncentraciju selena u zrnu soje i kukuruza. Četiri tretmana folijarne aplikacije provedeni su u fenofazi cvatnje soje i kukuruza (Se0 – kontrola bez selena, Se1 - 10 g/ha Se, Se2 – 20 g/ha Se i Se3 - 30 g/ha Se). Na lokalitetu 2 koncentracije selena u zrnu soje u odnosu na kontrolu (50,5 µg/kg Se) bile su 7, 21 i 37 puta veće na tretmanima Se1 (374,8 µg/kg Se), Se2 (1073,8 µg/kg Se) i Se3 (1879,3 µg/kg Se), dok su na lokalitetu 3 koncentracije tretmana Se1 (1003,1 µg/kg Se) i Se2 (1337,8 µg/kg Se) bile 26 i 35 puta veće od kontrole (38,7 µg/kg Se). Višestruko povećanje koncentracije selena utvrđeno je i u zrnu kukuruza na lokalitetima 2 i 3. Koncentracije selena u zrnu kukuruza na tretmanima Se1 (108,8 µg/kg Se), Se2 (223,3 µg/kg Se) i Se3 (361,8 µg/kg Se) na lokalitetu 3 bile su 25, 52 i 84 puta veće od kontrole (4,32 µg/kg Se), a na lokalitetu 1 bile su 40 (Se1 199,4 µg/kg Se), 50 (Se2 248,7 µg/kg Se) i 63 (Se3 309,1 µg/kg Se) puta veće od kontrole (4,9 µg/kg Se). Porast koncentracije selena u zrnu soje bio je veći na lokalitetu 3 nego na lokalitetu 1, a u zrnu kukuruza na lokalitetu 1. Folijarna aplikacija rastućih doza selena u obliku natrijevog selenata pokazala se učinkovitom, nije utjecala na prinos zrna soje i kukuruza, ali je rezultirala razmjernim porastima koncentracija selena u zrnu.

**Ključne riječi:** folijarna aplikacija, natrijev selenat, zrno, soja, kukuruz, selen

## Biofortification of soybean and maize with selenium

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### Summary

Selenium as an important micronutrient plays a significant role in physiological processes in humans, animals, plants and microorganisms. Biofortification of plants with selenium increases its concentration in the plant, and in the generative phase a large part of selenium is translocated into the grain. Biofortification of maize and soybean with selenium was performed by foliar application at three localities: locality 1 - Tenja, locality 2 - Tenja and locality 3 - Rakitovica. The aim of this study was to investigate the effect of foliar application of sodium selenate solution on the concentration of selenium in soybean and maize grain. Four foliar application treatments were performed in the flowering phenophase of soybean and maize (Se0 - control without selenium, Se1 - 10 g/ha Se, Se2 - 20 g/ha Se and Se3 - 30 g/ha Se). At locality 2, the concentrations of selenium in soybean compared to the control (50.5 µg/kg Se) were 7, 21 and 37 times higher in the treatments Se1 (374.8 µg/kg Se), Se2 (1073.8 µg/kg Se) and Se3 (1879.3 µg/kg Se), while at locality 3 the concentrations of treatment Se1 (1003.1 µg/kg Se) and Se2 (1337.8 µg/kg Se) were 26 and 35 times higher than control concentration (38.7 µg/kg Se). Multiple increase in selenium concentration was also found in maize grain at localities 2 and 3. Selenium concentrations in maize grain in treatments Se1 (108.8 µg/kg Se), Se2 (223.3 µg/kg Se) and Se3 (361.8 µg/kg Se) at locality 3 were 25, 52 and 84 times higher than the control (4.32 µg/kg Se), and at locality 1 were 40 (Se1 199.4 µg/kg Se), 50 (Se2 248,7 µg/kg Se) and 63 (Se3 309.1 µg/kg Se) times higher than the control (4.9 µg/kg Se). The increase in selenium concentration in soybean grain was higher at locality 3 than at locality 1, and in maize grain at locality 1. Foliar application of increasing doses of selenium in the form of sodium selenate proved effective, did not affect soybean and maize grain yield, but resulted in proportional increases in selenium concentrations in the grain.

**Key words:** foliar application, sodium selenate, grain, soy, corn, selenium

## Kres salata i krastavac kao indikatori fitotoksičnosti octene i limunske kiseline

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### Sažetak

Fitotoksičnost uzrokuje smanjenu klijavost, inhibira rast i razvoj biljke uz druge štetne učinke, a može biti uzrokovana solima, teškim metalima, fenolima, amonijskim oblikom dušika ili organskim kiselinama koje mogu nastati razgradnjom inkorporiranih svježih biljnih ostataka ili nezrelih organskih gnojiva. Cilj provedenog istraživanja bio je testom klijavosti utvrditi fitotoksičnost octene i limunske kiseline. Osnovna hipoteza istraživanja je da postoji razlika u fitotoksičnosti octene kiseline i limunske kiseline te da postoji razlika između kres salate i krastavca kao testnih vrsta. Za test klijavosti kres salate i krastavca korišteno je 20 sjemenki i 5 mL otopine rastućih koncentracija octene ili limunske kiseline (0,10 mM; 0,25 mM; 0,50 mM; 1,00 mM; 2,00 mM; 4,00 mM; 8,00 mM) te Petrijeve zdjelice, a kao kontrolni tretman korištena je deionizirana voda. Rezultati ukazuju da je krastavac osjetljiviji na fitotoksični učinak kiselina, ali je kres salata imala intenzivniju reakciju na različite koncentracije kiselina. Octena kiselina je intenzivnije utjecala na korijen kres salate i krastavca nego limunska kiselina, a kres salata je pogodnija kao indikator vrsta za osjetljivost na organske kiseline. Octena i limunska kiselina imaju visoki fitotoksični učinak u koncentracijama  $\geq 4,0$  mM. Fitostimulativni učinak nemaju na krastavac, a na kres salatu imaju u koncentracijama 0,5 mM i 1,0 mM, pri čemu je izraženiji fitostimulativni učinak octene nego limunske kiseline. Octena kiselina također ima veće raspone fitostimulativnog i fitotoksičnog učinka nego limunska kiselina, tj. krivulja utjecaja octene kiseline je strmija nego krivulja učinka limunske kiseline. Zaključno, octena kiselina je pri nižim koncentracijama fitostimulativnija, a pri višim koncentracijama fitotoksičnija nego limunska kiselina.

**Ključne riječi:** test klijavosti, fitotoksični učinak, indeks klijavosti, organska kiselina

## Watercress and cucumber as indicators of phytotoxicity of acetic and citric acid

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### Summary

Phytotoxicity causes a decrease in germination, inhibits plant growth and development along with other harmful effects, and can be caused by salts, heavy metals, phenols, ammonium nitrogen or organic acids that can be formed by the decomposition of incorporated fresh plant residues or immature organic fertilizers. The aim of the research was to determine the phytotoxicity of acetic and citric acid by a germination test. The main hypothesis research is that there is a difference in the phytotoxicity of acetic and citric acids and that there is a difference between watercress and cucumber as test species. 20 seeds and 5 ml of solutions of increasing concentrations of acetic or citric acid (0.10 mM; 0.25 mM; 0.50 mM; 1.00 mM; 2.00 mM; 4.00 mM; 8.00 mM) were used to test the germination of watercress and cucumber in Petri dishes. Deionized water was used as a control treatment. The results indicate that cucumber is sensitive to the phytotoxic effect of acid, but cress salad also had an intense reaction to different acid concentrations. Acetic acid had more intense effect on watercress and cucumber root than citric acid, and watercress is suitable as an indicator of species for sensitivity to organic acids. Acetic and citric acid have high phytotoxic effects at concentrations  $\geq 4.0$  mM. They do not have a phytostimulative effect on cucumber but they do have for watercress at a concentration of 0.5 mM and 1.0 mM, with a more pronounced phytostimulative effect of acetic than citric acid. Acetic acid also has larger ranges of phytostimulatory and phytotoxic effect than citric acid and the acetic acid curve is steeper than the citric acid curve. In conclusion, acetic acid is more phytostimulative at lower concentrations and more phytotoxic at higher concentrations than citric acid.

**Key words:** germination test, phytotoxicity, germination index, acetic acid, citric acid

## Sadržaj fosfora u cvjetači dostupan potrošačima grada Zagreba iz različitih kanala prodaje

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### Sažetak

Cvjetača (*Brassica oleracea* var. *botrytis*) je dvogodišnja kupusnjača koja je zbog svojih zdravstvenih koristi sve zastupljenija na tržištu. Fosfor, biljkama esencijalan mineral, utječe na prinos, ukorijenjivanje te prijelaz biljke u generativnu fazu dok u ljudskoj prehrani neophodan za zdravlje kostiju i zuba. Imperativ modernog tržišta jest ponuda nutritivno bogate i svježe hrane što omogućuje konkurentnost proizvođača na tržištu. Cilj rada bio je utvrditi sadržaj fosfora u cvjetači ponuđenoj potrošačima na području grada Zagreba. Uzorkovanje je provedeno u Zagrebu u tri trgovačka lanca, tri tržnice i tri prodavaonice ekoloških proizvoda. Nakon sušenja i homogeniziranja uzoraka te razgradnje mikrovalnom digestijom, sadržaj fosfora određen je spektrofotometrom. Sadržaj suhe tvari (ST) uzoraka cvjetače varirao je od 6,20 do 7,93 %, a prosječno najviše suhe tvari utvrđeno je u uzorcima iz trgovačkih lanaca (7,00 % ST). Sadržaj fosfora u suhoj tvari uzoraka cvjetače varirao je od 0,48 do 0,67 % P ST. Statistički najviše fosfora utvrđeno je u prodavaonicama ekoloških proizvoda (prosječno 0,65 % P ST), a najmanje u uzorcima s tržnica (prosječno 0,56 % P ST). U svježoj tvari cvjetače sadržaj fosfora varirao je od 61,93 do 110,83 mg P/100 g svježe tvari cvjetače. Dobiveni rezultati ukazuju da se unosom 100 g cvjetače može podmiriti 8,8-15,8 % dnevnih potreba čovjeka za fosforom što nisu zanemarive količine.

**Ključne riječi:** *Brassica oleracea* var. *botrytis*, P, prodajna mjesta, suha tvar, svježa tvar

## Phosphorous content of cauliflower available to consumers in the city of Zagreb from various sales channels

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### Summary

Cauliflower (*Brassica oleracea* var. *botrytis*) is a nutritious vegetable culture that is increasingly marketed due to its health benefits. Phosphorus, an essential mineral to plants, affects yield, rooting and development of the plant in the generative phase, while in human diet is essential for bone and tooth health. The imperative of modern market is the supply of nutritionally rich and fresh food which enables competitiveness of producers on the market. The goal of this research was to determine the phosphorus content of cauliflowers offered to consumers in the area of the city of Zagreb. Sampling has been carried out in the city of Zagreb in three retail chains, three markets and three organic products stores. After drying and homogenization, the samples were digested in a microwave oven followed by phosphorus determination by spectrophotometer. The content of dry matter (DM) in cauliflower samples varied between 6.20-7.93%, and on average the highest dry matter content was found in samples from retail chains (7.00% DM). The phosphorus content in dry matter of cauliflower samples varied between 0.48-0.67% P DM. Statistically, the highest phosphorus content was determined in organic product stores (on average 0.65% P DM), and the lowest in samples from markets (on average 0.56% P DM). In fresh cauliflower, the phosphorus content varied between 61.93-110.83 mg P / 100 g of fresh cauliflower. Obtained results indicate that by consuming 100 g of cauliflower can fulfil 8.8-15.8% of a recommended daily intake of phosphorus, which are not negligible amounts.

**Key words:** *Brassica oleracea* var. *botrytis*, dry weight, fresh weight, P, retail places

## ***Halyomorpha halys* (Stål, 1855) - do sada nepoznati štetnik masline u Hrvatskoj**

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### **Sažetak**

Mramorna stjenica *Halyomorpha halys* (Stål, 1855) (Hemiptera: Heteroptera: Pentatomidae) je invazivna vrsta stjenice podrijetlom iz istočne Azije. Sredinom 1990-ih slučajno je unesena u Sjedinjene Američke Države, gdje postaje ozbiljan poljoprivredni štetnik. U Europi je prvi puta zabilježena 2004. u Lihtenštajnu i 2007. u Švicarskoj, nakon čega se proširila diljem Europe, izuzev krajnjih sjevernoeuropskih zemalja. U Hrvatskoj je vrsta prvi puta zabilježena u siječnju 2017. godine u stambenoj zgradi u Rijeci. *H. halys* je polifagni štetnik te napada više od 300 kultiviranih i divljih biljnih vrsta, uključujući veliki broj vrsta voća i povrća. Ličinke i odrasli uzrokuju štete ishranom na pupovima, listovima, stabljikama i plodovima biljaka domaćina pri čemu napadnuti plodovi postaju deformirani. Tijekom 2019. i 2020. godine ličinke i imaga mramorne stjenice zamijećeni su na plodovima masline na nekoliko lokaliteta u Splitsko-dalmatinskoj županiji, a napadnuti su plodovi bili vidno deformirani. Populacija štetnika na pregledanim stablima nije bila visoka, što je vjerojatno rezultat provođenja programa zaštite insekticidima protiv najvažnijih štetnika masline. Prema statističkom ljetopisu Republike Hrvatske, maslina se 2017. godine uzgajala na 18683 ha, s ukupnom godišnjom proizvodnjom od 28947 tona, što ju čini jednom od najvažnijih poljoprivrednih kultura. Stoga su ovi nalazi polazište za daljnja istraživanja utjecaja ishrane mramorne stjenice na plodovima masline na količinu i kakvoću dobivenog ulja kao i njenu rasprostranjenost u Republici Hrvatskoj.

**Ključne riječi:** *Halyomorpha halys*, štete, maslina, Hrvatska



## ***Halyomorpha halys* (Stål, 1855) - unknown pest of olive in Croatia**

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### **Summary**

Brown marmorated stink bug *Halyomorpha halys* (Stål, 1855) (Hemiptera: Heteroptera: Pentatomidae) is an invasive species native to eastern Asia. During mid-1990s it was introduced into United States, where it became a serious agricultural pest. In Europe, *H. halys* was recorded for the first time in 2004 in Lichtenstein and 2007 in Switzerland, subsequently spreading throughout Europe, except for northernmost countries. The species was recorded in Croatia in January 2017 in an apartment building in the city of Rijeka. *H. halys* is a highly polyphagous pest, feeding on more than 300 species of cultivated and wild plants, including many fruit and vegetable species. Adults and nymphs damage host plants by feeding on buds, leaves, stems and fruits, causing deformations of attacked fruits. During 2019 and 2020 nymphs and adults of *H. halys*, as well as deformed olive fruits, were observed in several olive orchards in Split-Dalmatia county. Population density in olive orchards was rather low, probably due to insecticide treatments for the control of other olive pests. According to Croatian statistical yearbook for 2017, utilised area under olive orchards grossed 18683 ha, with total olive production of 28947 tonnes, which makes olive one of the most important agricultural crops in Croatia. Therefore, these findings present the basis for further research into effect of *H. halys* feeding on quantity and quality of olive oil retrieved from attacked olive fruits, as well as its distribution in Croatia.

**Key words:** *Halyomorpha halys*, damage, olive, Croatia

## Važnost travnjaka planine Obruč (SZ Dinaridi, Hrvatska) u zaštiti prirode

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### Sažetak

Travnjačke površine u području HR2000643 Obruč zauzimaju 824 ha i čine ovu planinu iznimnom u ekološkoj mreži Natura 2000 u PGŽ. Ti se travnjaci tradicionalno koriste za (transhumantnu) ispašu ovaca, a danas se ondje napasaju i konji. Cilj rada je sistematizirati i upotpuniti dosadašnje spoznaje o prirodoslovnoj važnosti travnjaka planine Obruča. Osnovne metode istraživanja uključuju izradu fitocenoloških snimaka Braun-Blanquetovim pristupom uz korištenje daljinskih istraživanja. Rezultati istraživanja ukazuju da se travnjaci Obruča mogu raščlaniti na veći broj sintaksona nego što je ranije bilo poznato. Posebnu je pažnju potrebno usmjeriti kompleksu endemičnih zajednica trave uskolisne šašike („*Seslerietum juncifoliae*“ s.l.), a napose zajednici *Genisto holopetalae*-*Caricetum mucronatae* Ht. 1956 koja nastanjuje ekstremna, buri izložena staništa i sadrži najznačajnije biljne endeme. Zanimljivost travnjaka Obruča jesu i krupni „vilinski krugovi“, nastali djelovanjem micelija gljiva, kao i erozijski žljebovi u kojima se dulje zadržava snijeg što uvjetuje posebne uvjete staništa i pripadajuće životne zajednice. Važne su i spoznaje da se koridorom travnjaka na Obruču koriste ptice tijekom hranjenja i migracija, a travnjake, osim domaćih životinja, redovito posjećuje divljač. Rezultati provedenog istraživanja potvrđuju iznimne prirodoslovne vrijednosti travnjaka Obruča i potrebu njihove zaštite.

**Ključne riječi:** Obruč, Natura 2000, ekološki (travnjački) koridor, *Genisto holopetalae*-*Caricetum mucronatae*, „vilinski krugovi“

## The importance of the grasslands of Mount Obruč (NW Dinarides, Croatia) in nature protection

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### Summary

Grasslands of the Ecological network "Natura 2000" area "HR2000643" - Mt Obruč occupies 824 ha and makes this mountain exceptional in terms of nature protection for Primorje and Gorski Kotar County, Croatia. Grasslands of Mt Obruč are traditionally used for sheep grazing known as transhumance but nowadays horses are grazed there, too. The aim of this research is to systematize and bring to light some current knowledge of Mt Obruč grasslands and the importance of nature protection. Basic research methods include phytocenologic records using the *Braun-Blanquet* approach and remote sensing. The results of the research indicate that the grasslands can be divided into a larger number of syntaxa than was previously known. Complex of endemic communities of narrow-leaved moor grass ("*Seslerietum juncifoliae*" s. l.), and especially the community *Genisto holopetalae-Caricetum mucronatae* Ht 1956, which inhabits extreme, wind-exposed habitats are of great importance for Mt Obruč area because of plant endemics. The so called *fairy rings*, created by the fungi mycelium, as well as erosion grooves in which snow lays longer during the spring are few more interesting phenomena taking place on Mt Obruč region. Moreover, the air corridor of the grasslands on the mountain area is used by birds during feeding and migration, and the grasslands itself is used both by domestic animals as well as wild ungulates. Finally, special ecological conditions of the habitats are associated with particular biological communities. The results of the research confirm both the exceptional natural values of Mt Obruč grasslands as well as the need for their protection.

**Key words:** Obruč, "Natura 2000", ecological (grassland) corridor, *Genisto holopetalae-Caricetum mucronatae*, fairy rings

## Agrokemijski pokazatelji plodnosti tla na području Istočne Hrvatske

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### Sažetak

Suvremena poljoprivredna proizvodnja značajno ovisi o upotrebi mineralnih gnojiva koja značajno utječu na kvalitetu i kvantitetu poljoprivrednih proizvoda.. Na području istočne Hrvatske u promatranom periodu od 2016. do 2019. u HAPIH -Centar za tlo uzorkovano je i analizirano 9.661 uzorak tla na dubini od 0 do 30 cm. Zastupljenost broja prosječnih uzoraka tla prema županijama: 1. Osječko-baranjska županija uzorkovano je 59 % (5.713) uzorka tla, 2. Vukovarsko-srijemskoj županiji uzorkovano je 38 % (3.630) uzoraka tla, 3. Virovitičko-podravskoj županiji uzorkovano je 1,5 % (161) uzoraka tla, 4. Brodsko-posavskoj županiji uzorkovano je 1 % (106) uzoraka tla, 5. Požeško-slavonskoj županiji uzorkovano je 0,5 % (51) uzorak tla. Minimalna vrijednost supstitucijske kiselosti tla iznosila je pH-KCl 3,55, dok je maksimalna vrijednost iznosila pH-KCl 8,54. Vrijednosti sadržaja humusa kretala se od 0,55 % do 7,82 %. Sadržaj fiziološki aktivnog fosfora iznosilo je od 1 mg P<sub>2</sub>O<sub>5</sub>/100 g tla do 43 mg P<sub>2</sub>O<sub>5</sub>/100 g tla. Dok se vrijednost sadržaja fiziološki aktivnog kalija kretala od 5 mg K<sub>2</sub>O/100 g tla do 60 mg K<sub>2</sub>O/100 g tla. Od toga u klasi 1 - vrlo dobre plodnosti tla nalazi se 49 % uzorkovanih površina, zatim u klasi 2 - umjerene plodnosti tla nalazi se 35 % analiziranih površina, slijedi klasa 3 - ograničene plodnosti tla gdje se nalazi 14 % analiziranih površina, dok u klasi 4 - vrlo ograničena plodnosti nalazi se 2 % analiziranih površina. Najviše analiziranih površina nalazi se u klasama vrlo dobre do umjerene plodnosti tla što ukazuje da su tla relativno pogodna za većinu uzgajanih kultura na području Istočne Hrvatske. Na temelju prikupljenih i obrađenih podataka kroz GIS alate izrađene su karte plodnosti tla.

**Ključne riječi:** analiza tla, plodnost tla, prostorna distribucija.

## Agrochemical indicators of soil fertility in eastern Croatia

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### Summary

Modern agricultural production significantly depends on the use of mineral fertilizers that significantly affect the quality and quantity of agricultural products. In the area of eastern Croatia in the observed period from 2016 to 2019 in HAPIH - Soil Center 9,661 soil samples were sampled and analyzed at a depth of 0 up to 30 cm. Representation of the number of average soil samples by counties: 1. Osijek-Baranja County 59% (5,713) of the soil sample were sampled, 2. Vukovar-Srijem Country where soil sampled 38% (3,630) soil samples, 3. Virovitica-Podravina County where soil sampled 15% (161) of soil samples, 4. Brod-Posavina County 1% (106) of soil samples were sampled, 5. Požega-Slavonia County 0.5% (51) soil samples were sampled. The minimum value of the substitution acidity of the soil was pH-KCl 3.55, while the maximum value was pH-KCl 8.54. The values of humus content ranged from 0.55% to 7.82%. The content of physiologically active phosphorus ranged from 1 mg P<sub>2</sub>O<sub>5</sub> / 100 g soil to 43 mg P<sub>2</sub>O<sub>5</sub> / 100 g soil. While the value of the content of physiologically active potassium ranged from 5 mg K<sub>2</sub>O / 100 g soil to 60 mg K<sub>2</sub>O / 100 g soil. Of that, in class 1 - very good soil fertility there are 49% of sampled areas, then in class 2 - moderate soil fertility there are 35% of analyzed areas, followed by class 3 - limited soil fertility where there is 14% of analyzed areas, while in class 4 - very limited fertility is found in 2% of the analyzed areas. Most of the analyzed areas are in the classes of very good to moderate soil fertility, which indicates that the soils are relatively suitable for most crops grown in Eastern Croatia. Based on the collected and processed data through GIS tools, soil fertility maps were made.

**Key words:** soil analyses, soil fertility, spatal distribution.

## Utjecaj klimatskih promjena na bilancu oborinske vode u tlu

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### Sažetak

Cilj rada je bio utvrditi utjecaj globalnih klimatskih promjena na temperaturu zraka, oborine, te viškove i manjkove vode koji se javljaju u tlima središnje i jugozapadne Istre tijekom razdoblja 1980. – 1999. i 2000. – 2019. godine. Analiza klimatskih značajki provedena je prema podacima DHMZ-a za klimatske postaje Pazin i Pula, a bilanca oborinske vode u rendzini i crvenici korištenjem računalnog programa Hidropedokalk. Usporedbom temperatura za klimatska razdoblja 1980. – 1999. i 2000. – 2019. godine, može se zaključiti da postoji značajan porast prosječne temperature zraka ( $P=0,01$ ) tijekom razdoblja 2000. – 2019. godine i to za  $0,9\text{ }^{\circ}\text{C}$  na području Pazina, odnosno za  $1,2\text{ }^{\circ}\text{C}$  na području Pule. Za oborine je također utvrđen značajni porast ( $P=0,05$ ) u razdoblju od 2000. - 2019. godine, ali samo na području Pazina. Rezultati proračuna bilance oborinske vode u rendzini i crvenici ukazuju da postoje razlike u vodnom režimu, kako između istraživanih lokacija, tako i između istraživanih razdoblja. Veći manjak vode u tlu utvrđen je na obje lokacije tijekom razdoblja 2000. – 2019. godine. Utvrđeni manjkovi vode koji su iznosili od 39,1 do 64,9 mm na području Pazina mogu uzrokovati smanjivanje prinosa maslina za 7,0 – 11,2 %. Na području Pule, utvrđeni manjak vode od 264,3 – 302,2 mm može smanjiti prinos maslina za čak 37,6 – 42,9 %. Analiza klimatskih čimbenika i rezultat proračuna bilance vode tla ukazuju na sve češće pojave klimatskih ekstrema što zahtijeva prilagodbu poljoprivrede tim klimatskim promjenama.

**Ključne riječi:** klimatske promjene, bilanca vode, tlo, Istra

## Influence of Climate Change on Water Balance in Soil

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### Summary

The aim of this study was to determine the impact of global climate change on air temperature, precipitation, and surpluses and shortages of water that occur in the soils of central and southwestern Istria during the periods 1980-1999 and 2000-2019. The analysis of climatic characteristics was performed according to the data of DHMZ for the climatic stations Pazin and Pula, and the balance of rainwater in rendzina and terra rossa using the computer program Hidropedokalk. By comparing temperatures for the climatic periods 1980-1999 and 2000-2019, it can be concluded that there is a significant increase in average air temperature ( $P = 0.01$ ) during the period 2000-2019 by  $0.9^{\circ}\text{C}$  in the area of Pazin, and by  $1.2^{\circ}\text{C}$  in the area of Pula. For precipitation, a significant increase was also found ( $P = 0.05$ ) in the period 2000-2019 but only in the area of Pazin. The results of the calculation of the rainwater balance in rendzina and terra rossa indicate that there are differences in the water regime, both between the investigated locations and between the studied periods. A greater shortage of water in the soil was found at both locations during the period 2000-2019. The identified water shortages, which ranged from 39.1 to 64.9 mm in the Pazin area, may cause a decrease in olive yield by 7.0-11.2%. In the area of Pula, the determined water shortage of 264.3-302.2 mm can reduce the olive yield by as much as 37.6-42.9%. The analysis of climatic factors and the result of the calculation of the soil water balance indicate the increasing occurrence of climatic extremes, which requires the adaptation of agriculture to these climate changes.

**Key words:** climate change, water balance, soil, Istria

## **Project SIMONA: Transnationally harmonized sediment sampling and laboratory protocols for HSs in DRB's countries**

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### **Summary**

The Interreg project Sediment-quality Information, MONitoring and Assessment System - SIMONA is designed to ensure support for transnational cooperation in joint Danube Basin Water Management. The main task of the project is a proposal of a SIMONA tool for harmonized monitoring of the hazardous substances (HSs) in drainage sediment in the Danube River Basin countries: Austria, Bosnia and Herzegovina, Bulgaria, Croatia, Germany, Hungary, Moldova, Montenegro, Romania, Serbia, Slovakia, Slovenia, and Ukraine. Croatian Geological Survey is responsible for developing the transnationally harmonized sampling and laboratory analysis protocols for sediment quality monitoring. The proposed techniques for monitoring of selected HSs in sediments in a river environment in both protocols are according to the 2000/60/EC Water Framework Directive, in particular the EQS Directives and CIS Guidance Documents 7, 19, 25 and 27, then ISO standards, ICPDR's List of Priority Substances for the DRB, and geological background and anthropogenic influences of the monitoring site. The Sampling protocol includes procedures for selections of the HSs to be monitored in sediments, sampling station, sediment collection, sampling equipment, field observation sheet, wet-sieving in the field, transport, field quality control, and safety measure. The Laboratory analyses protocol proposes the ISO and/or EPA standards for chemical analytical methods, procedures for sieving, drying, storage, and archive sediment samples, and laboratory quality control. Croatian Geological Survey with the contribution of its Associated Strategic Partners Croatian Waters, Croatia and Waters of Srpska, Bosnia and Herzegovina completed both protocols.

**Key words:** SIMONA, HSs, sediment, sampling protocol, laboratory analyses protocol



## **Praćenje stanja poljoprivredne mjere za očuvanje travnjaka velike prirodne vrijednosti i mjera za zaštitu leptira**

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### **Sažetak**

Veliki udio bioraznolikosti Hrvatske vezan je uz ekstenzivne travnjake, a čije bogatstvo biljnim i životinjskim vrstama ovisi između ostalog i o intenzitetu košnje i ispaše travnjaka. Zbog zaštite i očuvanja travnjaka velike prirodne vrijednosti i 4 vrste danjih leptira kroz Program ruralnog razvoja RH (PRR) provodi se dvije operacije (10.1.3. i 10.1.5.) u sklopu mjere „10 – Poljoprivreda, okoliš i klimatske promjene“. Poljoprivrednici koji provode ovu mjeru prilagodbom načina gospodarenja travnjacima na svojim parcelama doprinose očuvanju karakterističnih travnjačkih biljnih vrsta i danjih leptira i izvan svojih gospodarstava. Za potrebe utvrđivanja učinkovitosti ovih operacija PRR započeto je praćenje stanja bioraznolikosti travnjačkih staništa (raznolikosti biljnih vrsta) i populacija danjih leptira na parcelama na kojima se provodi navedena mjera. Istraživanje je provedeno na ukupno 450 lokaliteta u svim područjima Hrvatske, između svibnja i listopada 2020. godine. Istraživanje danjih leptira provedeno je metodom transekata, a istraživanje raznolikosti travnjačkih staništa procjenom brojnosti i pokrovnosti biljaka. Provedeno praćenje stanja predstavlja nulto stanje na parcelama koje će pratiti i sljedećih godina kako bi se zabilježio trend utjecaja primjene mjera. U radu je prezentirana metodologija i preliminarni rezultati praćenja stanja u 2020. godini.

**Ključne riječi:** bioraznolikost, livada, pašnjak, danji leptiri

## Monitoring the condition of agricultural measures for conservation of the high nature value grasslands and the butterflies

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### Summary

A significant proportion of Croatia's biodiversity is related to extensive grasslands, which richness in plant and animal species depends, among other things, on the intensity of mowing and grazing. Within the measure "10 - Agriculture, Environment and Climate Change" of the Rural Development Program of the Republic of Croatia (RDP) two operations (10.1.3. And 10.1.5.) are implemented for the protection and conservation of the high natural value grasslands and four (4) species of butterflies. Through adaptation of the grassland's management on their plots the farmers contribute to the conservation of characteristic grassland plant species and butterflies on the plot but also in broader area. To determine the effectiveness of these RDP operation started the monitoring of grassland habitats biodiversity (diversity of plant species) and populations of butterflies. The survey was conducted at a total of 450 sites all over Croatia, between May and October 2020. The research of butterflies was carried out by the method of transects, and the diversity of grassland habitats by estimating the number and cover of plants, respectively. The conducted monitoring is a baseline data on the plots that will be monitored in the following years to record the trend of the impact of the operations. In the paper are presented methodology and preliminary results of the monitoring from year 2020.

**Key words:** biodiversity, meadow, pasture, butterflies

## Model mogućeg razvoja zelenih infrastruktura grada Osijeka

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### Sažetak

Zelene infrastrukture kao i zelena gradnja danas postaju nužnost i dio razvoja modernih gradova. Grad Osijek zbog svog geografsko – povijesnog položaja, okruženja brojnom florom i faunom, razinom podzemnih voda te brojnih ekosustava ima prostora za poboljšanje zelenih infrastruktura. Cilj rada je prikazati moguću primjenu zelene gradnje i korištenje obnovljivih izvora energije, reciklažu i pravilno zbrinjavanje otpada, kao i mogući razvoj zelene osnove grada. Izvršene su analize slike grada prema K. Lynchu i šireg područja prema Godronu i Formanu. Definirana je krajobrazna osnova i granice promjenjivosti. Unutar rada navedene su metode i tehnologije koje je moguće primijeniti u Osijeku: Cradle to Cradle, krovni vrtovi, vertikalni vrtovi, model pročišćavanja komunalnih voda uz upotrebu autohtonih vodenih biljaka, konstrukcije zelene gradnje. Za svaku je metodu određeno granično područje primjene i određene su površine. Rezultati istraživanja prikazani su na karti odabranih područja istraživanja, a dokazi o mogućoj primjeni navedenih metoda izneseni su u zaključku gdje se tvrdi, da se uz primjenu opisanih tehnologija Osijek može u budućnosti razvijati kao „Zeleni grad“

**Ključne riječi:** krovni vrt, vertikalni vrt, urbani prostor, kvaliteta

## **A Model of Possible Development of the City of Osijek's Green Infrastructure**

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### **Summary**

Green infrastructures, as well as green construction, become a necessity and a part of modern cities' development. Due to its geographic and historical position, surrounded by an abundant flora and fauna, the subterranean water level, and numerous ecosystems, the City of Osijek has a space to improve the green infrastructures. The aim of this paper is to present the possible application of green building and the use of renewable energy sources, recycling and proper waste disposal, as well as the possible development of a green base of the city. Analyzes of the image of the city according to K. Lynch and the wider area according to Godron and Forman were performed. The landscape basis and limits of variability are defined. Within the paper, methods and technologies that can be applied in Osijek are listed: Cradle to Cradle, roof gardens, vertical gardens, model of communal water purification with the use of autochthonous aquatic plants, construction of green buildings. For each method, a boundary area of application is determined and areas are determined. The results of the research are presented on the map of selected research areas, and evidence of the possible application of these methods is presented in the conclusion where it is claimed that with the application of the described technologies Osijek can develop in the future as a "Green City"

**Key words:** roof garden, vertical garden, urban space, quality

## Antimikrobna rezistencija u otpadnim vodama iz sedam hrvatskih gradova

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### Sažetak

Antimikrobna rezistencija predstavlja ozbiljan problem na globalnoj razini, jer smanjuje učinkovitost antibiotika u liječenju bakterijskih infekcija. Postrojenja za pročišćavanje otpadnih voda smatraju se potencijalnim rezervoarima i izvorima širenja rezistentnih bakterija u prirodne vodotokove, ali i zemljišta putem navodnjavanja, što predstavlja rizik za zdravlje ljudi. Cilj ovog rada bio je analizirati zastupljenost bakterija i gena koji ispoljavaju rezistenciju na kritično važne antibiotike u medicini, cefalosporine proširenog spektra (CPS) i karbapeneme, u sirovim i pročišćenim otpadnim vodama iz pročišćavača 7 hrvatskih gradova: Zagreba, Bjelovara, Karlovca, Čakovca, Varaždina, Vinkovaca i Zadra. Uzgojem koliformnih bakterija na selektivnim podlogama pokazalo se da otpadne vode sadrže značajnu količinu rezistentnih koliforma ( $\log \text{CFU/mL}=1.43\text{-}2.26$ ) čak i nakon postupka pročišćavanja. Primjenom kvantitativnog PCR-a, geni za rezistenciju na CPS (*bla<sub>TEM</sub>* i *bla<sub>CTX-M-32</sub>*) određeni su u svim uzorcima i nisu se značajno smanjili ni nakon pročišćavanja. Geni za rezistenciju na karbapeneme, *bla<sub>NDM</sub>*, *bla<sub>KPC</sub>* i *bla<sub>OXA-48</sub>*, određeni su povremeno u pročišćenoj otpadnoj vodi, dok su geni *bla<sub>VIM</sub>* i *bla<sub>IMP</sub>* često detektirani u višim koncentracijama u pročišćenim nego u sirovim otpadnim vodama. Dobiveni rezultati ukazuju na prisutnost opasnih gena za antibiotsku rezistenciju u pročišćenim otpadnim vodama pa je stoga potrebno daljnje aktivno praćenje istih u cilju očuvanja okoliša i zdravlja ljudi.

**Ključne riječi:** antibiotska rezistencija, bakterije, geni, otpadne vode, uređaji za pročišćavanje otpadnih voda

## Antimicrobial resistance in wastewaters from seven Croatian cities

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### Summary

Antimicrobial resistance is an emerging concern at the global scale, threatening the effectiveness of antibiotics in treating bacterial infections. Wastewater treatment plants have been indicated as possible reservoirs and a source of dissemination of antibiotic resistant bacteria into natural watercourses, but also land through irrigation, which poses a risk to human health. The aim of this study was to analyze the abundance of bacteria and genes that show resistance to critical antibiotics in medicine, extended spectrum cephalosporins (CPS) and carbapenems, in raw and treated wastewater from wastewater treatment plants from 7 Croatian cities: Zagreb, Bjelovar, Karlovac, Čakovec, Varaždin, Vinkovci and Zadar. Culturing coliform bacteria on selective media showed that wastewater contained a significant amount of resistant coliforms ( $\log \text{CFU/mL} = 1.43\text{-}2.26$ ) even after the treatment process. Using quantitative PCR, CPS resistance genes (*bla*<sub>TEM</sub> and *bla*<sub>CTX-M-32</sub>) were determined in all samples and did not decrease significantly even after purification. The genes for resistance to carbapenems, *bla*<sub>NDM</sub>, *bla*<sub>KPC</sub> and *bla*<sub>OXA-48</sub>, were determined sporadically in treated wastewater, while the *bla*<sub>VIM</sub> and *bla*<sub>IMP</sub> genes were often detected at higher concentrations in treated than in raw wastewater. The obtained results indicate the presence of dangerous antibiotic resistance genes in the treated wastewater, so further active monitoring is needed in order to preserve the environment and human health.

**Key words:** antibiotic resistance, bacteria, genes, wastewater, wastewater treatment plants

## Fauna trčaka kukuruza u različitim agroekološkim uvjetima

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### Sažetak

Trčci se često koriste kao indikatori održive poljoprivredne proizvodnje i promjena u okolišu. Intenzivna poljoprivreda kao i nepovoljni vremenski uvjeti uzrokuju gubitak određenih vrsta i posljedično narušavanje biološke raznolikosti. Kukuruz se ubraja u kulture za čiji je uzgoj potrebna primjena intenzivnih agrotehničkih mjera, prvenstveno obrade tla i gnojidbe. Cilj ovog istraživanja bio je utvrditi sastav faune trčaka kukuruza uzgajanog na različitim lokacijama i pod različitim agroekološkim uvjetima. Istraživanje je provedeno tijekom 2016. godine u Lukaču i Tovarniku. Uzorci su prikupljeni četiri puta kroz vegetaciju pomoću "Pitfall" klopki. Ukupno je prikupljeno 5656 jedinki u Lukaču i 342 u Tovarniku. Prema Bray Curtis-ovom indeksu postoji velika razlika u populacijama trčaka između Lukača i Tovarnika, a tek nešto više od trećine vrsta zajedničko je za obje lokacije. Lukač pokazuje veću ukupnu raznolikost vrsta, dok na obje lokacije dominiraju velike brojnosti samo jedne vrste. Različiti indeksi dominantnosti, konstantnosti i ekološkog značaja pokazuju da su najistaknutije vrste u Lukaču *Pterostichus melanarius*, *Pseudoophonus (Carabus) rufipes* i *Poecilus cupreus*, dok su u Tovarniku *Pseudoophonus (Carabus) rufipes*, *Pterostichus melas* i *Harpalus distinguendus*. Lokaciju Lukač karakterizira viša vlaga, niže temperature i konzervacijska obrada tla, a lokaciju Tovarnik manja količina oborina uz više temperature i intenzivnu obradu tla. Rezultati upućuju na zaključak da su uvjeti s područja lokaliteta Lukač povoljniji za faunu trčaka te da manja intervencija u tlo povoljno djeluje na bioraznolikost.

**Ključne riječi:** bioraznolikost, dominantnost, indikatori, konstantnost, pitfall klopke

## Carabid species composition in maize under different agroecological conditions

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### Summary

Carabid beetles are often used as indicators for monitoring of agriculture management practices and environmental changes. Intensive agriculture as well as unfavorable weather conditions causes the loss of certain species and consequently the disruption of biodiversity. Maize is one of the crops whose cultivation requires the application of intensive agro-technical measures, primarily tillage and fertilization. Aim of this research was to determine carabid species composition in maize grown on distinct locations and under different agroecological conditions. Research was carried out during 2016 in Lukac and Tovarnik. Samples were collected four times through vegetation using pitfall traps. A total of 5,656 individuals were collected in Lukač and 342 in Tovarnik. According to Bray Curtis Dissimilarity Index there is a high difference in species populations between Lukac and Tovarnik and a little over a third species are common to both sites. Lukac shows a higher overall carabid diversity, while both locations are dominated by high abundances of a single species. Different indices of dominance, constancy and ecological significance show that the most prominent species in Lukac are *Pterostichus melanarius*, *Pseudoophonus (Carabus) rufipes* and *Poecilus cupreus*, while in Tovarnik *Pseudoophonus (Carabus) rufipes*, *Pterostichus melas* and *Harpalus distinguendus*. Location Lukac is defined as more humid with lower temperatures and conservation tillage contrary Tovarnik which is rather dry location with higher temperatures and intensive agriculture management. The results suggest that the conditions from the location Lukac are more favorable for the carabid species composition and that less intervention in the soil has a favorable effect on biodiversity.

**Keywords:** biodiversity, constancy, dominance, indicator species, pitfall traps



## Fizikalno-kemijska svojstva tradicionalnih sorti kruške s područja sjeverozapadne Hrvatske

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### Sažetak

Tradicionalne sorte kruške na području sjeverozapadne Hrvatske zastupljene su uglavnom kao pojedinačna stabla na okućnici, vrtovima, parkovima, uz ceste ili rubove šuma. Njihova stabla većinom su u razdoblju starenja ili odumiranja, a plodovi pojedinih sorti odlikuju se dobrom kakvoćom. Cilj istraživanja bio je utvrditi fizikalno-kemijska svojstva 13 najzastupljenijih tradicionalnih sorti kruške na području sjeverozapadne Hrvatske ('Badnjarka', 'Citronka', 'Dugačka', 'Dugodrška', 'Galonka', 'Kozolova', 'Krasanka', 'Rokovica', 'Stršljenka', 'Tepka', 'Zelena slatka', 'Zimka', 'Žutica') te izdvojiti potencijalne sorte za uzgoj. Nakon provedenih analiza (masa, visina i širina ploda, indeks oblika ploda, tvrdoća ploda, broj i masa zdravih sjemenki, udio topljive suhe tvari, udio kiselina, omjer topljive suhe tvari i ukupnih kiselina, pH vrijednost), utvrđeno je da se sorte značajno razlikuju u istraživanim svojstvima. Veličinom ploda te skladnim odnosom topljive suhe tvari i ukupnih kiselina istaknule su se sorte 'Krasanka' i 'Dugačka'. Sorta 'Tepka' istaknula se visokim sadržajem topljive suhe tvari što ju čini vrijednom sirovinom za proizvodnju rakije. Temeljem dobivenih rezultata može se zaključiti kako tradicionalne sorte kruške predstavljaju potencijal za uzgoj i preradu, a važno ih je očuvati kao izvor genetske varijabilnosti.

**Ključne riječi:** kakvoća, kruška, tradicionalne sorte, genetska varijabilnost

## Physico-chemical properties of traditional pear cultivars from the area of northwestern Croatia

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### Summary

Traditional pear cultivars in the area of northwestern Croatia are mainly present as individual trees in backyards, gardens, parks, along roads or forest edges. The trees are mostly in the stage of aging or dying, and the fruits of some cultivars are of good quality. The aim of the study was to evaluate the physico-chemical properties of the 13 most common traditional pear cultivars in northwestern Croatia ('Badnjarka', 'Citronka', 'Dugačka', 'Dugodrška', 'Galonka', 'Kozolova', 'Krasanka', 'Rokovica', 'Stršljenka', 'Tepka', 'Zelena slatka', 'Zimka', 'Žutica') and to filter out potential cultivars for cultivation. After analyzes (fruit weight, height and width, fruit shape index, fruit firmness, number and weight of seeds, soluble solids content, acidity, ratio of soluble solids content to total acidity, pH), it was found that the cultivars differ significantly in the studied characteristics. The cultivars 'Krasanka' and 'Dugačka' are characterized by their fruit size and harmonious ratio of soluble solids content and acids. The cultivar 'Tepka' stood out due to its high soluble solids content, which makes it a valuable raw material for the production of brandy. Based on the obtained results, it can be concluded that the traditional pear cultivars represent the potential for cultivation and processing and it is important to preserve them as a source of genetic variability.

**Keywords:** quality, pear, traditional varieties, genetic variability





## **Agroekonomika i ruralni razvoj**

# **02**

## **Agricultural Economics and Rural Development**



## Segmentacija inozemnih potrošača prema preferencijama obzirom na intrinzična i ekstrinzična obilježja maslinova ulja

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### Sažetak

Inozemni posjetitelji interesantni su potrošači jer tijekom svog boravka u destinaciji kupuju i konzumiraju proizvode među kojima i maslinovo ulje. Cilj rada je segmentirati inozemne potrošače prema preferencijama obzirom na intrinzična i ekstrinzična obilježja maslinova ulja. Ispitivanje je provedeno na prigodnom uzorku inozemnih posjetitelja koji su kupili maslinovo ulje tijekom njihova boravka na sjevernom Jadranu (N = 249) u razdoblju od lipnja do listopada 2018. godine. Podaci su prikupljeni pomoću strukturiranog upitnika. Za potrebe istraživanja razmatrana su pitanja o preferencijama prema intrinzičnim i ekstrinzičnim obilježjima maslinova ulja, te pitanja vezana uz socio-demografske osobine. Izračunate su frekvencije i distribucije podataka, a segmentacija je provedena pomoću analize glavnih komponenti i hijerarhijske klaster analize. U uzorku je nešto više ženskih ispitanika, onih između 41 i 55 godina, s fakultetskim obrazovanjem, zaposlenih, a pretežito su iz Austrije i Njemačke. Utvrđene su 3 komponente nazvane: 1) informacije, 2) okus, 3) cijena i pakiranje. Provedbom klaster analize identificirana su 4 segmenta potrošača: 1) ljubitelji vanjskog izgleda (37,4 %), 2) stručnjaci (28,3 %), 3) fascinirani oznakama (24,3 %) i 4) ravnodušni (10 %). Pripadnici prva tri klastera predstavljaju zanimljive segmente za planiranje strategija prodaje hrvatskih maslinovih ulja.

**Ključne riječi:** maslinovo ulje, intrinzična i ekstrinzična obilježja, inozemni potrošači, segmentacija

## Segmentation of foreign consumers based on their preferences for intrinsic and extrinsic olive oil attributes

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### Summary

Foreign visitors are interesting consumers because during their stay in the destination they purchase and consume products, including olive oil. The aim of this paper is to segment foreign consumers based their preferences for intrinsic and extrinsic attributes of olive oil. The study was conducted on a convenient sample of foreign visitors who bought olive oil during their stay in the northern Adriatic (N = 249) in the period from June to October 2018. Data were collected using a structured questionnaire. For research purposes, questions about preferences for intrinsic and extrinsic olive oil attributes and questions about sociodemographic characteristics are examined. The obtained results were analyzed by distribution, frequency, principal components analysis and hierarchical cluster analysis. There are slightly more female respondents in the sample, between 41 and 55 years of age, having a university degree, and in most cases, coming from Austria and Germany. Three components were identified: 1) information, 2) taste, 3) price and packaging. The cluster analysis identified 4 consumers segments: 1) exterior lovers (37.4 %), 2) experts (28.3 %), 3) fascinated by labels (24.3 %) and 4) indifferent (10 %). Members of the first three clusters represent interesting segments for planning sales strategies of Croatian olive oils.

**Key words:** olive oil, intrinsic and extrinsic attributes, foreign consumers, segmentation

## Poslovni rizici u proizvodnji mlijeka

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### Sažetak

Na poslovne rizike je potrebno preventivno djelovati i njima strateški upravljati. Tržišno gospodarstvo je povezano s neizvjesnosti i opasnosti od neželjenih promjena koje su izvori rizika. Cilj rada je identificirati vrste i oblike rizika te strateške ciljeve za umanjivanje opasnosti u proizvodnji mlijeka. U tu svrhu anketirano je 26 proizvođača mlijeka na području Slavonije i Baranje. Vrednovanjem važnosti različitih izvora rizika identificirani su sljedeći oblici: obolijevanje krava (4,53), neredovita naplata mlijeka (4,34), zdravlje zaposlenika (4,30), nedostatak radne snage (4,30), promjene poljoprivredne politike (4,00) i plasman proizvoda (3,34). Rizici su razvrstani na unutarnje i vanjske. Kao najznačajniji unutarnji rizik identificiran je proizvodni, a povezan je s kvalitetom mlijeka koje se plasira na tržište te sigurnosti konzumacije za ljude. Stoga svi ispitanici koriste HACCP sustav. Najznačajniji vanjski rizik je tržišni, a ocijenjen je sljedećim vrijednostima: trenutna prodaja (2,46), prodajno tržište (2,30), proizvodni troškovi (2,26) i otkupne cijene (1,77). Na osnovu identifikacije i vrednovanja unutarnjih i vanjskih izvora rizika, određeni su strateški ciljevi: prodaja stalnim kupcima (4,80), osiguranje osnovnog stada (4,73), cjeloživotno učenje (4,57), korištenje vlastitog zemljišta (4,38) i primjena suvremene tehnologije (4,34). Kako bi proizvođači ostvarili strateške ciljeve i preventivno djelovali na rizike neophodna je sustavna podrška komplementarnih institucija.

**Ključne riječi:** proizvodnja mlijeka, poslovni rizici, strateški ciljevi



## Business risks in milk production

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### Summary

Business risks need to be prevented and strategically managed. The market economy is associated with uncertainty and the danger of unwanted changes that are sources of risk. The aim of this paper is to identify the types and forms of risk and strategic goals for reducing the dangers in milk production. For this purpose, 26 milk producers in the area of Slavonia and Baranja were surveyed. By evaluating the importance of different sources of risk, the following forms were identified: cow disease (4.53), irregular milk collection (4.34), employee health (4.30), labor shortage (4.30), changes in agricultural policy (4.00) and product placement (3.34). Risks are classified into internal and external. Production risk was identified as the most significant internal risk, and it is related with the quality of milk placed on the market and the safety of consumption for humans. Therefore, all subjects use the HACCP system. The most significant external risk is market risk, which is rated with the following values: current sales (2.46), sales market (2.30), production costs (2.26) and purchase prices (1.77). Based on the identification and evaluation of internal and external sources of risk, strategic goals were determined: sales to regular customers (4.80), basic herd insurance (4.73), lifelong learning (4.57), use of own land (4.38) and the application of modern technology (4.34). In order for producers to achieve strategic goals and prevent risks, systematic support of complementary institutions is necessary.

**Key words:** milk production, business risks, strategic goals

## Percepcija potrošača o povezanosti sira škripavca s područjem njegove proizvodnje

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### Sažetak

Sir škripavac je hrvatski autohtoni punomasni meki sir s karakterističnom gumastom teksturom koja škripi pod zubima tijekom konzumacije. Osim na području Like, tradicionalno se proizvodi na obiteljskim poljoprivrednim gospodarstvima i na području Gorskog kotara, dijela Korduna, ogulinskog kraja te zagrebačke regije. Cilj ovog rada je istražiti percepciju potrošača o povezanosti sira škripavca s područjem njegove proizvodnje. Anketno ispitivanje provedeno je na uzorku od 100 ispitanika. Rezultati istraživanja pokazali su da ispitanici najčešće kupuju sir škripavac u supermarketima i na tržnicama. Utvrđena je statistički značajna povezanost između učestalosti kupnje i mjesta nabave sira škripavca s dobi ispitanika ( $p < 0,05$ ). Najveći broj ispitanika, njih čak 76 % povezuju sir škripavac s Likom kao izvornim područjem njegove proizvodnje, a ostale navedene regije su Dalmacija (8 %), otog Pag (11 %), Istra (3 %) i Dalmatinska zagora (1 %). Uočena je statistički značajna povezanost ( $p < 0,05$ ) između percepcije o podrijetlu i učestalosti konzumacije sira škripavca. Među ispitanicima koji odabiru Liku kao regiju podrijetla sira škripavca, njih 52,6 % konzumira sir škripavac na mjesečnoj bazi dok ga njih 42,1 % konzumira rjeđe. Većina ispitanika (79,2 %) koji ne povezuju sir škripavac s Likom konzumiraju isti rjeđe od jednom mjesečno, dok njih 20,8 % konzumira na mjesečnoj bazi. Nije pronađena statistički značajna povezanost ( $p > 0,05$ ) između percipiranog podrijetla i mjesta nabave sira škripavca. Među ispitanicima koji podrijetlo sira škripavca povezuju s Likom, najviše njih nabavlja ga na tržnicama (36,8 %) te od rodbine ili prijatelja (31,6 %). Provedeno istraživanje je pokazalo da većina ispitanika povezuje sir škripavac s Likom što je i činilo osnovu za zaštitu zemljopisnog podrijetla Ličkog škripavca.

**Ključne riječi:** sir škripavac, područje proizvodnje, percepcija potrošača

## Consumers' perception of the connection of Škripavac cheese with the area of its production

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### Summary

Škripavac cheese is a Croatian autochthonous full-fat soft cheese. The specific production technology results with a characteristic rubbery texture, and therefore “squeaking” during consumption. Apart from the area of Lika, it is traditionally produced on family farms in the area of Gorski kotar, part of Kordun, the Ogulin area and the Zagreb region. The aim of this paper is to investigate the consumers' perception of the connection of Škripavac cheese with the area of its production. The survey was conducted on a sample of 100 respondents. The results of the research showed that the respondents most often buy Škripavac cheese in supermarkets and at the open marketplaces. Statistically significant correlation ( $p < 0.05$ ) was found between the age of the respondents and frequency of purchase, as well as the place of purchase of Škripavac cheese. The largest number of respondents (76%), associate Škripavac cheese with Lika as the original area of its production, and the other mentioned regions are Dalmatia (8%), the island of Pag (11%), Istria (3 %) and Dalmatian hinterland (1%). A significant correlation ( $p < 0.05$ ) was observed between the perception of origin and the frequency of consumption of Škripavac cheese. Among the respondents who choose Lika as the region of production of Škripavac cheese, 52.6% of them consume Škripavac cheese monthly, while 42.1% of them consume it less than once a month. The majority of respondents who do not associate Škripavac cheese with Lika (79.2%) consume it less than once a month, while 20.8% of them consume it on a monthly basis. No statistical correlation ( $p > 0.05$ ) was found between perceived origin and place of purchase. Among the respondents who connect the origin of Škripavac cheese with Lika, the most of them procure it at open marketplaces (36.8%) and from relatives or friends (31.6%). The conducted research showed that the most of the respondents connect Škripavac cheese with Lika, which was the basis for the protection of the geographical origin of Lički škripavac cheese.

**Key words:** Škripavac cheese, area of production, consumers' perception

## Upravljanje rizikom i inovativni poslovni modeli u bioekonomiji

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### Sažetak

U vremenima ubrzanih klimatskih promjena, poslovni modeli u bioekonomiji postaju važan kanal za stratešku transformaciju poljoprivrednih gospodarstava i ruralne ekonomije prema prilagodbi klimatskim promjenama, istodobno ispunjavajući ciljeve politike održivog razvoja. Koristeći okvir integriranog upravljanja rizikom, rad analizira rizik u poslovanju na studijama u Hrvatskoj. Studije slučaja obuhvaćaju područja biljne proizvodnje uz primjenu inovativnih poslovnih modela u bioekonomiji. Također, u radu se ocjenjuje koliko je tradicionalno upravljanje poljoprivrednim rizicima prikladno za bioekonomiju. Istraživanje je nadogradnja postojećih istraživanja autora o potencijalu iskorištavanja ostataka drvene biomase nastale od poljoprivrednih rezidbenih ostataka i uklanjanja nasada na poslovanje poljoprivrednog gospodarstva i na ukupan ruralni razvoj. Povijesno gledano, primjena strategija za upravljanje rizikom od strane poljoprivrednika u Hrvatskoj je skromna. U složenom poslovnom okruženju, holistički pristup upravljanju rizicima mogao bi pomoći transformaciji iz „tradicionalnih“ modela poljoprivrednih gospodarstva u inovativne poslovne modele u bioekonomiji. Uspjeh će ovisiti o digitalizaciji, dobrom razumijevanju ponašanja voditelja gospodarstava, inovativnim alatima (upravljanje rizikom) Zajedničke poljoprivredne politike i učinkovitim javno-privatnim partnerstvima.

**Ključne riječi:** upravljanje rizikom, bioekonomija, poslovni modeli, inovacije

## Risk management and innovative bioeconomy business models

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### Summary

In the times of rapid climate changes, business models in bioeconomy are becoming crucial alley for strategic transformation of farm businesses and rural economy to the climate adaptation while simultaneously fulfilling policy goals towards more sustainable development. Using the enterprise risk management framework, the paper assesses risk on case studies in Croatia. Cases encompass crop production with development of innovative bioeconomy value chains. Also, the paper evaluates how suitable is traditional agricultural risk management for bioeconomy. The research adds up on authors work about the effects of agricultural pruning and plantation removal on farm economics and macroeconomy. Historically, the uptake of risk management tools by farmers in Croatia has been modest. While exposed to a complex environment, a holistic approach to risk management might enable the smooth transformation from “traditional“ farm models to innovative business models in bioeconomy. Success will depend on digitalization, a good understanding of farm risk behaviour, innovative (risk management) tools from Common Agricultural Policy toolbox and efficient public-private partnerships.

**Key words:** risk management, bioeconomy, business models, innovation

## Utjecaj zaslanjivanja na ekonomiku proizvodnje mandarina u dolini Neretve

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### Sažetak

Rad se temelji na istraživanjima projekta „Napredni sustav motrenja agroekosustava u riziku od zaslanjivanja i onečišćenja“. Cilj je rada ocijeniti društveno-ekonomski utjecaj klimatskih promjena na agroekosustav doline Neretve. Istraživanje se sastoji od ispitivanja percepcije poljoprivrednika o utjecaju rizika zaslanjivanja vode i tla na poljoprivrednu proizvodnju i razvoja stohastičkog simulacijskog modela proizvodnje mandarina na području doline Neretve. Za ispitivanje percepcija poljoprivrednika dizajnirat će se anketni upitnik. Anketno ispitivanje bit će provedeno na namjeravanom uzorku od 30 poljoprivrednika u dolini Neretve tijekom travnja 2021. godine. Ulazni parametri stohastičkog simulacijskog modela su trenutna struktura proizvodnje, prinosi, cijene i troškovi proizvodnje mandarina. Kroz scenarije različitih stupnjeva zaslanjivanja i vjerojatnosti njihove pojave (sa i bez projekta), simulirat će se utjecaj rizika na ekonomiku proizvodnje mandarina. Kao rezultat simulacije dobit ćemo uvid u promjene dohodovnosti sa i bez projekta. Postojeća istraživanja ukazuju kako zaslanjivanje, odnosno navodnjavanje vodom loše kvalitete, može smanjiti dohodak u proizvodnji mandarina i do 50 %. U izradi modela koristit će se @Risk dodatak u Excelu (Palisade Corporation). Rad će prikazati i utjecaj zaslanjenja na korištenje zemljišnih resursa, te će dati preporuke za mjere poljoprivredne politike u cilju prilagodbe i ublažavanja postojeće situacije.

**Ključne riječi:** klimatske promjene, zaslanjivanje, navodnjavanje, mandarine, ekonomika

## The impact of soil salinity on the economics of mandarin production in Neretva Valley

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### Summary

The paper is based on the research under the project “Advanced monitoring system of agroecological system in the risk of soil salinity and pollution”. The objective of the paper is to assess the socio-economic impact of climate change on the agroecological system of the Neretva River Valley. The research includes an analysis of farmers’ perceptions of the impact of water and soil salinity risk on agricultural production and the development of a stochastic simulation model of mandarin production in the Neretva Valley. A questionnaire will be designed to analyse farmers’ perceptions. The survey will be conducted on a purposive sample of 30 farmers in April 2021. Inputs to the stochastic simulation model are the current production structure and yields, market prices and costs of mandarin production. Scenarios with different salinity levels and probabilities for these scenarios (with and without the project) are used to simulate the impact of salinity risk on the economics of mandarin production. As a result of the simulation, insight into income variability with and without the project will be possible. Existing research shows that irrigation with insufficient water can decrease income in mandarin production by up to 50%. The @Risk Excel Add-in (Palisade Corporation) will be used to create the model. The paper will show the impact of salinization on land resource use and will provide recommendations for adaptation and mitigation policy measures.

**Key words:** climate change, soil salinity, irrigation, mandarins, economics

## Povijesna analiza korištenja zemljišta u svrhu očuvanja ruralnog krajobraza Nacionalnog parka Plitvička jezera

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### Sažetak

Povijesne analize korištenja prostora važan su alat za razumijevanje ekoloških procesa i uvelike doprinose informiranom upravljanju zaštićenim područjima. Ovo istraživanje, provedeno u okviru izrade Krajobrazne osnove NP Plitvička jezera, imalo je za cilj, na temelju povijesne analize ruralnog krajobraza, izraditi smjernice za očuvanje i unaprjeđenje identiteta Parka i karaktera njegovog krajobraza. Analiza korištenja poljoprivrednog zemljišta za novije razdoblje temeljena je na javno dostupnim podacima (Arkod baza) analiziranim GIS alatima i obuhvaća period od 2011. godine do danas. Za povijesno razdoblje, u nedostatku preciznih i mjerljivih podataka, analizirani su povijesni dokumenti, pri čemu su najvažniji kartografski prikazi. Dok su za analizu korištenja zemljišta u 18. i 19. stoljeću, kad je prostor Parka tek naseljavan, korištene karte napravljene prvom (1774. - 1775.) i drugom (1865. - 1869.) vojnom izmjerom, za razdoblje 20. stoljeća korišteni su arhivski podaci Parka koji uključuju fotografije i zračne snimke iz 1953. godine. Kroz analize su prikazane promjene u dinamici korištenja ruralnog prostora, pri čemu je najveća promjena zabilježena uslijed Domovinskog rata kad dolazi do izražene depopulacije i napuštanja poljoprivredne djelatnosti. Na temelju povijesnih analiza provedenih unutar Krajobrazne osnove Parka, izrađene su smjernice za očuvanje ruralnog krajobraza što će doprinijeti dugoročnoj zaštiti krajobrazne raznolikosti.

**Ključne riječi:** povijesna analiza, ruralni krajobraz, Nacionalni park Plitvička jezera, korištenje poljoprivrednog zemljišta, krajobrazna raznolikost



## Historical land use analysis for preserving the rural landscape of the Plitvice Lakes National Park

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### Summary

Historical land use analyses are an important tool for understanding ecological processes and substantially contribute to the informed management of protected areas. This research, conducted within the Plitvice Lakes NP Landscape Character Assessment, had the objective to establish guidelines for the conservation and improvement of the Park's identity and landscape character, based on historical analysis of the rural landscape. Agricultural land use analysis for the more recent period is based on publicly available data (Arkod base) analysed with GIS tools and covers the period from 2011 until today. For the historical period, lacking precise and measurable data, historical documents are analysed, with emphasis on cartographic documents. While for land use analysis in the 18<sup>th</sup> and 19<sup>th</sup> century, when the area was first settled, used maps were made by the first (1774 - 1775) and second (1865 - 1869) military land survey, archive Park data, which include photographs and air footage from 1953, were used for the 20<sup>th</sup> century. Analyses show changes in the rural land use dynamics, with the most significant recorded change during the Croatian War of Independence, when there is pronounced depopulation and agricultural activity abandonment. Based on historical analyses conducted within the Park Landscape Character Assessment, rural landscape conservation guidelines have been developed, which will contribute to landscape diversity long-term protection.

**Key words:** historical analysis, rural landscape, Plitvice Lakes National Park, agricultural land use, landscape diversity

## Novi pogledi na upravljanje državnim poljoprivrednim zemljištem

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### Sažetak

Od osamostaljivanja Republike Hrvatske u primjeni je bilo 18 zakona o poljoprivrednom zemljištu ili njegovih izmjena i dopuna, a posljednji zakon je donesen 2018. godine i od njegovoga donošenja su bile dvije dopune. Takve česte izmjene zakona kod poljoprivrednika izazivaju nesigurnost i nemogućnost dugoročnog planiranja proizvodnje, što se odražava u padu produktivnosti poljoprivredne proizvodnje. Prema podacima Eurostatata, Hrvatska je u 2019. godini imala pad produktivnosti od - 6,7 % u odnosu na 2018. godinu, dok na razini EU produktivnost raste za + 2,0 %. Razloge pada produktivnosti, ali i efikasnosti možemo tražiti u različitim čimbenicima, no jedan od njih je zasigurno usitnjenost i rascjepkanost poljoprivrednog zemljišta. U prilog daljnjem rascjepkavanju velikih poljoprivrednih gospodarstava ide i važeći Zakon o poljoprivrednom zemljištu, koji daje jedinicima lokalne samouprave kod raspisivanja natječaja mogućnost određivanja maksimalnog broja hektara koje će se fizičkoj ili pravnoj osobi dodijeliti. Na taj način su jedinice lokalne samouprave dobile vrlo važnu ulogu u kreiranju poljoprivredne politike. Cilj ovoga rada je analizirati način upravljanja državnim poljoprivrednim zemljištem, s osvrtom na ograničenja koja proizlaze iz nedorečenosti važeće zakonske regulative koja uređuje ovo područje. Složenost i sporost u prikupljanju dokumentacije potrebne za raspisivanje natječaja za zakup i prodaju poljoprivrednog zemljišta, te zbunjujuća zakonska regulativa, dovele su do toga da već gotovo dvije godine od donošenja Zakona o poljoprivrednom zemljištu brojne jedinice lokalne samouprave nisu raspisale natječaje, pa tako i dalje brojne poljoprivredne površine u vlasništvu države i dalje stoje neobrađene i zapuštene.

**Ključne riječi:** poljoprivredno zemljište, Zakon o poljoprivrednom zemljištu

## New aspect on state agricultural land management

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### Summary

Since the independence of the Republic of Croatia, 18 laws on agricultural land or its amendments have been in force, and the last law was adopted in 2018, and since its enactment, there have been two amendments. Such frequent changes in the law cause uncertainty among farmers and the impossibility of long-term production planning, which is reflected in agricultural production productivity decrease. According to Eurostat data, in 2019, Croatia had a productivity decrease of - 6.7% compared to 2018, while at the EU level productivity is growing by + 2.0%. The reasons for the decrease in productivity, but also efficiency, can be found in various factors, but one of them is small size farms and fragmentation of agricultural land. The further fragmentation of large agricultural holdings is supported by the current Agricultural Land Act, which gives local self-government units the possibility of determining the maximum number of hectares to be allocated to a natural or legal person when announcing tenders. In this way, local self-government units were given a very important role in creating agricultural policy. The aim of this paper is to analyze the method in management of state agricultural land, with reference to the limitations arising from the vagueness of the current legislation governing this area. The complexity and slowness in collecting documentation needed for tender announcements for the lease and sale of agricultural land, as well as confusing legislation, have led to the fact that for almost two years since the adoption of the Agricultural Land Act, many local governments have not announced tenders, so many agricultural state-owned areas remain uncultivated and neglected.

**Key words:** agricultural land, the Agricultural Land Act

## Proizvodnja voća u Republici Hrvatskoj - stanje i perspektive

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### Sažetak

Cilj rada je utvrditi stanje u voćarstvu te temeljem povijesnih podataka dati projekciju za 2025. godinu. U Republici Hrvatskoj postoje povoljni uvjeti za proizvodnju velikog broja voćnih vrsta. Iskorištenost navedenih uvjeta je upitna iz razloga što je u Republici Hrvatskoj samodostatnost u proizvodnji voća u 2016. godini iznosila 49,89 %. U radu je prikazana detaljna analiza površina pod voćarskim kulturama kao i analiza promjena u strukturi voćarske proizvodnje s obzirom na promjene ovih površina u razdoblju od 2015. do 2020. godine (obuhvaćene su površine za koje se traže potpore) te analiza strukture starosti nasada kojom su obuhvaćeni svi voćnjaci upisani u Upisnik voćnjaka u promatranoj godini. U radu su korišteni podatci Agencije za plaćanje u poljoprivredi, ribarstvu i ruralnom razvoju, Ministarstva poljoprivrede te rezultati dosadašnjih istraživanja. Za analizu proizvodnje te njenu projekciju do 2025. godine korištena je metoda trenda. Temeljem utvrđenih trendova dana je projekcija strukture voćarske proizvodnje u 2025. godini. Tijekom analiziranog razdoblja primjetne su promjene udjela pojedinih voćarskih kultura u strukturi površina pod voćnjacima, sve više dominiraju orah i lijeska, dok se udio jabuke, šljive i drugih voćnih vrsta smanjuje. U razdoblju projekcije do 2025. godine, ukoliko ne dođe do značajnih promjena u sustavu potpora i korištenju mjera ruralnog razvoja, očekuje se da će se tradicionalna struktura voćarske proizvodnje značajno promijeniti uslijed promjena strukture površina pod voćarskim kulturama.

**Ključne riječi:** voćnjaci, struktura površina, trendovi, Hrvatska

## Fruit production in the Republic of Croatia - state and perspectives

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### Summary

The aim of this paper is to determine the situation in fruit growing and, based on historical data, to provide a projection for 2025. In the Republic of Croatia there are favourable conditions for the production of a large number of fruit species. The utilization of these conditions is questionable due to the fact that in the Republic of Croatia self-sufficiency in fruit production in 2016 was 49.89%. The paper presents: detailed analysis of areas under fruit crops as well as analysis of changes in the structure of fruit production with regard to changes in these areas in the period from 2015 to 2020 (areas for which support is requested are covered) and structure analysis of age of plantations, which includes all orchards entered in the Register of orchards in the observed year. The paper uses data from the Paying Agency for Agriculture, Fisheries and Rural Development, Ministry of Agriculture and the results of previous research. The trend method was used for the analysis of production and its projection until 2025. Based on the established trends, a projection of the structure of fruit production in 2025 is given. During the analysed period, changes in the share of individual fruit crops in the structure of areas under orchards are noticeable, walnut and hazelnut are increasingly dominating, while the share of apples, plums and other fruit species is decreasing. In the projection period until 2025, unless there are significant changes in the support system and the use of rural development measures, it is expected that the traditional structure of fruit production will change significantly due to changes in the structure of areas under fruit crops.

**Key words:** orchards, areas structure, trends, Croatia

**Genetika,  
 oplemenjivanje bilja  
 i sjemenarstvo**

**03**

**Genetics,  
 Plant Breeding and  
 Seed Production**



## Markerima potpomognuta selekcija na nizak sadržaj Kunitz tripsin inhibitora u soje

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### Sažetak

Kunitz tripsin inhibitor (KTI) važan je antinutritivni čimbenik prisutan u zrnu soje [*Glycine max* (L.) Merr.]. Cilj ovog rada bio je validirati dvije vrste molekularnih markera povezanih s *Ti3* lokusom koji kodira sintezu KTI. Mikrosatelitni (SSR) marker Satt228 potvrdio je prisutnost homozigotnog nul-alela *ti3/ti3* za niski sadržaj KTI u talijanskim sortama Ascasubi i Bahia koje su korištene za razvoj dvije oplemenjivačke populacije križanjem s kultivarima DH 5170 i ES Mentor. Heterozigotne F<sub>1</sub> biljke uspješno su identificirane upotrebom Satt228 i dva dodatna SSR markera. Dvije populacije od po 72 F<sub>2</sub> biljke nadalje su analizirane na razdvajanje alela korištenjem ko-dominantnog SSR markera Satt228 i dominantnog alel-specifičnog markera *KTI*. Oba testirana markera pokazala su očekivanu segregaciju za F<sub>2</sub> generaciju prema mendelovskom nasljeđivanju na jednom lokusu. Homozigotne *ti3/ti3* biljke uspješno su identificirane pomoću Satt228 markera, dok bi se *KTI* specifični marker mogao koristiti u kasnijim fazama selekcije zbog svoje dominantne prirode. Sjeme genotipiziranih F<sub>2</sub> biljaka analizirano je na sadržaj KTI korištenjem metode tekućinske kromatografije visoke različitosti performansi (HPLC). Sadržaj KTI bio je u visokoj korelaciji sa utvrđenim genotipom. Željene homozigotne *ti3/ti3* linije, odabrane uz pomoć markera Satt228, izdvojene su za daljnje oplemenjivanje na poboljšanje kvalitete sjemena soje s ciljem razvoja prve sorte s niskim sadržajem kunitz tripsin inhibitora u Hrvatskoj.

**Ključne riječi:** soja, Kunitz tripsin inhibitor, molekularni markeri, HPLC, kvaliteta zrna



## Marker-assisted selection for low content of Kunitz trypsin inhibitor in soybean

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### Summary

Kunitz trypsin inhibitor (KTI) is an important antinutritional factor present in soybean seeds [*Glycine max* (L.) Merr.]. The aim of this work was to evaluate two types of molecular markers associated with the *Ti3* locus encoding KTI. The microsatellite marker Satt228 confirmed the presence of the homozygous null-allele *ti3/ti3* in the Italian cultivars Ascasubi and Bahia, which were used to develop two breeding populations by hybridization with DH 5170 and ES Mentor varieties, respectively. Heterozygous F<sub>1</sub> plants were successfully identified by using Satt228 and two additional microsatellite (SSR) markers. Two populations consisted of 72 F<sub>2</sub> plants each, were further analyzed for segregation using the co-dominant SSR marker Satt228 and the dominant allele-specific marker KTI. Both markers showed the expected segregation ratio for F<sub>2</sub> generation according to Mendelian single-locus inheritance. Homozygous *ti3/ti3* plants were successfully identified using Satt228, while the KTI marker, due to its dominant nature, might be used in later stages of selection. Seeds of each genotyped F<sub>2</sub> plant were analyzed for KTI content using high-performance liquid chromatography (HPLC). Chemical profile was in high correlation with observed molecular marker genotype. Finally, desired homozygous *ti3/ti3* lines were selected by marker-assisted selection with Satt228 for further breeding aimed at improving seed quality of soybean through developing the first low-KTI variety in Croatia.

**Keywords:** soybean, Kunitz trypsin inhibitor, molecular markers, HPLC, seed quality

## Odgovor klijanaca ječma na kratkotrajni solni stres

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### Sažetak

Zaslanjivanje tla abiotički je stres koji uvelike ograničava poljoprivrednu proizvodnju. Cilj rada bio je istražiti utjecaj solnog stresa na klijance ječma (*Hordeum vulgare* L.) te utvrditi mehanizme tolerancije koji se primarno aktiviraju u ranoj fazi razvoja. Sedam dana stare biljke uzgajane u kontroliranim uvjetima izložene su različitim koncentracijama natrijevog klorida (50, 100, 200 i 400 mM). Utjecaj solnog stresa praćen je nakon 3, 6, 12 i 24 sata. Fiziološka i biokemijska mjerenja izvršena su na prvim potpuno razvijenim listovima. Primijenjeni stres uzrokovao je smanjenje sadržaja fotosintetskih pigmenata i nije inducirao oksidativna oštećenja, što je pokazala smanjena razina malondialdehida. Niska razina malondialdehida obilježje je tolerantnih biljaka na stresne uvjete. Parametri fluorescencije klorofila *a* (L- i K- stupanj; indeks vitalnosti - PI<sub>ABS</sub>) potvrdili su izrazito dobru funkcionalnost fotosintetskog aparata. Povećanje razine solnog stresa i poboljšane performanse klijanaca ječma praćene su povećanim sadržajem prolina i relativnog sadržaja vode. Rezultati pokazuju da osmotska prilagodba pridonosi poboljšanju tolerancije na povišeni salinitet u ranim fazama rasta klijanaca, dok niti jedan pojedinačni parametar ne može biti izdvojen kao primarno odgovoran čimbenik osjetljivosti i/ili tolerancije. Kombinacija parametara bolje objašnjava doprinos komponenata osmotskog, ionskog i oksidativnog stresa ukupnoj toleranciji na povišeni salinitet komercijalno značajnih žitarica.

**Ključne riječi:** prolin, osmoregulacija, fluorescencija klorofila *a*, L- korak, K- korak

## The response of barley seedlings to short-term salinity stress

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### Summary

Soil salinization is an abiotic stress factor seriously limiting crop production. This study aimed to investigate the impact of salt stress on barley seedlings (*Hordeum vulgare* L.) and determine tolerance mechanisms primarily activated in the early stages of seedling growth. Seven-day-old plants were exposed to different sodium chloride concentrations (50, 100, 200, and 400 mM). The effect of salt stress was monitored after 3, 6, 12, and 24 hours. Physiological and biochemical measurements were performed on the first fully developed leaves. The applied stress caused a decrease in photosynthetic pigments and induced no oxidative damage, as demonstrated by decreased malondialdehyde levels. Low malondialdehyde levels are an important feature of salt-tolerant species. Chlorophyll *a* fluorescence parameter (L- and K-band; vitality index - PI<sub>ABS</sub>) confirmed the fully functional photosynthetic apparatus. The improved performance of barley seedlings under increased salinity was accompanied by increased proline and relative water content. The results indicate that cellular osmotic adjustment contributes to improved salinity stress tolerance in the early stages of seedlings growth pointing out that no individual parameter could be signed out as a primary responsible factor of salt sensitivity or tolerance. However, a combination of parameters gives a better explanation of the contribution of osmotic, ionic, and oxidative stress components to commercially important cereals overall salinity tolerance.

**Keywords:** proline, osmoregulation, chlorophyll *a* fluorescence, L- band, K- band

## Utjecaj stimulatora rasta na početni porast hibrida kukuruza

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### Sažetak

Tretiranje sjemena kukuruza stimulatorima rasta novija je mjera u procesu dorade i proizvodnje sjemena. Cilj istraživanja bio je utvrditi utjecaj različitih stimulatora rasta na početni porast mladih biljaka kukuruza. Istraživanja su provedena na tri hibrida kukuruza čije je sjeme tretirano s četiri komercijalne varijante tretmana stimulatora rasta. Nakon nicanja provedena su mjerenja visine biljke i mase nadzemnog dijela biljke u vegetacijskoj fazi početnog porasta kukuruza. Rezultati istraživanja pokazali su statistički vrlo značajan utjecaj stimulatora rasta na visinu biljke, a isto tako i na masu nadzemnog dijela biljke. Najveći pozitivan učinak izmjeren je kod hibrida kukuruza OS 403 za oba promatrana agronomska svojstva. Primjena stimulatora rasta na sjemenu hibrida kukuruza je vrlo jednostavna u samom postupku dorade te se zbog kasnijeg pozitivnog učinka na početni porast hibrida kukuruza može preporučiti u proizvodnji kukuruza. Pozitivno djelovanje stimulatora rasta na metabolizam biljaka u mnogome pomažu biljci kukuruza prevladavanju negativnih agroekoloških utjecaja.

**Ključne riječi:** kukuruz, tretiranje sjemena, hranjiva, stimulatori rasta

## **Influence of growth stimulators on the initial growth of maize hybrids**

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### **Summary**

Treatment of corn seeds with growth stimulants is a newer measure in the process of seed processing and production. The aim of the study was to determine the effect of different growth stimulators on the initial growth of young maize plants. The research was conducted on three maize hybrids whose seeds were treated with four commercial variants of growth stimulator treatment. After germination, measurements of plant height and mass of the aboveground part of the plant in the vegetation phase of the initial growth of maize were performed. The results of the research showed a statistically very significant influence of growth stimulators on the height of the plant and also on the mass of the aboveground part of the plant. The greatest positive effect was measured in maize hybrids OS 403 for both observed agronomic traits. The application of growth stimulators on maize hybrid seeds is very simple in the finishing process and due to the subsequent positive effect on the initial growth of maize hybrids can be recommended in maize production. The positive effects of growth stimulants on plant metabolism greatly help the maize plant to overcome negative agroecological impacts.

**Key words:** maize, seed treatment, nutrients, growth stimulators

## Opsežna analiza genetske strukture oplemenjivačke germplazme Poljoprivrednog instituta Osijek

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### Sažetak

Oplemenjivanje kukuruza na prinos zasnovano je na korištenju heterozisa. Heterotični efekt očituje se prepoznatljivim obrascima između inbred linija iz različitih heterotičnih skupina. Nove tehnologije genotipiziranja s visokom gustoćom markera predstavljaju vrijedan alat oplemenjivačima za klasifikaciju inbred linija u pripadajuće heterotične skupine. Cilj ovoga istraživanja bio je analizirati genetsku strukturu germplazme kukuruza razvijenu u zadnja dva desetljeća na Poljoprivrednom institutu Osijek korištenjem SNP tehnologije. Ukupno 1300 primki genotipizirano je upotrebom Illumina MaizeSNP50 čipom s 56000 polimorfnih SNP markera. Podaci su filtrirani za SNP markere koji nisu pridruženi nijednom kromosomu, za heterozigote (max = 2,5 %) i nedostajuće podatke (max = 5 %), nakon čega je ostalo ukupno 48374 SNP markera korištenih za analizu. Matrica markera je imputirana LDkNNI metodom s 30 pozicija visoke neravnoteže vezanosti i 10 najbližih susjeda. Analiza glavnih koordinata (PCoA) je provedena s pretpostavljenih osam osi. Filtriranje, imputacija i analiza glavnih koordinata provedeni su u programu Tassel, verzija 5.2.6. Analiza Admixture napravljena je u operativnom sustavu Ubuntu 20.04, verzija Admixture 1.3.0. Broj izvornih populacija (K) postavljen je od 1-15 nakon čega je provedena peterostruka unakrsna validacija. Pogreška unakrsne validacije bila je najniža u K = 7 pa je za daljnju analizu upotrijebljen model sa sedam izvornih populacija. U nedavno razvijenim inbred linijama primjetan je prijelaz germplazme prema ranijim skupinama zriobe. Genetska struktura primki i trendovi u praksi biti će objašnjeni.

**Ključne riječi:** admixture analiza, kukuruz, inbred linije, heterotične skupine, SNP

## Comprehensive study of genetic structure in Agricultural Institute Osijek proprietary breeding germplasm

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### Summary

Breeding maize for yield performance is based on utilization of heterosis. Heterotic effects follow recognizable patterns between inbreds from different heterotic groups. New genotyping technologies with high marker densities provide breeders a tool for precise classification of inbreds into heterotic groups. The aim of this study was to analyze genetic structure of proprietary maize germplasm of Agricultural Institute Osijek, developed over the last two decades using dense SNP array data. The 1300 accessions were genotyped using Illumina MaizeSNP50 BeadChip with ~56000 variants. The data were filtered for SNPs not assigned to any chromosome, heterozygotes (max. = 2.5%), and missing positions (max. = 5%) leaving a total of 48734 SNPs. Positions were imputed using a linkage disequilibrium k-nearest neighbor imputation (LDkNNI) with 30 high LD sites and 10 nearest neighbors. Principal coordinate analysis (PCoA) was carried out with eight axes. Filtering, imputation and PCoA were carried out in Tassel software version 5.2.6. Admixture analysis was run in Ubuntu 20.04 with Admixture version 1.3.0. Number of ancestral populations (K) was set from 1 to 15 and 5-fold cross validation was performed. Cross validation error was the lowest in K = 7, so the model with seven ancestral populations was used for further analysis. The shift towards early maturing germplasm was observed in more recently developed inbreds. The genetic structure of accessions and trends in farmer's fields will be discussed.

**Key words:** admixture, maize, inbred lines, heterotic groups, SNP array

## Importance of *Fusarium* resistant varieties regarding occurrence of mycotoxins and other fungal metabolites

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### Summary

*Fusarium* head blight (FHB) is one of the most dangerous wheat diseases causing yield and quality losses and is also associated with mycotoxin accumulation which threatens human and animal health. The aim of the study was to examine the occurrence of the mycotoxins/metabolites produced by *Fusarium* species. The experiment was set up in two treatments (*Fusarium* artificially inoculated and naturally infected) at two different locations (Osijek and Tovarnik) in the vegetation season 2019/2020. According to the data quantified by LC–MS/MS, deoxynivalenol (DON), DON-3-glucoside (D3G), nivalenol (NIV) and zearalenone (ZEN), as well as co-regulated metabolites (culmorin and 15-hydroxyculmorin) occurred at lower concentration in more resistant variety (Galopper) in each treatment at both locations. The highest occurrence of *Fusarium* mycotoxins/metabolites was expectedly recorded in susceptible variety (Golubica) in inoculated treatment. At natural infection at Osijek, there were no investigated mycotoxins/metabolites detected, while favorable weather conditions in Tovarnik enhanced fungal growth and mycotoxin production even at natural infection. Despite that, more FHB resistant variety showed lower infection rate at both locations which emphasize the fact that breeding work should be focused on the creation of resistant FHB wheat varieties.

**Key words:** *Fusarium*, mycotoxins, wheat

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## Prostorna genetska struktura inbred linija kukuruza u Europi otkrivena pomoću kriging metode

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### Sažetak

Genomski podaci predstavljaju vrlo vrijedan skup informacija za analizu genetske strukture relevantne u oplemenjivanju bilja za procjenu broja izvornih populacija (K). Za visokodimenzionalne vektorske prostore polimorfizma jednoga nukleotida (SNP) u genomu kukuruza koristili smo tzv. „kriging“ koncept, prvotno razvijen u geostatističkom kontekstu za predviđanja u niskodimenzionalnom prostoru. Pomoću Axiom 600k SNP čipa genotipizirano je 572 primki inbred linija Instituta za kukuruz „Zemun Polje“ podrijetlom iz Jugoistočne Europe. Genotipski podaci su zatim spojeni s komplementarnim podacima genotipizacije dvaju europskih panela DROPS i TUM. Genetska struktura je analizirana pomoću programa STRUCTURE za procjenu K. Prostorna pojekcija provedena je uporabom Bioconductor paketa LEA. Kružni grafovi s izračunatim koeficijentima za procijenjene izvorne populacije kartirani su na 18 europskih lokacija i proveden je kriging na dominantne prostorne obrasce. Glavna izvorna populacija u Zapadnoj Europi su materijali podrijetlom iz europskih tvrdunaca, dok u Italiji dominiraju inbred linije iz izvorne populacije Stiff Stalk Synthetic. U trećem obrascu prevladavaju ostale izvorne populacije uočene u Španjolskoj, Portugalu, kao i većini Istočne i Jugoistočne Europe. Značajan udio linija povezanih s izvornom populacijom podrijetlom iz Minnesote opažen je u Jugoistočnoj Europi.

**Ključne riječi:** 600k SNP čip kukuruza, genetska struktura, inbred linije, kriging, Europa

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## Spatial genetic structure of maize inbred lines in Europe revealed by a kriging method

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### Summary

Genomic data provide a valuable source of information for analysis of genetic structure relevant to plant breeding inferring a number of ancestral populations. We apply the kriging concept, originally developed in the geostatistical context for predictions in the low-dimensional space, to the high-dimensional space spanned by genomic single nucleotide polymorphism (SNP) vectors. Total of 572 accessions of inbreds from Maize Research Institute Zemun Polje representing the South East Europe (SEE) material were genotyped using the Axiom 600k SNP array. The genotyping results were merged with two complementary European panels DROPS and TUM. Genetic structure was analyzed with STRUCTURE software to obtain the optimal number of ancestral populations. Spatial projections of the calculated ancestry coefficients were performed using a Bioconductor package LEA. Pie charts of the average ancestries of samples with assigned putative origin were mapped to 15 European locations, and kriging on dominant spatial patterns was performed. Three different geospatial patterns were revealed. The main pattern in the Western Europe is mostly of European Flint materials. Another pattern was represented by the accessions from Italy closely related to the Stiff Stalk Synthetic germplasm. The third pattern represented by other ancestral populations can be observed in the Spain, Portugal and most of Eastern Europe and SEE. The larger proportions of the lines associated with materials from Minnesota in SEE was also observed.

**Key words:** 600k SNP maize array, genetic structure, inbred lines, kriging, Europe

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## Correlation and path coefficient analysis of agronomic traits in wheat

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### Summary

The aim of this study was to examine correlations between important agronomic traits of wheat and to determine their direct and indirect effects on grain yield. In a four-year study 120 wheat cultivars were evaluated for eight agronomic traits. Grain yield showed positive correlation with spike weight, number of grains per spike, days to heading and 1000 kernel weight. Plant height showed negative correlation with grain yield. The strongest correlation was determined for spike weight and number of grains per spike, as for number of grains per spike and number of spikelets per spike. Path coefficient analysis revealed positive direct effect of spike weight, number of grains per spike and 1000 kernel weight on grain yield, as well as negative direct effect of number of spikelets per spike on grain yield. Number of grains per spike via spike weight had the greatest positive indirect effect on grain yield. Obtained results indicate that spike weight, number of grains per spike and 1000 kernel weight should be given a special attention, when planning a breeding program for high-yielding wheat cultivars.

**Key words:** wheat, correlation, path coefficient

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## Determination of the nature of the vitreousness of wheat varieties

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### Summary

The average expected share of vitreous (glassy) grains in particular wheat variety is its varietal characteristic but also an important technological indicator of quality in certain industries (bakery, pasta, malting, etc.). In addition to the proportion of vitreous grains, it is very important to determine the nature of glassiness with regard to the ability to retain this property, i.e. to establish the share of grains that lose this property due to soaking (transient vitreousness). For certain technological processes, permanent vitreousness is desirable, but for others transient vitreousness is more appropriate. Although the total share of glassy grains is influenced by numerous ecological and agrotechnical conditions during the vegetation period, by monitoring the share and nature of vitreousness through the relevant statistical period (3-5 years) at several locations, relatively reliable data can be obtained based on which valid predictions of these values for particular variety can be made. In this paper, 33 wheat varieties were examined. The obtained results indicate large differences in the share of glassy grains, as well as large differences in the ratio of total/transient glassiness of grains by individual wheat varieties. Furthermore, for most of the examined assortment, a relatively high share of transient glass in total glass grains was found.

**Key words:** wheat varieties, total vitreous grains, transient vitreous grains

## Važnost kvalitete DNA u Real Time PCR reakcijama

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### Sažetak

Ekstrakcija DNA i lančana reakcija polimerazom (PCR) neizostavne su metode u molekularnom laboratoriju. Lančana reakcija polimerazom u stvarnom vremenu (Real Time PCR) je metoda zasnovana na umnažanju karakterističnih odsječaka molekule genomske DNA pomoću posebno dizajniranog para nukleotidnih početnica te fluorescirajuće probe. Intenzitet fluorescencije u izravnoj je korelaciji s količinom nastalog produkta što omogućava i kvalitativno i kvantitativno određivanje mjerenjem promjene fluorescencijskog signala u stvarnom vremenu. Svakoj PCR reakciji prethodi ekstrakcija DNA. Ekstrakcija DNA podrazumijeva niz fizikalno-kemijskih postupaka s ciljem razdvajanja DNA iz uzorka od ostalih staničnih komponenti koje bi mogle imati potencijalno negativan utjecaj na uspješnost PCR reakcije. Postoji veliki broj opisanih protokola za izdvajanje DNA, no svaki od njih mora osigurati dostatne količine DNA za PCR umnažanje oslobođene od PCR inhibitora. U radu su opisana dva protokola za ekstrakciju DNA iz biljnih uzoraka. Kvaliteta i prinos metode ekstrakcije DNA mjerena je spektrofotometrijski mjerenjem odnosa apsorbanci pri različitim valnim duljinama, te vizualizacijom na gelu agaroze. Prisutnost PCR inhibitora procijenjena je RealTime PCR umnažanjem serije razrjeđenja normalizirane otopine DNA.

**Ključne riječi:** kvaliteta, ekstrakcija DNA, Real Time PCR, inhibicija

## The importance of DNA quality for Real Time PCR reactions

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### Summary

DNA extraction and polymerase chain reaction (PCR) are indispensable methods in the molecular laboratory. Real Time PCR is a method based on amplifying characteristic segments of a genomic DNA molecule using a specially designed pair of nucleotide primers and a fluorescent probe. The fluorescence intensity is directly correlated with the amount of produced product, which enables both qualitative and quantitative determination by measuring changes in the fluorescence signal in real time. Each PCR reaction is preceded by DNA extraction. DNA extraction involves a series of physicochemical procedures aimed to separate DNA from other cellular components that could have a potentially negative impact on the success of PCR reaction. There are a number of DNA isolation protocols described, and each of them must provide a sufficient amount of DNA for PCR amplification free from PCR inhibitors. The paper describes two protocols for extracting DNA from plant samples. The quality and yield of the DNA extraction method is estimated spectrophotometrically by measuring the absorbance ratio at different wavelengths, and by visualization on an agarose gel. The presence of PCR inhibitors was assessed using Real Time PCR by amplifying a series of dilutions of normalized DNA solution.

**Key words:** quality, DNA extraction, Real Time PCR, inhibition

## Karakterizacija fenolnih kiselina u pšenici, ječmu i kukuruзу

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### Sažetak

Fenolne kiseline (FK) su najzastupljeniji i dobro okarakterizirani fenolni spojevi u žitaricama. FK su analizirane iz cjelovitog zrna različitih žitarica tijekom dvije vegetacijske godine. Analizom FK pomoću HPLC metode utvrđeno je da na njihovu koncentraciju i sastav značajno utječe tip žitarica. Prosječni ukupni sadržaj FK najveći je u zrnu kukuruza ( $2213 \text{ ug}_{\text{dm}^{-1}}$ ), zatim ozimog ječma ( $991 \text{ ug}_{\text{dm}^{-1}}$ ) i pšenice ( $604 \text{ ug}_{\text{dm}^{-1}}$ ), te je slijedom navedenog koncentracija dominantne ferulične kiseline također najveća u kukuruзу ( $1748 \text{ ug}_{\text{dm}^{-1}}$ ), ječmu ( $610 \text{ ug}_{\text{dm}^{-1}}$ ) i pšenici ( $448 \text{ ug}_{\text{dm}^{-1}}$ ). Od ukupnih FK na feruličnu kiselinu otpada 78 % u kukuruзу, 74 % u pšenici i 62 % u ječmu. Uz feruličnu kiselinu, u zrnu žitarica također su identificirane i p-hidroksibenzojeva, vanilinska, kafeinska, siringična i o-kumarinska kiselina, ali u manjoj koncentraciji. Utvrđen je značajni utjecaj genotipa i godine na koncentraciju FK. Dobiveni rezultati ukazuju na značajnu nutritivnu vrijednost analiziranih žitarica.

**Ključne riječi:** žitarice, genotipovi, fenolne kiseline, HPLC

## Characterization of phenolic acids in wheat, barley and corn

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### Summary

Phenolic acids (PAs) are the most prominent and well-characterized phenolic compounds in cereal grains. The whole grains of different cereals were evaluated for PAs during a two crop years. The PAs were determined by HPLC and their concentration and composition were significantly affected by cereal type. The mean of total PAs content was highest in corn (2213  $\mu\text{g g}_{\text{dm}}^{-1}$ ), followed by barley (991  $\mu\text{g g}_{\text{dm}}^{-1}$ ) and wheat (604  $\mu\text{g g}_{\text{dm}}^{-1}$ ). Ferulic acid as dominant PA was found to be significantly higher in corn (1748  $\mu\text{g g}_{\text{dm}}^{-1}$ ) in comparison to barley (610  $\mu\text{g g}_{\text{dm}}^{-1}$ ) and wheat (448  $\mu\text{g g}_{\text{dm}}^{-1}$ ). Ferulic acid accounted for approximately 78% in corn, 74% in wheat and 62% of total PAs. P-hydroxybenzoic acid, vanillic, caffeic, syringic and o-comaric were also found in cereals grains, but in minor concentration. A significant impact of genotype and crop years on the PAs concentration was detected. The obtained results indicate a significant health benefit potential of selected cereals.

**Key words:** cereals, genotypes, phenolic acids, HPLC



## Fotosinteza pšenice zaražene fuzarijskom paleži klasa

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### Sažetak

Fuzarijska palež klasa (FHB) je značajna bolest pšenice (*Triticum aestivum* L.) koja utječe na prinos i kvalitetu zrna. Kako bi se istražio utjecaj FHB na fotosintezu različito osjetljivih sorti ozime pšenice, provedena je umjetna inokulacija vrstama *Fusarium graminearum* i *F. culmorum* (1:1) na polju Poljoprivrednog Instituta Osijek 2019./2020. godine. Analiza brzog porasta fluorescencije klorofila *a* lista zastavičara i klasa ukazala je na značajnije promjene u fotosintetskoj učinkovitosti klasa uslijed FHB infekcije u usporedbi s listom. Smanjenje vrijednosti indeksa fotosintetske učinkovitosti (PI<sub>ABS</sub>) i maksimalnog kvantnog prinosa PS II (TR<sub>0</sub>/ABS) u inokuliranim klasovima u usporedbi s kontrolom (prirodna infekcija) u sorte Golubica zabilježeno je tri dana nakon inokulacije što ukazuje na promjene u fotosintetskom aparatu ove osjetljive sorte prije pojave vidljivih simptoma infekcije. U periodu pojave simptoma u inokuliranim klasovima sorte Golubica vrijednosti PI<sub>ABS</sub> i TR<sub>0</sub>/ABS su se povećale, ali daljnji razvoj bolesti rezultirao je značajnim smanjenjem fotosintetske učinkovitosti u usporedbi s kontrolom. Utjecaj FHB na fotosintetsku učinkovitost klasa je dokazana u otporne sorte (Galloper), osobito u kasnijim fazama infekcije, ali je utjecaj bio slabiji u usporedbi sa sortom Golubica. Dobiveni rezultati ukazuju da infekcija *Fusarium* sp. može uzrokovati promjene fotosintetske učinkovitosti i funkcije PSII u klasu pšenice.

**Ključne riječi:** biotički stres, *Fusarium*, fluorescencije klorofila *a*, fotosintetska učinkovitost, *Triticum aestivum*

## Photosynthesis of wheat infected with *Fusarium* head blight

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### Summary

*Fusarium* head blight (FHB) is a serious disease of wheat (*Triticum aestivum* L.) which can reduce yield and quality of the grain. In order to investigate effect of FHB on photosynthesis of winter wheat varieties with different susceptibility, artificial inoculation with *Fusarium graminearum* and *F. culmorum* (1:1) was performed in the field at the Agricultural Institute Osijek in 2019/2020. Analysis of fast chlorophyll *a* fluorescence transients of flag leaf and ear revealed that more significant changes in photosynthetic efficiency due to FHB occurred in ears, in comparison to leaves. Decrease of performance index (PI<sub>ABS</sub>) and maximum quantum yield of PS II (TR<sub>0</sub>/ABS) in the inoculated ears, in comparison to control (natural infection) of variety Golubica was detected three days post inoculation, indicating that changes in photosynthetic apparatus of this susceptible variety occurred before visual symptoms of the infection. Upon symptom development, inoculated ears of Golubica showed increase of PI<sub>ABS</sub> and TR<sub>0</sub>/ABS, while progression of the disease resulted in reduced photosynthetic performance, in comparison to control. Impact of FHB on ear photosynthetic efficiency of resistant variety (Galopper) was also evident, especially in the later stages of the infection, but it was less severe than for variety Golubica. Overall, this study indicated that *Fusarium* sp. infection may induce changes in photosynthetic performance and functioning of PSII in ears of wheat.

**Key words:** biotic stress, *Fusarium*, chlorophyll *a* fluorescence, photosynthetic efficiency, *Triticum aestivum*

## Utjecaj gustoće sjetve i agroklimatskih prilika na prinos zrna i komponente prinosa jaroga stočnog graška

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### Sažetak

Jari stočni grašak jedna je od najznačajnijih krupnozrnih mahunarki. Visoka gospodarska vrijednost suhog zrna graška proizlazi iz visoke koncentracije sirovih bjelančevina (do 30 %) i škroba (50 %) u suhoj tvari te njihovoj visokoj probavljivosti. Prinos zrna složeno je svojstvo uvjetovano različitim genetskim, fiziološkim i agroekološkim činiteljima. Istraživanje je provedeno kako bi procijenili reakciju utjecaja različitih gustoća sjetve (50, 100 i 150 biljaka po m<sup>2</sup>) i različitih agroekoloških uvjeta na prinos zrna i komponente prinosa zrna jaroga stočnog graška. U istraživanju je korištena komercijalna sorta jaroga stočnog graška Uran. Pokus je postavljen na istraživačkoj stanici Poljoprivrednog instituta Osijek po RCBD shemi u četiri ponavljanja tijekom dvaju vegetacijskih ciklusa 2017. i 2019. godine. Kombiniranom analizom varijance utvrđene su statistički značajne razlike između različitih gustoća sjetve, godina istraživanja i većine istraživanih svojstava (prinos zrna, visina biljke, broj mahuna po biljci). Najveće prosječne vrijednosti prinosa zrna ostvarene su u 2019. godini (4,7 t ha<sup>-1</sup>) dok je u 2017. ostvaren manji prosječan prinos (4,4 t ha<sup>-1</sup>). Unutar godina istraživanja utvrđene su statistički značajne razlike između različitih sklopova, odnosno gustoća sklopa za istraživano svojstvo. Najveći prosječan prinos zrna ostvaren je pri gustoći sklopa od 150 biljaka m<sup>2</sup> (6,01 t ha<sup>-1</sup>) dok je najmanji prosječan prinos realiziran pri gustoći sklopa od 50 biljaka po m<sup>2</sup> (2,7 t ha<sup>-1</sup>). Statistički opravdane razlike u prosječnim vrijednostima između godina ukazuju na značajan utjecaj klimatskih prilika u dva ispitivana vegetacijska razdoblja. Veće vrijednosti oborina u 2019. godini u tijekom rasta i razvoja graška (posebno u generativnoj fazi) u odnosu na sušniju 2017. godinu imale su značajan utjecaj na ekspresiju prinosa zrna kao i na nastale razlike u vrijednostima najznačajnijih komponenti prinosa.

**Ključne riječi:** jari stočni grašak, gustoća sjetve, prinos zrna, komponente prinosa

## Influence of plant density and agroclimatic conditions on seed yield and yield component of spring field pea

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### Summary

The spring field pea is one of the most important coarse legumes. The high economic value of dry pea seed arises from the high concentration of crude protein (up to 30%) and starch (50%) in dry matter and their high digestibility. Seed yield is a complex trait conditioned by different genetic, physiological, agroecological (environmental) factors. Study was carried out to investigate the response of a spring field pea variety to three plant densities (50, 100, and 150 plant per m<sup>2</sup>) in different agroecological conditions on grain yield and grain yield components. A local variety of Uran was used as a test crop. Field trial was conducted at the Agricultural Institute of Osijek's Research Station during the 2017 and 2019 growing seasons. Combined analysis of variance determined statistically significant differences between plant densities, years of research and most of the investigated traits (seed yield, plant height, number of pods per plant) of spring field pea. The highest mean yield values were scored in 2019 (4.7 t ha<sup>-1</sup>), compared to (4.4 t ha<sup>-1</sup>) in 2017. Significant differences in yield performances were determined between different plant densities within years. The highest mean seed yield was scored in 150 plants m<sup>-2</sup> density (6.01 t ha<sup>-1</sup>), while the lowest yield was scored in 50 plants m<sup>-2</sup> (2.7 t ha<sup>-1</sup>) density. The obtained statistically significant differences in average values between years indicate the climatic variability studied vegetation periods. Higher values of precipitation in 2019 in the vegetation period of pea growth and development (especially in the generative phase) compared to the drier 2017 had a significant impact on the expression of grain yield as well as the differences in the values of the most significant yield components.

**Key words:** spring field pea, plant densities, seed yield, yield components

## Utjecaj godine, lokacije i sorte na sadržaj proteina i urod zrna ozime pšenice

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### Sažetak

Ozima pšenica (*Triticum aestivum* L.) je druga najvažnija ratarska kultura u Republici Hrvatskoj. Uvođenjem Kodeksa otkupa žitarica i uljarica, pored uroda zrna, sve veću važnost ima i sadržaja proteina. U trogodišnjem istraživanju na šest sorata ozime pšenice, provedenom na 10 lokacija diljem Republike Hrvatske, procijenjen je utjecaj godine, lokacije i sorte na urod zrna i sadržaj proteina. Analizom varijance utvrđen je značajan utjecaj godine, lokacije i sorte na sadržaj proteina i urod zrna. Interakcija godina  $\times$  lokacija je bila značajna, dok interakcije godina  $\times$  sorta i lokacija  $\times$  sorta nisu bile značajne niti za jedno proučavano svojstvo. Na temelju udjela sume kvadrata pojedinih izvora varijabilnosti u ukupnoj sumi kvadrata, najveći utjecaj na svojstvo sadržaja proteina imala je godina, zatim sorta, a najmanji lokacija. Najveći utjecaj na urod zrna imala je godina, zatim slijedi lokacija, a najmanji utjecaj imala je sorta. Na temelju izračunatog koeficijenta varijacije po godinama, lokacijama i sortama sadržaj proteina se pokazao kao stabilnije svojstvo od uroda zrna.

**Ključne riječi:** pšenica, sorta, godina, lokacija, urod zrna

## Effect of year, location and variety on protein content and grain yield of winter wheat

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### Summary

Winter wheat (*Triticum aestivum* L.) is the second most important field crop in the Republic of Croatia. With the introduction of the Code of purchase of cereals and oilseeds, in addition to grain yield, the protein content is becoming more important. In a three-year study on six winter wheat varieties, conducted at 10 locations throughout the Republic of Croatia, the impact of year, location and cultivar on grain yield and protein content was assessed. Analysis of variance showed a significant influence of year, location and variety on protein content and grain yield. The year  $\times$  location interaction was significant, while the year  $\times$  variety and location  $\times$  variety interactions were not significant for any of the studied traits. Based on the share of the sum of squares of individual sources of variability in the total sum of squares, the greatest influence on protein content had the year, then the variety, and the smallest location. The greatest influence on grain yield had the year, followed by location, and the smallest influence had variety. Based on the calculated coefficient of variation over the years, locations and varieties the protein content proved to be a more stable trait than grain yield.

**Key words:** wheat, variety, year, location, grain yield

## Comparison of genomic selection models to predict wheat quality traits in a biparental population

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### Summary

Selection for wheat (*Triticum aestivum* L.) grain quality traits is often costly and time consuming since it requires extensive phenotyping in the process of development of new lines and cultivars. The development of high-throughput genotyping in the last decade enabled reliable and rapid predictions of breeding values based only on marker information. Genomic selection is a method that enables the prediction of breeding values of individuals by simultaneously incorporating all available marker information into a model. The main aim of this study was to investigate several different models, RR-BLUP and Bayesian models, for predicting wheat grain quality traits using a biparental population. Two varieties (Bezostaja and Klara) differing in all HMW glutenin subunits were selected, and a set of 139 recombinant inbred lines were derived from a cross between these two parents. All RILs were evaluated at two locations (Osijek and Slavonski Brod) during three years for the quality traits viz., grain protein content (GPC), wet gluten content (WGC) and mixograph midline peak height (MPT). Population was genotyped using the DArTseq technology and a total of 1087 SNPs were used for genomic selection. Response of the prediction accuracy of quality traits to changes in heritability and model applied were determined, in order to propose an optimal scenario for genomic selection within biparental wheat populations. Impact of genotype imputation on the performance of models for genomic prediction was also assessed. Results showed that trait heritability and genotype imputation significantly affect predictive ability of selected models when using biparental wheat population.

**Key words:** wheat quality, RILs, genomic selection, SNPs, imputation, heritability

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## Izvoz hrvatskog sjemena u treće zemlje nakon ulaska Hrvatske u EU

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### Sažetak

Ulaskom Republike Hrvatske u Europsku uniju izvoz hrvatskog sjemena orijentiran je na treće zemlje. Izvoz sjemena u treće zemlje provodi se prema međunarodnim propisima OECD-a (Organisation for Economic, Co-operation and Development) i ISTA (International Seed Testing Association) međunarodnim pravilima za ispitivanje sjemena. Za potrebe izvoza sjemena u treće zemlje neophodni su OECD i ISTA certifikat. Republika Hrvatska sudjeluje u OECD certifikacijskim shemama, a Laboratorij za ispitivanje sjemena, Centra za sjemenarstvo i rasadničarstvo, Hrvatske agencije za poljoprivredu i hranu. Laboratorij za ispitivanje sjemena jedini je ISTA akreditirani laboratorij u RH ovlašten za izdavanje ISTA certifikata sukladno ISTA akreditacijskom standardu i ISTA pravilima. Izdavanje OECD certifikata o sjemenu provodi se prema pravilima i standardima OECD certifikacijske sheme. U razdoblju od 2014. do 2020. godine najviše se izvezilo sjeme žitarica, od kojih se oko 77 % odnosi na sjeme strnih žitarica te oko 19 % na sjeme kukuruza. Ostale količine izvezenog sjemena se odnose na soju, lucernu, stočni grašak, suncokret, te sjeme trava i povrća. Očekivano, najveći izvoznici su domaće oplemenjivačke kuće i dorade s najvećim doradbenim kapacitetima. Najveće količine sjemena izvezene su u Bosnu i Hercegovinu, te Kosovo, a slijede Srbija, Makedonija i Ukrajina. U posljednje tri godine otvaraju se nova tržišta za hrvatsko sjeme, kao što su Crna Gora, Bjelorusija, Etiopija, Gana, Irak i Kazahstan, što ukazuje na konkurentnost hrvatskih proizvođača sjemena na EU i svjetskom tržištu.

**Ključne riječi:** izvoz, sjeme, OECD, ISTA akreditacija, treće zemlje



## **Export of Croatian seed to third countries after Croatia's accession to the EU**

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### **Summary**

With the accession of the Republic of Croatia to the European Union, the export of Croatian seed is oriented towards third countries. Seed is exported to third countries in accordance with the international regulations of the OECD (Organization for Economic, Co-operation and Development) and ISTA (International Seed Testing Association) International Rules for Seed Testing. OECD and ISTA certification are required for the export of seed to third countries. The Republic of Croatia participates in OECD certification schemes, and the Seed Testing Laboratory, of the Center for Seed and Seedlings, the Croatian Agency for Agriculture and Food is the only ISTA accredited laboratory in the Republic of Croatia authorized to issue ISTA certificates in accordance with the ISTA accreditation standard and ISTA Rules. The issuance of OECD seed certificates is carried out according to the rules and standards of the OECD Seed Scheme. In the period from 2014 to 2020, mostly cereal seed was exported, of which about 77% were small grain seed and about 19% maize seed. Other quantities of exported seed refer to soybeans, alfalfa, fodder peas, sunflowers and grass and vegetable seed. As expected, the largest exporters are domestic breeding companies, and seed processing with the largest processing capacities. The largest quantities of seed were exported to Bosnia and Herzegovina and Kosovo, followed by Serbia, Macedonia and Ukraine. In the last three years, new markets have been opened for Croatian seed, such as Montenegro, Belarus, Ethiopia, Ghana, Iraq and Kazakhstan, which indicates the competitiveness of Croatian seed producers in the EU and the world market.

**Key words:** export, seed, OECD, ISTA accreditation, third countries

## Use of Plant Gene Sources for Selection Breeding in Fruit Cultivation in Turkey

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### Summary

The regions where plant species first appeared and completed their evolution are known as Gene Centres, or Centres of Origin. There are eight known gene centres around the world, and owing to its location within both the Near East and the Mediterranean Basin, Turkey enjoys an exceptional position in terms of plant genetic diversity. With regards to garden plants, Turkey is actually the gene centre for many species of fruit. Of the 138 fruit species cultivated around the world, 75 varieties, including 16 subtropical ones, can be grown in Turkey. The richness of Turkey's flora presents an important source for selection breeding studies. Many selection studies have been - and are still being - conducted in different regions of Turkey on the numerous species of fruit that grow naturally in the country. Furthermore, certain types of fruit with superior characteristics that have been obtained through selection breeding studies in different regions have already been registered as varieties.

**Key words:** fruit diversity, gene centre, selection, Turkey

## Kvaliteta prostornih zapisa o dalmatinskom buhaču iz hrvatskih otvorenih baza podataka

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### Sažetak

Botanički zapisi visoke kvalitete (prostorni i drugi) mogu pružiti vrijedne informacije znanstvenicima i tijelima javne vlasti u donošenju odluka vezanih za zaštitu vrsta i staništa te održivo korištenje istih. Dvije botaničke baze podataka korištene su u procjeni kvalitete prostornih podataka: Flora Croatica database (FCD) i Baza podataka o biljnim genetskim izvorima (CPGRD). Kao najopsežnija botanička baza podataka u Hrvatskoj, FCD obuhvaća herbarijske zbirke, literaturne navode i opažanja s terenskih istraživanja u svrhu zaštite prirode, te korištenja u znanosti i edukaciji. CPGRD pruža podatke o prikupljanju u svrhu očuvanja biljnih genetskih izvora te za uzgoj i uporabu poljoprivrednih biljnih vrsta. Dalmatinski buhač (*Tanacetum cinerariifolium* /Trevir./Sch. Bip.) kao endemska i zaštićena vrsta s uzgojnim potencijalom primjer je preklapanja ove dvije baze. Zapisi o dalmatinskom buhaču ocjenjivani su u tri kategorije indikatora: potpunosti, logičke dosljednosti i pozicijske točnosti. Ukupno je pronađeno 1042 zapisa (FCD: 901, CPGRD: 141), njih 47 u obje baze podataka. Preliminarni rezultati ukazuju na visoku kvalitetu prostornih zapisa za dalmatinski buhač, s visokim ocjenama u sve tri kategorije (potpunost: 95,59 %, logička dosljednost: 93,38 % i pozicijska preciznost: 95,78 %). Ovi rezultati otvaraju mogućnost povezivanja podataka iz dva različita sektora uz istodobno poticanje na poboljšanje kvalitete podataka.

**Ključne riječi:** *Tanacetum cinerariifolium*, Flora Croatica Database, Croatian Plant Genetic Resources Database, točnost, dosljednost

## Dalmatian pyrethrum spatial records quality from Croatian Open Databases

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### Summary

High quality data of botanical records, spatial and other types, can provide valuable information to researchers and government stakeholders in decision-making processes regarding species and habitat protection and sustainable use. Two plant databases were used as a source of records for assessment of spatial quality: Flora Croatica database (FCD) and Croatian Plant Genetic Resources Database (CPGRD). As the most extensive botanical database in Croatia, FCD comprises of herbarium collections, literature, and fieldwork observations aimed at nature protection, science, and educational use. CPGRD provides data on collection for conservation of national plant genetic resources in agricultural plant production and use. Dalmatian pyrethrum (*Tanacetum cinerariifolium* /Trevir./Sch. Bip.) as an endemic and protected species with cultivation potential is an example of overlap in these two open databases. Records of Dalmatian pyrethrum were assessed based on three categories of indicators: completeness, logical consistency, and positional accuracy. In total, 1042 records were identified (FCD: 901, CPGRD: 141) with 47 records found in both databases. Preliminary results indicate a high quality of Dalmatian pyrethrum spatial records scoring high on all three categories (completeness: 95.59%, logical consistency: 93.38% and positional accuracy: 95.78%). These findings open a possibility for linking the data from two different sectors while promoting constant quality improvements.

**Key words:** *Tanacetum cinerariifolium*, Flora Croatica Database, Croatian Plant Genetic Resources Database, accuracy, consistency

## Utjecaj boje sjemene ljuske na upijanje vode, klijanje sjemena i nicanje graha

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### Sažetak

Grah (*Phaseolus vulgaris* L.) je najraširenija mahunarka u Hrvatskoj, a proizvodnja se temelji na tradicijskim kultivarima velike morfološke raznolikosti. Tradicijski kultivari se najviše razlikuju u boji sjemene ljuske koja utječe na upijanje vode, klijanje sjemena i nicanje biljaka. U ovom istraživanju je korišteno po 50 sjemenki dva kultivara bijele sjemene ljuske 'Biser' (sitnosjemeni) i 'Bijeli' (krupnosjemeni) te dva kultivara obojane sjemene ljuske 'Kornjača' (sitnosjemeni) i 'Trešnjevac' (krupnosjemeni). Za svaki od tri dijela pokusa odvojeno je po 200 sjemenki za pokus upijanja vode, za klijanje sjemena te za nicanje biljaka. Utvrđeno je da kultivari bijele sjemene ljuske upijaju više vode od kultivara obojane sjemene ljuske slične mase u istom vremenu te da dolazi do ispuštanja više elektrolita iz sjemena bijele sjemene ljuske što uzrokuje veća oštećenja unutar sjemena. Također je utvrđeno da sitnosjemeni kultivari i kultivari bijele sjemene ljuske kliju brže od krupnosjemenog kultivara obojane sjemene ljuske te da sitnosjemeni kultivari niču brže od krupnosjemenih.

**Ključne riječi:** boja sjemene ljuske, klijanje, *Phaseolus vulgaris* L., upijanje vode

## Effect of the seed coat colour on water uptake rate, seed germination and sprouting of common bean

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### Summary

Common bean (*Phaseolus vulgaris* L.) is the most widespread legume in Croatia and the production is based on landraces of great morphological diversity. Cultivars morphologically differ most in the seed coat colour, which affects water uptake, seed germination and sprouting. In this study, 50 seeds from each white-coloured landraces 'Biser' (small-seeded) and 'Bijeli' (large-seeded) and dark-coloured landraces 'Kornjača' (small-seeded) and 'Trešnjevac' (large-seeded) were used for three stages of the experiment. Namely, 200 seeds of Croatian common bean landraces were used for the water uptake experiment, 200 seeds for seed germination, and 200 for sprouting. It was found that the white-coloured seeds uptake more water than the dark-coloured seeds of similar mass at the same time. Also, white-coloured seeds release more electrolytes what leads to greater damage within the seeds. It was also found that white-coloured and smaller seeds germinate faster than dark-coloured large seeds and that small-seeded cultivars sprouted faster than large-seeded.

**Key words:** germination, *Phaseolus vulgaris* L., seed coat colour, water uptake

## Komponente varijance za prinos kukuruza različitih vegetacijskih skupina u službenim sortnim pokusima Hrvatske

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### Sažetak

Dužina vegetacije hibrida kukuruza vrlo je važan čimbenik pri utvrđivanju potencijala rodnošći za pojedine uzgojne okoline pogotovo u kontekstu klimatskih promjena. Dugoročni pokusi za ispitivanje gospodarske vrijednosti sorti (VCU) mogu pomoći pri odabiru optimalne vegetacijske skupine istraživanjem genotipske i okolinske varijabilnosti genotipova kukuruza različitih grupa zrenja. Cilj ovoga rada bio je usporediti komponente varijance u trima FAO grupama (FAO300, FAO400 i FAO500) procijenjenih za dva desetljeća (2001. - 2010. i 2011. - 2019.) kako bi se odredile moguće razlike u varijancama u VCU pokusima. Uobičajeni set podataka genotip x lokacija x godina (G x L x Y) analiziran je pomoću standardnog mješovitog modela za trofaktorijalne pokuse. Najvažnije komponente varijance bile su Y i L x Y kroz obje dekade i tri vegetacijske skupine. Najveća komponenta varijance bila je Y za genotipove FAO300 u dekadi 2011. - 2019. Međutim, općenito najveća komponenta varijance bila je L x Y. Nisu uočene znatne razlike u pojedinim komponentama varijanci između vegetacijskih skupina. Potrebno je provesti daljnju opsežnu analizu VCU pokusa kako bi se raščlanili učinci klimatskih promjena od genetskog napretka kod kukuruza različitih vegetacijskih skupina uključivanjem i ostalih agronomskih činitelja koji su se mijenjali tijekom vremena.

**Ključne riječi:** VCU pokusi, kukuruz, FAO skupine, komponente varijance, Hrvatska

## Variance components for yield in maize of different maturity groups in Croatian official variety trials

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### Summary

In the context of climate change, hybrid relative maturity in maize could be a decisive factor which set the grain yield potential in each environment. Long-term trials for assessing value for cultivation and use (VCU) could assist in choosing the right maturity group by investigating genotypic and environmental variability of maize genotypes different in maturity. The objective of this study was to compare variance components across the three maize maturity groups (FAO300, FAO400 and FAO500) combined in two respective decades 2001 - 2010 and 2011 - 2019 to determine possible differences in variance magnitudes in VCU trials. Genotype x location x year (G x L x Y) data set was analyzed using a standard mixed-effect three-way model. The most important components were either Y or L x Y consistently across the decades and three maturity groups. The greatest component was Y for the FAO300 group in the 2011 - 2019 decade. However, the greatest respective variance component was L x Y at most instances. No discernible differences among the variance components were found across the maturity groups. Further comprehensive analyses of VCU trials should be performed to disentangle the effects of climate change from those of genetic progress in maize of different maturity groups and of all other agronomic factors changed over time.

**Key words:** VCU trials, maize, FAO groups, variance components, Croatia





**Povrćarstvo,  
ukrasno, aromatično  
i ljekovito bilje**

**04**

**Vegetable Growing,  
Ornamental, Aromatic  
and Medicinal Plants**



## Zalamanje cvatne stapke utječe na parametre kvalitete češnjaka

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### Sažetak

Češnjak je jedna od najčešće uzgajanih *Allium* vrsta u svijetu. Koristi se kao začin, ali također i u medicini. Predstavlja bogati izvor fitonutrijenata koji mogu biti pod utjecajem poljoprivrednih praksi. Cilj ovog istraživanja bio je procijeniti kvalitetu dviju primki češnjaka, kultivara *istarskog crvenog* i *brsečkog* nakon zalamanja cvatne stapke koju uobičajeno primjenjuju proizvođači sjevernog hrvatskog primorja. *Istarski crveni* je pokazao značajno više vrijednosti u sadržaju ukupnih fenola, ukupno otopljenom suhoj tvari, suhoj tvari i pH u odnosu na primku *brsečki*. Češnjak sa stapkom je imao značajno viši sadržaj fenola, ukupno otopljenu suhu tvar i suhu tvar u odnosu na češnjak sa zalomljenom cvatnom stapkom. Zalamanje cvatne stapke povećao je pH i antioksidacijski kapacitet mjeren FRAP testom u odnosu na češnjak sa stapkom. Analiza varijance je pokazala da je interakcija primke i cvatne stapke bila značajna za sadržaj ukupnih fenola i antioksidacijski kapacitet mjeren sa FRAP testom. Analiza glavnih komponenata pokazala je razliku u dobivenim podacima između primki sa stapkom i kada je stapka bila zalomljena. Praksa zalamanja cvatne stapke može se primijeniti u proizvodnji češnjaka kao jednostavna i učinkovita metoda utjecaja na fizikalno-kemijske parametre i može se primijeniti ovisno o preferencijama tržišta ili za stvaranje pogodne sirovine za daljnju preradu.

**Ključne riječi:** antioksidacijski kapacitet, ekotipovi češnjaka, proizvodnja češnjaka, sadržaj ukupnih fenola

## Scape removal impacts garlic quality parameters

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### Summary

Garlic is one of the most produced *Allium* species worldwide. It is used as a food condiment but also in medicine. It represents a rich source of phytonutrients which can be affected by agricultural practices. The aim of this research was to assess the quality of two garlic accessions, cv. 'Istarski crveni' and 'Brsečki' following scape removal which is a practice applied by local garlic producers on the Northern Croatian coast. Accession 'Istarski crveni' has shown significantly higher values of total phenols, total soluble solids, dry matter and pH comparing to the 'Brsečki' accession. It was noted that garlic with scapes had significantly higher phenol content, total soluble solids and dry matter compared to garlic with removed scapes. The scape removal practice increased the pH and the antioxidant capacity measured by the FRAP assay compared to garlic with scapes. Analysis of variance showed that the interaction of accession and scape removal was significant for total phenol content and the antioxidant capacity measured by the FRAP assay. Principal Component Analysis showed a difference in the obtained data between accessions with scapes and when scapes were removed. The practice of scape removal can be applied to garlic production as an easy and efficient method to influence the tested physico-chemical parameters and can be applied depending on market preferences or to create a suitable raw material for further processing.

**Key words:** Antioxidant capacity, garlic ecotypes, garlic production, total phenolic content

## Stručna upotreba engleskih riječi i prijevodi stručnih pojmova unutar struke hortikulture

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### Sažetak

Pri prijevodu stranih znanstvenih i stručnih članaka i radova, kao i kod prevođenja znanstvenih i stručnih radova na engleski jezik, susrećemo se s mnoštvom stručnih pojmova koje je potrebno smisljeno prevesti ili pak prijevod prilagoditi da točno određuje opisani stručni ili znanstveni pojam te da značenje riječi ne izgubi osnovno značenje. Neki anglicizmi usvojeni su kao internacionalizmi, no pri prijevodu uvijek bi se trebao koristiti izvorni hrvatski izraz, ako postoji. Primjer je internacionalni pojam *park* i hrvatski izraz *perivoj*. Drugi problem se javlja pri prevođenju latinskih imena biljnih vrsta pri čemu se ne koristi direktan prijevod s latinskog, već se kao službeno ime biljne vrste, na hrvatski prevodi narodno ime s engleskog jezika. Tako se latinsko ime lipe *Tilia cordata* u prijevodu s latinskoga odnosilo na srcolikolisnu lipu (lat. *cordis*, „srce“), jer se oblik srca odnosi na list. U prijevodu toj je lipi nadjenut naziv *sitnolisna lipa*, što je prijevod engleskoga imena *small-leaved lime* ili *little leaf linden*. Treći slučaj potrebe točnoga definiranja prijevoda odnosi se na riječi u engleskome jeziku koje imaju mnogo značenja i obrnuto na riječi u hrvatskome jeziku koje se upotrebljavaju za različite pojmove u kontekstu sadržaja. Na primjer, u engleskome se jeziku za deblo koristi riječi *trunk*, *bole* i *stem* te je svaka riječ upotrijebljena unutar različitoga konteksta, što sve u hrvatskome jeziku označuje riječ *deblo* te se ona mora prevesti riječju koja najbliže tumači hrvatski smisao pojma.

**Ključne riječi:** primjeri, engleske riječi, anglicizmi, definicija

## Professional Usage of Anglicisms and Translations of Professional Terms in Horticulture

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### Summary

When translating the foreign scientific and professional journal articles and papers in the English language, we encounter a multitude of professional terms that necessitate a logical conversion so that the word's semantics are not lost. Certain Anglicisms are adopted as internationalisms, but, when paraphrasing, one should rather use a correspondent original Croatian term, if present. An example thereof is the international notion of *park* and its Croatian equivalent *perivoj*. Another problem is when translating the Latinisms of herbal species' nomenclature, whereby a direct translation from the Latin language is frequently not used, but is rather rendered by an adaptation of the English name. E.g., the Latin name of *Tilia cordata*, when decoded from the Latin, pertains to the cordate linden (Latin *cordis*, "heart"), for the cordate form is related to the leaves. Nonetheless, in the Croatian version, this linden is titled *sitnolisna lipa*, being a translation of the English terms *small-leaved lime* or the *little-leaf linden*. The third case necessitating a correct translational definition pertains to the English words having multiple meanings, as well as vice versa, to the Croatian words used for various notions in the context, i.e., that grasp the nuances of a language in a specific situation. E.g., the English language uses the words *trunk*, *bole*, and *stem* within a different context, while Croatian language denotes all these notions by the word *deblo*, so it has to always be rendered to reflect the spirit of the English language.

**Key words:** example, English words, Anglicisms, definition

## Ponašanje, percepcija i znanje ispitanika o čajevima odabranih vrsta aromatičnog i ljekovitog mediteranskog bilja za detoksikaciju organizma

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### Sažetak

Pod detoksikacijom se smatraju metabolički procesi gdje se otrovne tvari u organizmu pretvaraju u one koje su manje otrovne. Prema namjeni detoksikacija se može podijeliti na terapijsku, kozmetičku i preventivnu. U novije vrijeme potrošači su razvili svijest o djelotvornosti različitih biljnih vrsta za liječenje mnogobrojnih bolesti. Većina čajeva od ljekovitog i aromatičnog bilja pripravlja se kao oparak ili infuz. U ovom radu će se kroz teoretski dio opisati glavne biološke, kemijske i ljekovite karakteristike odabranih vrsta aromatičnog i ljekovitog mediteranskog bilja koje se kao čaj mogu koristiti za detoksikaciju organizma. Cilj anketnog istraživanja bilo je ispitivanje ponašanja, percepcija i znanja ispitanika o čajevima odabranih vrsta aromatičnog i ljekovitog mediteranskog bilja za detoksikaciju organizma. Anketno istraživanje je provedeno tijekom druge polovice 2020. godine na uzorku od 50 ispitanika. Rezultati anketnog istraživanja pokazali su da najveći postotak ispitanika vrlo često konzumira čajeve od paprene metvice, pasje ruže i kadulje. Ista situacija je utvrđena i u slučaju kada se radi o korištenju čajeva isključivo u svrhu detoksikacije organizma. I u pogledu ocjene općeg dojma (boja, miris, okus) ispitanici više preferiraju klasičnije-komercijalnije tipove čajeva (šipak, paprena metvica i kadulja). Ispitanici imaju najviše saznanja o biološkim, kemijskim i ljekovitim karakteristikama gore navedenih vrsta.

**Ključne riječi:** čajevi, detoksikacija, ljekovito i aromatično bilje, percepcije, Mediteran



## **Behaviour, perception and knowledge of respondents about teas of selected types of aromatic and medicinal Mediterranean herbs for body detoxification**

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### **Summary**

Detoxification is considered to be metabolic processes where toxic substances in the body are converted into those that are less toxic. According to the purpose, detoxification can be divided into therapeutic, cosmetic and preventive. More recently, consumers have developed an awareness of the effectiveness of different plant species for treating many diseases. Most teas from medicinal and aromatic herbs are prepared as a scald or infusion. In this paper, the main biological, chemical and medicinal characteristics of selected species of aromatic and medicinal Mediterranean herbs that can be used as tea for detoxification of the organism will be described through the theoretical part. The aim of the survey was to examine the behaviour, perceptions and knowledge of respondents about teas of selected species of aromatic and medicinal Mediterranean herbs for detoxification of the body. The survey was conducted during the second half of 2020 on a sample of 50 respondents. The results of the survey showed that the largest percentage of respondents very often consume peppermint, dog rose and sage teas. The same situation was found in the case when it comes to the use of teas exclusively for the purpose of detoxifying the body. And in terms of assessing the general impression (colour, smell, taste), respondents prefer more classic-commercial types of teas (pomegranate, peppermint and sage). Respondents have the most knowledge about the biological, chemical and medicinal characteristics of the above species.

**Key words:** teas, detoxification, medicinal and aromatic herbs, perceptions, Mediterranean

## Utjecaj organske gnojidbe na prinos i mineralni sastav hrena (*Armoracia rusticana* Ph. Gärten)

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### Sažetak

Hren (*Armoracia rusticana* Ph. Gärten) je višegodišnja povrtna kultura iz porodice kupusnjača (Brassicaceae). Oštar okus hrenu daje gorušičino ulje koje ima i antibiotsko djelovanje. Korijen hrena sadrži visoku razinu vitamina C, značajnih minerala (kalij, magnezij, kalcij, fosfor, željezo), glukozinolate, glikozide, glukonasturcin, singrin, asparagin, glutamin, oksidaze i peroksidaze. Uzgaja se zbog zadebljanog podanka (rizoma), a jednogodišnji izboji podanka koriste se za reprodukciju. Biljni biostimulatori su razne netoksične tvari uglavnom prirodnog podrijetla koje poboljšavaju i stimuliraju fiziološke procese u biljci. U istraživanju korištena je autohtona sorta koja je zaštićena kao Ludbreški hren. Cilj istraživanja bio je utvrditi utjecaj organsko mineralne gnojidbe na rast i razvoj biljaka te prinos i sadržaj minerala u podanku hrena. Pokus je postavljen po slučajnom bloknom rasporedu u četiri repeticije s različitim varijantama organsko mineralne gnojidbe (organsko mineralno gnojivo s dodatkom biostimulatora Biotech NPK 3:10:5 S+2 MgO u kombinaciji s organskim gnojivom s dodatkom aminokiselina Grena Biosprint Calcio NPK 9:1:1; organsko mineralno gnojivo Grena Biobase NPK 3:8:8; organsko mineralno gnojivo Grena life NPK 4:6:10 S+2 MgO). Promatrajući sve dobivene rezultate ovog istraživanja može se zaključiti da se za uzgoj hrena najpovoljnijom pokazala varijanta gnojidbe s organsko mineralnim gnojivom Grena life (NPK 4:6:10 S+2 MgO).

**Ključne riječi:** hren, organsko mineralna gnojidba, morfološka mjerenja, mineralni sastav

## **Influence of organic fertilization on yield and mineral composition of horseradish (*Armoracia rusticana* Ph. Gärtén, B. Mey et Scherb)**

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### **Summary**

Horseradish (*Armoracia rusticana* Ph. Gärtén) is a perennial plant of the family Brassicaceae. Horseradish gets its strong flavour from the mustard oil, which also serves as antibiotic. The root contains high levels of vitamin C, important minerals such as potassium, magnesium, calcium, phosphorus and iron, but also glucosinolates, glycosides, gluconasturtiin, sinigrine, asparagine, glutamine, oxidaseses and peroxidases. It is being cultivated for its rhizome, and the annual sprouts are used for reproduction. Plant biostimulators are non-toxic substances mostly of natural origin which contribute to the stimulation of physiological processes inside the plant. In our research we used an autochthonous variety that is protected as Ludbreški horseradish, the aim of the study was to determine the impact of organic mineral fertilization on plant growth and development and the yield and mineral content in the rootstock of horseradish. The experiment has been set randomly in blocks, in four repetitions using various types of organic mineral manures (organic mineral manure with additional Biotech NPK 3:10:5 S+2 MgO biostimulator and combined with Grena Biosprint Calcio NPK 9:1:1aminoacids; Grena Biobase NPK 3:8:8 organic mineral manure; Grena life NPK 4:6:10 S+2 MgO organic mineral manure). Observing all the obtained results, we conclude that the variant of G3 fertilization (Grena Biobase NPK 3:8:8) mostly gave the best results in the research.

**Key words:** horseradish, organic mineral fertilization, morphological measurements, mineral composition

## Utjecaj zasušivanja na parametre fotosinteze dva tradicijska kultivara raštike

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### Sažetak

Zbog bogatstva bioaktivnih spojeva, raštika privlači sve veću pozornost kao super-hrana pogodna za ljudsko zdravlje. U Hrvatskoj postoje mnogi tradicijski kultivari raštike koji se tradicionalno uzgajaju diljem Jadranske obale. Zbog velikog utjecaja suše na proizvodne površine raštike, važno je pronaći načine smanjenja njenog štetnog utjecaja. Smatra se kako je fotosinteza prvi proces na kojeg suša negativno utječe. Cilj ovog istraživanja bio je određivanje fotosintetskog odgovora dvaju tradicijskih kultivara raštike na nedostatak vode. Dva kultivara izložena su nedostatku vode u trajanju od tjedan dana, nakon čega su mjereni parametri fotosinteze pomoću LI-6800. Mjerena su sljedeća svojstva: asimilacija, transpiracija, provodljivost puči, unutarstanični CO<sub>2</sub> i temperatura lista. Signifikantna interakcija između kultivara i zasušivanja utvrđena je u svim promatranim svojstvima. Kultivar 'Kaštelir' pokazao je znatno smanjenje parametara fotosinteze pod vodnim stresom i povećanje temperature lista. Kultivar 'Vis' pokazao je parametre koji ukazuju na bolje podnošenje stresa izazvanog nedostatkom vode. Pronalazak na sušu otpornih kultivara raštike može poboljšati proizvodnju u područjima s nedostatkom vode. Tradicijski hrvatski kultivari raštike pokazuju mehanizme otpornosti na sušu, te bi se nad njima trebala provoditi daljna istraživanja.

**Ključne riječi:** abiotički stres, asimilacija, *Brassica oleracea* var. *acephala*, provodljivost puči, transpiracija

## Photosynthetic response to drought stress of two kale landraces

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### Summary

Recently, kale has gained attention as a superfood since it's rich in bioactive compounds associated with health benefits. In Croatia there are many kale landraces traditionally grown on the Adriatic coast. Since kale production is greatly impacted by drought, it is important to find strategies to minimize its negative effects. Photosynthesis is the first-line process that is altered by drought stress. The aim of this experiment was to test two kale landraces for their photosynthetic response to drought stress. Two landraces were subjected to a water deficit and photosynthetic measurements were made after 7 days of water withholding using LI-6800. Measured traits were assimilation, transpiration, stomatal conductance, intercellular CO<sub>2</sub>, and leaf temperature. A significant interaction between landrace and water withholding was found for all observed traits. Landrace 'Kaštelir' showed decreased photosynthetic activity and increased leaf temperature under drought stress. Landrace 'Vis' exhibited traits that indicate better tolerance to water withholding. Finding kale ecotypes which are well adapted to drought might improve kale production in regions with limited water resources. Croatian kale ecotypes exhibit drought adaptation mechanisms which should be further analyzed.

**Key words:** abiotic stress, assimilation, *Brassica oleracea* var. *acephala*, stomatal conductance, transpiration

## Etnobotaničke značajke ljekovitog i jestivog bilja Podravine

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### Sažetak

Razvoj farmaceutske industrije gotovo je potpuno potisnuo tradicionalnu uporabu biljaka u svrhu liječenja. Kako bi se prikupila znanja o tradicionalnoj uporabi ljekovitog i jestivog bilja u Podravini, u razdoblju od ožujka do listopada 2019. godine provedeno je istraživanje u 8 naselja: Bunančevica, Đurđevac, Kalinovac, Kloštar Podravski, Molve, Prugovac, Suha Katalena i Virje. Anketirano je 27 lokalnih stanovnika između 22 i 83 godine starosti. Ispitanici sakupljaju ukupno 102 biljne svojte svrstane u 44 porodice. Najveći broj ispitanika koristi biljke *Urtica dioica*, *Chamomilla recutita*, *Achillea millefolium*, *Sambucus nigra*, *Calendula officinalis*, *Mentha x piperita*, *Salvia officinalis* i *Tilia* sp. Biljne pripravke ispitanici većinom koriste za liječenje gastrointestinalnog, respiratornog i kardiovaskularnog sustava. Najčešće korišteni biljni pripravak je čaj te macerati, tinkture, džemovi, likeri, sirupi i sokovi. Iako stanovnici istraživanog područja još uvijek čuvaju vrijedna znanja o načinima korištenja ljekovitih i jestivih biljaka, potrebno je provesti opsežnija istraživanja koja bi pridonijela boljem očuvanju biljnih svojti i njihovoj upotrebi.

**Ključne riječi:** biljni pripravci, jestivo bilje, samoniklo bilje

## Ethnobotanical properties of medicinal and edible plants of Podravina

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### Summary

The development of the pharmaceutical industry has almost completely suppressed the traditional use of plants for medicinal purposes. To acquire knowledge on traditional usage of medicinal and edible plants in Podravina, the study was performed in the period from March to October 2019, in 8 settlements: Bunančevica, Đurđevac, Kalinovac, Kloštar Podravski, Molve, Prugovac, Suha Katalena and Virje. In a total of 27 local inhabitants between the ages of 22 and 83 were interviewed. The findings showed that the respondents gather a total of 102 plant taxa belonging to 44 families. The highest number of respondents use plants *Urtica dioica*, *Chamomilla recutita*, *Achillea millefolium*, *Sambucus nigra*, *Calendula officinalis*, *Mentha x piperita*, *Salvia officinalis* and *Tilia* sp. The herbal remedies are mostly used for the treatment of the gastrointestinal, respiratory and cardiovascular systems. The most commonly used herbal preparation is tea, followed by macerates, tinctures, jams, liqueurs, syrups and juices. Although the inhabitants of the investigated area still keep valuable knowledge of medicinal and edible plants uses, it is necessary to perform more extensive research that would contribute to better preservation of plant taxa and their usage.

**Key words:** edible plants, herbal remedies, wild plants

## Utjecaj sušenja i hladne ekstrakcije na bioaktivne spojeve u raštici (*Brassica oleracea* var. *acephala*)

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### Sažetak

Povrće iz roda *Brassicaceae* poznato je po nutritivnoj vrijednosti i sadržaju fitnutrijenata poput glukozinolata, karotenoida i fenola, kao i nutrijenata poput ugljikohidrata, vitamina te makro i mikro elemenata. Precizna analiza glukozinolata ovisi o inaktivaciji enzima mirozinaze koja katalizira hidrolizu navedenih spojeva. Najčešće korištena metoda inaktivacije mirozinaze je dehidracija uzorka postupkom liofilizacije te denaturacija visokom temperaturom tijekom koraka ekstrakcije. Cilj ovog rada bio je istražiti utjecaj primjene visoke temperature putem vrućeg zraka u postupku dehidracije, a prije koraka ekstrakcije te utjecaj hladne ekstrakcije na razinu ukupnih glukozinolata, ukupnih fenola te ukupne antioksidacijske aktivnosti ekstrakata raštike (*Brassica oleracea* var. *acephala*). Liofilizirani ili osušeni (u sušioniku) uzorci raštike ekstrahirani su vrućom ili hladnom smjesom metanola i vode te analizirani na ukupne glukozinolate, ukupne fenole i ukupnu antioksidacijsku aktivnost FRAP (Ferric Reducing Antioxidant Power) metodom te metodom redukcije DPPH sintetskog radikala. Najveći sadržaj ukupnih fenola kao i najviša antioksidativna aktivnost mjerena FRAP metodom uočena je kod uzoraka koji su sušeni u sušioniku te zatim ekstrahirani u hladnom postupku ekstrakcije. Najveći sadržaj glukozinolata utvrđen je u liofiliziranim uzorcima koji su podvrgnuti postupku hladne ekstrakcije dok je najviša razina antioksidativne aktivnosti DPPH metodom utvrđena kod liofiliziranih uzoraka koji su podvrgnuti postupku vruće ekstrakcije.

**Ključne riječi:** antioksidacijska aktivnost, *Brassica oleracea* var. *acephala*, ekstrakcija, ukupni fenoli, ukupni glukozinolati



## Hot air drying and cold extraction impact on bioactive compounds in kale (*Brassica oleracea* var. *acephala*)

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### Summary

Vegetables from the *Brassicaceae* family are known for its nutritive values and presence of phytonutrients such as glucosinolates, carotenoids and phenolic compounds as well as nutrients like carbohydrates, vitamins, macro, and micro elements. Myrosinase is an enzyme which catalyzes glucosinolate hydrolysis upon tissue damage and accurate glucosinolate analysis depends on myrosinase inactivation. The preferred method for myrosinase inactivation is sample dehydration by freeze drying and denaturation by moderately high temperature during the glucosinolate extraction step. The aim of this work is to evaluate the effect of applying high temperature for myrosinase inactivation via hot air (oven) drying prior to the extraction step as well as the effect of cold (ambient temperature) aqueous methanol extraction on total glucosinolates content, total phenolic content and total antioxidant activity in kale (*Brassica oleracea* var. *acephala*). Freeze dried or oven dried samples of *B. oleracea* var. *acephala* were extracted with either boiling or cold aqueous methanol and were analyzed for total glucosinolate and total phenolic content, as well as total antioxidant activity by the Ferric Reducing Antioxidant Power (FRAP) assay and DPPH radical scavenging ability. The highest total phenolic content and FRAP values were observed in oven dried plant tissues followed by cold extraction while the highest glucosinolate content was observed in freeze dried samples followed by cold extraction. The highest DPPH radical scavenging activity was observed in freeze dried tissues followed by hot extraction.

**Key words:** antioxidant activity, *Brassica oleracea* var. *acephala*, extraction, total glucosinolates, total phenolic content

## **Analiza zastupljenosti mirisnih vrsta i kultivara ruža u asortimanu ruža za vrtove i parkove**

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### **Sažetak**

Hortikulturna vrijednost ruža ovisi o nekoliko glavnih svojstava, kao što su boja i oblik cvjetova, broj cvjetova po stabljici te otpornost na bolesti, a kod kultivara koji se koriste za rez i trajnost u vazi. U posljednje vrijeme sve veću važnost ima i miris cvijeta, a ruže mirisnih cvjetova na tržištu postaju sve traženije. Cilj ovog istraživanja bio je analizirati zastupljenost mirisnih vrsta i kultivara ruža u asortimanu europskih uzgajivača ruža u 2020. godini. U analiziranim katalozima sadnica ruža, 24 % ruža opisano je vrlo mirisnima, dok se za njih 16,6 % navodi umjereno jak miris. Među vrlo mirisnim ružama, 3,3 % pripadalo je skupini divljih ruža, 40,8 % skupini starinskih vrtnih ruža, a 55,8 % skupini modernih vrtnih ruža. Najveći udio vrlo mirisnih ruža imale su starinske vrtno ruže (60,1 % kultivara), dok je u modernih vrtnih ruža udio vrlo mirisnih kultivara bio 16,8 % (među kojima je 42,5 % pripadalo hibridnim čajevkama). U katalozima se miris cvjetova vrlo mirisnih ruža najčešće opisuje kao kombinacija različitih tipova mirisa (kod 43,9 % ruža, uglavnom u skupini modernih vrtnih ruža) ili kao „miris starinske ruže“ (kod 29,4 % ruža, uglavnom u skupini starinskih vrtnih ruža). Provedena analiza pokazala je da su mirisne ruže u asortimanu analiziranih kataloga obuhvaćale ukupno 40,6 % vrsta i kultivara ruža, pri čemu je najveći broj pripadao starinskim vrtnim ružama i hibridnim čajevkama.

**Ključne riječi:** miris cvijeta, moderne vrtno ruže, starinske vrtno ruže, divlje ruže

## **Analysis of the presence of fragrant rose species and cultivars in the assortment of roses for parks and gardens**

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### **Summary**

Horticultural value of roses depends on several major traits, such as color and shape of flowers, number of flowers per stem, disease resistance, and long vase life for cut flower cultivars. Recently, floral scent has also become increasingly important and fragrant roses are becoming more and more popular on the market. The aim of this study was to analyze the presence of fragrant rose species and cultivars in the assortment of European rose breeding companies in the year 2020. In the analyzed rose catalogs, 24% of roses were described as strongly fragrant and 16,6% of roses as moderately fragrant. Among strongly fragrant roses, 3.3% belonged to wild (species) roses, 40.8% to old garden roses, and 55.8% to modern garden roses. The highest percentage of strongly fragrant roses were found in the old garden roses (60.1% of cultivars), while, in the modern garden roses, strongly fragrant roses accounted for only 16.8% of cultivars (among which 42.5% belonged to the Hybrid Tea class). In the strongly fragrant roses, the fragrance was most commonly described as combination of different types of scents (in 43.9% of roses, mostly belonging to the modern garden roses) or as „old rose scent“ (in 29.4% of roses, mostly belonging to the old garden roses). The analysis has shown that fragrant roses accounted for 40.6% of rose species and cultivars available in the assortment of analyzed catalogs, with the largest number of strongly fragrant roses belonging to old garden roses and Hybrid Tea roses.

**Key words:** floral fragrance, modern garden roses, old garden roses, wild roses

## Mikroinkapsulacija bioaktivnih spojeva kadulje (*Salvia officinalis* L.)

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### Sažetak

Kadulja (*Salvia officinalis* L.) je ljekovita biljka iz Mediteranskog podneblja čiji se ljekoviti učinci mogu povezati s prirodno prisutnim bioaktivnim spojevima koji imaju snažna antioksidativna, antibakterijska, protuupalna i antikancerogena svojstva. Obzirom na to da je bioraspoloživost takvih spojeva često ograničena, istražuju se tehnologije kojima će se bioaktivni spojevi moći dulje očuvati. Jedan od načina prevođenja biljnih ekstrakata u stabilniju formu je inkapsulacija koja omogućava očuvanje i kontrolirano otpuštanje aktivne tvari obložene omotačem od hidrokoloida. Cilj ovog rada bio je ekstrahirati bioaktivne komponente iz lista kadulje i provesti stabilizaciju dobivenih ekstrakata mikroinkapsulacijom s alginatnim omotačem. Rezultati su pokazali da dobivene mikrosfere imaju visoku učinkovitost inkapsulacije ukupnih polifenola (88,44 %) s brzim oslobađanjem (2-4 min) u vodi i soku od jabuke. U odnosu na mokre, osušene mikrosfere sporije otpuštaju bioaktivne komponente (nakon 120 min otpuštanje je i dalje prisutno). Brzo oslobađanje polifenola predstavlja funkcionalne napitke kao povoljan medij za mokre mikrosfere jer ih potrošači konzumiraju neposredno nakon pripreme, dok su suhe prikladne za upotrebu u prehrambenim proizvodima koji se ne konzumiraju neposredno nakon pripreve ili u kozmetičkim proizvodima. Ovi podaci predstavljaju veliki potencijal inkapsulacije ekstrakta kadulje i njegove široke primjene u prehrambenoj, farmaceutskoj i kozmetičkoj industriji.

**Ključne riječi:** kadulja, inkapsulacija, bioaktivni spojevi, ekstrakcija, mikrosfere

## Microencapsulation of bioactive compounds from sage (*Salvia officinalis* L.)

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### Summary

Sage (*Salvia officinalis* L.) is a medicinal plant native to Mediterranean region whose medicinal effects can be associated with its bioactive compounds with strong antioxidant, antibacterial, anti-inflammatory and anti-cancer properties. Since the bioavailability of such compounds is often limited, technologies that would preserve bioactive compounds for longer are being researched. A way of preserving plant extracts in a more stable form is encapsulation technology which allows the preservation and controlled release of the active substance coated with a hydrocolloid shell. The aim of this study was to extract bioactive compounds from sage and to carry out the stabilization of the obtained extracts by microencapsulation with an alginate coating. The results showed that obtained microspheres have a high efficiency of encapsulation of total polyphenols (88.44%) with rapid release (2-4 min) in water and apple juice. Compared to wet, dried microspheres release bioactive components more slowly (the release is still present after 120 min). The rapid release of polyphenols presents functional beverages as a favorable medium for wet microspheres because consumers consume them immediately after preparation, while dry ones are suitable for use in food products that are not consumed immediately after preparation or in cosmetic products. These data represent a great potential for encapsulation of sage extract and its wide application in the food, pharmaceutical and cosmetic industries.

**Key words:** sage, encapsulation, bioactive compounds, extraction, microcapsules

## Biofortifikacija nanoselenom – antioksidativni odgovor u lišću špinata

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### Sažetak

Tijekom posljednjeg desetljeća, selenove nanočestice (SeNPs) privukle su veću pažnju zbog svojih povećanih antioksidacijskih aktivnosti i smanjene toksičnosti u usporedbi s ostalim oblicima selena. Ovo istraživanje imalo je za cilj utvrditi utjecaj biofortifikacije špinata selenovim nanočesticama na antioksidativni odgovor biljke u usporedbi s konvencionalnom biofortifikacijom selenom u obliku selenata ( $\text{SeO}_4^{2-}$ ). Oba oblika selena primijenjena su u četiri različite koncentracije u rasponu od 40 do 320  $\mu\text{mol m}^{-3}$  hranjive otopine te je u pokus uključena kontrolna varijanta. Istraživanje je provedeno tijekom 2019. godine u suvremenom plasteniku u sustavu plutajućeg hidropona. Statističkom analizom je utvrđeno da je primjena SeNPs značajno utjecala na povećanje koncentracija klorofila *a*, *b* i karotenoida u usporedbi s nefortificiranim biljkama, dok je biofortifikacija selenatom značajno utjecala na koncentraciju klorofila *a* i karotenoida u usporedbi s nefortificiranim biljkama. Također, oblik selena je značajno utjecao na antioksidativnu aktivnost i koncentraciju fenola u listu špinata. Primjena SeNPs pri koncentraciji od 40  $\mu\text{mol m}^{-3}$  rezultirala je značajnim povećanjem antioksidativne aktivnosti u usporedbi s ostalim primjenjenim koncentracijama i nefortificiranim biljkama. Kod primjene selenata, najveća antioksidativna aktivnost utvrđena je pri koncentraciji 80  $\mu\text{mol m}^{-3}$ . Slijedom navedenog se može zaključiti da biofortifikacija SeNPs i selenatom značajno utječe na određene fiziološke procese u biljkama špinata poboljšavajući njen ukupni antioksidativni status. Ovo istraživanje je financirano od strane Hrvatske zaklade za znanost u sklopu projekata HRZZ IP-2018-01-8119 i HRZZ-PZS-2019-02-4323.

**Ključne riječi:** biofortifikacija, selen, nanočestice, špinat, antioksidativni status

## Biofortification with nanoselenium – antioxidative response in spinach leaves

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### Summary

Over the last decade, selenium nanoparticles (SeNPs) have attracted attention due to their increased antioxidant activities and reduced toxicity compared to other forms of selenium. This study aimed to determine the effect of spinach biofortification with SeNPs on plant antioxidant response compared to conventional selenium biofortification with selenate ( $\text{SeO}_4^{2-}$ ). Both selenium forms were applied in four different concentrations ranging from 40 to 320  $\mu\text{mol m}^{-3}$  of nutrient solution and control variant (unfortified plants) was included in the experiment. The research was conducted during 2019 in a modern greenhouse in a floating hydroponic system. Statistical analysis showed that the use of selenium nanoparticles significantly increased the concentrations of chlorophyll *a* and *b* and carotenoids compared to unfortified plants, while fortification with selenate significantly affected the concentration of chlorophyll *a* and carotenoids compared to unfortified plants. Also, the form of selenium significantly affected antioxidant activity and phenolic content in the spinach leaf. Application of SeNPs at concentration of 40  $\mu\text{mol m}^{-3}$  resulted in a significant increase in antioxidant activity compared to other applied concentrations as well as unfortified plants. Regarding application of selenate, significantly highest antioxidant activity were found at a concentration of 80  $\mu\text{mol m}^{-3}$ . Accordingly, it can be concluded that the biofortification with SeNPs as well as selenate significantly affects certain physiological processes in spinach plants by improving their overall antioxidant status. This work was supported by the Croatian Science Foundation (HRZZ) within the projects HRZZ IP-2018-01-8119 and HRZZ-PZS-2019-02-4323.

**Key words:** biofortification, selenium, nanoparticles, spinach, antioxidant status

## Morfološka raznolikost sjemena motra (*Crithmum maritimum* L.)

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### Sažetak

U suvremenoj prehrani koristi se mali broj jestivih biljaka dok porast stanovništva na globalnom nivou nameće potrebu za diversifikacijom prehrane i biljne proizvodnje. U novije vrijeme, u poljoprivrednu proizvodnju se pokušavaju introducirati nove vrste zbog interesa za različitim prehrambenim proizvodima. Posebna je potražnja za vrstama koje su se tradicionalno koristile u prehrani na nekom lokalnom području. Motar (*Crithmum maritimum* L.) je halofitna vrsta Jadranskog priobalja i koristi se u tradicionalnoj prehrani priobalnog stanovništva kao zeleno povrće ili začim. Odlikuje ga visok sadržaj sekundarnih metabolita i eteričnih ulja te se osim u kulinarstvu može koristiti i u industriji. Osim nutritivne vrijednosti motar je otporan na stres solima i/ili sušom te se može uzgajati na marginalnim tlima i u nepovoljnim uvjetima. Prvi korak u uvođenju u proizvodnju bilo koje divlje vrste je pronaći jedinke povoljnih agronomskih svojstava koje bi mogle biti uspješne u poljoprivrednoj proizvodnji. Stoga je sjeme motra prikupljeno s 25 lokacija na području Istre i Kvarnera. Morfološke karakteristike sjemena određene su pomoću Winseedle programa nakon skeniranja te je određena klijavost. Utvrđene su razlike između lokacija u masi 100 sjemenki, morfološkim svojstvima i klijavosti sjemena te visoka varijabilnost morfoloških svojstava sjemena unutar lokacije. Varijabilnost morfoloških parametara sjemena motra između populacija upućuje na veliku raznolikost populacija u Hrvatskom priobalju.

**Ključne riječi:** bioraznolikost, masa sjemena, halofiti, klijavost



## Morphological diversity of sea fennel seeds (*Crithmum maritimum* L.)

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### Summary

A small number of edible plants are used in the modern diet, while human population growth globally imposes the need to diversify the diet and plant production. In recent years, attempts have been made to introduce new species into agricultural production due to the interest in various food products. There is a special demand for species that have traditionally been used in the diet in a local area. Sea fennel (*Crithmum maritimum* L.) is a halophytic species of the Adriatic coast and is used in the traditional diet of the coastal population as a green vegetable or spice. It is characterized by a high content of secondary metabolites and essential oils and can be used not only in cooking but also in industry. In addition to its nutritional value, sea fennel is resistant to salts and/or drought stress and can be grown on marginal soils and in unfavorable conditions. The first step in introducing into production of any wild species is to find individuals of favorable agronomic traits that could be successful in agricultural production. Therefore, sea fennel seeds were collected from 25 locations in Istria and Kvarner. Seed morphological characteristics were determined using the Winseedle program after scanning and germination was observed. Differences between locations in the mass of 100 seeds, morphological properties and seed germination as well as a high variability of morphological properties of seeds within the location were observed. The variability of morphological parameters of sea fennel seeds between populations indicates a great diversity of populations in the Croatian coast.

**Key words:** biodiversity, germination, halophytes, seed mass

## Optimization and release kinetics of *Stevia rebaudiana* aqueous extracts from alginate-based microparticles

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### Summary

*Stevia rebaudiana* (Bertoni) represents a natural source of polyphenolic compounds. The extraction of polyphenols in aqueous medium from stevia leaves powder was achieved using an ultrasound-assisted extraction technique. Optimization of the extraction procedure was performed using response surface methodology and was used to determine optimal conditions ( $6 \text{ g L}^{-1}$ , 75A and 6 min) for extraction in terms of total polyphenolic compounds content ( $465.17 \text{ mg L}^{-1}$ ). Optimal extracts were used for the preparation of calcium-alginate and calcium-alginate/casein microparticles. Release kinetics were observed as a cumulative release (%) of total polyphenolic compounds from dry microparticles. Both kinetics curves showed a similar release pattern with a significantly higher maximum cumulative release for calcium-alginate microparticles. The microcapsules were also compared based on different parameters such as encapsulation efficiency (EE %), loading capacity (LC), relative size and swelling degree both in water and acidic medium. Calcium-alginate/casein microparticles showed enhanced results in comparison with calcium-alginate microparticles with higher EE % (5.3%), LC (44.3%) and size (11.9%) values for 1 mm nozzle. Similar results were obtained for 0.75 mm nozzle with increased values of EE % (8.2%), LC (248.4%) and particle size (10.1%). The obtained results showed that there is a significant influence of different matrices on the physicochemical properties of microparticles.

**Key words:** extraction, optimization, encapsulation, *Stevia rebaudiana*, microparticles

## Biofortifikacija šтира različitim kemijskim oblicima selena

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### Sažetak

U novije vrijeme sve se više promovira konzumacija divljih srodnika povrća i samoniklih biljaka. U ovom istraživanju je po prvi puta istražena mogućnost biofortifikacije šтира (*Amaranthus caudatus* L.) s različitim kemijskim oblicima selena u uvjetima plutajućeg hidropona. Selen je primijenjen u tri oblika i to kao selenat i selen nanočestice stabilizirane huminskom kiselinom (HA-SeNP) ili polisorbatom (PS-SeNP) te u dvije koncentracije ( $200 \mu\text{M m}^{-3}$  i  $400 \mu\text{M m}^{-3}$  hranjive otopine). Pokus je proveden u plasteniku u zasebnim bazenima ovisno o obliku selena. Vegetacija je trajala ukupno 27 dana (12 dana u hidroponu). Nakon uzorkovanja, izmjereni su svježa i suha masa lista, stabljike i korijena te visina biljke i broj listova. U prosjeku, najveće vrijednosti visine, dužine korijena te broja listova su zabilježene u slučaju biofortifikacije s HA-SeNP. Značajno najmanja vrijednost je zabilježena kod varijante PS-SeNP 400 gdje se očitovala pojava fitotoksičnosti jer je došlo do propadanja korijena i venuća biljaka. Značajno povećanje svježe mase lista, korijena i stabljike je uočeno kod varijanata SEL 200 i PS-SeNP 200. Općenito, kontrolne biljke su bile slabijeg rasta u usporedbi s biofortificiranim uz iznimku varijante PS-SeNP 400. Očekivano, slični trend je zabilježen kod suhe mase lista, korijena i stabljike. Prema ovim rezultatima je očito da selen utječe na rast i razvoj šтира te u ovisnosti o obliku i koncentraciji može doći do pojave fitotoksičnosti kao u slučaju primjene PS-SeNP. Ovo istraživanje je financirano od strane Hrvatske zaklade za znanost u sklopu projekata HRZZ IP-2018-01-8119 i HRZZ-PZS-2019-02-4323.

**Ključne riječi:** štir, biofortifikacija, selen, nanočestice, rast i razvoj

## Biofortification of Amaranth using different chemical form of selenium

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### Summary

Recently, the consumption of wild relatives of vegetables and wild edible plants has been increasingly promoted. In this study, the possibility of biofortification of Amaranth (*Amaranthus caudatus* L.) with different chemical forms of selenium under floating hydroponic conditions was investigated for the first time. Selenium was applied in three forms as selenate and selenium nanoparticles stabilized with humic acid (HA-SeNP) or polysorbate (PS-SeNP) and in two concentrations (200  $\mu\text{M m}^{-3}$  and 400  $\mu\text{M m}^{-3}$  of nutrient solution). The experiment was conducted in a greenhouse in separate pools depending on the selenium form. Vegetation lasted totally 27 days (12 days in floating hydroponics). After sampling, fresh and dry weight of leaves, stems and roots as well as plant height and number of leaves were recorded. Averagely, the highest values of height, root length and number of leaves were recorded when plants were biofortified with HA-SeNP. Significantly lowest value was recorded in the variant PS-SeNP 400 where phytotoxicity was observed due to visible root decay and plants wilting. A significant increase in fresh leaf, root and stem weight was observed in variants SEL 200 and PS-SeNP 200. In general, growth of control plants was lower compared to ones biofortified with the exception of PS-SeNP 400 variant. As expected, a similar trend was observed in dry weight of leaves, roots and stems. According to these results, it is obvious that selenium affects the growth and development of Amaranth and, depending on the form and concentration, phytotoxicity may occur as in the case of PS-SeNP application. This research was funded by the Croatian Science Foundation within the projects HRZZ IP-2018-01-8119 and HRZZ-PZS-2019-02-4323.

**Key words:** Amaranth, biofortification, selenium, nanoparticles, growth and development





**Ratarstvo**

**05**

**Field Crop  
Production**



## Komponente prinosa domaćeg maka u proljetnoj sjetvi

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### Sažetak

Cilj istraživanja bio je odrediti komponente prinosa četiri domaće sorte maka u 2020. godini. U istraživanje su bile uključene sorte upisane u Hrvatsku bazu podataka biljnih genetskih izvora (Croatian Plant Genetic Resources Database, CPGRD) kako slijedi: Gornji Bogičevci IND00042, Beli Manastir IND00043, Staro Petrovo Selo IND00044 i Trnovec Bartolovečki IND00046. Pokus je postavljen po slučajnom blok rasporedu u 5 ponavljanja na površinama pokušališta Fakulteta agrobiotehničkih znanosti Osijek. Sjetva je obavljena ručno 8. travnja 2020. godine, a prorjeđivanje od 4. do 6. lipnja 2020. godine. Svaka sorta je na jednoj parceli posijana u 6 redova s međurednim razmakom od 0,30 m i dužine 5,5 m, pri čemu je ukupna površina parcelice u žetvi iznosila 9,9 m<sup>2</sup>. Korovi su suzbijani mehaničkim načinom. Sa svake parcelice prikupljen je uzorak od 30 biljaka po ponavljanju za analizu komponenti prinosa. Ukupno je analizirano 600 pojedinačnih biljaka maka. U laboratoriju za analizu ratarskih usjeva Fakulteta agrobiotehničkih znanosti Osijek određen je broj tobolca po biljci, promjer i visina tobolca te masa tobolca i masa sjemenki u tobolcu. Prosječno su sve sorte formirale 1 tobolac po biljci, iako je bilo biljaka koje su formirale po 2 ili 3 tobolca. Prema prosjeku svih sorti, promjer tobolca iznosio je 1,9 cm, a visina tobolca 2,8 cm, dok je masa tobolca iznosila prosječno 1,43 g po tobolcu. Masa sjemenki u tobolcu se kretala od 0,55g (Staro Petrovo Selo IND00044) do 0,61 g (Beli Manastir IND00043).

**Ključne riječi:** mak, komponente prinosa, tobolci, sjeme, masa



## Yield components of domestic poppy varieties in spring sowing

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### Summary

The aim of this research was to determine the yield components of four domestic poppy varieties in 2020. Varieties entered in the Croatian Plant Genetic Resources Database (CPGRD) were included in the research, as follows: Gornji Bogičevci IND00042, Beli Manastir IND00043, Staro Petrovo Selo IND00044 and Trnovec Bartolovečki IND00046. The experiment was set up according to a random block schedule in 5 replications on the surfaces of the experimental site of the Faculty of Agrobiotechnical Sciences Osijek. Sowing was done manually on April 8, 2020, and thinning from June 4 to 6, 2020. Each variety was sown on one plot in 6 rows with a row spacing of 0.30 m and a length of 5.5 m, so that the plot at harvest was 9.9 m<sup>2</sup>. Weeds were controlled mechanically. A sample of 30 plants per replicate was collected from each plot for analysis of yield components. A total of 600 individual poppy plants were analyzed. In the laboratory for the analysis of field crops of the Faculty of Agrobiotechnical Sciences Osijek, the number of pods per plant, the diameter and height of the pods, and the weight of the pods and the mass of seeds in the pods were determined. On average, all cultivars formed 1 seed pod per plant, although there were plants that formed 2 or 3 pods. According to the average of all varieties, the diameter of the pod was 1.9 cm and the height of the pod was 2.8 cm. On average pods weight were 1.43 g. The mass of seeds in each pod ranged from 0.55 g (Staro Petrovo Selo IND00044) to 0.61 g (Beli Manastir IND00043).

**Key words:** poppy, yield components, pods, seeds, mass

## Pojavnost T-2 i HT-2 toksina u žitaricama uzgojenim u RH u razdoblju 2017.-2019. godine

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### Sažetak

Cilj rada bio je istražiti pojavnost T-2 i HT-2 toksina u različitim žitaricama uzgojenim u istočnoj i sjeverozapadnoj regiji Republike Hrvatske, uz praćenje utjecaja klimatskih čimbenika na njihovu pojavnost. Tijekom razdoblja 2017.-2019. godine uzorkovano je ukupno 300 uzoraka pet različitih žitarica te su određene pojedinačne koncentracije T-2 i HT-2 toksina, njihova suma i omjer. Rezultati u promatranom razdoblju pokazuju različitu pojavnost T-2 i HT-2 toksina u analiziranim žitaricama, s tim da su najčešće bili prisutni u zobi (63 %), potom u kukuruзу (44 %), ječmu (28 %), pšenici (22 %) i raži (8 %). Prosječna koncentracija bila je najveća u uzorcima zobi, zatim u kukuruзу, ječmu te pšenici. Suma koncentracija T-2 i HT-2 toksina iznad propisanih indikativnih vrijednosti dobivena je u dva uzorka kukuruза, s vrijednostima 252,8  $\mu\text{g kg}^{-1}$  u 2017. godini i 282,4  $\mu\text{g kg}^{-1}$  u 2019. godini. Prosječna vrijednost omjera koncentracija glavnog spoja (T-2) i njegovog toksičnog metabolita (HT-2) u razdoblju 2017.-2019. po godinama iznosi 1:4, 1:3 te 1:2. Tijekom predmetnog trogodišnjeg razdoblja najveća razina pojavnosti T-2 i HT-2 toksina određena je tijekom 2019. godine. Takvi rezultati bi mogli biti posljedica vremenskih prilika koje su u 2019. godini obilježene prosječno većom količinom padalina u regijama uzorkovanja, tijekom razdoblja uzgoja i žetve žitarica (travanj–listopad 2019.).

**Ključne riječi:** T-2 toksin, HT-2 toksin, pojavnost, žitarice

## Occurrence of T-2 and HT-2 toxins in cereals grown in the Republic of Croatia in the period 2017-2019

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### Summary

The aim of this study was to investigate the occurrence of T-2 and HT-2 toxins in different cereals grown in the eastern and northwestern region of the Republic of Croatia, with monitoring of climatic factors. During the period 2017-2019, a total of 300 samples of five different cereals were sampled and the individual concentrations of T-2 and HT-2 toxins, their sum and ratio were determined. The results in the observed period show different occurrence of T-2 and HT-2 toxins in analyzed cereals, with the highest in oats (63 %), followed by maize (44%), barley (28%), wheat (22%) and rye (8%). Their average concentration was the highest in oat samples, followed by maize, barley and wheat. Summary concentration of T-2 and HT-2 toxins above the prescribed indicative values was determined in two maize samples, with values of 252.8  $\mu\text{g kg}^{-1}$  in 2017 and 282.4  $\mu\text{g kg}^{-1}$  in 2019. The average ratio of the main compound (T-2) and its toxic metabolite (HT-2) in the period 2017-2019 was 1:4, 1:3 and 1:2, respectively. During observed three-year period, the highest level of occurrence of T-2 and HT-2 toxins was determined in 2019. These results can be a consequence of weather conditions, since there was higher average precipitation in the sampling regions during the period of cultivation and harvesting of cereals (April-October 2019).

**Key words:** T-2 toxin, HT-2 toxin, occurrence, cereals

## Response of corn hybrids to fertilizers and planting density

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### Summary

One of the most important practices for higher corn yield is to make appropriate fertilization management and the plants spatial arrangement. The objective of this study was to investigate grain yield and AEN (Agronomic Nitrogen Use Efficiency) of corn hybrids in response to fertilization and planting densities. Fertilizers included combinations of nitrogen (N), phosphorus (P) and potassium (K), where doses ranged from 50, 100, and 150 kg ha<sup>-1</sup> of active matter. Furthermore, there were two planting densities: 57.971 plants ha<sup>-1</sup> (LD) and 63.492 plants ha<sup>-1</sup> (HD) with two newer hybrids (NS 3023 and NS 6140) and two older hybrids (NS 444 and NS 640). The results showed that the average yield on HD was higher by 17.06% in comparison to the yield on LD. The greatest response in yield was on N<sub>3</sub>P<sub>1</sub>K<sub>1</sub> fertilizer variant, where the highest yield difference of 18.36% in favor of HD was seen. Adding of 50 kg ha<sup>-1</sup> of P and K elements (N<sub>3</sub>P<sub>2</sub>K<sub>2</sub>) resulted in yield decrease by 4.3%, while additional 50 kg ha<sup>-1</sup> (N<sub>3</sub>P<sub>3</sub>K<sub>3</sub>) of these elements decreased yield by 5.6% for all densities and hybrids. The highest response in AEN for both densities was with 50 kg N ha<sup>-1</sup>, where LD showed better AEN, but only with the lowest N dose. The AEN was higher by 6% on HD, and was by 25% lower in older hybrids, in average. All of the expected results were confirmed, except that early maturing hybrid NS 3022 showed yield decrease on HD, which means that interaction between corn yield and densities needs to be further examined.

**Keywords:** corn yield, corn hybrids, fertilizers, plant density, Agronomic N use efficiency

## Utjecaj sklopa na prinos uljane repice

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### Sažetak

Cilj istraživanja je bio utvrditi utjecaj gustoće sklopa uljane repice na prinos sjemena. Poljski pokus je postavljen na lokacijama Osijek i Tovarnik tijekom dvije vegetacijske godine (2016./2017. i 2017./2018.) po slučajnom blok sustavu u četiri ponavljanja. Ispitivan je utjecaj hibrida uljane repice u pet varijanti gustoće sklopa (20 biljka/m<sup>2</sup>, 35 biljka/m<sup>2</sup>, 50 biljka/m<sup>2</sup>, 65 biljka/m<sup>2</sup> i 80 biljka/m<sup>2</sup>) na prinos sjemena. Vremenske prilike tijekom vegetacijske godine 2016./2017. na lokaciji Osijek su bile nepovoljne za uzgoj uljane repice, jer je palo 72,8 mm manje oborina od višegodišnjeg prosjeka, dok su na lokaciji Tovarnik bile povoljne. U vegetacijskoj godini 2017./2018. vremenske prilike su bile povoljne na obje lokacije. Analizom varijance na obje lokacije utvrđen je statistički značajni utjecaj sklopa na prinos sjemena ( $p < 0,01$ ). Tijekom obje godine istraživanja najveći prinos (5,01 t ha<sup>-1</sup>) postignut je na varijanti od 65 biljaka/m<sup>2</sup>, a najmanji prinos (4,11 t ha<sup>-1</sup>) na varijanti od 20 biljka/m<sup>2</sup>. Prosječan prinos na varijanti 65 biljka/m<sup>2</sup> se statistički značajno razlikovao ( $p < 0,05$ ) od svih ostalih ispitivanih sklopova. Dobiveni rezultati potvrđuju da je gustoća sklopa bitan čimbenik u procesu proizvodnje, odnosno postizanju visokih prinosa.

**Ključne riječi:** uljana repica, sklop, prinos sjemena, lokacije

## Influence of plant density on yield of oilseed rape

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### Summary

The objective of this study was to determine the influence of plant density of oilseed rape on seed yield. The experiment was set up at the location Osijek and Tovarnik in two vegetation years 2016/2017 and 2017/2018. The experiment was set up according to randomized complete block system in four replications and have included five variants of different density (20 plants/m<sup>2</sup>, 35 plants/m<sup>2</sup>, 50 plants/m<sup>2</sup>, 65 plants/m<sup>2</sup> and 80 plants/m<sup>2</sup>). Weather conditions during the vegetation year 2016/2017 at the Osijek location were unfavorable for the cultivation of oilseed rape, because 72.8 mm less precipitation fell than the multi-year average, while at the Tovarnik location they were favorable. In the vegetation year 2017/2018 the weather conditions were favorable in both locations. Analysis of variance at both locations revealed a statistically significant influence of the plant density on seed yield ( $p < 0.01$ ). During both years of research, the highest yield (5.01 t ha<sup>-1</sup>) were achieved with the variant of 65 plants/m<sup>2</sup>, and the lowest yield (4.11 t ha<sup>-1</sup>) with the variant of 20 plants/m<sup>2</sup>. The average yield of variant with 65 plants/m<sup>2</sup> was significantly different ( $p < 0.05$ ) from all other tested variants. The obtained results confirm that the achieved plant density is an important factor in the production of oilseed rape.

**Key words:** oilseed rape, plant density, seed yield, locations

## **Intenzitet napada kukuruznog moljca (*Ostrinia nubilalis* Hübner) na demonstracijskom pokusu hibrida kukuruza u Križevcima u razdoblju 2008.-2020.**

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### **Sažetak**

Kukuruzni moljac (*Ostrinia nubilalis* Hübner) najveći je gospodarski štetnik u svim područjima Republike Hrvatske u kojima se uzgaja kukuruz. Cilj istraživanja bio je utvrditi utjecaj klimatskih prilika, hibrida i FAO grupe kukuruza na intenzitet napada kukuruznog moljca. Istraživanja su provedena na demonstracijskim pokusima hibrida kukuruza na površinama Visokoga gospodarskog učilišta u Križevcima u razdoblju 2008. - 2020, izuzev godina 2013., 2017. i 2018. Intenzitet napada je utvrđivan u vrijeme berbe disekcijom stabljike i vizualnim pregledom. Kod napadnutih biljaka utvrđivano je mjesto oštećenja (ispod klipa, iznad klipa, drška klipa i klip), broj gusjenica u stabljici, broj i težina klipova, posebno onih oštećenih ispod klipa i onih oštećenih samo iznad klipa. Kod neoštećenih biljaka utvrđen je broj i težina klipova. Rezultati istraživanja pokazuju da je prosječni intenzitet napada bio čak 73 %. Najviši napad zabilježen je u godini 2011. (91 %) u kojoj je palo najmanje oborine, a najniži u 2014. (25 %) koja se ističe po najvećoj količini oborina i visokoj relativnoj vlazi zraka. U pojedinoj godini uočene su značajne razlike u intenzitetu i pokazateljima napada (broj rupa, broj gusjenica) između hibrida, kao i između FAO grupa. U višegodišnjem prosjeku kod hibrida FAO grupe 200 i 600 zabilježen je najmanji napad, dok među FAO grupama 300, 400 i 500 nije bilo većih razlika. Prosječna težina klipova sa napadnutih biljaka manja je od prosječne težine klipova sa nenapadnutih biljaka, no razlike ovise o godini i hibridu i nisu uvijek značajne.

**Ključne riječi:** kukuruzni moljac, intenzitet napada, vremenske prilike, hibridi kukuruza FAO grupa

## **Intensity of European Corn Borer (*Ostrinia nubilalis* Hübner) attack on the corn hybrids on demonstration field in Križevci in the period 2008-2020**

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### **Summary**

The European Corn Borer (*Ostrinia nubilalis* Hübner) is the largest economic pest in all areas of the Republic of Croatia where corn is grown. The aim of the study was to determine the impact of climatic conditions, hybrid and FAO group on European Corn Borer attack. The research was conducted on demonstration experiments of corn hybrids on the field of the Križevci College of Agriculture in the period 2008-2020, except for the years 2013, 2017 and 2018. The attack was determined at harvest by stalk dissection and visual inspection. In infested plants, the site of infestation (below the ear, above the ear, ear shank and ear), the number of caterpillars in the stalk, the number and weight of ears, separately those coming from stalk infested below the ear and those infested only above the ear were determined. In uninfested plants, the number and weight of ears were determined. The results of the research show that the average intensity of attacks was as high as 73%. The highest attack was recorded in 2011 (91%) in which the least precipitation fell, and the lowest in 2014 (25%), which stands out for the highest amount of precipitation and high relative humidity. In each year, significant differences in the intensity and indicators of attacks (number of holes, number of caterpillars) were observed between hybrids, as well as between FAO groups. On a multi-year average, FAO groups 200 and 600 hybrids recorded the least attack, while there were no major differences between FAO groups 300, 400 and 500. The average weight of ears from infested plants is less than the average weight of ears from non-infested plants, but the differences depend on the year and hybrid and are not always significant.

**Key words:** European corn borer, attack intensity, weather conditions, corn hybrid, FAO group



## Utjecaj vlažnosti zamjesa na svojstva ekstrudiranih brašna različitih hibrida kukuruza

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### Sažetak

Proces ekstruzije omogućava obradu različitih vrsta sirovina i dobivanje gotovih proizvoda u kratkom vremenskom periodu. U postupku ekstruzije najčešće se koriste sirovine bogate škrobom i proteinima, a jedna od najpopularnijih je kukuruzna krupica. Cilj ovog rada bio je ispitati utjecaj vlažnosti zamjesa (30 i 35 %) na svojstva ekstrudiranih brašna 6 različitih hibrida kukuruza Poljoprivrednog instituta Osijek. Postupak ekstruzije proveden je na laboratorijskom jednopužnom ekstruderu uz primjenu sljedećih uvjeta: temperaturni profil ekstruzije – 80/100/120 °C; promjer sapnice – 4 mm; konfiguracija puža – 4:1. Dobivenim ekstrudatima, nakon sušenja na sobnoj temperaturi, određeni su sljedeći parametri: ekspanzijski omjer, nasipna masa, indeks apsorpcije vode, indeks topljivosti u vodi i reološka svojstva Brabenderovim Mikro-visko-amilografom. Rezultati su uspoređeni s neekstrudiranim brašnima kukuruza. Dobiveni rezultati pokazali su da povećanje vlažnosti zamjesa nije značajno utjecalo na ekspanzijski omjer i nasipnu masu ekstrudata. Proces ekstruzije i povećanje vlažnosti značajno su utjecali na povećanje indeksa apsorpcije vode i indeksa topljivosti u vodi. U usporedbi s neekstrudiranim uzorcima gotovo svi ekstrudirani uzorci imali su manju viskoznost vrha te je utvrđena njihova dobra stabilnost prilikom miješanja na visokim temperaturama, dok su veću sklonost retrogradaciji pokazali neekstrudirani uzorci.

**Ključne riječi:** ekstruzija, kukuruz, vlažnost, fizikalna i reološka svojstva

## Effect of the moisture content on the properties of extruded flours of different corn hybrids

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### Summary

The extrusion process enables the processing of different types of raw materials and obtaining finished products in a short period of time. Raw materials rich in starch and protein are most often used in the extrusion process, and one of the most popular is corn grits. The aim of this study was to examine the influence of moisture content (30 and 35%) on the properties of extruded flours of 6 different corn hybrids of the Agricultural Institute Osijek. The extrusion process was performed on a laboratory single-screw extruder using the following conditions: extrusion temperature profile – 80/100/120 °C; nozzle diameter – 4 mm; screw configuration – 4:1. The following parameters were determined on the obtained extrudates, after drying at room temperature: expansion ratio, bulk density, water absorption index, water solubility index and rheological properties using a Brabender Micro-viscoamylograph. The results were compared to non-extruded corn flours. The obtained results showed that the increase in the moisture content did not significantly affect the expansion ratio and the bulk density of the extrudates. The extrusion process and the increase in moisture content significantly influenced the increase in the water absorption index and the water solubility index. Compared to non-extruded samples, almost all extruded samples had lower peak viscosity and their good stability was found when mixed at high temperatures, while non-extruded samples showed a greater retrogradation tendency.

**Key words:** extrusion, corn, moisture, physical and rheological properties

## Učinkovitost botaničkih insekticida na odrasle oblike repičina sjajnika (*Brassicogethes aeneus*)

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### Sažetak

Repičin sjajnik (*Brassicogethes aeneus*) kao ekonomski najvažniji štetnik uljane repice, zbog razvoja rezistentnosti, predstavlja veliki problem u proizvodnji ove uljarice. Na području Republike Hrvatske rezistentnost repičina sjajnika potvrđena je za većinu dozvoljenih aktivnih tvari. Osim toga, velika većina aktivnih tvari izgubila je dozvolu za primjenu pa proizvođači nemaju učinkovita rješenja u suzbijanju ovog štetnika. Stoga je cilj ovog istraživanja bio utvrditi učinkovitost novih, ekološki prihvatljivih aktivnih tvari kao potencijalnih rješenja u suzbijanju repičina sjajnika. Tijekom 2020. godine, na osam lokaliteta u pet županija, prikupljene su populacije odraslih oblika repičina sjajnika koje su u laboratorijskim uvjetima testirane na aktivne tvari azadirahtin i piretrin. Pokusi su provedeni prema IRAC metodi broj 7, umakanjem netretiranih terminalnih cvatova uljane repice u škropivo pripremljeno u 100 %-tnoj i 20 %-tnoj dozi. Temeljem dobivenih rezultata učinkovitost azadirahtina na odrasle oblike repičina sjajnika iznosila je od 60 % do 100 %, a učinkovitost piretrina od 70 % do 100 %. Dobiveni rezultati ukazuju na zadovoljavajuću učinkovitost botaničkih insekticida u suzbijanju odraslih oblika repičina sjajnika, međutim njihova učinkovitost se mora potvrditi i u proizvodnim uvjetima uzgoja uljane repice. Primjena botaničkih insekticida zajedno s ostalim agrotehničkim mjerama predstavlja moguće rješenje za učinkovito suzbijanje repičina sjajnika.

**Ključne riječi:** rezistentnost, repičin sjajnik, azadirahtin, piretrin

## **Efficacy of botanical insecticides on adult forms of pollen beetle (*Brassicogethes aeneus*)**

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### **Summary**

Pollen beetle (*Brassicogethes aeneus*) as the economically most important pest of oilseed rape, due to the insecticide's resistance, is a major problem in the production of this crop. The resistance of pollen beetle has been confirmed for most active substances in the Republic of Croatia. Moreover, the vast majority of active substances have lost their authorization, so producers do not have effective solutions in control of this pest. Therefore, the aim of this study was to determine the efficacy of new, environmentally friendly active substances as possible solutions of the pollen beetle control. During 2020, in eight locations in five counties, adult forms of pollen beetle were collected and tested in laboratory conditions for the active substances azadirachtin and pyrethrin. The experiments were performed according to IRAC method number 7, by dipping untreated terminal rapeseed inflorescences in a solution prepared in 100% and 20% doses. Based on the obtained results, the efficiency of azadirachtin on adult forms of pollen beetle ranged from 60% to 100%, and the efficiency of pyrethrin from 70% to 100%. The obtained results indicate a satisfactory efficacy of botanical insecticides in pollen beetle control, but their efficacy have to be confirmed in the production conditions of oilseed rape cultivation. The application of botanical insecticides combined with other agro-technical measures represent a possible solution for the effective control of pollen beetle.

**Key words:** resistance, pollen beetle, azadirachtin, pyrethrin

## Oat yield in conventional and organic farming

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### Summary

Hulled and naked oat is a perspective crop for the organic farming production system. Oat has low requirements on soil fertility, good competition ability against weeds and can provide appropriate yield in organic farming in comparison with other cereal species such as wheat or barley. It is a perspective crop from the point of view of use in the food industry too. The aim of our study was to compare grain yield production of naked and hulled oat in organic and conventional production systems. Small plot trials were conducted on two locations in the Czech Republic (České Budějovice and Prague) in three years (2018-2020) and two production systems (organic and conventional). Total four varieties of hulled oat (Korok, Kertag, Raven and Seldon) and one variety of naked oat (Patrik) were used. The average grain yields at the locality in Prague in the organic growing system were lower than in the conventional growing system (organic on average 4.5 t ha<sup>-1</sup>, conventional 5.7 t ha<sup>-1</sup>). In České Budějovice the organic growing systems showed similar results (organic 3.0 t ha<sup>-1</sup>, conventional 5.0 t ha<sup>-1</sup>). The yield gap between organic and conventional growing systems was 30%. Similarly, the number of panicles in the organically grown system per square meter was reduced too. The thousand-grain weight reached similar values in the organic and conventional system in Prague and České Budějovice. The lower productivity of organically grown oat was caused by lower tillering ability of plants. However, in the conventional system, herbicides were applied and the crops were fertilized with nitrogen at a rate of 60 kg of nitrogen per hectare. In the organic system, the nutrient by nitrogen was based on nitrogen balance within the crop rotation. Based on our results we can propose both types of oat (hulled and naked) as perspective crops for organic farming. An organic farmer can expect to achieve stable yields which, in less favorable conditions for the production of cereals in the organic system, might be close to the level of conventional yields.

**Key words:** hulled oat, naked oat, organic farming, conventional farming, yield

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## Prinos Bc hibrida kukuruza u proizvodnim pokusima u 2020. godini

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### Sažetak

U proizvodnoj 2020. obrađeno je 99 lokacija s prosječno osam Bc hibrida kukuruza po lokaciji. Sjetva pokusa obavljena je na gotovo svim lokacijama u optimalnom roku, a uvjeti za sjetvu su bili uglavnom dobri što je dovelo do brzog nicanja i ostvarenja zadanih sklopova. Zaštita od korova, kultivacija i prihrane obavljene su u povoljnim vremenskim prilikama i u stanju umjerene vlažnosti tla. Nakon prihrane slijedio je duži period bez oborina što je utjecalo na porast kukuruza i u konačnici na znatno skraćenje stabljike. U srpnju kada je kukuruz bio u oplodnji, bili su povoljni vremenski uvjeti što se tiče temperatura uz zadovoljavajuće količine oborina izraženije na zapadnom dijelu Hrvatske. U prvoj dekadi kolovoza nastavljeni su povoljni uvjeti za razvoj kukuruza. Zadnja dva tjedna u kolovozu izostale su uobičajene ekstremno visoke temperature uz potpuni nedostatak oborina. U rujnu se nastavilo sušno razdoblje u Slavoniji i središnjoj Hrvatskoj, te učestale oborine na zapadu zemlje koje su produžile vegetaciju što je utjecalo na urode i sadržaj vode u zrnu. Rezultati obrade svih članova u svim pokusima pokazuju prosječni prinos od 12,04 t ha<sup>-1</sup>, prosječni sadržaj vode u zrnu pri berbi od 18,14 % uz ostvarenje prosječnog sklopa od 69 364 biljaka ha<sup>-1</sup>. Iz provedene analize rezultata vidljiva je razlika uroda u Slavoniji u odnosu na zapadni dio Hrvatske, a što je direktna posljedica većeg stresa na istoku zemlje zbog nedostatka oborina. Tako je najnoviji hibrid BC415 u četiri najistočnije županije imao prosječni urod 11,08 t ha<sup>-1</sup> s prosječnim sadržajem vode u zrnu 16,97 %, a u ostalim županijama 13,85 t ha<sup>-1</sup> i sadržajem vode 19,70 %. Ovakva značajna razlika u urodu i sadržaju vode u zrnu vidljiva je i kod ostalih hibrida (Agram, BC323, Majstor i Instruktor). Najbolji rezultat u 2020. godini od 20,70 t ha<sup>-1</sup> postigao je hibrid BC415 na lokaciji Belajske Poljice u Karlovačkoj županiji.

**Ključne riječi:** proizvodni pokusi, kukuruz, hibridi, prinos

## BC maize hybrids yield in performance trials in 2020

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### Summary

A total of 99 trials were processed in 2020 with an average of eight BC maize hybrids per location. The sowing of the trials was performed at almost all locations at the optimum planting time and the planting conditions were generally favourable, which led to the rapid seed germination and the expected plant densities were achieved. Crops protection, same as cultivation and fertilization of crops, was performed in favourable weather conditions and in a state of moderate soil moisture. After the fertilization was completed in June, there was a long period without the precipitation which had affected the growth of maize and ultimately resulted with a significant shortening of the stem. In July, when the maize was in the flowering and pollinating phase, the weather conditions were favourable in terms of temperature level, with satisfactory amounts of precipitation again. This was more pronounced in the western part of Croatia. In the first decade of August, preferred conditions for the development of maize continued. For the last two weeks in August there was an absence of the usual, extremely high, temperatures along with a complete absence of precipitation. The period without rain continued during September in Slavonia and Central Croatia, and on the other hand, frequent precipitation in western parts of Croatia prolonged vegetation which affected both yield and grain moisture. The outcome of all processed results shows the average yield of 12.04 t ha<sup>-1</sup>, average grain moisture at harvest of 18.14% with an average plant density of 69 364 plants ha<sup>-1</sup>. The analysis of the results shows the difference between maize yield from trials in Slavonia in relation to the yield from trials in western part of Croatia. This is a direct consequence of greater stress that maize suffered in the east of the country due to lack of precipitation. Thus, the newest hybrid BC415 in the four easternmost counties had an average yield of 11.08 t ha<sup>-1</sup> with an average grain moisture of 16.97% and in other counties 13.85 t ha<sup>-1</sup> and grain moisture of 19.70%. Such a significant difference in yield and grain moisture is visible in other hybrids (Agram, BC323, Majstor and Instruktor). The best result in 2020 of 20.70 t ha<sup>-1</sup> was achieved by the BC415 hybrid at the location of Belajska Poljica in Karlovac county.

**Key words:** production trials, maize, hybrids, yield

## Comparative examination of *Sorghum bicolor*'s dry matter production under different amount of nitrogen supply

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### Summary

Humans are increasing the environmental pollution mainly with agricultural processes, not caring about the fact that our planet will be needed for many generations. One of the main problems is fertilizer application in inadequate quantity that causes environmental, natural and health risk. In our research 9 genotypes of sorghum (*Sorghum bicolor* (L.) Moench) were investigated, because this plant has excellent drought tolerance and the farmers can grow it successfully on poor quality soil, as alternative to maize in feeding animals. Our goal was the comparative examination of different genotypes of sorghums physiological plasticity under different amount of nitrogen supply: how do different nitrogen levels affect physiological parameters of genotypes and the seed's tannin level. The two years (2019 and 2020) experiments were set up on the Research Institute of Karcag's fields. Total 9 hybrids were supplied with 2 nitrogen level (60 kg ha<sup>-1</sup> and 120 kg ha<sup>-1</sup>) and there were four repetitions per treatment. In pre-flowering phenophase, stomatal conductance, relative chlorophyll content, stoma number, dry weight and the seed's tannin level were measured. Based on our results different amounts of nitrogen treatment did not have significant effect on the examined parameters. Although, interaction was detected between hybrids and different amounts of nitrogen in the case of stoma number and tannin level. However, some genotype showed excellent results in terms of several parameters under all of the nitrogen supplies: Alföldi 1 was in the case of stoma number and relative chlorophyll content, ES Shamal was in the case of relative chlorophyll content, tannin level and dry weight while the Albanus was in the case of stomatal conductance, dry weight and tannin content. However, weather conditions influenced most of the examined parameters.

**Key words:** stomatal conductance, relative chlorophyll content, tannin, genotype, drought tolerance



## Učinak tretiranja sjemena kukuruza polimerskom emulzijom i biostimulatorom na prinos i komponente prinosa

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### Sažetak

Na Visokom gospodarskom učilištu u Križevcima tijekom 2020. postavljen je pokus s dva hibrida kukuruza iz FAO skupine 400 (Tesla) i 500 (Atomic) tretiranjem sjemena polimerom Flobond SC100 i smjesom Flobond-a SC 100 i biostimulatora HTS Bio V3304. Pokus je zasijan u tri varijante: (1) Kontrola (2) Flobond SC 100 i (3) Flobond SC100 + HTS Bio V3304 u pet repeticija, po slučajnom bloknom rasporedu. Flobond SC100 je super-absorbirajući polimer na vodenoj bazi kojim se obavija sjeme. Nanesen na sjeme, tijekom vegetacije trebao bi pospješiti usvajanje vode iz tla te tako u sušnom periodu smanjiti stres biljke uzrokovan nedostatkom vode. HTS Bio V3304 je mikrobiološki preparat od 5 sojeva bakterija *Bacillus* i dvije gljive koji se koristi za poboljšanje rasta biljaka. Cilj istraživanja bio je utvrditi utjecaj preparata na prinos zrna i komponente prinosa kukuruza: sklop, vlaga zrna u berbi, hektolitarska masa i masa 1000 zrna. Oba hibrida imala su u prosjeku signifikantno najveći sklop kod tretmana Flobondom 100 SC + HTS Bio V3304 (79 300 biljaka ha<sup>-1</sup>). Tretman Flobondom 100 SC + HTS Bio V3304 postigao je signifikantno najbolji prinos (14,81 t ha<sup>-1</sup>), zatim Flobond SC 100 (14,51 t ha<sup>-1</sup>), a najmanji kontrola (13,39 t ha<sup>-1</sup>). Razlika u prinosu između netretirane i tretirane varijante (9,6 %) opravdava dodatno financijsko ulaganje. U pogledu mase 1000 zrna oba tretmana su pokazala signifikantno bolje vrijednosti u usporedbi s kontrolom. Jedino kod hektolitarske mase nije bilo značajnih razlika između varijanata. Sadržaj vlage u oba tretmana je u prosjeku bio signifikantno veći u usporedbi s kontrolom.

**Ključne riječi:** kukuruz, Flobond SC 100, HTS Bio V3304, prinos zrna

## Effect of corn seed treatment with polymer emulsion and biostimulator on yield and yield components

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### Summary

In 2020, an experiment of two maize hybrids from FAO group 400 (Tesla) and 500 (Atomic) was set up at the Križevci College of Agriculture by treating seeds with Flobond SC100 polymer and a mixture of Flobond SC 100 and biostimulator HTS Bio V3304. It was sown in three variants: (1) Control (2) Flobond SC 100 and (3) Flobond SC100 + HTS Bio V3304 in five repetitions, according to the random block schedule. Flobond SC100 is water based, liquid, super absorbent polymer for seed coating. Applied to the seeds, during the growing season, it should enhance the absorption of water from the soil, and reduce the stress of a plant caused by the lack of water during the dry season. HTS Bio V3304 is the microbiological preparation of 5 strains of *Bacillus* bacteria and two fungi to improve the plant growth. The aim of the study was to determine the effect of the preparation on grain yield and yield components: plant density, grain moisture at harvest, hectoliter mass and weight of 1000 grains. Both hybrids have had, on average, the significantly largest assembly in the Flobondom 100 SC + HTS Bio V3304 treatment (79 300 ha<sup>-1</sup> plants). Treatment with Flobondom 100 SC + HTS Bio V3304 achieved significantly the best yield (14.81 t ha<sup>-1</sup>), followed by Flobond SC 100 (14.51 t ha<sup>-1</sup>), the lowest control (13.39 t ha<sup>-1</sup>). The difference in the yield between the untreated and treated variants (9.6%) justifies additional investments. In terms of 1000 grain weight, both treatments had significantly better values compared to the control. In case of hectoliter mass there were no significant differences between the variants. The moisture content in both treatments was on average significantly higher when compared to the control.

**Keywords:** corn, Flobond SC 100, HTS Bio V3304, grain yield

## Rezultati pokusa strnih žitarica Bc instituta d.d.

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### Sažetak

Bc Institut za oplemenjivanje i proizvodnju bilja svake godine provodi pokuse sa Bc sortama strnih žitarica na više lokacija diljem Republike Hrvatske. Cilj provođenja pokusa je testiranje i usporedba novih s aktualnim sortama te upoznavanje proizvođača sa sortimentom strnih žitarica Bc Instituta. U ovom radu prikazani su rezultati pokusa iz 2020. godine na tri lokacije sa svim Bc sortama strnih žitarica, zatim trogodišnji rezultati na tri lokacije aktualnih Bc sorata strnih žitarica kao i trogodišnji rezultati Bc sorata pšenice po županijama. Pokusi sa svim Bc sortama strnih žitarica 2020. godine postavljeni su na lokacijama Rugvica, Staro Topolje i Lovas. Analizom rezultata na ove tri lokacije utvrđeno je kako je najrodnija sorta ozime pšenice s prosječnim urodom od 10,89 t ha<sup>-1</sup> bila nova sorta Bc Senzacija, nova sorta Bc Trenk s prosječnim urodom od 10,3 t ha<sup>-1</sup> je bila najrodnija pšenoraž, a Bc Bosut s prosječnim urodom od 9,81 t ha<sup>-1</sup> je bio najrodniji ječam. Ozima zob Bc Marta ostvarila je prosječan urod od 7,62 t ha<sup>-1</sup>, a ozimi pravi pir Bc Vigor 6,77 t ha<sup>-1</sup>. Prema rezultatima uroda sorata koje su bile testirane tri uzastopne godine na navedenim lokacijama najrodnija sorta pšenice je Bc Opsesija s prosječnim urodom od 9,3 t ha<sup>-1</sup>, najrodniji ječam je Bc Vedran s prosječnim urodom od 8,44 t ha<sup>-1</sup>, a Bc Goran s prosječnim urodom od 9,18 t ha<sup>-1</sup> je najrodnija pšenoraž. Analizom trogodišnjih rezultata pokusa pšenice postavljenih na više lokacija u svakoj županiji primjećuje se da su veći urodi postignuti u županijama u zapadnom dijelu Republike Hrvatske u odnosu na županije u istočnom dijelu.

**Ključne riječi:** strne žitarice, sorta, pokus, urod

## Results of small grains trials of Bc Institute

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### Summary

Every year Bc Institute for breeding and production of field crops conducts trials with Bc small grains varieties at several locations throughout the Republic of Croatia. The aim of this trials is to test and compare new with current varieties and present to producers the small grains varieties of the Bc Institute. This paper presents the results of trials from 2020 at three locations with all Bc small grains varieties, then three-year results at three locations of actual Bc small grains varieties and three-year results of Bc wheat varieties conducted by counties. Trials with all Bc small grains varieties in 2020 were set up at the locations Rugvica, Staro Topolje and Lovas. The analysis of the results showed that at these three locations winter wheat variety with the highest average yield of 10.89 t ha<sup>-1</sup> was the new variety Bc Senzacija, new variety Bc Trenk with average yield of 10.30 t ha<sup>-1</sup> was the best triticale, and Bc Bosut with average yield of 9.81 t ha<sup>-1</sup> was the best barley. Winter oat Bc Marta achieved average yield of 7.62 t ha<sup>-1</sup>, and winter spelt Bc Vigor 6.77 t ha<sup>-1</sup>. According to yield results of varieties that were tested three consecutive years at these three locations, the best wheat variety was Bc Opsesija with average yield of 9.3 t ha<sup>-1</sup>, the best barley is Bc Vedran with average yield of 8.44 t ha<sup>-1</sup>, and Bc Goran with average yield of 9.18 t ha<sup>-1</sup> was the best triticale. By analyzing the three-year results of wheat trials conducted at several locations in each county, we notice that higher yields were achieved in the counties in the western part of the Republic of Croatia compared to the counties in the east part.

**Key words:** small grains, variety, trial, yield

## Effect of resting time on the dough rheological properties prepared from wheat used in the Albanian market

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### Summary

Wheat flour is widely used for the production of different kind of products daily used, such as bread, biscuits, pasta etc. Apart from the quality of the raw material, the dough rheological properties are crucial for the perfect texture and sensorial characteristics of finished products. During the dough preparation, the resting time is a crucial factor which defines dough rheology properties and therefore the viscoelastic characteristics of gluten. Gluten is a network matrix that is formed when flour and water are mixed. This study aims to evaluate the effects of different resting time on dough rheological properties of wheat used in Albanian food processing industry. More than 400 samples of wheat grains from Albania and abroad were used to study the impact of resting time on the viscoelastic properties of gluten. The extensograph laboratory device was used for evaluation of dough energy, elasticity and extensibility during 45, 90 and 135 min of rest. The result has shown that the resting time has a big effect on the dough rheology properties, so the best time for the dough development was 90 min for most of the samples, because 135 min significantly impairs the viscoelastic properties of gluten.

**Key words:** wheat, flour, dough development, extensograph, resting time

## Učinkovitost herbicidnih tretmana na korovnu floru u pšenici (*Triticum aestivum* L.)

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### Sažetak

Korovi u poljoprivredi značajno utječu na smanjenje prinosa stoga je njihovo učinkovito suzbijanje svim raspoloživim mjerama zaštite neophodno za ostvarivanje uspješnosti proizvodnje. Cilj rada bio je utvrditi korovnu floru u usjevu ozime pšenice te učinkovitost herbicida i njihovih kombinacija u preporučenoj dozi na suzbijanje korovnih vrsta. Istraživanje je provedeno na proizvodnim površinama obiteljskoga poljoprivrednoga gospodarstva Hager u selu Zdenci koje se nalazi u Virovitičko-podravskoj županiji Republike Hrvatske. Poljski pokus je postavljen prema slučajnom bloknom rasporedu u tri ponavljanja. Herbološkom analizom utvrđeno je ukupno 11 korovnih vrsta koje pripadaju uobičajenoj korovnoj zajednici usjeva gustoga sklopa: *Apera spica-venti* (L.) PB., *Alopecurus myosuroides* Hunds., *Poa annua* L., *Capsela bursa-pastoris* (L.) Med., *Lamium purpureum* L., *Stelaria media* (L.) Vill., *Trifolium pratense* L., *Veronica persica* Poir., *Matricaria chamomilla* L., *Mysotis arvensis* (L.) Hill. i *Galium aparine* L.. Korovne vrste mogu se sistematski razvrstati u jedan odjeljak, dva razreda, osam redova, devet porodica i 11 rodova. Najzastupljenije korovne vrste u istraživanju su bile *Apera spica-venti*, *Alopecurus myosuroides*, *Poa annua*, *Capsela bursa-pastoris* i *Lamium purpureum*. Najveći koeficijent učinkovitosti ostvaren je kombinacijom herbicida djelatnih tvari flufenacet + diflufenikan i beflubutamid u dozi 0,3+0,3 l ha<sup>-1</sup>, jednako kao i primjena herbicida s djelatnom tvari flufenacet+diflufenikan u dozi 0,6 l ha<sup>-1</sup>. Najmanji učinak na suzbijanje korova ostvaren je primjenom herbicida djelatne tvari beflubutamid u dozi od 0,5 l ha<sup>-1</sup>.

**Ključne riječi:** korovna flora, pšenica, herbicidi, učinkovitost

## Efficacy of herbicidal treatments on weed flora in wheat (*Triticum aestivum* L.)

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### Summary

Weeds in agriculture have a significant impact on yield reductions, so their effective control by all available protection measures is necessary to achieve successful production. The aim of this study was to determine weed flora of the winter wheat crop and efficacy of herbicides and their combinations in the recommended doses on weed control. The research was conducted on the production areas of the family farm Hager in the village of Zdenci, which is located in Virovitica-Podravina County of the Republic of Croatia. The field experiment was set up as randomized block design in three replications. Analysis of weed flora revealed the presence of a total of 11 weed species typical for densely sown crops: *Apera spica-venti* (L.) PB., *Alopecurus myosuroides* Huds., *Poa annua* L., *Capsela bursa-pastoris* (L.) Med., *Lamium purpureum* L., *Stelaria media* (L.) Vill., *Trifolium pratense* L., *Veronica persica* Poir., *Matricaria chamomilla* L., *Mysotis arvensis* (L.) Hill. and *Galium aparine* L. Taxonomical classification revealed that weed species belong to one division, two classes, eight orders, nine families and 11 genera. The most abundant weed species in the study were *Apera spica-venti*, *Alopecurus myosuroides*, *Poa annua*, *Capsela bursa-pastoris* i *Lamium purpureum*. The highest efficacy coefficient was achieved with combination of herbicides with active ingredients flufenacet + diflufenican and beflubutamide at a dose of 0.3 + 0.3 l ha<sup>-1</sup>, as well as with application of herbicide with the active ingredients flufenacet + diflufenican at a dose of 0.6 l ha<sup>-1</sup>. The lowest weed control was achieved by applying the herbicide with the active ingredient beflubutamide at a dose of 0.5 l ha<sup>-1</sup>.

**Key words:** weed flora, wheat, herbicides, efficacy

## Nutritivna vrijednost klijanaca pšenice (*Triticum aestivum* L.) obogaćenih selenom

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### Sažetak

Dnevni unos selena (Se) kroz prehranu najčešće je odraz njegove prisutnosti u tlu određenog područja. Zbog velike zastupljenosti područja siromašnih Se, sve je veći broj oboljelih od malnutricije, koja se može spriječiti biofortifikacijom usjeva i različitim dodacima prehrani. Danas su na tržištu dostupni različiti preparati klijanaca pšenice koji se zbog svoje velike nutritivne vrijednosti koriste kao dodatak svakodnevnoj prehrani. Zbog velike važnosti Se za zdravlje čovjeka i biljaka kao glavnog izvora ovog esencijalnog mikronutrijenta, cilj je istraživanja bio uzgojiti klijance pšenice (*Triticum aestivum* L., sorta Kraljica) obogaćene Se. Kako asimilacija Se može utjecati na različite metaboličke puteve, cilj je također bio odrediti utjecaj različitih kemijskih oblika Se (selenata i selenita) u rastućim koncentracijama na nutritivnu vrijednost klijanaca pšenice starosti 7 dana. Kao pokazatelji nutritivne vrijednosti mjereni su koncentracija vitamina C, koncentracije klorofila i karotenoida, sadržaj topljivih fenola, sadržaj proteina, ukupnih šećera i količina celuloze (vlakana) te ukupna antioksidacijska aktivnost. Tretmani selenatom i selenitom značajno su povećali količinu Se u izdancima pšenice ovisno o primijenjenoj koncentraciji, s tim da su količine Se bile znatno veće pri tretmanu selenatom. Selenat kao i selenit neznatno su ili uopće nisu utjecali na većinu mjerenih parametara nutritivne vrijednosti, osim u slučaju antioksidacijske aktivnosti gdje su oba tretmana uzrokovala njeno povećanje. Stoga, klijanci pšenice obogaćeni Se zbog svoje velike nutritivne vrijednosti obećavajući su dodatak prehrani te bi mogli pridonijeti rješenju problema malnutricije.

**Ključne riječi:** biofortifikacija, klijanci pšenice, nutritivna vrijednost, selenat, selenit



## Nutritional quality of wheat seedlings (*Triticum aestivum* L.) biofortified with selenium

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### Summary

Daily dietary intake of selenium (Se) is usually a reflection of its presence in the soil of a particular area. Due to the high prevalence of Se-poor areas, there is an increasing number of people suffering from malnutrition that can be prevented by crop biofortification and various nutritional supplements intake. Nowadays, there are different wheat seedlings preparations available on the market used as dietary supplements because of their high nutritional value. Due to the great importance of Se for humans, and plants as the main source of this essential micronutrient, the aim of this study was to grow wheat seedlings (*Triticum aestivum* L., cv. Kraljica) biofortified with Se. Since Se assimilation could affect different metabolic pathways, the aim was also to estimate the impact of different Se forms (selenate and selenite) in increasing concentrations on the nutritional value of wheat seedlings (7 days old). As for indicators of nutritional value, contents of vitamin C, chlorophyll and carotenoids, soluble phenol content, protein content, total sugars and cellulose (fibers) and total antioxidant activity were measured. Treatments with selenate and selenite significantly increased the amount of Se in wheat shoots in a concentration-dependent manner, with Se levels much higher in selenate treatment. Selenate, as well as selenite, had little or no impact on most of the measured nutritional parameters, with exception of the total antioxidant activity that was increased in both treatments. Due to their high nutritional value, young wheat shoots enriched with Se could be promising nutritional supplement and could contribute to solving malnutrition problem.

**Key words:** biofortification, wheat seedlings, nutritional value, selenate, selenite

## Utjecaj lokacija i hibrida na napad kukuruza s kukuruznim moljcem i gljivama iz roda *Fusarium*

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### Sažetak

Cilj istraživanja ovog rada je bio odrediti utjecaj lokacija i hibrida te načina obrade tla na intenzitet napada kukuruza s kukuruznim moljcem (*Ostrinia nubilalis*) i gljivama iz roda *Fusarium* te njihov utjecaj na prinos oklasaka i zrna kukuruza. Na pokusnim parcelama su u 2019. i 2020. godini bili posijani hibridi kukuruza Arnauto, Ajovan i P9241 iz FAO grupe 350 te P9757 i Aurelio iz FAO grupe 390. Na osnovu rezultata utvrđeno je da se napad kukuruznog moljca na stabljici i klipu statistički razlikuje između lokacija (odnosno tipu tla), ali ne i hibrida. Jači napad kukuruznog moljca se dogodio na pjeskovito-šljunčanim tipovima tla u usporedbi sa težim ilovasto-glinastim tipovima tla. Nadalje, na lakšim tipovima tla je manji napad kukuruznog moljca utvrđen kod klasične obrade tla sa oranjem u usporedbi sa konzervacijskom obradom. Kod napada *Fusarium spp.*, utvrđene su statističko opravdane razlike između pojedinih hibrida. Jači napad *Fusarium spp.* na klip u obje godine istraživanja je utvrđen kod hibrida P9757 dok je kod hibrida P9241 to uočeno samo u 2019. godini. Međutim, najviši prosječni prinos oklasaka (3 123 kg ha<sup>-1</sup> s 11 % vlage) i prinos suhog zrna (16 800 kg ha<sup>-1</sup> s 14 % vlage) postigao je hibrid P9757 u 2020. godini. Istraživanje pokazuje kako je intenzitet napada kukuruznog moljca više vezan uz lokaciju tj. tip tla, dok je napad fuzarijske truleži vezan na svojstva hibrida.

**Ključne riječi:** kukuruzni moljac, oklasak, fuzarijske bolesti, lokacija, hibrid

## The effect of locations and hybrid on infestation of corn with European corn borer and *Fusarium* molds

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### Summary

The aim of this study was to determine the effect of location, hybrid and tillage practice on the intensity of corn infestation with the European corn borer (*Ostrinia nubilalis*) and molds of *Fusarium spp.* The influence of infestation on grain and corn cob yield was determined in 2019 and 2020 on Arnauto, Ajovan and P9241 hybrids from FAO group 350 and Aurelio and P9757 hybrids from FAO group 390. Results show that the intensity of infestation of corn stem and cob with European corn borer differed between locations, i.e. soil types, but not among the hybrids. The corn grown on sandy soils had a higher infestation of stem and corn cob with European corn borer than corn grown on clay soils. On sandy soils, the infestation of corn was lower on the plots managed with deep tillage than on the plots managed with conservational tillage. Significant differences were found among hybrids in *Fusarium spp.* infestation. In both studied years *Fusarium spp.* were most prevalent on corn cobs of hybrid P9757 while in the case of the P9241 hybrid, this was observed only in 2019. Nevertheless, the hybrid P9757 had the highest yield of dry corn cob (3123 kg ha<sup>-1</sup>, 11% moisture) and the highest yield of grain (16 800 kg ha<sup>-1</sup>, 14% moisture) in 2020. In this study, we found that the intensity of European corn borer infestation was connected to the location, i.e. soil type, while the intensity of *Fusarium* fungi infestation depended on the characteristics of corn hybrids.

**Ključne riječi:** European corn borer, cob, fusarium diseases, location, hybrid

**Ribarstvo,  
lovstvo i  
pčelarstvo**

**06**

**Fisheries,  
Game Management  
and Beekeeping**



## Early expression profile of sex-related genes in African catfish (*Clarias gariepinus*)

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### Summary

African catfish (*Clarias gariepinus*) is a dominant species in Hungarian intensive aquaculture. Sex-specific differences are present in production characteristics, economically important traits are superior in males. This species is also widely used as a model organism in developmental or reproductive studies, however, our understanding about its sexual development is still limited. Phenotypic sex can be differentiated from 50 days post hatching (dph), therefore, sex-specific gene expression was analysed following this stage in previous publications. The early expression of sex-related genes was investigated during this study. Genotypic sex was determined by a sex-specific DNA marker from fin tissue. RNA was isolated from the head and the trunc representing the brain and the gonad. Temporal and spatial analyses of the expression of Sox3, Foxl2, Vasa, Mark2 and Amh genes were performed at 10, 20, 30 and 40 dph. We found that Sox3 expression was higher in the head in both sexes and at all developmental stages, although the differences were insignificant. Foxl2 was expressed in male and female heads at 10 dph. Significant differences in Vasa and Mark2 expressions were found at 30 dph in male bodies. Amh had a slightly higher expression in females at 10dph. Our findings suggest that sexual development might be initiated between 10 and 20 dph in this species and these genes could play an important role in the differentiation of the bipotential gonad.

The work was supported by the EFOP-3.6.3-VEKOP-16-2017-00008 project, which is co-financed by the European Union and the European Social Fund.

**Key words:** African catfish, sexual development, gene expression

## The improvement of sperm cryopreservation methods in the endemic tench (*Tinca tinca*) and crucian carp (*Carassius carassius*) for conservation purposes

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### Summary

Tench and crucian carp are endemic ecologically important fish species in Hungary. The angling interest and demand was increased for the two fish in the last decades. The size of their natural populations shows a drastic decreasing tendency in Hungary and in other European countries as well. Sperm cryopreservation is an efficient tool to support the reintroduction of the vulnerable natural populations using spermbanks. The aim of the study was to improve sperm cryopreservation methods in the two endemic species for conservational purposes. In our experiments, two different extenders (E1: 200 mM glucose, 40 mM KCl, 30 mM Tris, pH: 8.0±0.2; E2: 150 mM glucose, 75 mM NaCl, 30 mM KCl, 1 mM Na<sub>2</sub>HPO<sub>4</sub> \* 12H<sub>2</sub>O, 1 mM MgCl<sub>2</sub> \* 6H<sub>2</sub>O, 1 mM CaCl<sub>2</sub> \* 2H<sub>2</sub>O, 20 mM Tris, and 0.5% BSA, pH: 8.0 ± 0.2) and two different cryopreservation methods (Styrofoam box and controlled-rate freezer) were compared according to the experimental design. Sperm was frozen using the conventional 0.5 mL straw and 10% methanol as cryoprotectant. Sperm motility (progressive motility) and other kinetic parameters (distance curved line, distance straight line, curvilinear velocity, straight line velocity, linearity) was investigated using a Computer-assisted Sperm Analysis (CASA) system. A significantly higher post-thaw progressive motility was recorded using E1 (34±4%) than in E2 (22±4%) in crucian carp. Contrary, a significantly higher progressive motility was observed in E2 (45±20%) compare to E1 (36± %) in tench following thawing. No significant difference was measured between the Styrofoam box (10±2%) and the controlled-rate freezer (6±1%) cryopreservation methods in thawed tench sperm. Furthermore, no significant difference was recorded in the other kinetic parameters between the different treated groups tench and crucian carp as well. The results can contribute to the establishment of future spermbanks in the case of the two endemic species. The study was supported by the Ministry of Innovation and Technology within the framework of the Thematic Excellence Programme 2020, Institutional Excellence Subprogramme (TKP2020-IKA-12). The experiments were funded by the EFOP-3.6.3-VEKOP-16-2017-00008 project. The project is co-financed by the European Union and the European Social Fund. Our study was also supported by the project “The establishment and improvement of the gene bank strategies at the 21<sup>th</sup> century in different indigenous species, breeds and ecotypes of the Carpathian basin” VEKOP-2.3.2-16-2016-00012.

**Keywords:** tench, crucian carp, sperm motility, cryopreservation, conservation.

## Parasite fauna of fish from Reservoir Streževo, N. Macedonia

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### Summary

During the parasitological investigations of the fishes from Reservoir Streževo (N. Macedonia), 5 species of parasites have been identified, which in addition have great importance in the pathology of fish. These are: the monogenean trematodes *Gyrodactylus derjavini* in the *Oncorhynchus mykiss*, as well as *Dactylogyrus extensus* and *D. minutus* in *Cyprinus carpio*, the nematode *Raphidascaris acus* in *Alburnus thessalicus*, and the crustacean *Ergasilus sieboldi* in *Alburnus thessalicus* and *Squalius vardarensis*. At the same time, *Gyrodactylus derjavini* is a new species for the parasitofauna of fish from N. Macedonia.

**Keywords:** fish, parasites, pathology, N. Macedonia.



## Development of the breeding and intensive fry rearing technology of an important sportfish: chub (*Squalius cephalus*)

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### Summary

Recently sportfishing became a priority on natural waters of Hungary against market-based fish exploitation therefore demand for stocking material is under change. To fulfil this demand, the development on sportfish breeding technologies is a need. In Hungary, besides the dominance of carp-centred, extensive pond fish breeding, intensive fish rearing gathers ground. Beyond carp and some predator fish species, or sometimes instead of them, growing demand is detected on important sport fish species e.g. the native cyprinid, the chub. The improvement of recirculation aquaculture technology provides a platform for not only hatcheries but also for rentable, small scale, low-head, intensive systems for fry rearing. But to exploit this infrastructure, the effectiveness of breeding capacities should be developed, details on the fry rearing and fingerling rearing technologies should be elaborated. Our experiment focused on the complex breeding technology of chub. Broodstock of natural origin was transferred into small (3 m<sup>3</sup>), closed recirculation pools. After a hormonal induction (Ovopel AUV, in two repeats) and an incubation temperature of 19±1°C, Pseudo Gonadosomatic Index (PGSI) remained only 5-8%. Despite the low PGSI value, the fertilization rate exceeded 90%. Eggs were hatching after four days, resulting in a highly photophobic larva. *Artemia nauplii* proved to be a suitable feed for fries starting the feeding on the 3<sup>rd</sup> day from hatching. Despite relative high stocking density (20-60 specimen/l), survival remained more than 90% 28 days after hatching. All the processes, including egg incubation, non-feeding and feeding larva phase was followed in a small (a total capacity of 1 m<sup>3</sup>) recirculation where a system including a simple mechanical filter, moving bed filter and daily water exchange of 10% provided suitable circumstances. Our experiments were supported by the MAHOP-2.1.1-2016-2017-00002 (RESEARCHFISH) and the EFOP-3.6.3-VEKOP-16-2017-00008 project. The project is co-financed by the European Union and the European Social Fund. This research was also supported by the Ministry of Innovation and Technology within the framework of the Thematic Excellence Programme 2020, National Challenges Subprogramme (TKP2020-NKA-16).

**Keywords:** chub, Ovopel, induced fish breeding, fry rearing

## Gospodarenja srnom običnom (*Capreolus capreolus* L.) u zajedničkom otvorenom lovištu XVI/133 – „Asađ“ u razdoblju od 2010. do 2020. godine

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### Sažetak

Cilj ovog istraživanja bio je analizirati uspješnost gospodarenja srnom običnom kroz razdoblje od 10 lovni godina (2010. - 2020.) u lovištu XVI/133 – „Asađ“ u Antinu. Lovište se nalazi u sjeverozapadnom dijelu Vukovarsko-srijemske županije, a površina lovišta iznosi 1430 hektara. Podaci o gospodarenju prikupljeni su iz lovno gospodarske osnove i evidencije ocijenjenih trofeja u razdoblju gospodarenja. Lovno produktivna površina za srnu običnu iznosi 400 ha u II. bonitetnom razredu (8 grla /100 ha), koeficijent prirasta iznosi 0,9 (11 grla) na sva ženska grla starija od dvije godine (12). Od početka razdoblja gospodarenja matični fond je stabilan i uz dozvoljena odstupanja u skladu s propisom lovno gospodarske osnove. Zimsko prihranjivanje obavljano je svake godine bez obzira na vremenske prilike. Sol za divljač izlagana je tijekom cijele godine. Prema podacima u osnovi vidljivo je da je ukupno izlučenje iznosilo oko 83 %, a od toga je odstrijeljeno 43 muška i 45 ženskih grla. U otpadu su bila 3 muška grla iz kategorije lanadi i svi su stradali u poljoprivredi prilikom skidanja usjeva. Trofejna vrijednost odstrijeljenih srnjaka u razdoblju istraživanja bila je dosta dobra (4 srnjaka u srebrnoj medalji: 119,95; 126,70; 120,00; 124,32 i 2 u brončanoj: 108,05; 113,82 CIC točaka). Vidljivo je da se održavanjem optimalne brojnosti divljači, pravilnom prehranom i selekcijskim odstrijelom može postići poželjna kvaliteta populacije i trofejna vrijednost divljači u lovištu.

**Ključne riječi:** srna obična, trofejna vrijednost, gospodarenje

## Management of roe deer (*Capreolus capreolus* L.) in the joint open hunting ground XVI / 133 - "Asadj" in the period from 2010 to 2020

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### Summary

The aim of this research was to analyze the successfully management of roe deer over a period for 10 hunting years (2010 - 2020) in the hunting ground XVI / 133 - "Asadj" in Antin. The hunting ground is located in the northwest part of Vukovar-Srijem County, and the hunting ground area is 1430 hectares. Management data were collected from the hunting economic base and records of evaluated trophies in the management period. Hunting productive area for roe deer is 400 ha in II credit rating class (8 heads / 100 ha), the growth rate is 0.9 (11 heads) for all female heads older than two years (12). From the beginning of the management period, the parent fund was stable and with allowed deviations in accordance with the regulation of the hunting economic basis. Winter feeding was performed every year regardless of the weather conditions. Salt for game was on display throughout the all year. According to the data, it is clearly that the total excretion was about 83%, of which 43 male and 45 female heads were shot. There were 3 male heads from the category of cub in the waste and all of them died during agricultural works, more precisely during the harvesting of crops. The trophy value of shot roe deer in the study period was quite good (4 roe deer in the silver medal: 119.95; 126.70; 120.00; 124.32 and 2 in the bronze: 108.05; 113.82 CIC points). It is evident that by maintaining the optimal number of game, proper nutrition and selective hunt, the desired quality of the population and the trophy value of game in the hunting ground can be achieved.

**Key words:** roe deer, trophy value, management

## Utjecaj raspodjele financijskih sredstava od naknade za pravo lova na razvoj i unapređenje lovstva na lokalnoj razini

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### Sažetak

Cilj istraživanja bio je analizirati razlike u raspodjeli financijskih sredstava od naknade za pravo lova prema „starom“ i „novom“ modelu. Zakonom o lovstvu (NN br. 140/05-67/16) sredstva od uplaćenih lovozakupnina za lovišta su se raspodjeljivala na slijedeći način: 50 % od uplaćenih sredstava pripadao je vlasnicima zemljišta bez prava lova preko proračuna županija, 30 % sredstava uplaćivalo se u proračun RH, 10 % sredstava na poseban račun Ministarstva poljoprivrede za provođenje Zakona o lovstvu i 10 % sredstava na račun županija. Zakonom o lovstvu (NN br. 99/18, 32/19 i 32/20) sredstva se dijele na slijedeći način: 10 % vlasnicima zemljišta bez prava lova preko proračuna županija, 30 % u državni proračun, 50 % na račun Ministarstva (trenutno se koriste za naknadu šteta u prometu) i 10 % sredstava na račun županija. Sredstva su se po „starom“ zakonu dijelila u omjeru 60 %-40 % u korist županija, odnosno vlasnika-korisnika zemljišta bez prava lova. Po trenutno važećem zakonu omjer raspodjele sredstava je 20 %-80 % u korist državnog proračuna. Godišnji prihodi od zakupnine lovišta na području Vukovarsko-srijemske županije iznose 861.988,60 kn. Po „starom“ zakonu Vukovarsko-srijemskoj županiji i vlasnicima-korisnicima zemljišta pripadalo je 517.193,16 kn, a po trenutno važećem pripada 172.397,72 kn. Prihodi koje su slavonske županije ostvarivale od naknade za pravo lova na godišnjem nivou iznosile su 3,9 milijuna kuna, dok se novim zakonom prihod smanjio na 1,2 milijuna kuna što u 10 godina iznosi 27 milijuna kuna manje. Prihodi koje su sve županije u RH ostvarivale od naknade za pravo lova na godišnjem nivou iznosile su 18,6 milijuna kuna, dok prema postojećem zakonu iznose 6,2 milijuna kuna, što u 10 godina iznosi 124 milijuna kuna manje krajnjim korisnicima, vlasnicima-korisnicima zemljišta, lovoovlaštenicima i lokalnim zajednicama.

**Ključne riječi:** naknada, pravo lova, proračun, vlasnici zemljišta

## **The impact of the distribution of financial resources from the fee for the right to hunt on the development and improvement of hunting at the local level**

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### **Summary**

The aim of the research was to analyze the differences in the distribution of financial resources from the fee for the right to hunt according to the "old" and "new" model. According to the Hunting Act (OG 140/05-67/16), funds from paid hunting rents for hunting grounds were distributed as follows: 50% of paid funds belonged to landowners without the right to hunt through the county budget, 30 % of funds were paid in budget of the Republic of Croatia, 10% of funds to the special account of the Ministry of Agriculture for the implementation of the Law on Hunting and 10% of funds to the account of counties. According to the Hunting Act (OG 99/18, 32/19 and 32/20), the funds are distributed as follows: 10% to landowners without the right to hunt through the county budget, 30% to the state budget, 50% to the account of the Ministry (currently are used to compensate for traffic damages) and 10% of funds to the account of the county. According to the "old" law, the funds were distributed in the ratio of 60% -40% in favor of the counties, ie the owners-users of land without the right to hunt. According to the current law, the ratio of funds distribution is 20% -80% in favor of the state budget. Annual income from the lease of hunting grounds in the area of Vukovar-Srijem County amounts to HRK 861,988.60. According to the "old" law, the Vukovar-Srijem County and the owners-users of the land received HRK 517,193.16, and according to the currently valid one, HRK 172,397.72. Revenues generated by Slavonian counties from annual hunting fees amounted to HRK 3.9 million, while the new law reduced revenues to HRK 1.2 million, which is HRK 27 million less in 10 years. Revenues generated by counties from the fee for the right to hunt on an annual basis amounted to HRK 18.6 million, while according to the existing law they amount to HRK 6.2 million, which in 10 years amounts to HRK 124 million less to end users, land owners, hunting rights holders and local communities.

**Keywords:** fee, hunting right, budget, landowners

## Procjena gustoće i strukture populacije plemenite periske *Pinna nobilis* (Linnaeus, 1758) na području Paškog zaljeva u Jadranskom moru

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### Sažetak

Provedeno je istraživanje procjene gustoće i strukture populacija plemenite periske (*Pinna nobilis*) na 8 lokacija duž Paškog zaljeva u Jadranskom moru u razdoblju od svibnja – rujna 2020. g. Koristila se metoda transektnog vizualnog cenzusa ronjenjem na dah uz uporabu autonomnog ronilačkog aparata (SCUBA) i plovila opremljenog *side scan* tehnologijom. Kvadratni transekti određeni su površinom od 900 m<sup>2</sup>. Tijekom istraživanja, uz zabilježbu osnovnih mjera periski (nadzemna visina, maksimalna širina) i mortaliteta, bilježena je i vrsta supstrata te dubina mora. Gustoća periski varirala je između 0,67 – 2,33 živih jedinki/100 m<sup>2</sup>, a zabilježen mortalitet iznosio je od 56 do 100 % ovisno o istraživanoj lokaciji. Primijećena je određena povezanost između strukture staništa, nadzemne visine, temperature i dubine mora u odnosu na mortalitet jedinki. Istraživanjem se pokušalo doprinijeti spoznajama gustoće i strukture populacija plemenite periske na različitim geografskim područjima Jadranskog mora, u ovom slučaju Paškog zaljeva.

**Ključne riječi:** *Pinna nobilis*, gustoća populacije, stanište, Paški zaljev

## Abundance and structure assessment of fan mussel *Pinna nobilis* (Linnaeus 1758) population in the area of the Pag Bay, Adriatic Sea

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### Summary

Abundance and population structure of *Pinna nobilis* on 8 locations in Pag Bay, Adriatic Sea during May – September 2020 was evaluated. Methodology of transect visual census by scuba diving breathing apparatus (SCUBA) and vessel equipped with side scan technology was used. Quadrants transects are determined by area of 900 m<sup>2</sup>. During the research, besides recording of basic measurements (height, maximum width) and mortality rate of *Pinna nobilis*, type of substrate and sea depth was recorded. Abundance of *Pinna nobilis* was between 0.68 and 2.33 of living individuals per 100 m<sup>2</sup>, and recorded mortality was between 57 and 100% depending on location. Connection between structure of habitat, height, sea depth and temperature comparing to mortality of individuals was observed. The research tried to contribute to the knowledge of the abundance and structure of fan mussel populations in different geographical areas of the Adriatic Sea, in this case the Bay of Pag.

**Keywords:** Fan mussel, *Pinna nobilis*, abundance, habitat, Pag Bay

## Genetic variability of Hungarian Tench (*Tinca tinca* Linnaeus 1758) populations – preliminary results

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### Summary

Tench is a native freshwater fish species in the Carpathian-basin. The species prefers lentic habitats. The populations of the species are now on the decline in Hungary due to habitat loss. To be able to develop conservation and management plans for the species, one must have information on the genetic structure of the stocks. In the present study, 288 tench individuals originated from 8 natural populations and one fish farm were studied using 12 microsatellite DNA markers. The number of alleles ranged from 30 to 51 in different populations, along with a total of 10 private alleles. The fish farm stock kept in the live genebank of the Institute for Farm Animal Gene Conservation deviates from H-W equilibrium in case of 3 markers, while the wild stocks deviate in case of 0 to 3 markers. The analysis of molecular variances (AMOVAs) revealed that 11% of the whole molecular variance is among populations, while 14% is among individuals, and 65% is within individuals. Pairwise  $F_{st}$  values ranged from little to great (0.012 - 0.210), suggesting a population structure and showing a significant level of population differentiation. Bayesian model-based clustering (STRUCTURE) analysis has confirmed the existence of 4 sub-populations within the 9 stocks. The results suggest that Hungarian tench populations are genetically moderately diverse and conservation efforts must focus on the maintenance of this variability.

This research was supported by VEKOP-2.3.2-16-2016-00012 project.

**Keywords:** tench, genetic variability, conservation, microsatellite, wild stocks, live genebank



## **Predacija nad umjetnim gnijezdima poljskih koka na području mediteranske i kontinentalne Hrvatske**

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### **Sažetak**

Istraživanje predacije nad umjetnim gnijezdima poljskih koka provedeno je na području lovišta na otoku Hvaru, u mediteranskoj, i u okolici Volavja u kontinentalnoj Hrvatskoj. Cilj ovog istraživanja je utvrditi, primjenom fotozamki, vrste predatora te potencijalnu učestalost predacije nad gnijezdima poljskih koka na različitim tipovima staništa. Umjetna gnijezda su postavljena u razdoblju prirodne reprodukcije koka, tijekom mjeseca svibnja i lipnja, pri čemu su monitorirana tijekom 25 dana. U gnijezda su postavljana kokošja, prepeličja ili umjetna jaja. Na otoku Hvaru je postavljeno 16 gnijezda, a u Volavju 44 gnijezda. Analizom snimki, na Hvaru je utvrđena predacija nad 68,75 %, a u Volavju nad 77,27 % postavljenih gnijezda. Najznačajniji predatori na oba lokaliteta su bili kuna bjelica (*Martes foina*) i siva vrana (*Corvus cornix*). Na otoku Hvaru je utvrđena predacija i od strane vrsta: mungos (*Herpestes auropunctatus*), crni štakor (*Rattus rattus*) i divlja svinja (*Sus scrofa*), a na lokalitetu Volavje vrste: šojka (*Garrulus glandarius*), svraka (*Pica pica*), lisica (*Vulpes vulpes*), jazavac (*Meles meles*), čovjek (*Homo sapiens*) i divlja svinja (*Sus scrofa*). Rezultati istraživanja potvrđuju da je predacija nad gnijezdima poljskih koka vrlo značajan čimbenik brojnosti ovih vrsta na području lovišta.

**Ključne riječi:** poljske koke, gnijezdo, jaja, predacija, Hrvatska

## Artificial nest predation on field game birds in the area of Mediterranean and continental Croatia

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### Summary

The research of predation on artificial nests of field game birds was carried out in the hunting grounds on the island of Hvar, in the Mediterranean, and around Volavje in continental part of Croatia. The aim of this research was to determine, by using photo traps, different predator species and the potential frequency of predation over field game bird nests in different habitat types. Artificial nests were set up during the period of natural reproduction of the field game birds, during the months of May and June, during which they were monitored for 25 days. Chickens, quails and artificial eggs were placed in the nests. 16 nests have been set up on the island of Hvar and 44 nests in Volavje. Analyzing the recordings, a nest predation of 68.75% was determined on Hvar, and 77.27% in Volavje. The most significant predators in both localities were stone marten (*Martes foina*) and hooded crow (*Corvus cornix*). On the island of Hvar, a predation was also carried by the species: Indian mongoose (*Herpestes auropunctatus*), black rat (*Rattus rattus*) and wild boar (*Sus scrofa*), and on the locality of Volavje species: Eurasian jay (*Garrulus glandarius*), Eurasian magpie (*Pica pica*), red fox (*Vulpes vulpes*), European badger (*Meles meles*), human (*Homo sapiens*) and wild boar (*Sus scrofa*). The results of the research confirm that the predation over the nests of field game birds significantly affects populations of these species in the hunting area.

**Key words:** field game birds, nest, eggs, predation, Croatia

## Uzgoj lososa u zatvorenom recirkulacijskom sustavu

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### Sažetak

Uzgoj lososa najbrže je rastući segment akvakulture u svijetu s godišnjom proizvodnjom od 2,5 milijuna tona. Samo na europskom tržištu, potražnja za ovom vrstom ribe prelazi milijun tona. Najveća količina lososa na europsko tržište dolazi iz kaveznog uzgoja iz Norveške, Farskih Otoka, Škotske i Irske. Sama industrija proizvodnje lososa prošla je značajne promjene i razvitak tijekom posljednjeg desetljeća. Intenzivan nadzor sve negativnijih utjecaja kaveznog uzgoja lososa, uključujući bolesti, bjeg iz uzgajališta i zagađenje okoliša, rezultirali su razmatranjem alternativnih uzgojnih opcija. Opći je zaključak da se recirkulacijska tehnologija u akvakulturi (RAS) treba šire usvojiti kako bi uzgoj lososa postao ekološki prihvatljiva i poželjna industrija. U tu svrhu, a s ciljem postepene zamjene kavezne proizvodnje u morskoj sredini, trenutno su masovna ulaganja širom svijeta usmjerena na izgradnju velikih uzgojnih pogona u zatvorenom recirkulacijskom sustavu. Norveška, koja je financirala većinu kaveznog uzgoja lososa, sada prelazi na ulaganje u recirkulacijske proizvodne sustave na kopnu. Ispravno dizajnirani RAS siguran je zatvoreni sustav koji u potpunosti sprječava bijeg ribe iz uzgojnih prostora te sukladno Uredbi Vijeća (EZ) br. 708/2007 omogućuje uzgoj lososa u zemljama i regijama u kojima ta komercijalno vrijedna riba predstavlja stranu ili lokalno neprisutnu vrstu. Recirkulacijska akvakultura relativno je nova tehnologija, a uz korektne, mnoštvo neadekvatnih dizajna preplavljuje tržište. U ovom radu su prikazana osnovna pravila i preporuke za procjenu sigurnosti i učinkovitosti dizajna zatvorenog recirkulacijskog sustava, koja se prvenstveno odnose na ekološku sigurnost uzgoja stranih i lokalno neprisutnih vrsta.

**Ključne riječi:** RAS, dizajn sustava, losos, uzgoj stranih i lokalno neprisutnih vrsta

## Growing salmon in a closed recirculation system

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### Summary

Salmon farming is the fastest growing aquaculture segment in the world, accounting for 2.5 million t annually. The European salmon market alone has a volume of more than one million t per year. Most of the fish is supplied from net-cage farming in Norway, Faroe Islands, Scotland and Ireland. But salmon industry has gone through significant evolution over the past decade. Intense scrutiny of the increasingly negative influences of off-shore net pen culture, including disease, escapes, and the pollution of the environment, has resulted in the consideration of alternative options. The overall conclusion is that recirculating aquaculture operations (RAS), must be more widely adopted if salmon aquaculture is to be accepted as a clean and thus desirable industry. To this end, massive investments have now been directed towards the construction of large-scale RAS facilities for the inland culture of harvestable-sized salmon, with the goal of replacing all levels of offshore production. Norway, which has funded most of salmon cage farming, is now moving to land-based indoor water-recirculating production systems. A properly designed RAS is a safe closed system that completely prevents escapes, and according to the Council Regulation (EC) No. 708/2007 allows salmon farming in countries and regions where that commercially valuable fish represents alien and locally absent species. Recirculation aquaculture is a relatively new technology and in addition to accurate, many inadequate designs are flooding the market. This article provides several basic rules and recommendations for assessing the safety and efficiency of the indoor recirculation system design, which relate primarily to the environmental safety of breeding alien or locally absent species.

**Key words:** RAS, system design, salmon, breeding of alien and locally absent species

## Predacija nad gnijezdima poljskih koka u dalmatinskom zaleđu

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### Sažetak

U posljednjih nekoliko desetljeća došlo je do opadanja brojnosti većine populacija ptica. Glavni razlozi za opadanje brojnosti populacija ptica su gubitak staništa uz istovremeni porast populacija grabežljivaca. Razdoblje gniježdenja je doba godine kada su ptice i njihov potencijalni pomladak najosjetljivije na predaciju, posebno ptice koje gnijezde na tlu. Jarebica kamenjarka – grivna (*Alectoris graeca* M.) i trčka skvržulja (*Perdix perdix* L.) autohtone su hrvatske koke čije su populacije u opadanju. Ciljevi istraživanja su utvrditi uspješnost opstanka gnijezda u vremenu polaganja jaja i identificirati grabežljive vrste koje uništavaju gnijezda. U travnju i svibnju 2020. godine postavljene su senzorne kamere nad umjetna gnijezda na tlu s prepeličjim jajima smještenima na dva područja u dalmatinskom zaleđu u Šibensko-kninskoj županiji. Gnijezda su postavljena na mjestima na kojima se gnijezde jarebica kamenjarka i trčka skvržulja te su napravljena s namjerom da budu što sličnija pravim gnijezdima. Na području gniježdenja trčke skvržulje (oranice i livade) stradalo je 71,5 % (10/14) gnijezda, na području jarebice kamenjarke (krški pašnjaci u sukcesiji) 10 % (2/20) gnijezda, a na području preklapanja areala ove dvije vrste (zapuštene poljoprivredne površine) 30 % (3/10) gnijezda. Siva vrana (*Corvus cornix* L.), svraka (*Pica pica* L.), lisica (*Vulpes vulpes* L.) i antropogeni utjecaj (košnja) zabilježeni su predatori gnijezda na području gniježdenja trčke skvržulje, divlja svinja (*Sus scrofa* L.) na području jarebice kamenjarke, a štakor (*Rattus sp.*) na području prisutnosti obje vrste. Za porast uspješnosti opstanka gnijezda na područjima gniježdenja trčke skvržulje potrebno je kontrolirati brojnost predatora te educirati poljoprivrednike.

**Ključne riječi:** predacija gnijezda, umjetna gnijezda, senzorne kamere, *Alectoris graeca*, *Perdix perdix*

## Ground nest predation in Dalmatian hinterland

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### Summary

The numbers of most bird populations have declined in recent decades. The main reasons for the decline in bird populations are habitat loss with a concomitant increase in predator populations. The nesting period is the time of year when birds and their potential offspring are most vulnerable to predation, especially ground-nesting birds. Rock partridge (*Alectoris graeca* M.) and grey partridge (*Perdix perdix* L.) are autochthonous Croatian species whose populations are declining. The objectives of the study are to determine the success of nest survival at egg laying period and to identify predatory species that destroy nests. In April and May 2020, sensor cameras were installed over artificial ground nest with quail eggs located in two areas in the Dalmatian hinterland in Šibenik-Knin County. The nests were placed on the locations where the rock partridge and the grey partridge nest and were made with the intention of being as similar as possible to real nests. In the nesting area of the grey partridge (arable land and meadows) 71,5% (10/14) of nests were destroyed, in the area of the rock partridge (karst pastures in succession) 10% (2/20) of the nests, and in the area of overlapping of these two species (abandoned agricultural areas) 30% (3/10) of the nests. Hooded crow (*Corvus cornix* L.), magpie (*Pica pica* L.), red fox (*Vulpes vulpes* L.) and anthropogenic influence (mowing) have been recorded as nest predators in the nesting area of the grey partridge, wild boar (*Sus scrofa* L.) in the area of the rock partridge, and rats (*Rattus sp.*) in the area of presence of both species. To increase the success of the survival of the nest in the nesting areas of the grey partridge, it is necessary to control the number of predators and educate local farmers.

**Key words:** nest predation, artificial nests, sensor cameras, *Alectoris graeca*, *Perdix perdix*

## Mikroflora morske i slatkovodne ribe iz komercijalnog uzgoja

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### Sažetak

Komercijalni uzgoj ribe značajan je doprinos u osiguranju visokovrijedne proteinske hrane na tržištu RH. Lubin (*Dicentrarchus labrax*) i komarča (*Sparus aurata*) najzastupljenije su vrste u marikulturi, dok se od slatkovodnih riba najviše uzgajaju šaranske i pastrvske vrste. Kako sigurnost hrane predstavlja osnovnu predispoziciju za distribuciju na tržište, cilj ovog rada bio je identificirati bakterijsku mikrofloru lubina, šarana i potočne pastrve (*Salmo trutta*) iz uzgoja. Brisevi kože i škrga uzimani su tijekom tri godine kroz sva godišnja doba na uzgajalištima lubina kod Pelješca, šarana kod rijeke Ilove i pastrve na rijeci Krki. MALDI TOF metodom detektirano je 70 vrsta bakterija iz 25 rodova. Na lubinu je utvrđeno 42 vrste iz 19 rodova, na šaranu 26 vrsta iz 10 rodova, a na potočnoj pastrvi 23 vrste iz sedam rodova. Rodovi *Achromobacter*, *Aeromonas*, *Pseudomonas* i *Shewanella* utvrđeni su u sve tri vrste riba. U lubina i šarana utvrđeni su rodovi *Acinetobacter*, *Delftia* i *Stenotrophomonas*. Rodovi *Arthrobacter*, *Bacillus*, *Exiguobacterium*, *Leclercia*, *Microbacterium*, *Micrococcus*, *Pantoea*, *Photobacterium*, *Providencia*, *Psychrobacter*, *Rhizobium* i *Vibrio* utvrđeni su samo u lubina, *Enterococcus*, *Morganella* i *Proteus* samo u šarana, a *Carnobacterium*, *Hafnia* i *Serratia* samo u potočne pastrve. Rezultati upućuju na potrebu daljnjeg praćenja stanja mikrobiološke flore uz primjenu dobre higijenske prakse i drugih mjera za smanjenje potencijalnog štetnog utjecaja na zdravlje ljudi i samih riba.

**Ključne riječi:** morska i slatkovodna riba, bakterijska mikroflora, komercijalni uzgoj, akvakultura

## Microflora of marine and freshwater fish from commercial breeding

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### Summary

Commercial fish farming is a significant contribution to the provision of high-quality protein food on the Croatian market. Sea bass, *Dicentrarchus labrax* and gilthead sea bream, *Sparus aurata*, are the most common species in mariculture, while ciprinides and trout are the most widely cultivated freshwater fish. Since food safety is a basic predisposition for market distribution, the aim of this study was to identify the bacterial microflora of sea bass, common carp and brown trout, *Salmo trutta*, from commercial farming. Skin and gill swabs were taken over three years throughout the seasons at sea bass farms near Pelješac, carp farm near the Ilova River and trout farm on the Krka River. 70 types of bacteria from 25 genera were detected by the MALDI TOF method. 42 species from 19 genera were found on sea bass, 26 species from 10 genera on carp, and 23 species from seven genera on brown trout. The genera *Achromobacter*, *Aeromonas*, *Pseudomonas* and *Shewanella* were found in all three fish species. The genera *Arthrobacter*, *Bacillus*, *Exiguobacterium*, *Leclercia*, *Microbacterium*, *Micrococcus*, *Pantoea*, *Photobacterium*, *Providencia*, *Psychrobacter*, *Rhizobium*, and *Vibrio* were found only in sea bass, *Enterococcus*, *Morganella*, and *Proteus* only in carp, and *Carnobacterve*, *Hafnia* and *Serratia* only in brown trout. The results indicate the need for further monitoring of the state of the microbiological flora with the application of good hygiene practice and other measures to reduce the potential harmful impact on farmed fish and human health.

**Key words:** marine and freshwater fish, bacterial microflora, commercial breeding, aquaculture



## Standardization of common carp sperm concentration for cryopreservation

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### Summary

The objective of the present work was to facilitate sperm cryobanking in the common carp (*Cyprinus carpio*) by standardization of sperm concentration measurement as well as its use in cryopreservation. Sperm concentration determination was improved with the use of spectrophotometer as well as a computer-assisted sperm analysis (CASA) system which was correlated to sperm counting with a hemocytometer. We have found significant linear correlations between sperm concentration counted with a hemocytometer and absorbance ( $P = 0.0022$ ,  $R^2 = 0.7602$ ,  $y = 1.576 \times 10^9 + 1.363 \times 10^{11}x$ ) as well as between sperm concentration counted with hemocytometer and measured with CASA ( $P = 0.0000$ ,  $R^2 = 0.8559$ ,  $y = 8.555 \times 10^8 + 0.7317x$ ). Sperm concentration measurement using CASA was later used to standardize sperm concentration in cryopreserved samples, however, no significant effect of this parameter (ANOVA,  $P = 0.243$ ) was detected on the post-thaw progressive motility of sperm (49-67% at various concentrations ranging between  $0.5-4 \times 10^9$  spermatozoa/ml). Thus, sperm concentration measurement in common carp can greatly be facilitated by the use of spectrophotometry and CASA systems, however, this has little effect on cryopreservation efficiency.

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**Key words:** carp, sperm, concentration, cryopreservation, CASA

## Preklapaju li se u prehrani invanzivne i autohtone vrste slatkovodnih riba – riječni glavočić *Neogobius fluviatilis* (Pallas, 1814) i grgeč *Perca fluviatilis* Linnaeus 1758?

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### Sažetak

Invazivne slatkovodne vrste riba, među kojima je i riječni glavočić *Neogobius fluviatilis* (Pallas, 1814), mogu uzrokovati velike promjene struktura slatkovodnih ribljih zajednica - bilo kroz izravnu predaciju autohtonih riba, bilo kroz kompeticiju za hranu ili prostor. Pretpostavlja se da postoje značajna preklapanja u prehrani invazivnih glavoča i europskih autohtonih ribljih vrsta kao što je grgeč (*Perca fluviatilis* Linnaeus 1758). Cilj ovog istraživanja bio je odrediti kvalitativni i kvantitativni sastav prehrane riječnog glavočića i grgeča te analizirati kompeticiju u prehrani (Schoenerov indeks ili indeks preklapanja prehrambenih navika) ove dvije vrste tijekom tri godišnja doba (jesen, zima i proljeće). Uzorci riba (54 jedinke riječnog glavočića i 40 jedinki grgeča) prikupljeni su elektroagregatom u kanalu Kupa-Kupa u mjestu Rečica pored Karlovca. U probavilu većine jedinki grgeča opažen je veći broj maločetinaša Oligochaeta, a manji broj dvokrilaca Diptera u odnosu na jedinke riječnog glavočića, kod kojih je opaženo obrnuto. Kod najmlađih jedinki obje vrste riba, u probavilu su opažene veće brojnosti Diptera, dok su u starijih jedinki opažene veće brojnosti Oligochaeta. Jedino je u siječnju zabilježena biološki značajna vrijednost Schoenerovog indeksa i međusobna kompeticija između grgeča i riječnog glavočića, dok u travnju i listopadu ovaj indeks nije ukazao na kompeticiju za hranu između ove dvije riblje vrste. Pretpostavljamo da je uzrok takvom opažanju limitirana raspoloživost hrane u siječnju.

**Ključne riječi:** kompeticija, slatkovodna ihtiofauna, makrozoobentos, autohton, invazivan

## Do invasive and indigenous freshwater fish species – monkey goby *Neogobius fluviatilis* (Pallas, 1814) and perch *Perca fluviatilis* Linnaeus 1758 - overlap in their diet?

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### Summary

Invasive freshwater fish species, including monkey goby *Neogobius fluviatilis* (Pallas, 1814) can cause major changes in the structure of freshwater fish communities — either through a direct predation on indigenous fish or through a competition for food or space. It is assumed that there are significant overlaps in a diet of the invasive monkey goby and indigenous European fish species such as perch *Perca fluviatilis* Linnaeus 1758. The aim of the study was to determine the qualitative and quantitative diet composition of monkey goby and perch, and to analyse the competition in the diet (Schoener index of between-species diet overlap) of these two species during the seasons (autumn, winter and spring). Fish samples (54 individuals of monkey gobies and 40 individuals of perch) were collected by electrofishing in the Kupa-Kupa canal in village Rečica near Karlovac. In the gut content of most perch individuals, a higher number of Oligochaetes and a lesser number of Diptera was observed, whereas in monkey gobies the opposite trend was observed. In the gut content of the youngest individuals of both fish species, higher numbers of Diptera were observed, while in elder individuals higher numbers of Oligochaeta were observed. Biologically significant value of the Schoener index, and mutual competition between monkey goby and perch were recorded only in January, while in April and October this index did not indicate a competition for food between these two fish species. We suggest that the cause of such observation is the limited availability of food in January.

**Key words:** competition, freshwater ichthyofauna, macrozoobenthos, autochthonous, invasive

## U društvu pčela

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### Sažetak

S ciljem edukacije o tehnologijama u pčelarstvu i metodama biotehnologije koje se primjenjuju kod analize meda osmišljen je muzejski edukativni program „U društvu pčela“ namijenjen različitim ciljnim skupinama. Edukativni program temelji se na muzejskim predmetima Tehničkog muzeja Nikola Tesla (TMNT), prethodno osmišljenim i provedenim edukativnim radionicama TMNT-a te na suvremenim tehničkim i biotehničkim spoznajama o pčelarstvu s posebnim osvrtom na uzgoj medonosnog bilja, laboratorijski rad i analize meda sukladno zakonskim propisima. Ovaj program čine interdisciplinarne pedagoške radionice s temama: sadnja i uzgoj medonosnog bilja, život u košnici i vrcanje meda, botaničko i zemljopisno porijeklo meda, formiranje i dizajn deklaracije proizvoda. Tijekom radionica koriste se prostori Muzeja - postav muzeja s košnicama i živim pčelama te vrt s medonosnim biljem koji je uspostavljen u okviru ovog programa. Radionice su osmišljene na način da čine zasebne cjeline, ali se mogu pohađati i kao cjeloviti program. Tako se npr. u prvoj radionici uspostavljanja nasada medonosnog bilja koriste vrste kao kadulja (*Salvia officinalis* L.), agrumi (*Citrus* spp.), uljana repica (*Brassica napus* L.) i vrijesak (*Calluna vulgaris* L.), a u kasnijim radionicama se med spomenutog botaničkog porijekla koristi za demonstriranje fizikalno – kemijske i peludne analize meda.

**Ključne riječi:** pčelarstvo, medonosno bilje, muzejski predmeti

## In the company of bees

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### Summary

Museum educational programme „In the company of bees“ aimed at different groups of visitors was developed / designed with an objective to educate on beekeeping technologies and biotechnology methods used in honey analysis. Educational programme is based on: museum objects of the Technical Museum Nikola Tesla (TMNT) previously designed and implemented educational workshops in TMNT and on modern technical and biotechnical knowledge on beekeeping with special attention on the cultivation of melliferous plants, laboratory work and honey analysis in accordance with Legislation. This programme consists of the interdisciplinary pedagogic workshops on the following themes: Planting and growing of melliferous plants; In the beehive and Harvesting and extracting honey; Botanical and geographical origin of honey; Formation and design of product declaration. During the workshops Museum spaces are used - a museum display with hives and live bees and the garden with melliferous plants which was designed in the Museum courtyard within this programme. The workshops are designed to form separate entities but can also be attended as a complete periodical programme covering all of the themes. For example, during the first workshop on creating the garden with melliferous plants, species such a sage (*Salvia officinalis* L.), citrus fruits (*Citrus* spp.), rapeseed (*Brassica napus* L.) and heather (*Calluna vulgaris* L.) are used. In later workshops the honey of the aforementioned botanical origin is used for demonstration of physicochemical and pollen analysis of honey.

**Key words:** beekeeping, melliferous plants, museum objects

## Buražna razgradljivost suhe tvari biljaka dostupnih srnama (*Capreolus capreolus* L.) tijekom zimskog razdoblja

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### Sažetak

Izvori hrane dostupni papkarima su biljke različite hranidbene vrijednosti, a tijekom zimskog razdoblja dostupan im je mali broj vrsta. Osim kemijskog sastava hranidbena vrijednost biljke ovisi i o njenoj razgradljivosti, te je cilj ovog rada bio istražiti buražnu razgradljivost suhe tvari (ST) biljaka dostupnih srnama tijekom zimskih mjeseci. Uzorci biljaka su sakupljeni jednom mjesečno u prosincu 2020., te veljači i ožujku 2021. godine, te je ukupno sakupljeno 27 uzoraka biljaka. Uzorci su determinirani kao: *Rubus ulmifolius* Schott, *Rubus hirtus* Waldst.et Kit., *Rubus canescens* DC., *Glechoma hederacea* L., *Hedera helix* L., *Calamagrostis arundinacea* (L.) Roth, *Chelidonium majus* L. te mješavina vrsta iz porodice *Poaceae*. Biljke su se razlikovale u buražnoj razgradljivosti ST ( $P < 0,001$ ) nakon 48 sati inkubacije, a prosječne vrijednosti su iznosile 49,1 % - *R. ulmifolius* Schott, 55,4 % - *R. hirtus* Waldst.et Kit., 43,0 % - *R. canescens* DC., 73,5 % - *G. hederacea* L., 65,9 % - *H. helix* L., 40,2 % - *C. arundinacea* (L.) Roth, 71,5 % - *C. majus* L., i 44,6 % - mješavina vrsta iz porodice *Poaceae*. Tijekom zimskog razdoblja mijenjala se buražna razgradljivost ST sakupljenih biljaka te je rasla ( $P < 0,001$ ) od prosinca (46,8 %) do ožujka (56,1 %). Unatoč smanjenoj raznolikosti dostupnih biljaka i njihovoj kvaliteti tijekom zimskog razdoblja, a posebno tijekom hladnijih mjeseci, dobiveni raspon vrijednosti buražne razgradljivost ST analiziranih biljaka upućuje i na njihovu različitu hranidbenu vrijednost.

**Ključne riječi:** vrste biljaka, srna, ruminalna razgradljivost suhe tvari

## Ruminal dry matter degradability of plants available to female roe deer (*Capreolus capreolus* L.) during winter period

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### Summary

The diet sources available to ungulates are plants of varying nutritional value, and a small number of species are available to them in winter. In addition to chemical composition, the nutritional value of the plant also depends on its degradability, and the aim of this study was to investigate the dry matter (DM) ruminal degradation of plants available to female roe deer during the winter months. Plant samples were collected once a month in December 2020 and February and March 2021, resulting in 27 plant samples. Samples were determined as: *Rubus ulmifolius* Schott, *Rubus hirtus* Waldst.et Kit., *Rubus canescens* DC., *Glechoma hederacea* L., *Hedera helix* L., *Calamagrostis arundinacea* (L.) Roth, *Chelidonium majus* L. and a mixture of species from the *Poaceae* family. The plants differed in DM ruminal degradability ( $P < 0.001$ ) after 48 hours of incubation, and mean values were 49.1% - *R. ulmifolius* Schott, 55.4% - *R. hirtus* Waldst.et Kit., 43.0% - *R. canescens* DC., 73.5% - *G. hederacea* L., 65.9% - *H. helix* L., 40.2% - *C. arundinacea* (L.) Roth, 71.5% - *C. majus* L., and 44.6% - a mixture of species from the family *Poaceae*. During the winter period, the DM ruminal degradability of the collected plants increased ( $P < 0.001$ ) from December (46.8%) to March (56.1%). Despite the reduced diversity of available plants and their quality during the winter period, and especially during the colder months, the obtained range of values of DM ruminal degradability of the analyzed plants indicates their different nutritional value.

**Key words:** plant species, female roe deer, third, fourth, fifth

## ***In vitro* maturation and ovulation of African catfish (*Clarias gariepinus*) ovarian follicles**

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### **Summary**

The aim of this study was to determine the optimal conditions for *in vitro* maturation and ovulation of postvitellogenic follicles of African catfish, *Clarias gariepinus* (Burchell 1822). Primarily, actions of various hormones, in different concentrations known to promote oocyte maturation in fish, were evaluated by scoring the percentage of follicles that underwent germinal vesicle breakdown (GVBD) and ooplasm clearing. Among all groups, only 17 $\alpha$ ,20 $\beta$ -dihydroxy-4-pregnen-3-one (DHP) induced GVBD in a time-dependent manner, with the highest percentage of GVBD (88%) observed after 12 h. However, prolonged incubation with DHP did not lead to ovulation. Pre-treatment and co-incubation with human chorionic gonadotropin, insulin-like growth factor-1 and activin A had no discernible effect on GVBD. To stimulate ovulation in culture, prostaglandins F<sub>2 $\alpha$</sub>  (PGF<sub>2 $\alpha$</sub> ) and E<sub>2</sub> (PGE<sub>2</sub>) were tested by adding to the incubation media containing DHP at different time points. Both prostaglandins were able to induce ovulation in a concentration- and time-dependent manner, with a higher percentage of ovulated oocytes present in the PGF<sub>2 $\alpha$</sub>  group (54%), compared to PGE<sub>2</sub> (15%). In addition, ovulation was greater in groups where the PGF<sub>2 $\alpha$</sub>  was added after oocytes have fully matured, which implies the stage-sensitivity of this process. *In vitro* techniques developed in this study can serve in aiding artificial reproduction of this, or closely related catfish species.

**Key words:** artificial reproduction, oocytes, *in vitro* culture, 17 $\alpha$ ,20 $\beta$ -dihydroxy-4-pregnen-3-one, GVBD

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## VSH svojstvo u selekciji medonosne pčele (*Apis mellifera*)

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### Sažetak

Grinja *Varroa destructor* uz viruse koje prenosi osnovni je uzročnik zimskih gubitaka pčelinjih zajednica. Veterinarsko medicinski preparati gube na značaju i sve se više uvode alternativne metode suzbijanje varoe, dok se selekcija na otpornost na grinju percipira kao moguće dugoročno rješenje. Pčele imaju nekoliko svojstava otpornosti na varou od kojih se higijensko ponašanje potencira kao najvažnije. To je svojstvo radilica da prepoznaju, otklope i uklone zaraženo ili mrtvo leglo. Varoa specifično higijensko ponašanje (eng. *Varroa sensitive hygiene*, VSH) svojstvo je radilica da prepoznaju i uklone leglo zaraženo grinjom. Uzgojni programi u svijetu pokazali su kako se selekcijom na ovo svojstvo mogu dobiti zajednice otporne na varou. U ovom istraživanju prvi puta je u Hrvatskoj ispitana prisutnost VSH svojstva. Istraživanje je provedeno u Baranji na 30 zajednica 2020 godine. U svakoj zajednici 30 tek poklopljenih stanica legla je zaraženo grinjom te je 30 stanica otklopljeno i poklopljeno kako bi služile kao kontrole. Žive varoe su prikupljene neposredno prije zaražavanja stanice uz pomoć šećera u prahu. Nakon 8 dana je utvrđen postotak očišćenih stanica. Prosječno je očišćeno 41,51 % zaraženih stanica, s rasponom od 6,66 % do 71,67 %, a 6 zajednica imalo je rezultat >66 % očišćenih stanica. Prosječan postotak uklonjenih kontrolnih stanica je 4,29 %. Ovi rezultati pokazuju kako u testiranoj populaciji postoje zajednice s izraženim VSH svojstvom na koje se može provoditi selekcija.

**Ključne riječi:** medonosna pčela, *Varroa destructor*, VSH

## VSH trait in selection of honey bees (*Apis mellifera*)

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### Summary

Ectoparasitic mite *Varroa destructor*, along with the viruses it transmits, is the main cause of honey bee winter losses. Veterinary medicines are losing importance and alternative methods of Varroa control are being introduced, while selection for mite resistance is perceived as a possible long-term solution. Bees have several traits of resistance to Varroa, of which hygienic behavior is emphasized as the most important. It is the trait of the worker bees to recognize, uncap and remove an infected or dead brood. Varroa sensitive hygiene (VSH) is the trait of workers to recognize and remove a brood infested with mites. Breeding programs around the world have shown that selection for this trait can produce colonies resistant to Varroa. In this study, the presence of VSH trait was examined for the first time in Croatia. The research was conducted in Baranja on 30 colonies in 2020. In each colony, 30 newly capped brood cells were infested with mites and 30 cells were opened and closed to serve as controls. Live Varroa mites were collected just before infestation of the cells using powdered sugar. After 8 days, the percentage of cleaned cells was determined. On average, 41.51% of infested cells were cleaned, ranging from 6.66% to 71.67%, and 6 colonies had a result of > 66% of cleaned cells. The average percentage of control cells removed was 4.29%. These results show that in the tested population there are colonies with pronounced VSH trait to which selection can be performed.

**Key words:** honey bee, *Varroa destructor*, VSH

## Genetic analysis of Hungarian natural and farmed pike-perch (*Sander lucioperca*) populations

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### Summary

Pikeperch (*Sander lucioperca*) is an important artificially bred and native species in the European and Asian basin. However, our information on the genetic background and diversity is limited. The genetic effect and risk of stocking natural waters with farmed individuals are barely studied and known, despite of that the production and the number of bread stocks have increased significantly in the last decades. Our aim was to develop new species-specific molecular genetic markers and compare the genetic diversity of natural and farmed pikeperch populations from the Danube drainage basin. Thirty-four novel species-specific microsatellite markers were developed and seven of them were used for population genetic analysis of ten stocks. The  $F_{ST}$  value (0.214) indicated a moderate genetic difference among the groups. The phylogenetic and STRUCTURE analyses are showing the same result: the ten populations divided into six genetically separate groups. Deviation from the HW equilibrium and lack of heterozygosity was detected in most of the populations and stocks. Besides, the effect was proved that farm stocks do not necessarily originate from the geographically closest natural populations. Based on an independent microsatellite analysis the diversity reducing effect of pond culture on the genetic diversity of pike-perch stocks was demonstrated. All of these predict an increase in anthropogenic influences.

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**Key words:** Pike-perch, microsatellite, anthropogenic effect, population genetics

## Health Status in Aquarium Fish in Aquatika – Freshwater Aquarium Karlovac

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### Summary

This study presents data on regular health monitoring of fish in Aquatika – Freshwater Aquarium Karlovac, in a period from 2016 to 2019. Aquatika aquarium hold more than 85 different freshwater fish species. 31 of them are endemic. Regular health monitoring revealed different diseases and disorders. For the effective management of aquarium, preventive fish medicine is the most important. Except taking care of water quality, aquarium hygiene and nutrition, regular quarantine and health monitoring is essential. The most common disease in freshwater aquarium fish is Ichthyophthiriosis, the same for endemic and for the other freshwater fish.

**Key words:** health status, aquarium fish, Aquatika – Freshwater Aquarium Karlovac, Ichthyophthiriosis

## Artificial propagation and larva rearing in recirculation aquaculture system (RAS) of the Hungarian carp landrace (*Cyprinus carpio morpha accuminatus*)

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### Summary

An increasing tendency was observed in the angling trends at lake Balaton since 5 years ago. The growing angling demand directly affects the natural populations of the common gamefish (e.g. common carp). The angling management belongs to the Balaton Fish Management Non-Profit Ltd who is responsible for the annual reintroduction of the natural populations in the same time. Recirculating aquaculture system (RAS) allows a controlled propagation and a larvae rearing in a constant safe environment. In our experiments, stripped egg batch (332 g) from 1 female was fertilized using pooled sperm (7,5 mL) from 5 males. Hatched larvae were reared at a "Rack" system in a RAS. The infrastructure was performed using 10 L plastic tanks. The water quality was maintained with a programmable logic controller (PLC system) as well as using UV, mechanical and biological filtration. Larvae were reared at a density 50 individual L<sup>-1</sup>. Feeding was carried out 4 times per day (*ad libitum*) with freshly hatched *Artemia salina* nauplii. Standard length (mm, *N*=20), average body weight (mg, *N*=20) and larvae malformation (*N*=10, curved body, deformed tail development: eye deformity, yolk-sac deformation, craniofacial malformation, edema, somites deformation) was recorded at 3 developmental stages (1. hatched, 2. non-feeding: 3 days post hatching and 3. feeding: 7 days post non-feeding). Results showed a slight increment in the *ichthyological* parameters between the hatched (standard length: 4.4±1 mm, average bodyweight: 1.0±0.3 mg) and non-feeding larvae stage (standard length: 5.5±0.5 mm, average bodyweight: 1.5±0.1 mg). A notable increasing tendency was recorded at the feeding larvae stage in standard length (10.5±0.7 mm) and average bodyweight (12.1±1.7 mg). A low prevalence of malformations was observed at the 3 different larvae stages. A high survival rate (94±2%) was recorded at the end of the experiment (10 days post hatching). The results can contribute: 1. to the efficiency of the hatchery process in the mentioned carp landrace; 2. to maintain the natural population at Lake Balaton; 3. to satisfy the increasing angling demand. Our experiments were supported by the GINOP-2.3.2-15-2016-00004: "Establishing the sustainable angling-aimed management of Lake Balaton.", the EFOP-3.6.3-VEKOP-16-2017-00008, TKP2020-IKA-12 projects and by the Balaton Fish Management Non-Profit Ltd.

**Keywords:** recirculating aquaculture system, artificial propagation, larvae rearing, Hungarian carp landrace

## The artificial propagation of a Hungarian carp landrace (*Cyprinus carpio morpha accuminatus*) in a recirculating aquaculture system using large-scale cryopreserved sperm

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### Summary

Common carp (*Cyprinus carpio*) is one of the most important cultured freshwater fish species in Hungary. The production is nearly 17 thousand tons per year. *Cyprinus carpio morpha accuminatus* from Lake Balaton has a great economic and angling value in Hungary. Balaton Fish Management Non-Profit Ltd. is the owner of the official carp landrace. Sperm cryopreservation can play an important role to maintain the genetical diversity and to support the reintroduction of the natural populations in the case of the increasing angling demand. The aim of the study was to test thawed sperm during artificial propagation large-scale cryopreserved using two different extenders (Grayling ext.: 200 mM glucose, 40 mM KCl, 30 mM Tris, pH: 8.0±0.2; Pike ext.: 150 mM glucose, 75 mM NaCl, 30 mM KCl, 1 mM Na<sub>2</sub>HPO<sub>4</sub> \* 12H<sub>2</sub>O, 1 mM MgCl<sub>2</sub> \* 6H<sub>2</sub>O, 1 mM CaCl<sub>2</sub> \* 2H<sub>2</sub>O, 20 mM Tris, and 0.5% BSA, pH: 8.0±0.2). Sperm freezing was carried out in 10 mL cryotube using a controlled-rate freezer and 10% methanol as cryoprotectant. Progressive motility, curvilinear velocity and linearity were also recorded using a Computer-assisted Sperm Analyzing system. Fertilized eggs were incubated in a rack system maintained at a recirculating aquaculture system. The motility of fresh sperm post stripping (91±2%) and immediately prior to fertilization (92±2%) was also recorded. Both control fresh groups showed higher pMOT in comparison with the two frozen. Furthermore, a significantly lower motility was measured in Pike extender (25±12%) than in Grayling (43±8%). In the case of the VCL parameter, there was no significant difference between fresh (147±7 μm s<sup>-1</sup>) and fresh sperm prior to fertilization (136±7 μm s<sup>-1</sup>). However, a significantly lower curvilinear velocity was observed using a Grayling (55±4 μm s<sup>-1</sup>) Pike (52±4 μm s<sup>-1</sup>) extender compared to the two control fresh groups. Cryopreserved groups did not show notable difference in VCL. The Grayling extender (88±1%) showed significantly higher LIN in comparison with the Pike extender (85±1%) and the fresh control (70±10%). Significant difference in LIN was also recorded between prior to the fertilization control (73±9%) and the Pike extender. The highest hatching rate was observed in the fresh control group (40±4%). Significant difference was recorded between the Grayling (33±2%) and the Pike extender (15±4%) as well as the fresh control. Our experiments were supported by the GINOP-2.3.2-15-2016-00004: "Establishing the sustainable angling-aimed management of Lake Balaton.", the EFOP-3.6.3-VEKOP-16-2017-00008, and by the Ministry of Innovation and Technology within the framework of the Thematic Excellence Programme 2020, National Challenges Subprogramme (TKP2020-NKA-16). projects and by the Balaton Fish Management Non-Profit Ltd.

**Keywords:** large-scale, cryopreservation, extender, artificial propagation, Hungarian carp landrace

## Cyanobacterial blooming in a Hungarian reservoir

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### Summary

Cyanobacteria are prokaryotic photosynthetic organisms known to uncontrollably proliferate in water ecosystems characterized by poor water quality and eutrophication. During their proliferation (cyanobacterial blooming), cyanobacteria are known to enter secondary metabolism and start producing toxic compounds - cyanotoxins. Therefore, regular monitoring of freshwater ecosystems is needed. During our research on the Fehérvárcsurgó reservoir (Hungary) during 2018, we have observed a blooming event characterized by the presence of a large number of cyanobacterial cells (up to 2.8 million cells/ml). The most dominant species were *Aphanizomenon flos-aquae*, *Microcystis flos-aquae* and *Microcystis wesenbergii*. In July and September the microcystin-synthetase encoding gene *mcyE* and the saxitoxin-synthetase encoding gene *sxtG* were amplified in the biomass samples. A very low concentration of a common cyanotoxin – microcystin-RR was detected in the water sample in July, however, no accumulation of this toxin was observed in the tissues of *Abramis brama* and *Carassius gibelio* caught from the reservoir. Certain histopathological alterations in the livers, kidneys and gills of these fish were observed. Obtained results suggest that cyanobacterial blooming is occurring in the Fehérvárcsurgó reservoir, therefore, further monitoring is necessary to determine the potential adverse effects of blooming and presence of cyanotoxins in this multipurpose freshwater ecosystem.

**Key words:** cyanobacteria, cyanotoxins, fish histopathology, freshwater ecosystem, monitoring

## The comparison of sperm motility and density in four different goldfish types

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### Summary

Different goldfish types play an important role both in ornamental fish farming and science. Considering its historical background and morphological characteristics, the goldfish is a suitable model animal for the study of artificial selection as well as for developmental biological studies. Chilled storage of sperm can contribute genetic research, artificial reproduction, and shipping or trade of valuable samples. Sperm motility and cell density is an important parameter in determining sperm quality. Both parameters can directly affect the fertilization rate in fish. The aim of our study was to investigate the effects of the artificial selection on the sperm quality. The males were kept in a recirculating system at 22°C. We compared the sperm motility of four different goldfish types (Common goldfish-“wild type”  $N=5$ , Shubunkin  $N=4$ , Black Moor  $N=4$ , Oranda  $N=5$ ) during 60 hours of refrigerated storage (4°C). In our experiments, progressive motility (pMOT, %), curvilinear velocity (VCL,  $\mu\text{m/s}$ ), linearity (LIN, %), amplitude of lateral head displacement (ALH,  $\mu\text{m}$ ), beat cross frequency (BCF, Hz), straight line velocity (VSL, %) were analysed using a CASA (Computer-assisted Sperm Analysis) system. Sperm cells were activated in an activating solution designed for cyprinids. Measurements were carried out during 60 hours of refrigerated storage at 12-hour intervals. In addition, we investigated and compared the sperm cell density between the various types. Sperm samples of the goldfish types were diluted in a sugar-based extender at a ratio of 1:999 and were loaded into a Bürker-type haemocytometer. Based on the examined CASA parameters, we did not find significant difference between the variants, as well as did not find decrease significantly during 60 hours of storage in neither of them. Furthermore, a similar cell concentration was determined among the variants (Common goldfish  $2.01 \times 10^{10} \pm 3.46 \times 10^9$ ; Shubunkin  $1.71 \times 10^{10} \pm 3.25 \times 10^9$ ; Black Moor  $1.66 \times 10^{10} \pm 3.02 \times 10^9$ ; Oranda  $1.56 \times 10^{10} \pm 5.83 \times 10^9$ ). Further studies can investigate the possible effects of the artificial selection on the reproductive biology of goldfish variants. This research was supported by the Ministry of Innovation and Technology within the framework of the Thematic Excellence Programme 2020, Institutional Excellence Subprogramme (TKP2020-IKA-12). The publication is supported by the EFOP-3.6.3-VEKOP-16-2017-00008 project. The project is co-financed by the European Union and the European Social Fund.

**Key words:** goldfish, sperm, short-term storage, sperm density



## Ihtiofauna rijeke Orljave i potoka Brzaja

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### Sažetak

Uzorkovanje ihtiofaune provedeno je na tri postaje smještene na longitudinalnom profilu: rijeke Orljave kod sela Mijača i nizvodno od mosta kod sela Vranić te potoka Brzaja kod mosta, uzvodno od ušća u rijeku Orjavu kod naselja Kamensko (rkm 76+687).

Uzorkovanje je obavljeno u proljetnom, ljetnom i jesenskom razdoblju, metodom elektroribolova koja je propisana europskim standardom (CEN 14011, 2003), ribolovnim elektroagregatom IGT 200 te okvirnim smjernicama metodologije za prikupljanje podataka o ribama. Za potrebe analize podataka u GIS okruženju, tijekom uzorkovanja ihtiofaune korišten je Garmin GPSMAP 78s te su izrađeni kartografski prikazi rute uzorkovanja. Sve ribe su determinirane na terenu odmah nakon ulova na temelju morfoloških značajki i pomoću determinacijskih ključeva (Kottelat i Freyhof, 2007). Utvrđeno je ukupno devet (9) vrsta riba koje su svrstane u sedam (7) porodica. Najbrojnija vrsta je dvoprugasta uklija (*Alburnoides bipunctatus*), a slijedi je potočna mrena (*Barbus balcanicus*), potočna pastrva (*Salmo trutta*), obični klen (*Squalius cephalus*), peš (*Cottus gobio*), dunavska krkuša (*Cottus obtusirostris*) te zlatni vijun (*Sabanejewia balcanica*). Zabilježena je i jedna kružnosta, dunavska paklara (*Eudontomyzon vladykovi*) te bezribica (*Pseudorasbora parva*). Na postaji Orjlava Mijači, najviše vrsta ulovljeno je u srpnju (osam), a brojnošću je dominirala dvoprugasta uklija sa 63,41 % u ukupnom ulovu. Isto tako, ova vrsta dominirala je u ulovu u lipnju (44,19 %) dok je u rujnu dominirala potočna mrena (73,99 %). Potočna mrena je ciljna vrsta nizvodno od postaja uzorkovanja - POVS „HR2001329 Potoci oko Papuka“. Na postaji potoka Brzaja, u sva tri ribolova dominira dvoprugasta uklija od 47,3 % do 52,7 % ukupnog ulova. Na postaji Orjlava Vranić, dvoprugasta uklija je zastupljena u sva tri ulova s najvećim udjelom koji se kreće od najniže vrijednosti 66,3 % u srpnju, do najviše vrijednosti od 75,0 % u lipnju. Na postaji Orjlava Mijači masom dominira potočna pastrva u lipnju (70,0 %) i u rujnu (54,9 %) dok je u srpnju iznosila svega (20,5 %), a veće vrijednosti u srpnju su imale klen (23,5 %), dvoprugasta uklija (22,9 %) te potočna pastrva (22,25 %). Na postaji Orjlava, Vranić, masom je dominantna vrsta obični klen u srpnju (52,9 %) i u rujnu (46,7 %) dok je u lipnju masom najzastupljenija bila dvoprugasta uklija (65,4 %) u ukupnom ulovu. U ova dva vodotoka prevladavaju reofilne vrste riba, vretenastog oblika tijela, prilagođene za život u brzim strujama toka vode s niži temperaturama i u pravilu s više otopljenog kisika.

**Ključne riječi:** riblja zajednica, Orjlava, Brzaja, reofilne vrste, *Barbus balcanicus*, ciljna vrsta

## Ichthyofauna of the river Orłjava and the stream Brzaja

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### Summary

Sampling of ichthyofauna was carried out at three stations located on the longitudinal profile: the Orłjava river near the village of Mijača and downstream from the bridge near the village of Vranić and the Brzaja stream near the bridge, upstream from the mouth of the Orłjava river near Kamensko (rkm 76+687). The sampling was performed in the spring, summer and autumn periods, using the electric fishing method prescribed by the European standard (CEN 14011, 2003) and the IGT 200 electric fishing unit as well as the basic guidelines of the methodology for collecting data on fish. For the purposes of data analysis in the GIS environment, Garmin GPSMAP 78s was used during ichthyofauna sampling and cartographic representations of the sampling route were made. All fish were identified immediately on-site upon catch based on their morphological characteristics and using identification keys (Kottelat and Freyhof, 2007). A total of nine (9) fish species were identified and classified into seven (7) families. The most numerous species is the schneider (*Alburnoides bipunctatus*) followed by the southern barbel (*Barbus balcanicus*), the brown trout (*Salmo trutta*), the common chub (*Squalius cephalus*), the European bullhead (*Cottus gobio*), Danube gudgeon (*Gobio obtusirostris*) and Balcan spined loach (*Sabanejewia balcanica*). One cyclostomata, the Vladykov's lamprey (*Eudontomyzon vladykovi*), was also recorded, as well as the Topmouth gudgeon (*Pseudorasbora parva*). At the Orłjava Mijači station, most species were caught in July (eight), the schneider being the most numerous one with 63.41% of the total catch. Likewise, this species dominated the catch in June (44.19%), while the southern barbel dominated the total catch in September (73.99%). The southern barbel is the target species downstream of the sampling stations - POVS "HR2001329 Streams around Papuk". At the station of the Brzaja stream, in all three instances of sampling, the schneider was the most abundant species with 47.3% to 52.7% of the total catch. At the Orłjava Vranić station, the schneider was present in all three instances of sampling, with the largest share ranging from the lowest value of 66.3% in July to the highest value of 75.0% in June. At the Orłjava Mijači station, in the total catch, the brown trout had the most abundant mass in June (70.0%) and in September (54.9%), while in July its mass was only 20.5%, and higher values in July were obtained for the common chub (23.5%), the schneider (22.9%) and brown trout (22.25%). At the station Orłjava, Vranić, the dominant species regarding mass was common chub in July (52.9%) and in September (46.7%), while in June it was the schneider (65.4%) with the most abundant mass in the total catch. Rheophilic species of fish with a spindle-shaped body, adapted to life in fast currents of water flow with lower temperatures and typically holding more dissolved oxygen, predominate.

**Keywords:** fish community, Orłjava, Brzaja, rheophilic species, *Barbus balcanicus*, target species

## Inheritance of sperm cryoresistance in zebrafish (*Danio rerio*)

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### Summary

The objective of this study was to investigate the inheritance of sperm cryoresistance in zebrafish (*Danio rerio*). A previous study has shown that sperm of rainbow trout males originated from cryopreserved sperm had a higher post-thaw fertilizing capacity than that of males originated from fresh sperm. In order to investigate this effect in zebrafish, 3 subsequent generations were created. For fertilization, 6 females were selected per group and pooled eggs from females were divided into two and were fertilized with cryopreserved or fresh sperm pooled from 3-3 of the F1 and F2 males, thus, creating full-sib families. The pooled sperm was cryopreserved using grayling extender (200 mM glucose, 40 mM KCl, 30 mM Tris, pH 8.0) and 8% methanol in a programmable freezer at a cooling rate of 10 °C/min. Following thawing, sperm concentration, post-thaw motility and fertilizing capacity of sperm was measured in the F1 and F3 generations; sperm concentration and post-thaw motility were tested in the F2 generation. For fertilization 5000 spermatozoa/egg were used and also fresh sperm was used as a control. No significant difference was found in any of the subsequent generations (F1, F2, F3) ( $p=0.27$ ,  $p=0.54$ ,  $p=0.781$ ) in post-thaw progressive motility of zebrafish sperm from individuals originating from fresh (B) ( $21 \pm 12\%$ ;  $21 \pm 3\%$ ;  $15 \pm 2\%$ ) or cryopreserved (A) ( $25 \pm 8\%$ ;  $17 \pm 9\%$ ;  $30 \pm 16\%$ ) sperm. The sperm concentrations in F1, F2 and F3 after thawing in group A were  $6 \pm 3 \times 10^8$ ;  $1 \pm 2 \times 10^9$ ;  $2 \pm 1 \times 10^9$  spermatozoa/ml and in group B were  $5 \pm 2 \times 10^8$ ;  $2 \pm 1 \times 10^9$ ;  $3 \pm 2 \times 10^9$  spermatozoa/ml, thus, no significant difference ( $p=0.61$ ;  $p=0.073$ ;  $p=0.44$ ) was found between the concentrations. Again, no significant difference ( $p=0.73$ ;  $p=0.89$ ) was found between the post-thaw fertilizing capacity of group A ( $1 \pm 1\%$ ;  $5 \pm 7\%$ ) and group B ( $1 \pm 3\%$ ;  $5 \pm 9\%$ ). Consequently, there was no significant difference in any sperm parameter of individuals originating from fresh or cryopreserved sperm in the different generations (F1, F2, F3) of zebrafish.

**Keywords:** zebrafish, fertilization, motility, sperm concentration, generations, cryopreservation

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## Management of roe deer populations (*Capreolus capreolus* L.) in Serbia

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### Summary

The importance of researching roe deer lies in the fact that this is the most numerous species from the order of ungulates and it is widespread at the most hunting grounds in Serbia. The aim of this paper is to present the analysis of roe deer population management at the hunting grounds of different hunting areas in Serbia. The research was conducted during the 2018/19 hunting year at the three hunting grounds: "Barajevska reka" - Belgrade hunting area, "Takovo" - Central hunting area and "Jadar" - Western hunting area. The analysis included determining the number, gender ratio, age structure of the population, fertility, real growth and losses. The average density of roe deer in hunting grounds varies from 48.67 to 74 individuals per 1000 ha of hunting-productive area. However, when observing the number of individuals per 1000 ha of total hunting area, the density varies from 16.07 individuals to 34.72 individuals. The determined gender ratio at the hunting ground "Jadar" was (M: F = 1: 0.93). At the hunting ground "Takovo", the gender ratio is (M: F = 1: 1.22), while at the hunting ground "Barajevska reka" (M: F = 1: 1.59). The average fertility of roe deer was 1.67 embryos per roe deer, or 1.75 embryos per pregnant roe deer. Depending on the experimental area, the real growth varied from 0.54 to 0.73 fawns per roe deer. Losses in roe deer are caused mostly by biotic factors. The determined average age of shot individuals at the hunting ground varied depending on the hunting ground from 3.53 to 5.24 years. The current situation of roe deer populations at the hunting grounds in Serbia is different from hunting ground to hunting ground, but overall situation is quite unsatisfactory, especially in terms of density, gender ratio and age structure of culled individuals.

**Key words:** *Capreolus capreolus* L., management, growth rate, losses.

## Procjena polimorfizma lokusa MHC DRB1 u srne obične: upotreba sekvenciranja i molekularnog kloniranja

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### Sažetak

Srna obična (*Capreolus capreolus*) rasprostranjena je na većem dijelu Europe i prilagođena raznolikim staništima. Zbog socioekonomskih promjena u ruralnim područjima i šumskim nasadima, te reintrodukcija, brojnost populacije povećava se u zadnjih 30 godina, s iznimkom područja odnedavno zaraženih fasciolidozom (*Fascioloides magna*) gdje je zabilježen pad brojnosti. Rast populacije u većini staništa i pojava alohtonog parazita povećali su izloženosti parazitima. Raznolikost gena glavnog sustava tkivne podudarnosti (engl. Major histocompatibility complex – MHC) pogodan je pokazatelj kapaciteta populacije za suprotstavljanje novim patogenima i sposobnosti za prilagodbu. Geni MHC kodiraju membranske molekule čija je glavna funkcija prezentacija antigena T limfocitima te stoga imaju središnju imunoregulacijsku ulogu. Cilj istraživanja bio je utvrditi varijabilnost lokusa DRB1 klase II gena MHC u srne obične iz Hrvatske. DNA je izolirana iz 50 uzoraka mišićnog tkiva. Rezultati sekvenciranja nagovjestili su značajno veći udio heterozigota u odnosu na naše preliminarno istraživanje (70 % naspram 25 %). Međutim, pojava nukleotidne delecije kod nekih heterozigota onemogućila je potpunu identifikaciju alela isključivo putem Sangerovog sekvenciranja, te smo upotrijebili molekularno kloniranje kako bi potvrdili novopronađene sekvence. Ova metoda je dugotrajna i skupa pa bi ciljano sekvenciranje sljedeće generacije u budućnosti moglo reducirati vrijeme i trošak razdvajanja alelnih faza.

**Ključne riječi:** *Capreolus capreolus*, Glavni sustav tkivne podudarnosti, imunogenetika, genetička raznolikost, adaptivni markeri

## Assessment of MHC DRB1 polymorphism in roe deer: Sequencing and molecular cloning approach

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### Summary

Roe deer (*Capreolus capreolus*) can be found throughout most of Europe and is well adapted to a variety of habitats. Because of the socioeconomic changes in rural areas, forest plantations and reintroductions, population numbers in the last 30 years are increasing, with the recent exception of fascioloidosis (*Fascioloides magna*) infected areas in which decline in population was observed. Population increase in majority of habitats and a challenge of allochthonous parasite-enhanced pathogen exposure. Variability of the major histocompatibility complex (MHC) genes serves as a good candidate for detection of population's capacity to confront new pathogens and the ability to adapt. The MHC genes code for membrane molecules whose main function is to present peptide antigens to T lymphocytes and therefore have a central immunoregulatory role. Our aim in this study was to explore the extent of MHC class II DRB1 locus variability in roe deer from Croatia. DNA was extracted from 50 muscle tissue samples. Sequencing results indicated considerably higher percentage of heterozygotes than in our preliminary research (70% compared to 25%). However, occurrence of nucleotide deletion in some heterozygotes disabled complete allele identification by Sanger sequencing alone. Therefore, we used molecular cloning to confirm newly found sequences. This method is costly and time-consuming, and future targeted next generation sequencing approach could reduce both time and cost of allelic phasing.

**Keywords:** *Capreolus capreolus*, Major histocompatibility complex, immunogenetics, genetic diversity, adaptive markers

## **Inflammatory response in livers of red deer and wild boar infected with *Fascioloides magna***

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### **Summary**

*Fascioloides magna* is an alien parasite species in Croatia. Despite the fact that the red deer is termed as definitive final host, we can classify this relationship as a recently established and still developing host-parasite association. On the opposite, wild boar is classified as a dead-end host. Following the infection, juvenile flukes migrate through the liver causing the extensive tissue damage, while in the same time liver responds initiating various defence mechanisms. We have collected 29 samples of red deer livers from four counties (Vukovarsko-srijemska, Požeško-slavonska, Sisačko-moslavačka, and Bjelovarsko-bilogorska) from which 58 pseudocysts were isolated and 4 wild boar livers originating from Sisačko-moslavačka County, with 4 isolated lesions suggestive to be caused by flukes. Tissue samples were collected from selected areas that cover most of the wall of pseudocysts and surrounding tissues and fixed in the 10% buffered formalin. Samples were processed routinely and stained using H&E. In comparison, non-infected wild boar livers have more pronounced connective tissue than those of red deer. Inflammatory infiltrate in red deer livers contains predominantly lymphocytes, followed by neutrophils and eosinophils. In wild boar it is formed of mainly eosinophils, followed by neutrophils and lymphocytes. Thickening of blood vessels media and dilatation of sinusoids was observed in areas surrounding pseudocysts. The most common finding in the pseudocyst included necrotic debris, fluke's eggs, and pigmented granules.

**Key words:** *Fascioloides magna*, red deer, wild boar, liver, inflammatory response

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## Utjecaj uzgajališta tuna na fenotipska obilježja komarče *Sparus aurata* duž istočnog Jadrana

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### Sažetak

Posljednjih godina zamijećeno je povećanje ulova divlje komarče na području istočnog Jadranskog mora. Doprinos povećanju brojnosti populacija u prirodnom staništu uglavnom se pripisuje zbjegovima iz ribogojilišta kao i priljevu jedinki iz kavezno povezanih okoliša uzgajališta tuna. Fenotipska plastičnost omogućava jedinkama prilagodbu u zatečenom staništu kroz odgovore u obliku fenotipskih promjena koji služe kao poveznica između prethodnih i novih sredina. Predmetno istraživanje imalo je za cilj ustanoviti koje su morfološke, bihevioralne i fiziološke prilagodbe nastupile kod kavezno povezanih komarči u okolini tunogojilišta, uspoređujući ih sa jedinkama divljih i uzgojnih populacija. Dostupnost i tip hrane te lokalni hidrodinamični uvjeti prepoznati su kao glavni doprinosioci razlika u tjelesnoj obojenosti i morfološkim strukturama povezanih s hranidbom i plivanjem između divljih i kavezno povezanih komarči. Zabilježene su razlike i u obliku otolita između jedinki koji obitavaju u prirodnim staništima naspram onih u okolini tunogojilišta te je sam oblik identificiran kao pouzdan fenotipski marker koji uspješno razlikuje uzgojno od druga dva podrijetla. Budući da zbjegovi imaju potencijalno brojne socio-ekonomske i ekološke implikacije, iznesena saznanja mogu se iskoristiti za uspostavu programa upravljanja prebjeglih uzgojnih riba u prirodnom staništu.

**Ključne riječi:** marikultura, uzgajalište tuna, komarča, plastičnost, fenotip



## The impact of tuna farms on gilthead seabream *Sparus aurata* phenotypic traits along the eastern Adriatic sea

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### Summary

Over the past decade, a significant increase of the gilthead seabream in fisheries landing has been documented in the eastern Adriatic Sea. The increased abundance was mainly contributed by the farmed escapees from sea cages and spillover of individuals from the tuna farm-associated environments. Phenotypic plasticity allows individuals to adapt in the existing environment in form of phenotypic changes that serve as a link between previous and newly inhabited environments. The aim of the present work was to investigate what morphological, behavioral and physiological adaptations occurred in gilthead seabream associated with tuna farm in comparison to the wild and farmed populations. Food resources availability and type, as well as the local hydrodynamics conditions, were recognized as the main contributors to the observed differences in body coloration and morphological structures related to feeding and swimming performance between wild and farm-associated seabreams. Otolith shape differences were found between individuals residing in the natural environment and in the vicinity of tuna farms, and was identified as a reliable phenotypic marker that successfully distinguished farmed fish from the other two origins. Since escaped fish have a number of potential socio-economic and ecological implications, these findings can also be used in prevention or mitigation programs for escaped fish in wild.

**Key words:** mariculture, tuna farms, gilthead seabream, phenotype, morphology

## Encapsulation and release kinetics of apitoxin from alginate-based microparticles

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### Summary

*Apitoxin*, or honey bee venom, contains various enzymes, polypeptide toxins, and other substances, some of which are allergenic or immunogenic or both. Studies indicated that apitoxin aqueous solutions may be used as a potential new agroecological insecticide. The apitoxin solution of various concentrations (2 to 6 g L<sup>-1</sup>) was used for the preparation of calcium-alginate microparticles (80 µm nozzle). Release kinetics were observed as a cumulative release (%) of apitoxin from dry and wet microparticles in distilled water and a buffer solution (NaHCO<sub>3</sub> / Na – citrate, pH = 8.28). Kinetics curves showed different patterns and significantly slower release of apitoxin from dry microparticles in comparison with wet microparticle in water (26% vs. 100% cumulative release after seven days) and a buffer solution (100% cumulative release in 18 min vs. 4 min and 30 s). Microcapsules were characterized based on parameters such as encapsulation efficiency (EE%), loading capacity (LC), size (µm), and a swelling degree (%) in an aqueous medium. Loading capacity vs. apitoxin concentration plot showed linear correlation ( $R^2 = 0,9929$ ) with a slope of 0.0127 while other parameters remained almost constant with different concentrations. The obtained results indicated that there is a significant difference in kinetics properties between dry and wet apitoxin microparticles.

**Key words:** encapsulation, aqueous solutions, apitoxin, microparticles, release kinetics

## Inhibicijski učinak plazmom aktivirane vode na rast micelija vrste *Saprolegnia parasitica*, uzročnika saprolegnioze u salmonidnoj akvakulturi

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### Sažetak

Oomicetni mikroorganizam *Saprolegnia parasitica* oportunistički je patogen koji izaziva saprolegniozu, bolest koja uzrokuje velike gubitke u salmonidnoj akvakulturi. Neke od kemikalija koje su se do nedavno koristile za suzbijanje saprolegnioze zabranjene su u Europskoj uniji zbog kancerogenosti i toksičnosti te je potreban razvoj novih, ekološki prihvatljivih tretmana. Plazmom aktivirana voda (engl. *Plasma Activated Water*, PAW) ima široki raspon primjena zbog dokazanog antimikrobnog učinka i niskog rizika za zdravlje ljudi i okoliš. S obzirom da primjena PAW još nije testirana u akvakulturi, cilj ovog rada bio je po prvi puta istražiti može li PAW inhibirati rast micelija vrste *S. parasitica*. Micelij je tretiran s PAW kroz 30 i 60 minuta te su rezultati uspoređeni sa tretmanom vodikovim peroksidom kao pozitivnom kontrolom i vodom (engl. *Artificial Water*, AW) kao negativnom kontrolom. Utvrđeno je da tretiranje micelija s PAW kroz 60 minuta uzrokuje sporiji rast patogena (do 33 % smanjeni rast u odnosu na negativnu kontrolu). U usporedbi s tim, rast micelija bio je potpuno inhibiran nakon tretmana vodikovim peroksidom koncentracije 1000 mg/L u trajanju od 60 minuta. Zaključno, iako utjecaj PAW na micelij *S. parasitica* nije bio jednako snažan kao djelovanje vodikovog peroksida, ovo istraživanje otvorilo je mogućnost primjene PAW, kao ekološki prihvatljivog tretmana, u akvakulturi.

**Ključne riječi:** oomicetni patogeni, plazmom aktivirana voda, vodikov peroksid

## The inhibitory effect of plasma-activated water on the growth of oomycete *Saprolegnia parasitica*, the causative agent of saprolegniosis in salmonid aquaculture

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### Summary

The oomycete *Saprolegnia parasitica* is an opportunistic pathogen that causes saprolegniosis, a disease responsible for large losses in salmonid aquaculture. Some of the chemicals that were used until recently for the control of saprolegniosis have already been banned in the European Union due to carcinogenicity and toxicity, and the development of new, environmentally friendly treatments is urgently needed. Plasma-activated water (PAW) has a wide range of applications due to its proven antimicrobial properties and low risk to human health and the environment. Since the application of PAW has not yet been tested in aquaculture, the aim of this study was to investigate for the first time whether PAW can inhibit the growth of *S. parasitica* mycelium. Mycelium was treated with PAW for 30 and 60 minutes, and the results were compared with hydrogen peroxide treatment as a positive control, and artificial water (AW) as a negative control. Treatment of mycelium with PAW for 60 minutes was found to cause the retardation of pathogen growth (up to 33% reduced growth compared to the negative control). In comparison, mycelial growth was completely inhibited after 60 min treatment with 1000 mg/L hydrogen peroxide. In conclusion, although the effect of PAW on the mycelium of *S. parasitica* was not as strong as the action of hydrogen peroxide, this study opened the possibility of using PAW, as an environmentally friendly treatment, in aquaculture.

**Key words:** oomycete pathogens, plasma-activated water, hydrogen peroxide





**Stočarstvo**

**07**

**Animal  
Husbandry**



## Usporedba modela laktacijskih krivulja u ovaca

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### Sažetak

Cilj ovog rada bio je utvrditi najbolji odgovarajući model laktacijskih krivulja za količinu mlijeka, sadržaj proteina i mliječne masti za istarsku i pašku ovcu. Podaci su prikupljeni od Ministarstva poljoprivrede za 2016., 2017. i 2018. godinu. Koristili smo pet laktacijskih modela u ovome radu: Wood, Wilmink, Ali-Schaeffer, Guo-Swalve te Kubični model. Za statističku analizu podataka korišten je statistički program SAS 9.4 i procedura NLIN, u kojem je izračunati i koeficijent determinacije za mlijeko koji se kretao od 0,726 do 0,884, za razinu mliječne masti od 0,898 do 0,971, te za bjelančevine u mlijeku od 0,928 do 0,992. U radu je pokazano da su Wood, Ali-Schaeffer te Guo-Swalve modeli koji najbolje opisuju laktacijsku krivulju za istarsku i pašku ovcu, dok su druga dva (Wilmink i Kubični) neznatno slabiji.

**Ključne riječi:** laktacijska krivulja, istarska ovca, paška ovca, modeli



## Comparison of lactation curve models in sheep

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### Summary

The goal of this work was to determine the most suitable lactation curve model for milk, protein and fat from Istrian and Pag sheep. All data were acquired from the Ministry of Agriculture in the period from the year 2016 to 2018. Five different lactation models were used in the analysis: Wood, Wilmink, Ali-Schaeffer, Guo-Swalve and Cubic. Statistical program SAS 9.4 was used for data analysis and procedure NLIN, where coefficient of determination was calculated for milk ranging from 0.726 to 0.884, milk fat content from 0.898 to 0.971 and milk protein content from 0.928 to 0.992. It was concluded that Wood, Ali-Schaeffer and Guo-Swalve models are the most efficient in describing lactation curve for Istrian and Pag sheep, while Wilmink and Cubic were a bit less efficient.

**Key words:** lactation curve, Istrian sheep, Pag sheep, models

## Ekonomska isplativost korištenja veće količine sirovih proteina u hranidbi mliječnih koza

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### Sažetak

Uravnotežena hranidba smatra se temeljem učinkovite proizvodnje kozjega mlijeka. Općenito, prema istraživanjima, troškovi hranidbe čine oko 50 % izravnih troškova proizvodnje kozjeg mlijeka, a proteini predstavljaju najskuplju komponentu obroka. Stoga uravnotežena struktura hranidbe i bilanciranje stvarnih potreba životinja donose uštede, uz istovremeno povećanje količine i poboljšanje kvalitete mlijeka. Cilj ovog istraživanja bio je utvrditi optimalan i ekonomski isplativ udio sirovih proteina u krmnoj smjesi kao dopunskom obroku u intenzivnoj proizvodnji kozjeg mlijeka. Istraživanje je provedeno u stadu od 70-ak alpina koza tijekom dvije proizvodne godine. U prvoj (baznoj) godini sve su koze hranjene krmnom smjesom sa 11 % sirovih proteina dok su u drugoj godini slučajnim odabirom koze podijeljene u 3 hranidbene skupine i hranjene krmnom smjesom s različitim udjelom sirovih proteina (14 %, 16 % i 18 % sirovih proteina). S obzirom na kretanje proizvodnje mlijeka, te odnos prihoda i troškova u sve tri hranidbene skupine, utvrđena je pokrivenost prosječnog troška krmne smjese cijenom proizvedenoga mlijeka. Na temelju dobivenih razlika može se zaključiti kako je opravdano koristiti krmnu smjesu sa 14 % sirovih proteina jer jedina ima veći doprinos pokriću od bazne godine.

**Ključne riječi:** kozje mlijeko, krmna smjesa, doprinos pokriću, sirovi proteini

## **Economic profitability of using a larger amount of crude protein in dairy goat nutrition**

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### **Summary**

A balanced diet is considered to be the basis of efficient goat milk production. In general, according to previous studies, feeding costs make around 50% of the direct costs in goat's milk production and protein is the most expensive component of a meal. Therefore, a balanced feeding structure and balancing the real nutritional requirements of the animals reduce production costs while increasing the quantity and improving the quality of the milk. The aim of this study was to determine the optimal and economically viable crude protein (CP) content in the feed mixture used as a supplementary meal in intensive goat milk production. The research was conducted in a herd of about 70 alpine goats during two production years. In the first (base) year, all goats were fed a feed mixture with 11% crude protein, while in the second year, goats were randomly divided into 3 feeding groups and fed a feed mixtures with different crude protein content (14%, 16% and 18% CP). Considering the trend of milk production, and the income/costs ratio in all three experimental groups, the coverage of the average cost of feed mixture by the price of produced milk was determined. Based on the obtained differences, it can be concluded that it is justified to use a feed mixture with 14% CP because it's the only one that has a higher gross margin than feed mixture used in base year.

**Key words:** goat milk, feed mixture, gross margin, crude protein

## Izgled krivulje protoka mlijeka krava Jersey pasmine

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### Sažetak

Cilj rada bio je izmjeriti i prikazati izgled krivulja protoka mlijeka krava Jersey pasmine na primjeru jedne suvremene govedarske farme za proizvodnju mlijeka. Za mjerenje muznih svojstava koristio se mjerni uređaj LactoCorder, a mjerili su se slijedeći parametri: brzina protoka mlijeka, trajanje pojedinih faza krivulje protoka mlijeka, te trajanje glavne i cijele mužnje. Prosječno trajanje glavne i cijele mužnje iznosilo je približno 6,0 odnosno 10,0 minuta po kravi. Trajanje uzlazne, plato i silazne faze krivulje protoka mlijeka variralo je ovisno o obliku krivulje protoka mlijeka od 1,5 do 3,9 minuta. Sa stajališta dobre muznosti, utvrđeno je nešto kraće trajanje plato faze u odnosu na silaznu fazu krivulje protoka mlijeka. Nadalje, utvrđena je nešto veća zastupljenost poželjnih krivulja protoka mlijeka koje su dobar indikator zdravlja vimena. Nužna su daljnja istraživanja ove problematike kako bi se dobili što kvalitetniji zaključci o muznosti krava Jersey pasmine.

**Ključne riječi:** krivulja protoka mlijeka, dijelovi krivulje protoka mlijeka, muzna svojstva, Jersey

## Appearance of the milk flow curve of the cows Jersey breed

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### Summary

The aim of the study were to measure and show the appearance of the milk flow curves of Jersey cows on the example of a modern dairy cattle farm. The LactoCorder measuring device was used to measure milkability traits. The following parameters were measured: milk flow, duration of individual phases of the milk flow curve, and duration of main and whole milking. The average duration of main and whole milking were approximately 6.0 and 10.0 minutes per cow, respectively. The duration of the ascending, plateau and descending phases of the milk flow curve varied depending on the shape of the milk flow curve from 1.5 to 3.9 minutes. From the good milkability point of view, a slightly shorter duration of the plateau phase was found compared to the descending phase of the milk flow curve. Furthermore, a slightly higher prevalence of desirable milk flow curves was found, which are good indicator of udder health. Further research into these issues is necessary to obtain the highest possible conclusions about the milkability of Jersey cows.

**Key words:** milk flow curve, phases of the milk flow curve, milkability, Jersey cows

## Računalni model planskog sparivanja goveda

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### Sažetak

Plansko sparivanje goveda putem računalnog modela predstavlja uslugu za uzgajivače razvijenu u suradnji Centra za stočarstvo Hrvatske agencije za poljoprivredu i hranu sa središnjim uzgojnim udruženjima (Središnji savez hrvatskih uzgajivača simentalskog goveda i Savez udruga hrvatskih uzgajivača holstein goveda) i austrijskim partnerom Genostar Rinderbesamung GMBH. Računalni model uključuje planski odabir bika iz sustava umjetnog osjemenjivanja za svaku kravu ili junicu u stadu kako bi se dobili genetski superiorniji potomci. Izračun uključuje uzgojne vrijednosti roditelja, porijeklo i genetske karakteristike (defekti i osobine). Najvažnije prednosti modela su brži genetski napredak, uvažavanje komparativnih prednosti roditelja, smanjenje/eliminacija uzgoja u srodstvu, kontrola genetskih defekata, te ravnomjerno korištenje najboljih bikova. Uzgajivač određuje uzgojne ciljeve za svoje stado, te udio genomski i progno testiranih bikova. U izračun su uključena ženska grla starija od 12 mjeseci, te bikovi preporučeni od strane uzgojnih udruženja pri čemu uzgajivač može odabrati pojedinačne bikove. Rezultati sparivanja dostupni su u obliku izvještaja koji uzgajivačima mogu biti koristan alat. Računalni model prikladan je za korištenje u stadima najbrojnijih mliječnih i kombiniranih pasmina, što predstavlja 90 % populacije krava u Hrvatskoj. Od primjene ovog modela u Hrvatskoj napravljeno je oko 1000 izračuna i može se očekivati povećanje broja uključenih stada.

**Ključne riječi:** goveda, osjemenjivanje, sparivanje, model, izvještaj

## Mating tool in cattle

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### Summary

Mating plan in cattle based on computer program is breeders service developed in the cooperation between the Centre for Livestock Breeding of the Croatian Agency for Agriculture and Food and Breeding Associations (Central Association of Croatian Simmental Cattle Breeders and Croatian Holstein Breeders Federation) together with Austrian Genostar AI station GMBH. Computer program involves selection of AI bull for each cow or heifer in the herd to obtain genetically superior offspring. Selection includes several parameters: sire and dam breeding values, pedigree, and genetic disorders and characteristics. The most important advantages of the program are faster genetic progress, taking into account comparative advantages of the parents, decreasing/elimination of inbreeding, control of genetic disorders, uniformly semen distribution of the best AI bulls in the population. Breeder determines breeding goals for own herd as well as the proportion of genomically and progeny tested bulls. The calculation includes females older than 12 months and AI bulls recommended by Breeding Associations, whereby the breeder selects bulls from the bull pool. Results of the mating service are available in the form of reports which represents useful tool for breeders. Computer program is suitable for herds of dairy and combined breeds which represents 90% of the Croatian cow population. So far, around 1000 calculations have been applied and further increase of herds involved can be expected.

**Key words:** cattle, insemination, mating, tool, report

## The impact of age at first lambing on some dairy traits in Istrian sheep breed

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### Summary

The optimum age at first lambing (AFL) in dairy sheep heavily relies on husbandry system, local dairy facilities policies, inherent characteristics of the breed etc. Early-life AFL poses risk for incomplete ewe's body development and soundness, and belated one for generating the opportunity expenses. The study aimed to determine the impact of AFL on daily milk yield, fat%, protein%, and lactose% in 1891 Istrian ewes under selection (5024 records for each trait). The distribution of phenotypic records from 1<sup>st</sup> to 7<sup>th</sup> parity was 1715, 1034, 770, 545, 310, 193, and 158, respectively. The average daily milk yield, fat%, protein%, and lactose% were 1.07 kg, 7.07%, 5.9%, and 4.3%, respectively. The distribution of AFL with peaks centered at 14<sup>th</sup> and 24<sup>th</sup> month of age enabled partition of the first parity ewes to those mated in the first (n=889) or second year of life (n=1002). The inferential statistical analysis (model) was suited for unbalanced repeated measurement experimental design. The AFL, litter size, and parity were fitted as categorical, and length of suckling and milking period as continuous fixed predictors. The flock-season and animal were fitted as random effects. The AFL had statistically significant effect only on daily milk yield ( $P < 0.01$ ), and surprisingly, in the favor of younger AFL class. However, the magnitude of the effect was negligible (0.03 kg) to be of any practical importance. The genetic component of the traits was only partially accounted for by fitting the animal in the model, so we hereby argue that generalization of the effect should wait the analysis (BLUE) within the upcoming single step genomic evaluation (BLUP) in this population.

**Key words:** sheep, age, lambing, milk, chemical composition



## Analysis of genealogical information and estimation of population parameters in population of Istrian sheep

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### Summary

Regardless of living in the era of genomics, pedigrees still play an important role in quantitative and conservation genetics. Transition to genomic selection is upcoming in many livestock populations, including Istrian sheep, but that won't happen instantly, and for sure won't make the pedigrees redundant. The study aimed to determine some important pedigree information and population parameters of Istrian sheep under selection. The pedigree with 6480 individuals was constructed by tracing back all the known ancestors for the 5701 phenotyped ewes. The average (and max) *number of full generation*, *number of equivalent complete generations (equiGen)*, and *index of pedigree completeness (PCI)* were 1.34 (5), 2.16 (6.56), and 0.46 (1), respectively. The average *PCI* from 1<sup>st</sup> to 5<sup>th</sup> recent generation was 0.92, 0.79, 0.63, 0.43, and 0.26, respectively. The maximum *mid-parent age* was 11 years, and the average *generation interval* was 3.8 years. The *coefficient of inbreeding (F)* and *effective population size (Ne)* estimated as increase in pairwise coancestry were obtained on individuals with *equiGen*>3 that were born within the last generation interval (year 2015 to 2018,  $N_{ref}=650$ ). The average  $F_{ref}$  was 0.089. The females ( $F_{ref}=0.091$ ) were more inbred than males ( $F_{ref}=0.056$ ). The slope of regression of annually obtained *F* on birth year (BY) was  $\approx 0$  ( $P>0.1$ ). The estimated  $N_{eref}$  was 117 animals, and the regression of annually estimated  $N_{eref}/N_{ref}$  on BY was also insignificant ( $P>0.1$ ) and  $\approx 0$ . Despite the stagnation of the *F* in the last couple of years, its' magnitude is still high and poses risk to this population. Carefully designed matting plan based on all the available information is required to keep it under control while trying to achieve desired selection progress.

**Key words:** pedigree, completeness, inbreeding, effective population size

## Trendovi u govedarskoj proizvodnji u Zagrebačkoj županiji od 2009. do 2019. godine

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### Sažetak

Zabilježeni su negativni trendovi u govedarskoj proizvodnji u Republici Hrvatskoj i u Zagrebačkoj županiji u razdoblju od 2009. do 2019. godine te smanjenje broja goveda svih pasmina (osim mesnih). Mladi poljoprivrednici koji rade na OPG-u, budući nasljednici OPG-ova i poljoprivrednici koji se još uvijek bave govedarskom proizvodnjom, ali su pred zatvaranjem proizvodnje ili su se preorijentirali, planiraju i dalje proizvoditi. Svojoj djeci ne savjetuju nastavak govedarske proizvodnje. Oni koji su odustali od govedarske proizvodnje ni pod kojim se uvjetima neće vratiti u proizvodnju. Uočeni su problemi u govedarskoj proizvodnji od kojih se ističu manjak radne snage, niske otkupna cijena mlijeka i mesa, nesigurno tržište poljuljano uvozom, nepovoljni krediti i komplicirana kreditna papirologija. Poljoprivrednici se malo i nerado usavršavaju, ne poznaju i ne iskorištavaju mjere ruralnog razvoja, ne udružuju se. Od mjera koje bi poboljšale situaciju u sektoru govedarske proizvodnje prioritetno proizvođači spominju povećanje otkupne cijene proizvoda, veće poticaje i rasterećenje poljoprivrednika u davanjima.

**Ključne riječi:** govedarska proizvodnja, trendovi u govedarskoj proizvodnji, anketiranje uzgajivača goveda

## Trends in cattle production in Zagreb County from year 2009 to 2019

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### Summary

Negative trends in cattle production in the Republic of Croatia and in Zagreb County in the period from year 2009 to 2019 and a decrease in the number of cattle of all breeds (except meat breeds) were recorded. Young farmers working on family farms, future heirs of family farms and farmers who are still engaged in cattle production, but are about to close production or have reoriented, plan to continue producing. They do not advise their children to continue cattle production. Those who have given up cattle production will not return to production under any circumstances. Problems have been observed in cattle production, of which labor shortages, low purchase prices of milk and meat, an uncertain market shaken by imports, unfavorable loans and complicated credit paperwork stand out. Farmers are little and reluctant to improve, do not know and do not take advantage of rural development measures, do not associate. Among the measures that would improve the situation in the cattle production sector, producers primarily mention the increase in the purchase price of products, higher incentives and relieving farmers of benefits.

**Key words:** cattle production, trends in cattle production, survey of cattle breeders

## Identification of microflora composition of pork meat with essential oils using by PCR method

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### Summary

Pork is one of the most valued types of meat among the four main types of meat consumed in the world. The essential oils (EOs), formed in the secondary metabolism of aromatic plants, consist of volatile substances and generally, they have a low molecular weight. However, some natural factors such as physiological variations, environmental conditions, geographic variations, genetic factors, and also plant evolution can alter the chemical composition of these oils, as well as their yield. The extraction of EOs usually occurs with the use of conventional techniques such as hydrodistillation using a Clevenger type extractor, which is the most widespread technique for the isolation of volatile EOs. In the industry, these oils are widely studied, mainly for their potential applications as agents promoting biological activities. The volatile compounds have presented over the years several pharmacological applications, such as antioxidant, antitumor, antiprotozoal, antimicrobial, and antiinflammatory activities. This work aimed to analyze the microbiological quality of pork meat treated with essential oils (basil and rosemary) to extend using classical and molecular analytical methods. The examined material was pork (pork neck, pork loin, shoulder). The following methods were used in the research: determination of the total number of microorganisms, identification of pathogenic microflora with the use of selective media (VRBGA, SS, ENDO Agar, PCA, *Pseudomonas* Agar), and identification of microorganisms using the PCR method. Based on the conducted PCR tests, the following *E. coli* bacteria were identified in: pork loin, neck, and shoulder from the 3rd day of storage, *P. areuginosa* in: pork shoulder. However, the presence of *Salmonella* bacteria was not confirmed, despite the fact that its growth was observed when grown on selective media. The PCR method is a fast and reliable method of identifying microorganisms at the molecular level. Identification by means of the PCR method showed the presence of bacteria: *E. coli* and *P. areuginosa*. Rosemary oil has better antimicrobial properties than basil oil.

**Key words:** analysis, essential oils, identification of microorganisms, molecular methods, PCR, pork meat

## Methods for detecting selection signatures in livestock species

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### Summary

The genomic footprints remained by natural and artificial selection are called selection signatures. To identify these footprints, several statistical methods have been developed. Site frequency spectrum is a series of fundamental statistical tests based on the distribution of allele frequencies in a population. These tests include Tajima's D, composite likelihood ratio test as well as Fay and Wu's H statistic. The linkage disequilibrium based methods (LD) are focused on long homozygous regions with haplotypes of high frequencies generated by selective sweeps. One of the most preferable approaches within LD is the integrated haplotype score (iHS), which represents a measure of how the haplotypes are unusual around the SNP (Single Nucleotide Polymorphism) compared to the whole genome. Reduced local variability methods are based on identification of genomic regions with reduced variation relative to the genome average. The most common approach is the runs of homozygosity (ROH) which is defined as the contiguous genomic regions in an individual, which are homozygous across all sites. Finally, when comparing two different populations, the most common statistics are the fixation index ( $F_{ST}$ ) and FLK. While the  $F_{ST}$  represents the proportion of total genetic variance in a subpopulation relative to the total genetic variance, the FLK test is extended to account for the haplotype structure in the sample.

**Key words:** selection signatures, linkage disequilibrium, variation, population differentiation, homozygosity

## Prinos i kvaliteta mesa svinja masne (mangulica), polumasne (crna slavonska svinja) i mesne (landras) pasmine

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### Sažetak

Istraživan je prinos i kvaliteta mesa svinja mangulice (masni tip), crne slavonske svinje (polumasni tip) i landrasa (mesni tip), približno istih tjelesnih masa (105 kg) i iz istih uvjeta tova. Mangulica i crna slavonska svinja imale su manju mesnatost polovica (37,5 % odnosno 45,5 %) nego li landras (56,49 %). Meso mangulice i crne slavonske svinje imalo je normalne vrijednosti pH<sub>24</sub> (5,70 i 5,81), kao i meso landrasa (5,86), ali bolju sposobnost vezanja vode (4,00 cm<sup>2</sup> i 4,34 cm<sup>2</sup>), intenzivniju crvenu boju a\* (12,00 i 17,30), veći sadržaj masti (8,00 % i 6,97 %), te manje vode (70,64 % i 67,78 %) nego li meso landrasa (6,99 cm<sup>2</sup>, a\* = 10,50, 1,71 %, 73,10 %). Bolja senzorna svojstva (boja, mramoriranost, čvrstoća, sočnost, miris i okus), također je imalo meso mangulice i crne slavonske svinje u odnosu na meso landrasa.

**Ključne riječi:** kvaliteta mesa, mangulica, crna slavonska svinja, landras

## Yield and quality of fat pigs (Mangalitsa), semi-fat (Black Slavonian Pig) and meaty (Landras) breeds

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### Summary

The yield and meat quality of pigs Mangalitsa (fat type), Black Slavonian Pig (semi-fat type) and Landrace (meat type), approximately of the same body weight (105 kg) and from the same fattening conditions, were investigated. Mangalitsa and Black Slavonian Pigs had less meatiness of halves (37.5% and 45.5%, respectively) if compared to Landrace (56.49%). The meat of Mangalitsa and Black Slavonian Pig had normal values of pH<sub>24</sub> (5.70 and 5.81), as well as the meat of Landrace (5.86), but a better ability to bind water (4.00 cm<sup>2</sup> and 4.34 cm<sup>2</sup>), more intense red color a\* (12.00 and 17.30), higher fat content (8.00 % and 6.97%), and less water (70.64% and 67.78%) than Landrace meat (6.99 cm<sup>2</sup>, a\* = 10.50, 1.71%, 73.10%). Mangalitsa and Black Slavonian Pig meat also had better sensory properties (color, marbling, firmness, juiciness, odor and taste) if compared to Landrace meat.

**Key words:** meat quality, Mangalitsa, Black Slavonian Pig, Landrace

## Implementation of optimum contribution selection in the Black Slavonian pig population

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### Summary

Breeding programmes of indigenous pig breeds aim to balance genetic diversity within populations and the achievement of genetic improvement for important traits. The object of the present study was to apply optimum contribution selection procedures in the population of Black Slavonian pig and to find a balance between genetic gain and the loss of genetic diversity within the population. The genetic diversity parameters were assessed by analysing pedigree (n=6 099 records) and microsatellite data on 70 animals using the set of 23 microsatellite markers from the ISAG/FAO recommendation list. An evolutionary algorithm was applied to optimise selection for the number of piglets born alive and loss of genetic diversity. Three different scenarios were analysed: truncation selection based on BLUP breeding values; optimised selection based on restrictions on inbreeding rate; and optimised selection based on applying different weights on genetic merit and average coancestry. The average inbreeding coefficient, inbreeding rate, and effective population size were 3.24%, 2.12%, and 23.58, respectively. The average number of alleles per locus, expected and observed heterozygosity were 7.826, 0.685, 0,625, respectively. The application of the evolutionary algorithm showed a different distribution of candidates in mating plans when different constrains were applied. The application of optimised selection showed that genetic improvement can be obtained with reduced loss of genetic diversity.

**Keywords:** indigenous breeds, genetic diversity, inbreeding, selection

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## Mogućnosti uzgoja izvornih hrvatskih pasmina koza za potrebe agroturizma

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### Sažetak

Izvorne hrvatske pasmine koza (hrvatska šarena koza, hrvatska bijela koza i istarska koza) čine gotovo polovinu ukupne evidentirane populacije koza u Hrvatskoj. Međutim, uzgoj hrvatskih izvornih pasmina koza najčešće je obilježen izrazitom ekstenzivnošću te vrlo niskom dohodovnošću i učinkovitošću proizvodnje. Možebitnu dodatnu prihodovnu mogućnost uzgajivačima izvornih pasmina koza omogućava ponuda njihovih proizvoda kroz agroturizam. Stoga je cilj rada bio utvrditi informiranost potrošača i njihove spoznaje o izvornim pasminama koza te utvrditi percepciju o potencijalu izvornih pasmina koza i/ili njihovih proizvoda u sklopu agroturističke ponude. Online anketno ispitivanje provedeno je na uzorku 353 ispitanika. Rezultati istraživanja ukazuju na dobre mogućnosti uzgoja izvornih hrvatskih pasmina koza za potrebe agroturizma. Više od 90 % ispitanih smatra da bi izvorne pasmine koza i njihovi proizvodi upotpunili i obogatili agroturističku ponudu, a nešto više od polovice ispitanih smatra da bi uzgoj izvornih hrvatskih pasmina koza za potrebe agroturizma pridonio ostanku mladih ljudi na selu i revitalizaciji ruralnih prostora. Više od dvije trećine ispitanih bi češće posjećivao neki agroturizam na kojemu se uzgajaju izvorne pasmine koza i/ili u ponudi ima njihove proizvode. Gotovo polovica ispitanika smatra da su proizvodi izvornih pasmina koza kvalitetniji od proizvoda ostalih pasmina, dok otprilike trećina ispitanih smatra da bi proizvodi izvornih pasmina trebali biti cjenovno skuplji nego proizvodi ostalih pasmina koza.

**Ključne riječi:** agroturizam, hrvatska šarena koza, hrvatska bijela koza, istarska koza, kozji proizvodi

## Possibilities of breeding indigenous Croatian goat breeds for the purposes of agritourism

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### Summary

Indigenous Croatian goat breeds, primarily the Croatian Spotted goat and the Croatian White goat, make up almost half of the total recorded goat population in Croatia. However, the breeding of indigenous Croatian goat breeds is most often characterized by distinctive extensiveness and very low profitability and production efficiency. Possible additional income opportunity for breeders of indigenous goat breeds is to offer their products through agritourism. Therefore, the aim of this study was to determine the awareness of consumers and their knowledge of the indigenous breeds of goats and determine the perception of the potential of indigenous breeds of goats and/or their products as part of agritourism offer. An online survey was conducted on a sample of 353 respondents. The results of the research indicate good possibilities for breeding indigenous Croatian goat breeds for the purposes of agritourism. More than 90% of respondents believe that the indigenous goat breeds and their products would complement and enrich the agritourism offer, and slightly more than half of the respondents believe that breeding of indigenous Croatian goat breeds for agritourism would contribute to young people staying in the countryside and revitalizing rural areas. More than two thirds of the respondents would more often visit an agritourism where the indigenous breeds of goats are bred and/or their products are offered. Almost half of the respondents believe that the products of the original goat breeds are of better quality than the products of other breeds, while approximately one third of the respondents think that the products of the original breeds should be more expensive than the products of other goat breeds.

**Key words:** agritourism, Croatian Spotted goat, Croatian White goat, goat products

## Comparison of genetic diversity between Holstein and Simmental breeds reared in Croatia

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### Summary

Conventional dairy cattle breeding programs usually lead to substantial genetic progress, but also to depletion of genetic pool in selected populations. The objective of the study was to compare some pedigree based estimates of genetic diversity between Holstein (HOL) and Simmental (SIM) breeds in Croatia. The pedigrees with 307486 (HOL) and 330556 (SIM) animals were prepared by tracing back all known ancestors for the 200760 (HOL) and 231329 (SIM) routinely phenotyped cows. The SIM breed had more informative pedigree. The number of full generation, number of equivalent complete generations (*equiGen*), and index of pedigree completeness (*PCI*) for SIM were 1.47, 3.35, and 0.58, and for HOL 1.22, 2.99, and 0.51, respectively. SIM had longer generation interval than HOL (6.2 vs 5.7 years). The coefficient of inbreeding (*F*) and effective population size (*N<sub>e</sub>*) were obtained for animals with *equiGen*>3 which were born in the last six years which corresponds to the size of the estimated generation interval ( $N_{ref(SIM)} = 45807$ ,  $N_{ref(HOL)} = 54540$ ). The average  $F_{ref(SIM)}$  and  $F_{ref(HOL)}$  were 0.0097 and 0.0163, respectively. Cows ( $F_{ref(SIM)} = 0.0097$ ,  $F_{ref(HOL)} = 0.0163$ ) were more inbred than bulls in both breeds ( $F_{ref(SIM)} = 0.0071$ ,  $F_{ref(HOL)} = 0.0118$ ). The estimated  $N_{ref(SIM)}$  and  $N_{ref(HOL)}$  were 227 and 140, respectively. The obtained results suggest greater genetic variability of SIM breed which is in accordance with the expectations based on the known history of intensive selection work in HOL.

**Key words:** genetic diversity, pedigree, completeness, inbreeding, effective population size

## Praćenje dinamike bakterija roda *Lactococcus* tijekom različitih faza zrenja istarskog sira

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### Sažetak

Istarski sir je visokvalitetan tradicionalan hrvatski proizvod koji se proizvodi od nepasteriziranog ovčjeg mlijeka bez dodavanja starter kultura na obiteljsko-poljoprivrednim gospodarstvima diljem Istre. Njegova specifična organoleptička svojstva posljedica su metaboličke aktivnosti prirodno prisutnih autohtonih bakterija mliječne kiseline (BMK) u mlijeku i siru tijekom zrenja. Među njima se ističu bakterije roda *Lactococcus*. Tradicionalno, raznolikost, funkcija i uloga BMK tijekom fermentacije i zrenja sira ispitivane su metodama ovisnim o kultivaciji. Međutim, nedovoljno poznavanje kultivacijskih uvjeta i neselektivnost komercijanih hranjivih medija često rezultiraju djelomičnom izolacijom i nepouzdanom identifikacijom mikrobnih grupa koje ne reflektiraju stvarnu mikrobnu raznolikost. Stoga, metode neovisne o kultivaciji se sve više primjenjuju u proučavanju mikrobne raznolikosti mliječnih proizvoda. U ovom istraživanju, kako bi se utvrdila raznolikost mikrobnih populacija tijekom različitih faza zrenja i selektivnost M17 hranjive podloge, analizirani su konzorciji uzoraka sira nakon 30, 60 i 90 dana zrenja s dva gospodarstva. Istovremeno, u istim fazama zrenja sira, s oba gospodarstva, prikupljeno je ukupno 60 izolata. Prikupljeni izolati detaljno su genetički i fenotipski okarakterizirani. Brojnost i sastav BMK varira tijekom fermentacije i zrenja sira. Nadalje, raznolikost BMK (41,7 % laktokoka i 58,3 % enterokoka) ukazuju na nedovoljnu selektivnost M17 podloge i naglašava potrebu za razvojem novog sustava, neovisnog o kultivaciji, za detekciju i identifikaciju bakterija roda *Lactococcus*. T-RFLP (engl. *Terminal Restriction Fragment Length Polymorphism*) metoda pokazala se kao izvrstan alat za identifikaciju bakterija roda *Lactococcus* i razlikovanje od drugih BMK sa sličnim morfološkim karakteristikama.

**Ključne riječi:** sir, *Lactococcus* spp., M17, selektivnost, T-RFLP

## Monitoring the dynamics of *Lactococcus* spp. during ripening stages of Istrian cheese

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### Summary

Istrian cheese is a high-quality traditional Croatian product made from unpasteurized sheep's milk without the addition of starter cultures on the family farms throughout Istria. Its specific organoleptic properties are contributed to the metabolic activity of naturally occurring indigenous lactic acid bacteria (LAB) in the milk and cheese during the ripening. Among them, bacteria of the genus *Lactococcus* are of particular interest. Traditionally, the diversity, function, and role of LAB during cheese fermentation and ripening have been studied by cultivation-dependent methods. However, insufficient knowledge of cultivation conditions and non-selectivity of commercial media often results in partial isolation and unreliable identification of microbiota that do not reflect actual microbial diversity. Therefore, cultivation-independent methods for assessing the microbial diversity of dairy products are becoming more common. In this study, to determine the diversity of microbial populations during different ripening phases and the selectivity of the M17 medium, consortia of cheese samples after 30, 60, and 90 days of ripening from two farms were analyzed. At the same time, a total of 60 isolates from the same stages of cheese ripening, were collected from both farms. The collected isolates were characterized, in detail, genetically and phenotypically. The abundance and composition of LAB vary during the fermentation and cheese ripening. Furthermore, the diversity of LAB (41.7% lactococci and 58.3% enterococci) indicates insufficient selectivity of the M17 medium and emphasizes the need for a new, culture-independent system for the detection and identification of the genus *Lactococcus* bacteria. The T-RFLP (*Terminal Restriction Fragment Length Polymorphism*) method was proven as an excellent tool in identifying and distinguishing the genus *Lactococcus* bacteria from other LAB with similar morphological characteristics.

**Key words:** cheese, *Lactococcus* spp., M17, selectivity, T-RFLP

## Bioraspoloživost tokola kao uvjet za njihovo iskorištenje iz zrna kukuruza

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### Sažetak

Vitamin E je pojam koji obuhvaća isto biološko djelovanje strukturno sličnih spojeva tokoferola i tokotrienola, a zrno kukuruza, glavno krmivo smjesa, njihov je važan izvor. Bioraspoloživost pokazuje količine tokola koje se u odnosu na prisutne oslobode iz matrice zrna te budu životinji dostupne za apsorpciju. Cilj ovog istraživanja bio je odrediti sadržaj pojedinačnih i ukupnih tokola te njihovu bioraspoloživost iz zrna 105 komercijalnih hibrida kukuruza u modelu koji oponaša probavu u želucu i tankom crijevu monogastričnih životinja. Prosječan sadržaj tokola u istraživanim hibridima je iznosio 4,1, 25,0 i 0,7  $\mu\text{g/g}$  ST za  $\alpha$ -,  $\gamma$ - i  $\delta$ -tokoferol te 0.9 i 2.2  $\mu\text{g/g}$  ST za  $\alpha$ - i  $\gamma$ -tokotrienol. Prosječne vrijednosti bioraspoloživosti smanjivale su se redom:  $\delta$ -tokoferol (54 %),  $\gamma$ -tokotrienol (53 %),  $\gamma$ -tokoferol (46 %),  $\alpha$ -tokoferol (40 %) i  $\alpha$ -tokotrienol (36 %) te je za ukupne tokole zrna varirala od 27 do 87 %. Sadržaj otpuštenih tokola istraživanih hibrida je rastao s porastom njihovog sadržaja u zrnu ( $P < 0,001$ ), međutim, bioraspoloživost je opadala ( $P < 0,001$ ) što ukazuje da se učinkovitost otpuštanja tokola iz matrice zrna i njihove micelarizacije smanjuje što je viši sadržaj u zrnu. Unatoč zabilježenim varijabilnim vrijednostima bioraspoloživosti, dobiveni rezultati pokazuju da je tek oko polovice tokola prisutnih u zrnu dostupno životinji za apsorpciju.

**Ključne riječi:** vitamin E, hibridi kukuruza, bioraspoloživost

Ovaj je rad financirala Hrvatska zaklada za znanost projektom ColourMaize (IP-2019-04-9063). Rad doktorandice Dore Zurak financiran je iz „Projekta razvoja karijera mladih istraživača – izobrazba novih doktora znanosti“ Hrvatske zaklade za znanost.

## Bioaccessibility of tocopherols as a prerequisite for their utilization from maize grain

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### Summary

Vitamin E is a term that encompasses the same biological activity of the structurally similar compounds tocopherols and tocotrienols, and maize grain, as the main component of animal diet, is their important source. Bioaccessibility represents the fraction of tocopherols released from the grain matrix and available for absorption by the animal. The aim of this study was to determine the content of individual and total tocopherols and their bioaccessibility from the grain of 105 commercial maize hybrids in a model that mimics digestion in the stomach and small intestine of monogastric animals. The average tocopherol content in the tested hybrids was 4.1, 25.0 and 0.7 µg/g DM for  $\alpha$ -,  $\gamma$ - and  $\delta$ -tocopherol, respectively, and 0.9 and 2.2 µg/g DM for  $\alpha$ - and  $\gamma$ -tocotrienol, respectively. The average bioaccessibility values decreased in the order:  $\delta$ -tocopherol (54%),  $\gamma$ -tocotrienol (53%),  $\gamma$ -tocopherol (46%),  $\alpha$ -tocopherol (40%) and  $\alpha$ -tocotrienol (36%) and bioaccessibility of total grain tocopherols ranged from 27 to 87%. The content of released tocopherols in the tested hybrids increased with the increase of their content in the grain ( $P < 0.001$ ), however, bioaccessibility decreased ( $P < 0.001$ ), indicating that the efficiency of tocopherol release from the grain matrix and their micellization decreased the higher the grain tocopherol content was. Despite the recorded variable values of bioaccessibility, the obtained results indicate that only about half of the tocopherols present in the grain is available for absorption by the animal.

**Key words:** vitamin E, laying hens, maize hybrids, digestibility, bioaccessibility

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**Voćarstvo,  
Vinogradarstvo  
i vinarstvo**

**08**

**Viticulture,  
Enology and  
Pomology**





## Potencijal proizvodnje biogljenâ iz ostataka rezidbe vinove loze

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### Sažetak

U kontekstu klimatskih promjena, vinova loza i njen uzgoj imaju značajnu ulogu na globalno zagađenje kroz emisiju stakleničkih plinova. Razlog tome jest činjenica što se u proizvodnji mogu pronaći različiti načini postupanja s ostacima rezidbe, poput spaljivanja ili usitnjavanja i malčiranja. Kako bi se riješio taj problem, posljednjih se godina proizvodnja i uporaba biogljenâ od ostataka rezidbe intenzivno istražuje. U ovom istraživanju analizirani su ostaci rezidbe autohtone sorte 'Malvazija istarska', uzgojene na podlogama 420A i SO4 te su isti korišteni za proizvodnju biogljenâ. Analize hraniva u uzorcima ostataka rezidbe i biogljenâ provedene su korištenjem ICP-OES tehnike nakon obavljene mikrovalne digestije. Temeljem dobivenih rezultata, možemo zaključiti da je proizvedeni biogljen hranivima bogat materijal koji je moguće primijeniti kao poboljšivač tla. Količina pojedinih elemenata u proizvedenom biogljenâ bila je različita u odnosu na ishodišni materijal, te je uočena razlika temeljem istraživanih podloga na kojima se uzgaja 'Malvazija istarska'. Predložena metoda pretvorbe ostataka rezidbe u biogljen predstavlja kvalitetan način za smanjenje negativnog utjecaja vinogradarstva na klimatske promjene.

**Ključne riječi:** ostaci rezidbe, biogljen, podloge, ishrana vinove loze

## Potential of grapevine pruning residues for biochar production

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### Summary

In the context of climate change, grapevine with its production have major effect on global pollution through greenhouse gasses. The reason is fact that in the production can be found several pruning waste management practices like burning or chipping and mulching. To solve that problem, in last years production and use of biochar from pruning residues has been intensively researched. In this work pruning residues of indigenous variety 'Istrian Malvasia' grafted on 420A and SO4 rootstocks were analyzed and used for biochar production. Pruning wood and biochar samples were analyzed using ICP-OES technique after microwave digestion. Based on the obtained results, we can conclude that produced biochar is a nutrient rich material which can be used as soil amendment. The amount of individual elements in the produced biochar changed in relation to pruning residues. Differences were also spotted depending on the rootstock on which is grafted 'Istrian Malvasia'. The proposed method for pruning residues conversion to biochar presents an effective method to reduce negative viticulture impact on climate change.

**Key words:** pruning residues, biochar, rootstock, grapevine nutrition

## An importance of the artificial reference material in the olive oil sensory analysis: a review of OLEUM project results

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### Summary

Virgin olive oil (VOO) is highly appreciated due to its exceptional sensory characteristics. During the VOO sensory analysis (panel test), oils are classified into quality categories based on the intensity of the predominant defect and the fruity attribute. The use of reference materials (RM) for VOO sensory evaluation is a fundamental tool to ensure the effectiveness of the panel test performance. For that purpose RM from natural matrix are commonly used, however there are some limitations regarding limited amounts available and low homogeneity. Therefore, the setting up of artificial and reproducible RMs in order to increase the proficiency of the sensory panels was one of the objectives of the H2020 OLEUM project. In this review, the process of development and validation of two artificial RMs, for the winey-vinegary and rancid defect, are summarized. During the validation, representativeness, the panels' detection threshold for RMs, and shelf-life of RMs were evaluated. The utilization of proposed artificial RMs could improve the effectiveness of the method by offering advantages as reproducibility over time and unlimited availability. Further studies, involving formulation of RMs for other specific VOO sensory attributes, are of great importance. This work was developed in the context of the project OLEUM "Advanced solutions for assuring authenticity and quality of olive oil at global scale" funded by the European Commission within the Horizon 2020 Programme (2014–2020, GA no. 635690).

**Key words:** virgin olive oil, sensory analysis, Panel test, reference material

## Utjecaj reflektirajuće folije na razvoj i intenzitet boje te internu kvalitetu plodova jabuke cv. Gala Must

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### Sažetak

Istraživanje s ciljem utvrđivanja utjecaja reflektivnog mulcha na poboljšanje i očuvanje interne kvalitete jabuke cv. Gala Must u pre- i post-harvest periodu provedeno je 2020. godine (Istočna Hrvatska) u pokusnom nasadu jabuka. Sorta je cijepljenja na podlogu M9, uzgojnog oblika vitko vreteno s gustoćom sklopa 0,9 x 3,2 m. Pokus je postavljen po split-plot metodi (4 repeticije po 6 stabala). Tretmani su uključivali stabla ispod kojih je postavljena reflektirajuća folija i kontrolni tretman. Tretman folijom je postavljen 20 dana prije očekivane tehnološke zriobe plodova. Tijekom istraživanja svakodnevno je mjerena refleksija svjetlosti na tretmanima uz pomoć Lux metra, u jutarnjem i večernjem terminu, na visini prve i treće žice. Po berbi obavljena su pomološka mjerenja (promjer, visina, masa, tvrdoća, Brix i JŠI), intenzitet obojenosti plodova chromametrom po CIE L\*a\*b\* sustavu te mjerenja internih pokazatelja kvalitete plodova (antocijani, polifenoli i vitamin C). Navedeni pomološki parametri mjereni su u 3 roka berbe te je nakon 3 mjeseca skladištenja (hladnjača s kontroliranom atmosferom) ponovljena analiza internih pokazatelja. Disperzija svjetlosti unutar krošnje na prvoj i trećoj žici bila je značajno veća pri tretmanu s folijom na obje strane reda. Plodovi pod reflektirajućom folijom u svim rokovima berbe i svim smjerovima redova bili su tamniji i s više crvene, odnosno manje žute boje prema CIE L\*a\*b\* sustavu (saturiraniji bojom); niži L\* i b\*. Tretman s folijom rezultirao je značajno većom visinom plodova, većim promjerom i JŠI, dok je u trećem roku berbe sadržaj Brix bio značajniji u prosjeku za obje strane reda. Nije bilo značajne razlike u masi plodova. Sadržaj antocijana na tretmanu s folijom bio je značajno veći u prosjeku za obje strane reda i sve rokove berbe. Koncentracija vitamina C i antocijana bila je najznačajnija u trećem roku berbe, a fenola u prvom roku berbe. Nakon 3 mjeseca skladištenja nije zabilježeno opadanja koncentracije vitamina C i fenola između primijenjenih tretmana, jedino je koncentracija antocijana ostala značajno veća na plodovima pod tretmanom s folijom. Dobiveni rezultati istraživanja upućuju na veliki potencijal reflektirajuće folije u dostizanju, odnosno povećanju dopunske boje i interne kvalitete plodova. Standardiziranje ove dopunske pomotehničke mjere nameće se kao kvalitativno rješenje u prevladavanju nepovoljnih klimatskih prilika u periodu dozrijevanja.

**Ključne riječi:** jabuka, reflektirajuća folija, boja, kvaliteta

## Influence of reflective mulch foil on the development and intensity of color and internal quality of apple fruits cv. Gala Must

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### Summary

The research with the aim of determine impact on the influence of reflective mulch foil to improve and preserve the internal quality of apple cv. Gala Must in the pre- and post-harvest period was conducted in 2020 in an experimental apple orchard (Eastern Croatia). The variety is grafted on a rootstock M9, growing form slender spindle with a density 0.9 x 3.2 m. The experiment was set up by the split-plot method (4 repetitions of 6 trees). Treatments included the trees beneath which is set reflective mulch foil and control treatment. The foil treatment was set up 20 days before technological ripeness of fruits. During the research, light reflection was measured daily in the morning and evening with the Lux meter, at the height of the first and third wires. Pomological measurements were performed after harvest (diameter, height, weight, firmness, °Brix and Iodine–starch test), fruit color intensity according to Chroma meter (CIE L\*a\* b\* system) and internal indicators of fruit quality (anthocyanin, polyphenols and vitamin C). These pomological parameters were measured in 3 harvest periods and after 3 months of storage (CA storage) the analysis of internal indicators was repeated. The dispersion of light within the canopy on the first and third wires was significantly higher on the reflective foil treatment on both sides of the row. Fruits under reflective foil in all harvest periods and in all directions of the rows were darker and with more red or less yellow color according to the CIE L\*a\*b\* system (more saturated in color); lower L\* and b\*. The treatment with reflective foil resulted in significantly higher fruit height, larger diameter and Iodine–starch test, while in the third harvest period the °Brix content was more significant for both sides of the row. There was no significant difference in fruit weight. The anthocyanin content on the reflective foil treatment was significantly higher for both sides of the row and all harvest dates. The concentration of vitamin C and anthocyanin was most significant in the third harvest period, and phenols content in the first harvest period. After 3 months of storage were not recorded declining levels of vitamin C and phenols between the applied treatments, only the anthocyanin concentration remained significantly higher on the fruits under the reflective foil treatment. The obtained research results indicate a great potential of the reflective mulch foil in reaching, i.e. increasing the complementary color and internal quality of the fruit. Standardizing these additional pomotechnical measures imposed as a qualitative solution to overcome the unfavorable weather conditions during the period of maturation.

**Key words:** apple, reflective mulch foil, color, quality

## Proizvodnja voćnog i loznog poljoprivrednog sadnog materijala u Republici Hrvatskoj

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### Sažetak

Odjel za rasadničarstvo, Centra za sjemenarstvo i rasadničarstvo, Hrvatske agencije za poljoprivredu i hranu obavlja poslove stručnog nadzora nad proizvodnjom voćnog i loznog sadnog materijala. Stručni nadzor započinje zaprimanjem i obradom prijave za stručni nadzor. U Odjelu se provodi provjera prateće dokumentacije uz prijave, usklađenosti sa zakonskim propisima i vođenje evidencije, unos podataka iz prijave u bazu podataka, komunikacija sa rasadničarima u svrhu dopunjavanja dokumentacije. Nakon obrade prijave u odjelu se organizira, koordinira, raspoređuje i provodi stručni nadzor nad prijavljenom proizvodnjom na terenu. Proizvodnju voćnog i loznog poljoprivrednog sadnog materijala u 2020. godini za stručni nadzor Centru za sjemenarstvo i rasadničarstvo prijavilo je 50 voćnih rasadnika i 12 loznih rasadnika. Ukupno je prijavljeno 4.016.642 voćnih sadnica i 1.931.749 loznih cijepova, što je na razini proizvodnje kao i prethodne, 2019. godine. Ukupno je u proizvodnji 35 voćnih vrsta i 72 sorte vinove loze. U strukturi proizvodnje prijavljenih voćnih sadnica najviše su zastupljeni lijeska sa 40 % i jabuka sa 21 %, a zatim maslina (5 %), šljiva (4 %), trešnja (3,50 %), agrumi (3 %), kruška (2,50 %) itd. Od ukupne prijavljene količine voćnih sadnica 8 % su sadnice certificirane kategorije, dok je od ukupne prijavljene količine loznih cijepova certificiranih 52 %. Najzastupljenije vinske sorte vinove loze u proizvodnji su Graševina (26 %), Plavac mali (7 %), Sauvignon bijeli (4 %) itd.

**Ključne riječi:** sadni materijal, voćne sadnice, lozni cijepovi

## Production of fruit and vine agricultural planting material in Republic of Croatia

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### Summary

Department for Seedlings established at the Center for Seed and Seedlings, of the Croatian Agency for Agriculture and Food performs quality controls over the production of fruit and vine planting material. Supervision begins by receiving and processing applications for professional supervision. The Department checks the accompanying documentation with applications, compliance with legal regulations, entering data from applications into the database, communication with nurseries in order to supplement the documentation, than organizes, coordinates, schedules and conducts professional supervision over the reported production in the field. The production of fruit and vine planting material in 2020 was reported by 50 fruit and 12 vine nurseries. A total of 4.016.642 of fruit plants, and 1.931.749 of vine plants have been reported, which represents a similar fruit and vine planting material production as it was in 2019. The total of reported applications for professional supervision includes 35 fruit species and 72 varieties of grapevine. In the structure of reported fruit plants production, the most represented fruit varieties are hazelnuts with 40% and apples with 21%, followed by olives (5%), plums (4%) sweet cherries (3.50%), citrus fruits (3%), pears (2.50%), etc. Of the total reported amounts of fruit plants 8% of the plants are category “certified”, while the total reported quantities of “certified” vine plants is 52%. The most represented vine grape varieties in production are Graševina (26%), Plavac mali (7%), Sauvignon Blanc (4%) etc.

**Key words:** planting material, fruit plants, vine plants



## Evaluacija kemijskog sastava i trendovi na tržištu desertnih i predikatnih vina u RH

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### Sažetak

Proizvodnja grožđa i vina u Republici Hrvatskoj tradicionalno je zastupljena i u primorskom i u kontinentalnom dijelu Hrvatske. Predikatna i desertna vina, kao zasebne kategorije vina koje se dobivaju preradom i vinifikacijom zrelog, prezrelog i prosušenog grožđa, zemljopisno, tradicijski i zakonski su vezana uz područje uzgoja. Predikatna vina uz kontinentalni, a desertna uz primorski dio Hrvatske. Predikatna vina su isključivo vrhunska vina koja u dobrim godinama i prikladnim uvjetima dozrijevanja grožđa na trsu, a ovisno o postignutom stupnju zrelosti grožđa te vremenu berbe i prerade, postižu posebnu kakvoću. Sukladno zakonskim propisima moraju biti proizvedena od grožđa preporučenih kultivara vinove loze za pojedino vinorodno područje. Kategorije predikatnih vina u Hrvatskoj su: kasna berba, izborna berba, izborna berba bobica, izborna berba prosušenih bobica te ledeno vino. Predikatna vina su uvrštena u proizvodne specifikacije zaštićenih oznaka izvornosti na području kontinentalne Hrvatske. Desertna vina dobivena posebnim načinom prerade prezrelog ili prosušenog grožđa, također su uvrštena u proizvodne specifikacije zaštićenih oznaka izvornosti na području Primorske Hrvatske i za razliku od predikatnih mogu nositi tradicionalne izraze „vrhunsko vino KZP“, odnosno „kvalitetno vino KZP“. U ovom radu je prikazan pregled proizvodnje i prometa predikatnih i desertnih vina u Republici Hrvatskoj kroz desetgodišnje razdoblje (2010. - 2020.). Podatci su iskazani s obzirom na količine predikatnih i desertnih vina u prometu, kategorije vina, sortnu zastupljenost, regionalnu zastupljenost te specifičnosti vezane uz fizikalno kemijski sastav i senzorno ispitivanje. Analizirane su količine i kategorije predikatnih i desertnih vina stavljene u promet međusobno i unutar promatranih godina, kao i klimatski uvjeti u godinama berbe.

**Ključne riječi:** predikatna vina, desertna vina, tržište vina, kakvoća, fizikalno kemijski sastav

## Evaluation of chemical composition and trends on the market of dessert and predicate wines in the Republic of Croatia

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### Summary

Predicate and dessert wines, as separate categories of wines obtained by processing and vinification of ripe, overripe and dried grapes are geographically, traditionally and legally related to the area of cultivation, predicate to the continental and dessert wines to littoral Croatia. Predicate wines are exclusively top wines that in good years and suitable conditions for dosing grapes on the vine, regardless of the degree of ripeness of grapes and the time of harvesting and processing, achieve special quality. In accordance with legal regulations, they must be produced from grapes of recommended grapevine cultivars for a particular wine-growing area. Categories of the predicate wines in Croatia are: late harvest, selected harvest, selected harvest of berries, selected harvest of dry berries and the ice wine. Predicate wines are included in the Protected Designations of Origin in the area of continental Croatia. Dessert wines are obtained by a special way of processing overripe or dried grapes, they are also determined in the specifications of protected designations of origin in the area of littoral Croatia and, unlike predicate, the traditional expressions „vrhunsko vino KZP“, ie „kvalitetno vino KZP“ can be used. This paper will give an overview of the production and trade of the predicate and dessert wines in Croatia through the ten-year period from year 2010 to 2020 (source: database of, Viticulture, Enology and Edible Oils Analysis). The data is reported with regard to the quantity of the produced and marketed dessert and predicate wines, varietal and regional representation and specifics related to physical and chemical composition and sensory testing of dessert and predicate wines. Results represent an analysis of the quantities and categories of dessert and predicate wines placed on the market as well as the influence of the climate conditions in the harvest years.

**Key words:** predicate wines, dessert wines, trading, quality, physical and chemical composition

## Različiti fenolni odgovor na folijarnu primjenu K-silikata u lišću dvaju kultivara masline (*Olea europaea* L.)

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### Sažetak

Znatne kvantitativne varijacije fenolnih spojeva sadržanih u lišću masline rezultat su kontinuiranih prilagodbi na brojne biotske i abiotske čimbenike. Primjenom različitih hraniva moguće je stimulirati njihovu sintezu te podići razinu spremnosti masline na nepovoljne uvjete. Cilj ovog istraživanja bio je utvrditi utjecaj folijarne primjene K-silikata na sadržaj ukupnih fenola mladog i starog lišća kultivara 'Istarska bjelica' i 'Leccino'. Pokus je postavljen na jednogodišnjim mladima po shemi slučajnog bloknoeg rasporeda u 6 ponavljanja. Obavljena su 3 tretiranja u razmaku od 15 dana s početkom 13. lipnja. Prvo uzorkovanje lišća obavljeno je 15, a drugo 90 dana od zadnjeg tretiranja. Primjena K-silikata utjecala je na sadržaj fenola starog lišća kultivara 'Leccino' pri čemu su vrijednosti tretiranog lišća bile značajno veće (5134,36 mg/100 g suhe tvari, ST) u odnosu na netretirano (3972,85 mg/100 g ST). Istovremeno nije zabilježen sličan učinak K-silikata na sadržaj fenola kultivara 'Istarska bjelica', premda se razine usvojenog silicija (Si) u lišću nisu značajno razlikovale među kultivarima. Tijekom drugog uzorkovanja također nije zabilježena razlika među kultivarima u sadržaju Si, a utjecaj K-silikata na ukupne fenole ponovno je zabilježen isključivo kod 'Leccino' kultivara (6522,05 mg/100 g ST). Rezultati ukazuju na izraženu sortnu varijabilnost u utjecaju K-silikata na sadržaj ukupnih fenola kao i na povoljan utjecaj Si na njihovu akumulaciju kod 'Leccino' kultivara.

**Ključne riječi:** folijarna ishrana, ukupni fenoli, 'Istarska bjelica', 'Leccino', silicij

Ovaj je rad sufinancirala Hrvatska zaklada za znanost projektom "Bilinogojstvom do sekundarnih biljnih metabolita: primjena mineralnih hraniva i elicitora za povećanje koncentracije fenola u listu masline,, (UIP-2017-05-8464; PhytoFarmOL) i putem „Projekta razvoja karijera mladih istraživača – izobrazba novih doktora znanosti, doktoranda Marina Cukrova (DOK-2020-01-3872).

## Different phenolic response to foliar application of K-silicate on leaves of two olive (*Olea europaea* L.) cultivars

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### Summary

Variations in olive leaf phenolic compounds are a result of continuous adaptations to biotic and abiotic stressors. By application of certain nutrients it is possible to stimulate their synthesis and augment olive fitness to unfavorable conditions. The aim of this trial was to determine the effects of K-silicate foliar application on total phenolic content in young and old leaves of two olive cultivars (cv. 'Istarska bjelica' and 'Leccino'). Experiment was conducted as a randomized block design in 6 repetitions on young olive plantlets. Treatments were applied in intervals of 15 days, beginning from June 13<sup>th</sup>. First sampling was carried 15, and second 90 days from the last application. Application of K-silicate significantly affected phenolic content in older leaves of cv. 'Leccino', showing higher values in treated (5134.36 mg/100 g dry weight, DW) than non-treated leaves (3972.85 mg/100 g DW). Similar effect of K-silicate on total phenolic content was not recorded in leaves of cv. 'Istarska bjelica', despite the similarity in silicon (Si) leaf content. No differences between cultivars regarding Si leaf content were recorded during the second sampling period. However, K-silicate treatments again affected only leaves of cv. 'Leccino' which showed highest phenolic content (6522.05 mg/100 g DW). Results appoint to distinct cultivar variability in leaf phenolic content under K-silicate treatments, and to the favorable effects of silicon on their accumulation in cv. 'Leccino'.

**Key words:** foliar nutrition, total phenols, 'Istarska bjelica', 'Leccino', silicon

This work has been supported in part by Croatian Science Foundation under the project "Phytochemical Farming: Mineral Nutrients and Elicitors Application to Enhance Olive Leaf Phenolics" (UIP-2017-05-8464). The work of doctoral student Marin Cukrov has been supported in part by the "Young researchers' career development project-training of doctoral students" under the Croatian Science Foundation project (DOK-2020-01-3872).

## Mogućnost korištenja ostataka rezidbe vinove loze kao alat za planiranje gnojidbe vinograda

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### Sažetak

Metodom analize biljnog tkiva dobivamo uvid u količinu biogenih elemenata u različitim biljkama, pa tako i vinovoj lozi. List, peteljka ili bobica standardno se koriste kao tkivo za dijagnosticanje statusa ishranjenosti vinograda. Vinogradari svake godine provode ampelotehničku mjeru rezidbe pri čemu uklanjaju prošlogodišnje rodne izdanke te na taj način pripremaju vinograd za iduću vegetacijsku sezonu. Upravo takvi ostaci rezidbe prikupljeni su u fenofazi mirovanja 2020. godine na priobalnom području Hrvatske. Istraživanje je provedeno na ostacima rezidbe vinove loze i uzorcima tla uzetih iz vinograda s ciljem utvrđivanja količine hraniva u istima te poveznice između ta dva čimbenika. Samo istraživanje provedeno je na dvije autohtone sorte (Maraština i Plavina) i jednoj međunarodnoj sorti (Syrah). Uzorci tla uzeti su u zoni razvoja korijena vinove loze. Određivanje količine hraniva u uzorcima rozgve i tla provedena je korištenjem ICP-OES tehnike nakon obavljene mikrovalne digestije. Dobiveni rezultati ukazuju na činjenicu da analiza ostataka rezidbe vinove loze predstavlja kvalitetan alat za utvrđivanje statusa ishranjenosti vinove loze i planiranje gnojidbe vinograda. Međutim, potrebna su višegodišnja istraživanja na različitim sortama i lokacijama kako bi se definirale referentne vrijednosti pojedinih elemenata.

**Ključne riječi:** gnojidba, rezidba, rozgva, tlo, hraniva

## Vine pruning residues as a tool for planning vineyard fertilization

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### Summary

Tissue nutrient tests are used commonly to understand the nutritional status of many crop plants including grapevines. Leaf blades, petioles or berries are the standard tissues to diagnose nutrition of vineyards. Grape growers each winter remove last year's fruiting shoots to prepare the vines for the upcoming growing season. Grapevine dormant stems collected in winter of 2020 on coastal area of Croatia were collected. The research of grapevine dormant stems and soil samples taken from the vineyards had a goal to determine nutrient status and connection between these two factors. Research was carried out on two indigenous varieties (Maraština, Plavina) and one introduced international variety (Syrah). Soil samples were taken in the root-developing zone. To determine nutrient content in stem and soil samples ICP-OES technique was used after microwave digestion was used. Results indicate the fact that the analysis of grapevine pruning residues is an effective tool for determining grapevine nutritional status and planning vineyard fertilization. However, further research is required on different varieties and locations to define the reference values of individual elements.

**Key words:** grapevine, pruning, dormant stems, soil, nutrient

## Pojavnost virusa u autohtonim dalmatinskim sortama vinove loze

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### Sažetak

Zaraženost vinove loze virusima predstavlja limitirajući faktor u proizvodnji grožđa i vina. Spoznaje o štetnom djelovanju virusa na samu biljku i na kvalitetu grožđa naglašavaju važnost kontrole ovih patogena te primjene kvalitetnog bezvirusnog sadnog materijala. U ovom radu testirano je 16 autohtonih sorti vinove loze na prisutnost 10 ekonomski važnih virusa: Virusna lepezastog lista vinove loze (GFLV), Virusna mozaika gušarke (ArMV), Virusna uvijenosti lista vinove loze -1, -2 i -3 (GLRaV-1, GLRaV-2 i GLRaV-3), Virusna A- i B- vinove loze (GVA, GVB), Virusna pjegavosti vinove loze (GFkV), Rupestris stem-pitting virusa (RSPaV) i Virusna Pinota sivoga (GPGV). Ukupno je analiziran 101 trs primjenom dvije dijagnostičke metode: ELISA (*Enzyme linked immunosorbent assay*) te RT-PCR (*Reverse transcription-polimerase chain reaction*). Nije utvrđena nijedna loza bez virusa. Najveća pojava zabilježena je kod GLRaV-3 (91,09 %) i GVA (82,18 %), a slijedili su RSPaV (67,33 %), GPGV (54,46 %) i GLRaV-1 (40,59 %). Pojava ostalih virusa bila je redom: GFkV (16,81 %), GLRaV-2 (13,86 %), GFLV (11,89 %), GVB (10,89 %) i ArMV (8,91 %). Najviše trsova imalo je barem 4 virusa (28,71 %). Nešto manje bilo ih je s 5 (25,74 %) i 3 virusa (16,83 %), dok je najmanja zastupljenost bila onih trsova sa 7 virusa (0,99 %). Visoka pojava virusa u promatranoj populaciji i nedostatak adekvatnog programa mjera suzbijanja i kontrole patogena doprinijet će daljnjem širenju virusa u dalmatinskim autohtonim sortama vinove loze.

**Ključne riječi:** vinova loza, autohtone sorte, virusi, ELISA, RT-PCR

## Presence of viruses in Dalmatian indigenous grapevine varieties

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### Summary

Presence of viruses and their damaging effects on grapevine host plants emphasise the importance of pathogen control and using of virus-free plant material. In this study 16 indigenous Dalmatian varieties were tested for the presence of 10 economically important viruses: *Grapevine fanleaf virus* (GFLV), *Arabidopsis mosaic virus* (ArMV), *Grapevine leafroll-associated virus -1, -2 i -3* (GLRaV-1, GLRaV-2 and GLRaV-3), *Grapevine virus A and B* (GVA, GVB), *Grapevine fleck virus* (GFkV), *Rupestris stem-pitting virus* (RSPaV) and *Grapevine pinot gris virus* (GPGV). In total 101 plants were tested using two diagnostic methods: ELISA (*Enzyme linked immunosorbent assay*) and RT-PCR (*Reverse transcription-polymerase chain reaction*). Not a single plant was found virus-free. The most common viruses detected were GLRaV-3 (91.09%), GVA (82.18%), RSPaV (67.33%), GPGV (54.46%) and GLRaV-1 (40.59%). Incidence of other viruses was smaller, as following: GFkV (16.81%), GLRaV-2 (13.86%), GFLV (11.89%), GVB (10.89%) and ArMV (8.91%). Coinfections with more viruses were the most common; largest number of vines were infected with at least 4 (28.71%) and 5 viruses (25.74%), following with those with 3 viruses (16.83%). The lowest prevalence was coinfection with 7 viruses (0.99%) in vines tested. High occurrence of viral infections and lack of a proper certification scheme will contribute to further virus expansion in Dalmatian indigenous varieties.

**Key words:** grapevine, indigenous varieties, viruses, ELISA, RT-PCR



## Pomološka svojstva jesensko-zimskih sorata jabuke uzgajanih na pokušalištu Šašincev

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### Sažetak

Jabuka je voćka rasprostranjena na gotovo svim kontinentima. Divlja jabuka (*Malus sieversii*), koja potječe iz centralne Azije, te šumska jabuka (*Malus silvestris*), koja potječe iz Europe navode se kao glavni donori gena koji su doveli do nastajanja današnje jabuke. Cilj ovog rada je utvrditi pomološka svojstva 13 jesensko-zimskih sorata/genotipova jabuke iz kolekcije Nacionalne banke biljnih gena na pokušalištu Šašincev. Promatrane su sorte: 'Brutnika', 'Calville Madame Lesans', 'Citronka', 'Kraljevčica', 'Majdofija', 'Paradija', 'Paradija 2', 'Petrovnjača', 'Rjavka', 'Slastica', 'Voštanka', 'Wagener', 'Zuccalmalgios Renette'. Plodovi svake sorte jabuke opisani su prema UPOV-u (International Union for the Protection of New Varieties of Plants) deskriptoru za jabuku ta su provedene fizikalno-kemijske analize plodova. Utvrđeno je kako sorta 'Petrovnjača' ima najniži indeks oblika (0,67), dok 'Paradija' i 'Paradija 2' imaju najveći (0,98 i 0,93). Sorta 'Rjavka' ima najveću masu (208,09 g) dok sorta 'Slastica' ima najmanju masu (89,67 g). Najveću tvrdoću imale su sorte 'Brutnika' i 'Majdofija' (9,31 i 9,46 kg/cm<sup>2</sup>), a najmanju sorta 'Slastica' (2,69 kg/cm<sup>2</sup>). Najveću količinu topljive suhe tvari ima sorta 'Brutnika' (21,2 %), dok najmanju količinu topljive suhe tvari ima sorta 'Calville Madame Lesans' (13,57 %). Najveću količinu ukupnih kiselina ima sorta 'Wagener' (0,92 %), a najmanju količinu imaju sorta 'Paradija', 'Paradija 2' i 'Calville Madame Lesans' (0,29, 0,29 i 0,3 %).

**Ključne riječi:** jabuka, sorte, pomološka svojstva

## Pomological properties of autumn-winter apple cultivars grown at the Šašincev experimental station

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### Summary

The apple is a fruit species spread on almost all continents. The wild apple (*Malus sieversii*), which originates from Central Asia, and the forest apple (*Malus silvestris*), which originates from Europe, are listed as the main donors of the genes that led to the formation of today's apple. The aim of this study was to determine the pomological properties of 13 autumn-winter apple cultivars/genotypes from the collection of the National Bank of Plant Genes at the Šašincev experimental station. The following varieties were observed: 'Brutnika', 'Calville Madame Lesans', 'Citronka', 'Kraljevčica', 'Majdofija', 'Paradija', 'Paradija 2', 'Petrovnjača', 'Rjavka', 'Slastica', 'Voštanka', 'Wagener', 'Zuccalmalgios Renette'. The fruits of each apple variety were described according to the UPOV (International Union for the Protection of New Varieties of Plants) descriptor for apples, and physico-chemical analyzes of the fruits were performed. It was found that the variety 'Petrovnjača' has the lowest shape index (0.67), while 'Paradija' and 'Paradija 2' have the highest (0.98 and 0.93). The variety 'Rjavka' has the highest weight (208.09 g) while the variety 'Slastica' has the lowest weight (89.67 g). The cultivars 'Brutnika' and 'Majdofija' had the highest hardness (9.31 and 9.46 kg/cm<sup>2</sup>), and the lowest cultivars 'Slastica' (2.69 kg/cm<sup>2</sup>). The 'Brutnika' variety has the highest amount of soluble dry matter (21.2%), while the 'Calville Madame Lesans' variety has the lowest amount of soluble dry matter (13.57%). The highest amount of total acids has the variety 'Wagener' (0.92%), and the lowest amount have the varieties 'Paradija', 'Paradija 2' and 'Calville Madame Lesans' (0.29, 0.29 and 0.3%).

**Key words:** apple, cultivars, pomological properties

## Utjecaj gnojidbe borom na koncentracije oleuropeina i verbaskozida u listu masline (*Olea europaea* L.)

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### Sažetak

Bor (B) je esencijalni biogeni element, neophodan za rast i razvoj masline, a oleuropein i verbaskozid dominantni su spojevi u listu masline značajni za zaštitu masline od različitih patogena. Iako je poznato da nedostatak B značajno utječe na povećanje koncentracije fenolnih spojeva, učinak primjene viših koncentracija B na fenolni profil lista masline nedovoljno je istražen. Stoga, cilj ovog istraživanja bio je utvrditi utjecaj različitih koncentracija B u hranivoj otopini na koncentracije oleuropeina i verbaskozida u listu masline. Istraživanje je provedeno na jednogodišnjim sadnicama masline sorte 'Istarska bjelica' po shemi slučajnog bloknoeg rasporeda s tri gnojidbena tretmana (B0, B3, B5) u četiri ponavljanja. Tijekom 240 dana biljke su prihranjivane s različitim koncentracijama B u modificiranoj Hoaglandovoj otopini (B0 (0 μM B), B3 (200 μM B), B5 (800 μM B)). Koncentracije oleuropeina i B u listu masline značajno su se razlikovale između gnojidbenih tretmana (B5>B3>B0). Tretman B0 značajno je povećao koncentraciju verbaskozida u odnosu na tretman B3, dok u odnosu na tretman B5 nisu utvrđene statistički značajne razlike. Pritom je koncentracija B u listu masline tretmana B5 (96 mg/kg ST) bila viša, a koncentracija B u tretmanu B0 (3 mg/kg ST) niža, od optimalne koncentracije B u listu masline tretmana B3 (20 mg/kg ST). Značajne razlike u koncentraciji oleuropeina i verbaskozida u listu sorte 'Istarska bjelica' mogu se povezati s ulogom B u biosintezi fenolnih spojeva.

**Ključne riječi:** borna kiselina, fenolni profil, hraniva otopina, Istarska bjelica, ukupni fenoli

Ovaj je rad sufinancirala Hrvatska zaklada za znanost projektom „Bilinogojstvom do sekundarnih biljnih metabolita: primjena mineralnih hraniva i elicitora za povećanje koncentracije fenola u listu masline“ (UIP-2017-05-8464, PhytoFarmOL). Rad doktorandice Kristine Grozić sufinanciran je iz „Projekta razvoja karijera mladih istraživača – izobrazba novih doktora znanosti“ Hrvatske zaklade za znanost, DOK-2018-09-1841.

## The effect of boron fertilization on oleuropein and verbascoside concentrations in olive (*Olea europaea* L.) leaf

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### Summary

Boron (B) is an essential element fundamental for olive growth and development, whereas oleuropein and verbascoside are predominant compounds in olive leaves significant in olive protection against pathogens. Even if B deficiency can significantly affect the increase of phenolic profile, the effect of higher B concentrations remains mainly unknown. Therefore, this study aimed to investigate the impact of different concentrations of B, in the nutrient solution, on the concentration of oleuropein and verbascoside in olive leaf. This study was conducted on one-year-old seedlings of variety 'Istarska bjelica' in random block design with three fertilization treatments (B0, B3, B5) and four replications. During 240 days different concentrations of B were applied in modified Hoagland solution (B0 (0 µM B), B3 (200 µM B), B5 (800 µM B)). The concentrations of oleuropein and B in olive leaf were significantly different between the treatments (B5>B3>B0). Treatment B0 had significantly higher verbascoside concentration compared to B3, whereas no statistically significant difference was found when compared to B5. The concentration of B in the olive leaf of B5 (96 mg/kg DW) was higher, whereas the concentration of B in B0 (3 mg/kg DW) was lower than the optimal B leaf concentration in B3 (20 mg/kg DW). Significant differences in the concentrations of oleuropein and verbascoside in the leaf cultivar 'Istarska bjelica' can be related to the role of B in the biosynthesis of phenolic compounds.

**Key words:** boric acid, phenolic profile, nutrient solution, Istarska bjelica, total phenol content

This work has been supported in part by Croatian Science Foundation under the project “Phytochemical Farming: Mineral Nutrients and Elicitors Application to Enhance Olive Leaf Phenolics” (UIP-2017-05-8464). The work of doctoral student Kristina Grozić has been supported in part by the “Young researchers’ career development project–training of doctoral students” under the Croatian Science Foundation project DOK-2018-09-1841.

## Improving the quality of Slovenian wines produced by smaller winegrowers

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### Summary

Slovenia is characterized by a large fragmentation of vineyards. The average area of vineyards per producer is 0.53 ha. Of the 30,000 growers enrolled in the Register of Grape and Wine Growers-RPGV, 90% are those who cultivate a vineyard up to 1 hectare in size. Smaller winegrowers and winemakers are connected in associations, 90 of them are registered in Slovenia. Among the most important professional activities are wine evaluations, which have been carried out since 1987. The largest number of associations operates in the wine-growing region of Podravje, which is the largest in Slovenia in terms of vineyards. The article presents data on the actual areas of vineyards in Slovenia as well as data on the areas entered in the RPGV. The actual area of vineyards is about 3000 ha larger than the area entered in the RPGV. This difference is due to the fact that many smaller vine growers did not register in the RPGV. The quality of wines produced by smaller winegrowers has improved significantly in recent decades. The article presents data on the number of assessed samples and average scores of wines produced by small winegrowers in the Podravje wine-growing region. From 1988 to 2016 inclusive, 95,343 wine samples were evaluated. The wines were evaluated according to the 20-point Buxbaum evaluation method. In 1988, the average score was 16.35 points, and in 2016 it was 18.10.

**Key words:** viticulture, wine, quality, evaluation

## Inhibition of $\alpha$ -amylase by polyphenols present in the peel of traditional, indigenous apple varieties

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### Summary

The aim of this work was to evaluate polyphenols from the peel of two traditional apple varieties as  $\alpha$ -amylase inhibitors. The extraction of polyphenols from the peel of two traditional apple varieties (Citronka and Kolačara) was conducted using 80% methanol as a solvent with the help of an ultrasonic bath. The main polyphenol subgroups (dihydrochalcones, flavanols, flavonols, and phenolic acids) found in extracts were separated using gel chromatography. Three fractions were collected for each apple variety and analyzed using reversed-phase high-performance liquid chromatography (RP-HPLC). The  $\alpha$ -amylase activity was evaluated based on the spectrophotometric determination of maltose released from starch by the action of the enzyme. To inhibit enzyme activity, various concentrations of fractions were added to the reaction mixture.  $IC_{50}$  values were calculated (concentration of polyphenols that gives 50% inhibition). Fraction 1 was mainly composed of flavanols (94% and 100%), fraction 2 was rich in dihydrochalcones and phenolic acids (69% and 54%) while fraction 3 was predominantly made of flavonols (92% and 64%) for Citronka and Kolačara, respectively. All the fractions showed inhibition capacity with  $IC_{50}$  values ranging from 0.54  $\mu\text{g/mL}$  (fraction 1 of Citronka) to 40.01  $\mu\text{g/mL}$  (fraction 3 of Citronka). The results suggest that polyphenols from the peel of traditional, indigenous apple varieties are potent inhibitors of  $\alpha$ -amylase activity.

**Key words:** apple varieties, traditional, inhibition,  $\alpha$ -amylase

## Rezultati praćenja američkog cvrčka (*Scaphoideus titanus* Ball, 1932) u vinogradima u Hrvatskoj (2018.-2020.)

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### Sažetak

Američki cvrčak (*Scaphoideus titanus* Ball, 1932) najznačajniji je vektor opasnog oboljenja zlatne žutice vinove loze (Grapevine Flavescence dorée). U razdoblju od 2018. do 2020. godine praćena je prisutnost i gustoća populacije američkog cvrčka u ukupno 205 vinograda u 20 županija i Gradu Zagrebu. Na različita mjesta u svakom vinogradu postavljene su po tri žute ljepljive ploče. Ploče su mijenjane tri puta u vremenskom intervalu od dva do tri tjedna. Postavljanje ploča u vinogradima započelo je u lipnju, neposredno prije pojave odraslih oblika vektora, i trajalo je do sredine listopada. Tijekom trogodišnjeg perioda istraživanja američki cvrčak zabilježen je u 139 nadziranih vinograda. Rezultati istraživanja upućuju na izrazitu varijabilnost gustoće populacije između pojedinih vinograda. Broj jedinki američkog cvrčka u vinogradima kretao se od jedne jedinke do 3809 jedinki. Značajne razlike u gustoći populacije su zabilježene i između županija. Prisutnost američkog cvrčka nije zabilježena u vinogradima u Zadarskoj, Šibensko-kninskoj i Ličko-senjskoj županiji. Visoke populacije američkog cvrčka predstavljaju opasnost od daljnjeg širenja zlatne žutice vinove loze. Također, rezultati istraživanja pokazuju da se na pojedinim područjima mjere redovitog suzbijanja američkog cvrčka ne provode u dovoljnoj mjeri.

**Ključne riječi:** *Scaphoideus titanus*, populacija, zlatna žutica, vinova loza, Hrvatska

## Monitoring results of American grapevine leafhopper (*Scaphoideus titanus* Ball, 1932) in vineyards in Croatia (2018-2020)

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### Summary

The American grapevine leafhopper (*Scaphoideus titanus* Ball, 1932) is the most significant vector of dangerous Grapevine Flavescence dorée disease. In the period from 2018 to 2020, the presence and population density of the American grapevine leafhopper in a total of 205 vineyards in 20 counties and the City of Zagreb was monitored. Three yellow sticky plates were placed in different places in each vineyard. The plates were changed three times in a time interval of two to three weeks. Placement of plates in vineyards began in June, just before the appearance of adult vectors, and lasted until mid-October. During the three-year research period, the American grapevine leafhopper was recorded in 139 monitored vineyards. The results of the research indicate a significant variability in population density between individual vineyards. The number of American grapevine leafhoppers in vineyards ranged from one to 3809. Significant differences in population density were also recorded between counties. The presence of the American grapevine leafhopper has not been recorded in vineyards in Zadar, Šibenik-Knin and Lika-Senj counties. High populations of the American grapevine leafhopper pose a danger of further spread of Grapevine flavescence dorée phytoplasma. Also, the results of this research show that in some areas the measures of regular control of the American grapevine leafhopper are not sufficiently implemented.

**Key words:** *Scaphoideus titanus*, population, Grapevine flavescence dorée, grapevine, Croatia



## Performance of fungus-tolerant grapevine cultivar Morava grown under organic and conventional management

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### Summary

Grapevine production is among the most intensive productions with high inputs of fungicides and mineral fertilizers. It negatively affects both, human health and environment. Growing fungus-tolerant cultivars with satisfied grape quality can reduce the inputs of synthetic pesticides. As a result of grapevine breeding program in Serbia several cultivars were released. Due to an interesting aroma profile and its tolerance to pathogens, cultivar Morava has already found its place in vineyards. Cultivar Morava (Riesling renano x SK 86-2/293), released in Sremski Karlovci, has a high percentage of *Vitis vinifera* genes. The experiment was conducted at the Experimental field for viticulture (University of Novi Sad, Faculty of Agriculture) situated in Sremski Karlovci. Fungus-tolerant grapevine cultivar Morava was grown under organic and conventional management during the period 2015-2018. Although the yield was significantly lower in organic compared to conventional counterpart, in both systems the yield exceeded 10 t/ha. There was no difference in sugar content between organic and conventional production (20.4 and 20.5%, respectively). Titratable acidity was higher in conventional compared to organic production. The wine of Morava from the organic plot achieved higher score in wine sensory analysis compared to the wine derived from the conventional production. Therefore, cultivar Morava allows sustainable grape production in moderately continental climate conditions.

**Key words:** organic viticulture, Morava, yield, grape quality, wine

## Kaštela i otok Rava – izvori dva nova virusa vinove loze

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### Sažetak

Virusi vinove mogu predstavljati velik ekonomski problem, a u novije vrijeme, korištenjem naprednih metoda sekvenciranja genoma, broj novootkrivenih virusa vinove loze znatno se povećao. G-virus vinove loze (GVG) prvi put je detektiran na Novom Zelandu 2017. godine, a godinu dana kasnije i na području Republike Hrvatske. Badnavirus vinove loze 1 (*GBV-1*) detektiran je prvi puta u Hrvatskoj 2018. godine i to kao prvi nalaz u svijetu. Cilj ovoga rada bio je utvrditi rasprostranjenost navedenih virusa u vinovoj lozi na dva lokaliteta: Kaštela i otoku Ravi. U tu svrhu tijekom ljeta na području Kaštela prikupljeni su uzroci sa 304 (6 lokacija/vinograda), odnosno na otoku Ravi sa 103 biljke (okolica mjesta Mala Rava). Uzorak sa svake biljke sačinjavala su tri lista iz čijih peteljki je izolirana ukupna DNA i RNA korištenjem odgovarajućih pufera. Rezultati molekularnih testiranja dobiveni su metodom lančane reakcije polimerazom u realnom vremenu (qPCR) pomoću uređaja Thermo Fisher Scientific 7500 Real-Time PCR System (Applied Biosystems, SAD). Na području Kaštela pristunost GVG je potvrđena kod ukupno 185 trsova (60,9 %), a prisutnost GBV-1 kod 47 trsova (15,1 %). Na otoku Ravi GVG je utvrđen u 52 uzorka (50,5 %), a GBV-1 u 44 trsa (42,7 %). Na oba područja utvrđene su i istovremene zaraze sa oba virusa (Kaštela – 5,6 %, Rava – 28,2 %). Istraživanja o načinu prijenosa, krugu domaćina te utjecaju na podloge i plemke su u tijeku, ali uzimajući u obzir činjenicu da navedeni virusi pripadaju u rodove *Vitivirus* odnosno *Badnavirus* koji sadrže ekonomski značajne viruse vinove loze, nije isključena mogućnost njihove značajne štetnosti na rast, razvoj i prinose vinove loze.

**Ključne riječi:** G-virus vinove loze, badnavirus vinove loze 1, vinova loza, qPCR

## Kaštela and the island of Rava - sources of two new grapevine viruses

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### Summary

Grapevine viruses are a major economic problem and recently the number of newly discovered grapevine viruses has increased significantly through the use of new genome sequencing techniques. Grapevine virus G (GVG) was first detected in vineyards in New Zealand in 2017 and one year later in Croatia. Grapevine badnavirus 1 (GBV-1) was first reported as a newly discovered grapevine virus from Croatia in 2018. The aim of this study was to determine the prevalence of these two grapevine viruses in two wine growing regions: Kaštela and Rava Island. For this purpose, 304 samples (6 sites/vineyards) were collected in the Kaštela region and 103 samples (surroundings of Little Rava) on the island of Rava during the summer of 2020. Each sample, consisted of three leaves, was subjected to extraction of total DNA and RNA performed from leaf petioles using appropriate extraction buffers. The molecular tests were performed by real-time polymerase chain reaction (qPCR) using the Thermo Fisher Scientific 7500 Real-Time PCR system (Applied Biosystems, USA). In the Kaštela region, the presence of GVG was confirmed in 185 vines (60.9%) and of GBV-1 in 47 vines (15.1%). On the island of Rava, GVG was confirmed in 52 vines (50.5%) and GBV-1 in 44 vines (42.7%). Mixed infections were also confirmed in both regions (Kaštela - 5.6%, Rava - 28.2%). A study of transmission modes, host spectrum and effects on rootstocks and top-graft vines is underway, but given that both viruses belong to the genus *Vitivirus* and *Badnavirus*, both of which contain economically important grapevine viruses, the possibility of their significant adverse effects on growth, development and yields can be suspected.

**Key words:** grapevine virus G, grapevine badnavirus 1, grapevine, qPCR

## **Influence of dry tomato addition on bioactive compounds of virgin olive oil used as a storage medium**

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### **Summary**

Extra virgin olive oil (EVOO) is often used as a natural medium for the storage of different types of food, although its presence could modify the EVOO composition. Therefore, this study aimed to evaluate the influence of dry tomato addition on EVOO bioactive compounds (phenols and pigments) used as a storage medium. For that purpose, 15 g of dry tomatoes were placed in glass jars filled with Istarska bjelica EVOO (100 mL) and stored for one month at room temperature. The control samples, EVOO without dry tomatoes, were stored under the same conditions. The phenolic composition of the oils was determined by HPLC-DAD, the antioxidant capacity was studied by evaluating the free radical-scavenging effect of DPPH radical while chlorophylls and carotenoids were determined spectrophotometrically. After storage, all the oil samples showed a reduction in secoiridoids and flavonoids concentration, consequently decreasing the total phenols and radical-scavenging activity of the oils. However, the decrease was more notable in oil samples stored with dry tomatoes. The chlorophyll and carotenoid concentration of the oils remained preserved. Obtained results indicate that the addition of dry tomato accelerated the oxidation of the phenolic compounds during storage, decreasing the virgin olive oils nutritional value. This work has been supported by the Croatian Science Foundation (DOK-2018-09-2293 and DOK-2018-01-4693) and co-financed by the EU from the European Social Fund (DOK-2018-01-4693).

**Key words:** virgin olive oil, dry tomato, phenolic compounds, bioactive compounds, radical-scavenging activity

## **Kemometrijska karakterizacija vina sorte Merlot obzirom na zaštićene oznake izvornosti**

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### **Sažetak**

Merlot je druga po redu najzastupljenija crna sorta u vinogradima domaćih proizvođača. Područje njezina uzgoja proteže se gotovo cijelom Hrvatskom, te je navedena u 15 od ukupno 16 specifikacija zaštićenih oznaka izvornosti (ZOI) hrvatskih vina. Visoka zastupljenost vina ove sorte u ukupnom sortimentu prisutnom u Hrvatskoj u smislu količina na tržištu iz različitih zemljopisnih područja ukazuje na prilagodljivost ove sorte uzgoju u klimatskim uvjetima našeg podneblja. Educirani potrošači vina imaju jasne zahtjeve prema proizvodima koje konzumiraju, a uz kvalitetu proizvoda jedan od najvažnijih im je zemljopisno podrijetlo proizvoda. Stoga je naziv zaštićene oznake izvornosti među najvažnijim informacijama za potrošača (uz proizvođača, sortiment, sadržaj alkohola u vinu i cijenu). Cilj ovog rada bio je procijeniti utjecaj različitih fizikalno kemijskih karakteristika vina proizvedenih od sorte Merlot na definiranje regionalnih karakteristika uz primjenu odgovarajućih kemometrijskih tehnika poput analize varijance (ANOVA) i analiza glavnih komponenata (PCA), koje pružaju mogućnost sistematiziranja dobivenih podataka iz različitih ZOI. Fizikalno kemijski parametri prikupljeni su u postupku stavljanja vina sa ZOI na tržište Hrvatske u proteklih pet godina. Ovaj rad proširuje dosadašnja znanja o nacionalnim vinima proizvedenim od sorte Merlot te doprinosi definiranju regionalnih karakteristika određenih fizikalno kemijskim parametrima.

**Ključne riječi:** Vino, Merlot, zaštićena oznaka izvornosti, kemometrija, fizikalno kemijska svojstva

## Chemometric characterization of cv. Merlot wines according to protected denominations of origin

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### Summary

Merlot is the second most common red variety in the Croatian vineyards. The area of its cultivation extends almost throughout Croatia and it is listed in 15 out of the current 16 Croatian wines specifications of protected designations of origin (PDO). The high representation of Merlot wines in regards to quantities on the market from different geographical areas, indicates the adaptability of this variety to cultivation in Croatian climate. Educated wine consumers have clear requirements for the products they consume, and in addition to product quality, one of the most important to them is the geographical origin of the product. Therefore, the protected designation of origin is among the most important information for the consumer (along with the name of producer, variety, alcohol content and price). The aim of this study was to assess the impact of different physicochemical characteristics of wines produced from Merlot variety on the definition of regional characteristics using appropriate chemometric techniques such as analysis of variance (ANOVA) and principal components analysis (PCA), which provide systematization of data from different PDO-s. Physicochemical parameters were collected in the process of placing PDO wines on the Croatian market in the past five years. This study expands the current knowledge about national wines produced from the Merlot variety and contributes to the definition of regional characteristics determined by physicochemical parameters.

**Key words:** wine, Merlot, protected designations of origin, chemometrics, physicochemical properties

## Utjecaj folijarne gnojidbe sumporom i dušikom na morfološke karakteristike ploda masline

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### Sažetak

Maslina (*Olea europaea* L.) je ekonomski važna mediteranska voćna vrsta koja se primarno uzgaja za proizvodnju maslinovog ulja. Sumpor (S) i dušik (N) dva su važna biogene elementa koja se intenzivno proučavaju kod uljarica zbog njihove fiziološke uloge u sintezi ulja. Stoga, cilj ovog rada bio je utvrditi kako folijama gnojidba sumporom i dušikom utječe na morfološke karakteristike ploda masline. Dvofaktorijalni poljski pokus (gnojidba x sorta) proveden je po shemi potpuno slučajnog rasporeda. Ukupan broj stabala u pokusu bio je 32. Gnojidba s 4 tretmana (folijarna primjena 3 koncentracije sumpornog gnojiva s dodatkom dušika (SN1, SN2, SN3) i jedan kontrolni tretman – bez gnojiva (K)) primijenjena je na dvije različite sorte masline ('Istarska bjelica' i 'Leccino'). Na 40 zdravih plodova po stablu provedena su morfološka mjerenja prema međunarodnoj metodi za morfološki opis ploda i koštice (masa, duljina i širina ploda i koštice). Plodovi su u tehnološkoj zriobi ubrani iz središnjeg obodnog djela krošnje ujednačeno sa svih strana svijeta. Sorta 'Istarska bjelica' imala je sve mjerene parametre ploda značajno veće od sorte 'Leccino', dok je kod morfoloških parametara koštice zabilježen suprotan trend. Također, kod gnojidbe kao glavnog faktora, zabilježen je pozitivan učinak folijarnih tretmana SN2 i SN3 na morfološke karakteristike ploda i koštice u odnosu na kontrolu. Pri tom, primjena tretmana SN1 rezultirala je samo većom širinom ploda u odnosu na kontrolni tretman.

**Ključne riječi:** 'Istarska bjelica', koštica, 'Leccino', *Olea europaea* L., plod.

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## The impact of sulphur and nitrogen foliar fertilization on olive fruit morphological characteristics

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### Summary

The olive is an economically important Mediterranean fruit tree primarily grown for the olive oil production. Sulphur (S) and nitrogen (N) are two important biogenic elements intensively studied in oil crops due to their physiological role in oil synthesis. Therefore, the aim of this study was to determine the impact of S and N foliar fertilization on the olive fruit morphological characteristics. A two-factor field experiment (fertilization x cultivar) set as a completely randomized design was conducted. The total number of trees in the experiment was 32. Fertilization with 4 treatments (foliar application of 3 concentrations of S fertilizer with additional N (SN1, SN2, SN3) and one control treatment - without fertilizer (K)) was applied to two different olive cultivars ('Istarska bjelica' and 'Leccino'). Morphological measurements were performed on 40 healthy fruits per tree (weight, length and width of fruits and stones). The fruits were harvested at their technological maturity. The fruits of 'Istarska bjelica' cultivar had significantly higher measured values than 'Leccino' cultivar, while an opposite trend was recorded for the stone morphological parameters. In addition, with fertilization as the main factor, a positive effect of foliar treatments SN2 and SN3 on the morphological characteristics of fruits and stones in relation to the control was recorded. However, the application of SN1 treatment resulted only with a larger fruit width compared to the control treatment.

**Key words:** fruit, 'Istarska bjelica', 'Leccino', *Olea europaea* L., stone.

This work has been supported in part by Croatian Science Foundation under the project "Phytochemical Farming: Mineral Nutrients and Elicitors Application to Enhance Olive Leaf Phenolics" (UIP-2017-05-8464).



## Kemijski sastav neretvanske mandarine- potencijal bioaktivnih komponenti

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### Sažetak

Mandarina (*C. Unshiu*) uživa veliku popularnost na tržištu jer se lako guli, ne sadrži sjemenke i ima specifičan okus omiljen potrošačima pa se globalna proizvodnja mandarina, kako u svijetu tako i u Hrvatskoj gdje se najviše uzgaja u dolini rijeke Neretve, konstantno povećava. Neretvanska mandarina postiže jedinstvenu kvalitetu ploda zbog mikroklimatskog utjecaja mora, rijeke Neretve te okolnih jezera. U ovom radu određeni su osnovni fizikalno kemijski parametri (TSS, ukupna kiselost, ukupni i reducirajući šećeri, vlakna, boja, pH) ploda mandarine na sorti *Kawano Wase*. Također, određeni su ukupni fenoli, flavonoidi, karotenoidi, vitamin C i antioksidacijski kapacitet (ABTS i DPPH) u soku, pulpi i kori mandarine. Dobiveni rezultati pokazuju kako je neretvanska mandarina bogata bioaktivnim komponentama. Sadržaj bioaktivnih komponenti (ukupni fenoli, flavonoidi i karotenoidi) u pulpi i kori analizirane mandarine je bio visok. Pulpa i kora mandarine mogu predstavljati biootpad u prehrambenoj industriji te kao takve imaju potencijal biti iznimno bogat izvor flavonoida i karotenoida za daljnju aplikaciju u kozmetičkoj, farmaceutskoj ili prehrambenoj industriji.

**Ključne riječi:** neretvanska mandarina, Citrus Unshiu, flavonoidi, karotenoidi

## Chemical composition of Neretva mandarin- potential of bioactive components

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### Summary

Mandarin (*C. Unshiu*) enjoys great popularity on the market because it peels easily, does not contain seeds and has a specific taste favored by consumers, so global mandarin production, both in the world and in Croatia where it is mostly grown in the Neretva Valley, is constantly increasing. The Neretva mandarin achieves a unique fruit quality due to the microclimatic influence of the sea, the Neretva river and the surrounding lakes. In this paper, the basic physicochemical parameters (TSS, total acidity, total and reducing sugars, fibers, color, pH) of mandarin fruit on *Kawano Wase* variety were determined. Also, total phenols, flavonoids, carotenoids, vitamin C and antioxidant capacity (ABTS and DPPH) in mandarin juice, pulp and peel were determined. The obtained results show that the Neretva mandarin is rich in bioactive components. The content of bioactive components (total phenols, flavonoids and carotenoids) in the pulp and peel of analyzed mandarins was high. Mandarin pulp and peel can be biowaste in the food industry and as such have the potential to be an extremely rich source of flavonoids and carotenoids for further application in the cosmetics, pharmaceutical or food industry.

**Key words:** mandarins from Neretva Valley, Citrus Unshiu, flavonoids, carotenoids

## The olive leaf addition during Leccino olive oil extraction improves its oxidative stability

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### Summary

Virgin olive oils are exclusively extracted from olive fruits, but small amount of olive leaves are usually present during the fruit extraction. Since the olive leaf is an excellent source of phenols, in this study the effect of the olive leaves present during the Leccino cv. olive oil extraction on the phenolic compound composition and oxidative stability of the produced oils were investigated. For that purpose, olive fruits were extracted at the industrial scale without the leaf (control oil) and with the addition of Leccino cv. leaves (2.5% in relation to the total amount of olive fruits), in triplicate. In the oils, phenolic profiles using high performance liquid chromatography (HPLC-DAD) and oxidation stability index (OSI-time) evaluated as resistance to forced oxidation were determined. The leaf addition increased concentration of simple phenols, phenolic acids, flavonoids, and secoiridoids in the obtained oils, as well as oils' oxidative stability index (about 20%). These results indicate that the olive leaf addition during olive oil production can be an effective way for producing enriched oil with natural antioxidants, thus improving nutritional properties and extending its shelf life. This work has been supported by the Croatian Science Foundation (DOK-2018-09-2293 and DOK-2018-01-4693) and co-financed by the EU from the European Social Fund (DOK-2018-01-4693).

**Key words:** olive oil, olive leaf, phenolic compounds, oxidative stability

## Utjecaj prorjeđivanja grozdova na kakvoću mošta kultivara Chardonnay

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### Sažetak

Vinogorje Kutjevo smješteno na južnim obroncima Papuka i Krndije najpoznatije je po uzgoju grožđa Graševina, međutim ne smije se zanemariti i sve veća zastupljenost ostalih sorti. Chardonnay je najraširenija vinska sorta u svijetu, a u Požeško-slavonskoj županiji zauzima oko 5 % površine vinogradarskih nasada. Cilj ovog rada bio je odrediti utjecaj prorjeđivanja grozdova u vinogorju Kutjevo na kinetiku dozrijevanja grozdova kultivara Chardonnay, te kakvoću mošta. Istraživanje je provedeno tijekom 2020. godine na lokalitetu Podgorje (vinogorje Kutjevo), a pokus je postavljen po slučajnom bloknom rasporedu u dva tretiranja po tri repeticije. Repeticiju čini pet trsova u nizu. Ispitivani su slijedeći parametri: udio šećera i ukupna kiselost u grožđu u periodu mjesec dana prije berbe, broj grozdova po trsu i prosječna masa grozdova. U moštu su određeni slijedeći parametri: gustoća, ukupna kiselost, hlapiva kiselost, vinska, jabučna i mliječna kiselina, pH, reducirajući šećeri, ekstrakt, glukoza, fruktoza, glicerol, alfa amino dušik, amonijačni dušik, te kalij. Analiza rezultata je pokazala kako je prorjeđivanje grozdova imalo utjecaj na statistički značajnu razliku u broju i masi grozdova po trsu, no razlika u kemijskom sastavu mošta ispitivanih tretmana u najvećem broju parametara nije statistički značajna. Značajna razlika je samo u parametrima amonijačnog dušika, pH i mliječne kiseline.

**Ključne riječi:** Chardonnay, vinogorje Kutjevo, prorjeđivanje grozdova

## **Influence of grape thinning on must quality of Chardonnay cultivar**

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### **Summary**

Kutjevo wine-hills are located on southern slopes of Papuk and Krndija mountains. The area is the most famous by production of Graševina grapes, but increasing share of other varieties cannot be ignored. Chardonnay is the most widespread variety all over the world, and in Požeško-slavonska county is represented by 5% of total vineyards surface. The aim of this research was to determine the influence of cluster thinning in Kutjevo wine-hills on maturation kinetics of Chardonnay grapes and must quality. Research was conducted in 2020. in Podgorje location (Kutjevo wine-hills). Experiment was established by a randomized block schedule in two treatments with three repetitions. One repetition makes five vines in a row. Following parameters have been determined: sugar content and total acidity in grapes in period of one month before harvest, number of clusters per vine, cluster mass, density, total acidity, volatile acidity, tartaric acid, mallic acid, lactic acid, pH, reducing sugars, extract, glucose, fructose, glycerol, alfa amino nitrogen, ammonia nitrogen and potassium. Results have showed that cluster thinning had significant influence on cluster mass and number of clusters per vine, but majority of chemical parameters were not significantly different between two treatments. Statistically significant difference was only in case of ammonia nitrogen, pH and mallic acid.

**Key words:** Chardonnay, Kutjevo wine-hills, cluster thinning

## Biogljen proizveden iz ostataka rezidbe vinove loze kao poboljšivač kiselih tala

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### Sažetak

Trenutne strategije upravljanja rezidbenim ostacima u mediteranskim područjima uključuju spaljivanje istih na poljima, što svakako negativno utječe na emisije stakleničkih plinova, te malčiranje i unošenje u tlo, što može negativno utjecati kroz rizik od bolesti i štetnika koji na taj način ostaju u nasadu. Proizvodnja biogljena iz ostataka rezidbe vinove loze predstavlja održivi i ekološki prihvatljiv upravljanja ostacima te može pozitivno utjecati na klimatske promjene. S obzirom na to da kiselina tla predstavljaju ograničavajući proizvodni čimbenik, dodatak biogljena iz ostataka rezidbe vinove loze u tlo može pozitivno utjecati na proizvodna svojstva kroz povećanje reakcije tla. U ovom su istraživanju sakupljeni ostaci rezidbe vinove loze autohtonih i introduciranih sorti diljem mediteranskog dijela Hrvatske te je iz istih proizveden biogljen korištenjem metode mufolne peći. Proizvedenom biogljenu određena je pH vrijednost prema DIN ISO 10390 normi. Rezultati pokazuju da su se pH vrijednosti biogljena iz ostataka rezidbe vinove loze kretale u rasponu od 9,06 do 11,33, te je uočen utjecaj sorte. Može se zaključiti da dodatak biogljena iz ostataka rezidbe vinove loze u tlo može podići pH vrijednosti kiselih tala te, posljedično, istovremeno riješiti problem valorizacije ostataka rezidbe vinove loze i povećanja poljoprivredne proizvodnje na kiselim tlima.

**Ključne riječi:** pH tla, alkalizacija, ugljik, klimatske promjene

## **Grapevine-pruning-residue-derived biochar as a soil amendment for acidic soils**

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### **Summary**

Current management strategies for pruning residues in Mediterranean areas consist of burning them in the field, which is controversial because of its contribution to greenhouse gas emissions, and chipping and utilization as a mulching agent in soil, the drawback of which is the increased risk of pests and diseases. The production of biochar from grapevine pruning residues can be a sustainable and environment-friendly strategy to mitigate climate change. Since acidic soils represent a limiting factor for agricultural production, soil amendment with grapevine-pruning-residue-derived biochar may act beneficially and increase soil pH. In the present research, grapevine pruning residues of native and introduced varieties were collected along the Mediterranean part of Croatia and subjected to biochar production using the muffle furnace method. The produced biochar was analyzed for pH value according to DIN ISO 10390. Results show that grapevine-pruning-residue-derived biochar pH values ranged from 9.06 to 11.33 and the grapevine variety effect was noted. It can be concluded that soil amendment with grapevine-pruning-residue-derived biochar can increase the pH value of acidic soils and therefore can simultaneously solve the problem of pruning residues valorization and increase agricultural production on acidic soils.

**Key words:** soil pH, alkalization, carbon, climate change

## Kemometrijska karakterizacija vina sorte Graševina obzirom na zaštićene oznake izvornosti

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### Sažetak

Politika kvalitete Europske unije ima za cilj zaštitu određenih proizvoda radi promicanja njihovih jedinstvenih karakteristika povezanih s njihovim zemljopisnim podrijetlom, kao i tradicionalnim znanjem. Stoga je vrlo važno za proizvođače vina i regulatorne institucije utvrditi i kvantificirati specifične parametre kvalitete takvih proizvoda kako bi se izbjegle prijevare i potvrdilo njihovo zemljopisno podrijetlo odnosno oznaka izvornosti. Najčešće korišteni alati za razvoj analiza kojima se definira podrijetlo proizvoda je primjena novih analitičkih tehnika i kemometrijskih metoda koje omogućuju važan razvoj takve klasifikacije. Cilj ovog rada je utvrditi razlike u osnovnom fizikalno kemijskom sastavu između vina sorte Graševina na tržištu RH u proteklih pet godina obzirom na deklariranu zaštićenu oznaku izvornosti (ZOI). Kako bi se istražila diferencijacija odabranih vina s obzirom na ZOI korištene su multivarijatne statističke analize. Prilagodljivost uzgoja sorte Graševina u povoljnim uvjetima našega podneblja čini je najzastupljenijom sortom u hrvatskim vinogradima. Ali ipak, unatoč globalnoj rasprostranjenosti ove sorte, nema dovoljno dostupnih znanstvenih podataka i istraživanja koja bi izdvojila zemljopisno područje u kojem Graševina nedvojbeno iskazuje svoj maksimalni sortni potencijal. Ovim je radom procijenjen utjecaj različitih fizikalno kemijskih karakteristika vina proizvedenih od sorte Graševina na deklarirane ZOI.

**Ključne riječi:** vino, Graševina, zaštićena oznaka izvornosti, kemometrija, fizikalno kemijska svojstva



## **Chemometric characterization of cv. Graševina wines according to protected denominations of origin**

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### **Summary**

The European Union's quality policy aims to protect specific products in order to promote their unique characteristics linked to their geographical origin and traditional knowledge. It is very important for wine producers and regulatory institutions to establish and quantify specific quality parameters of such products in order to avoid fraud and to confirm their geographical origin or designation of origin. The most commonly used analysis development tools that define the origin of products are the application of new analytical and chemometric methods that allow the development of such classification. The aim of this study is to determine the differences in the basic physicochemical composition between Graševina/Riesling Italico wines on the Croatian market in the past five years with regard to the declared protected designation of origin (PDO). In order to investigate the differentiation of selected wines, multivariate statistical analyzes were used. The adaptability of Graševina/Riesling Italico vine variety in favorable conditions of our climate makes it the most represented variety in Croatian vineyards. Despite the global distribution of this variety, there is not enough available scientific data to single out the geographical area in which Graševina/Riesling Italico undoubtedly shows its maximum varietal potential. This study evaluates the influence of different physicochemical characteristics of wines produced from the Riesling Italico variety on the declared PDO-s.

**Key words:** wine, Graševina/Riesling Italico, protected designation of origin, chemometric, physicochemical parameters

## CroViZone - Prilagodba vinogradarskih zona RH klimatskim promjenama

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### Sažetak

Vinogradarstvo i vinarstvo su iznimno značajne gospodarske grane za Republiku Hrvatsku. Vinogradarstvo kao radno intenzivna djelatnost omogućava zapošljavanje više ljudi i postizanje većih prinosa po jedinici površine u odnosu na većinu poljoprivrednih kultura koje se uzgajaju u Republici Hrvatskoj. Analiza sadašnjeg stanja u vinorodnim područjima, poznavanje sortimenta, starosti nasada, potencijali nekih regija za proizvodnju vina i sl. su bitni aspekti važni za napredak i razvoj. Zoniranje podrazumijeva određivanje geografskih granica vinogradarskih područja unutar kojih je dopušten uzgoj grožđa za proizvodnju vina, a podrazumijeva i specifičan sortiment karakterističan za područje. Vinogradarske zone razlikuju se obzirom na klimu, tlo ali i druge uvjete važne za uzgoj vinove loze, do te mjere da se razlikuju i obzirom na sortiment, prinos i kvalitetu grožđa i vina. Utvrđivanje granica vinogradarskih zona utoliko je točnije što je gustoća mreže meteoroloških postaja veća i što su nizovi podataka mjerenja dulji. Osim toga, rezultati ovise i o lokacijama meteoroloških postaja jer one često nisu smještene u središtu određenog vinogorja. Na osnovi dobivenih rezultata moći ćemo zaključiti da li su i koliko porasle srednje vrijednosti Winklerovog indeksa (WI) u Hrvatskoj posljednjih 30 godina u odnosu na referentno razdoblje. Zbog sve češćih ekstremno toplih godina (srednje godišnje temperature zraka iznad 98 percentila) u 21. stoljeću, pretpostavka je da će se pomicati i područja pogodna za uzgoj vinove loze. Povećanje temperature zraka u vegetacijskom razdoblju uzrokuje ranije dozrijevanje grožđa, a za očekivati je da će se u vinorodnim područjima Hrvatske u razmjerno bliskoj budućnosti mijenjati sortiment vinove loze. Svrha projekta je povećati prilagodljivost i smanjiti ranjivost hrvatskog vinogradarstva vezano uz utjecaj klimatskih promjena na proizvodnju grožđa i vina kroz reviziju postojećih i eventualni prijedlog uspostave novih vinogradarskih zona Hrvatske.

**Ključne riječi:** klima, vinova loza, agroklimatski indeksi, vinogradarske zone

## Adaptation of Croatian viticulture zones to climate change

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### Summary

Viticulture and winemaking are very important economic drivers for the Republic of Croatia. As a labor-intensive activity, viticulture enables the employment of more people and the achievement of higher yields per unit area in relation to most other agricultural crops grown in the Republic of Croatia. Analysis of the current state of viticultural areas, information on the sort and age of the grapevines planted, potential of specific regions for grape cultivation, and other factors are important to consider for further development of this industry. Zoning implies determining the geographical boundaries of wine-growing areas within which the cultivation of grapes for wine production is allowed, and it also implies a specific assortment characteristic of the area. Viticultural zones differ in terms of climate, soil and other conditions important for the cultivation of vines, to the extent that they differ in terms of assortment, yield and quality of grapes and wine. Determining the boundaries of wine-growing zones is more accurate the higher the density of the network of meteorological stations and longer the series of recorded data. In addition, the results depend on the locations of meteorological stations because they are often not located in the center of a particular vineyard. Based on the obtained results, we will be able to conclude whether and to what extent the mean values of the Winkler Index (WI) in Croatia have increased in the last 30 years compared to the reference period. Due to the increasingly frequent extremely warm years in the 21st century, with annual air temperatures above the 98th percentile, it is assumed that areas suitable for growing vines will also move. The increase in air temperature in the vegetation period causes earlier ripening of grapes, and it is to be expected that the assortment of vines in the wine-growing areas of Croatia will change in relatively near future. The purpose of this project is to increase the adaptability and reduce the vulnerability of Croatian viticulture related to the impact of climate change on grape and wine production through the revision of existing and possible proposal for the establishment of new wine-growing zones in Croatia.

**Key words:** climate, grapevine, agroclimatic indices, viticultural zones

## Fizikalno-kemijska svojstva tradicionalnih sorti jabuke

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### Sažetak

Prema prethodnim istraživanjima, tradicionalne sorte jabuke bogate su polifenolnim spojevima, a također imaju i zanimljiva fizikalno-kemijska svojstva koja su često važna potrošačima. Cilj ovog istraživanja bio je utvrditi fizikalno-kemijska svojstva ploda (masa, visina, širina, indeks oblika, boja, tvrdoća, indeks razgradnje škroba, indeks zrelosti, udio topljive suhe tvari, ukupne kiseline, omjer topljivih topljive suhe tvari i ukupnih kiselina, pH, svojstva sjemenki) te količinu fenola u kožici i mesu ploda 25 različitih tradicionalnih sorti jabuke iz Hrvatske. Rezultati istraživanja ukazali su na različitost fizikalno-kemijskih svojstva plodova istraživanih sorti jabuke. U plodovima su utvrđene velike količine flavan-3-ola, dihidrohalkona, fenolnih kiselina i flavonola, dok su u kožici dodatno utvrđeni i antocijani. Statistička analiza rezultata korištenjem analize glavnih komponenata pokazala je moguće grupiranje istraživanih sorti. Tradicionalne sorte jabuke treba očuvati jer predstavljaju vrijedan izvor polifenola i raznolikost fizikalno-kemijskih svojstava koje potrošači cijene.

**Ključne riječi:** jabuka, polifenoli, plod, tradicionalne sorte

## Physico-chemical properties of traditional apple cultivars

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### Summary

According to previous studies, traditional apple cultivars are rich in polyphenolic compounds. They also have interesting physico-chemical properties often important to consumers. The aim of this study was to determine physico-chemical properties of fruit (weight, height, width, shape index, color, firmness, starch decomposition index, maturity index, total soluble solids, total acids, total soluble solid/total acids ratio, pH, seed characteristics) and polyphenols from peel and flesh of 25 different traditional apple cultivars from Croatia. Physico-chemical properties highlighted a broad diversity of these apples. Apples also contained high amounts of flavan-3-ols, dihydrochalcones, phenolic acids, and flavonols, while anthocyanins were additionally found in the peel. Statistical analysis of the results using principal component analysis showed possible clustering. Traditional cultivars of apple should be preserved since they represent a valuable source of polyphenols, and a diversity of characteristics appreciated by consumers.

**Key words:** apple, polyphenols, fruit, traditional cultivars

## Utjecaj inaktivnih kvasaca na kakvoću grožđa u proizvodnji proška

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### Sažetak

Tradicionalni način prosušivanja grožđa sve je više zanemaren zbog nemogućnosti kontroliranja uvjeta, pa se traže nove metode. Sušenje grožđa u kontroliranim uvjetima modernih sušara sve je zastupljenija metoda za proizvodnju desertnih vina. Istraživanje je provedeno na vinogradarskom pokušalištu Baštica, sorti 'Plavina' (*Vitis vinifera* L.). Na početku fenofaze šare dio grožđa tretiran je inaktivnim kvascima (Lalvigne mature), sredstvom koje stimulira razvoj bobice, a rezultati su čvršća kožica, bolja fenološka zrelost i bolja kakvoća grožđa. Kao kontrolna varijanta poslužilo je grožđe 'Plavine' na kojoj nije proveden tretman. Temperatura tijekom sušenja grožđa bila je 40 °C, prosušivanje je trajalo 6 dana. Nakon prosušivanja utvrđeno je smanjenje mase grozdova od 25 % kod tretiranog, a 35 % kod netretiranog grožđa 'Plavina'. Primijenjenom tehnologijom prosušivanja izbjegnuta je pojava nepoželjnih mikroorganizama čime je osigurano optimalno zdravstveno stanje grozdova. Značajna razlika uočena je u sadržaju polifenola kod tretiranog grožđa. S obzirom na svojstva sorte 'Plavina' kao što su tanka kožica, osjetljivost na bolesti, zbijen grozd i velike bobice s manjom mogućnosti nakupljanja suhe tvari što najčešće daje laganija, slabija obojena vina, primijenjena tehnologija prosušivanja omogućuje iskorištenje njezinog stvarnog kvalitativnog potencijala i proizvodnju novog stila, desertnog vina.

**Ključne riječi:** Plavina, prosušivanje grožđa, prošek, inaktivni kvasci

## Influence of inactive yeasts on grape quality in prošek production

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### Summary

The traditional way of drying grapes is increasingly neglected due to the inability to control conditions, so new methods are being sought. Drying grapes in the controlled conditions of modern dryers is an increasingly common method for the production of dessert wines. The research was carried out at the Baštica vineyard on variety Plavina (*Vitis vinifera* L.). At the beginning of veraison, the part of the grape intended for the experiment was treated with inactive yeasts (*Lalvigne* mature). The impact is manifested in the acceleration of physiological processes, firmer skin and better phenological maturity. The control variant was Plavina, which were not treated. The temperature during the drying of the grapes was 40°C, drying took 6 days. After drying, a decrease in the mass of grapes of 25% was found in treated and 35% in untreated Plavina grapes. The applied drying technology avoids the appearance of undesirable microorganisms, which ensures the optimal health of the bunches. A significant difference was observed in the polyphenol content of the treated grapes. Given the characteristics of the Plavina variety such as thin skin, susceptibility to disease, compact cluster and large berries with less possibility of dry matter accumulation, usually gives lighter, lower intensity colored wines. Drying technology enable the use of its real qualitative potential and the production of a new style of dessert wine.

**Key words:** Plavina, grape drying, prošek, inactive yeasts

## ***Podosphaera aphanis* causing powdery mildew of blackberry in Serbia**

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### **Summary**

Blackberries (*Rubus* L. subgenus *Rubus* Watson) are delicious and popular fruits. Together with raspberries and strawberries, blackberries are famous for high content of beneficial nutrients and antioxidants. Many diseases are common for these crops, including powdery mildew caused by *Podosphaera aphanis*, known for its substantial genetic diversity. During summer of 2019 and 2020, blackberry plants with chlorotic spots on the leaves accompanied by the white powdery mildew colonies were collected in Pakovraće, Serbia. Symptoms were visible on primorcanes and floricanes. Morphological characteristics of pathogen included the presence of conidiophores (75 - 200 µm) bearing ellipsoid conidia (22.5 to 35.5 × 12.5 to 15 µm) containing fibrosin bodies resembling to *Podosphaera* spp. Molecular identification confirmed that isolates 420G-19 (530 bp) and 30G-20 (530 bp) (Acc. No. MN914995 and MT514661) shared 99.81% nt identity with 32 *Podosphaera aphanis* strawberry and raspberry isolates in the GenBank. Pathogenicity was confirmed by artificial inoculations of healthy blackberry plants dusted with conidia and maintained in the glasshouse. This showed that *P. aphanis* expanded its host range in Serbia, threatening the blackberry production.

**Key words:** *Podosphaera aphanis*, powdery mildew, blackberry, morphology, molecular identification

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## Utjecaj dušične gnojidbe na neke kvantitativne i kvalitativne parametre sorte Graševina

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### Sažetak

Gnojidba vinograda dušikom predstavlja važnu agrotehničku mjeru za postizanje stabilnog rasta vinove loze te uroda i kakvoće grožđa. Cilj ovog istraživanja bio je utvrditi utjecaj aplikacije različitih oblika dušika i folijarne prihrane na neke kvantitativne i kvalitativne odlike grožđa i mošta sorte Graševina u vinogorju Baranja na karbonatnom tlu te optimizaciju gnojidbe nasada. Pokus je proveden 2018. godine na lokalitetu Zmajevac na nasadu starosti 8 godina. Gnojidbeni tretmani su postavljeni po slučajnom bloknom rasporedu u tri ponavljanja uz aplikaciju 70 kg N, 40 kg P<sub>2</sub>O<sub>5</sub> i 60 kg K<sub>2</sub>O. Osnovna gnojidba provedena je aplikacijom 200 kg/ha kompleksnog NPK gnojiva (7-20-30) na svim tretmanima, dok je prihrana obavljena u 2 navrata aplikacijom dušičnog gnojiva u amonij nitratnom, amonij sulfatnom, amonij sulfo-nitratnom te amidnom obliku uz podtretman folijarne prihrane B i Fe, koja je provedena u tri aplikacije tijekom vegetacije. Provedenim istraživanjem je utvrđeno da je gnojidba amidnim oblikom dušika utjecala na značajno povećanje broja i mase grozdova po trsu te na povećanje ukupne kislosti mošta (6,57 g/L). Tretman amonij nitratom pokazao je najvišu visinu grozda (11,72 cm), a tretman amonij sulfatom pokazao je najvišu razinu šećera u moštu (92,33°Oe). Na temelju provedenog istraživanja, možemo zaključiti kako izbor mineralnog dušičnog gnojiva različite rezidualne (fiziološke) reakcije može značajno utjecati na neke kvantitativne i kvalitativne odlike grožđa i mošta sorte Graševina već u prvoj godini istraživanja, ali i da je potrebno nastaviti s višegodišnjim istraživanjima.

**Ključne riječi:** dušik, prinos i kvaliteta grožđa, Graševina

Zahvala: Rad je financiran od strane Sveučilišta Josipa Jurja Strossmayera u Osijeku, kroz projekt „Utjecaj fizikalno-kemijskih svojstava karbonatnih tala i gnojidbe dušikom na ishranjenost vinove loze u baranjskom vinogorju“ (UNIOS-ZUP 2018-38).

## Influence of nitrogen fertilization on some quantitative and qualitative parameters of Graševina variety

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### Summary

Nitrogen fertilization of vineyards is an important agro-technical measure for achieving stable grapevine growth and yield and quality of grapes. The aim of this study was to determine the impact of application of different forms of nitrogen and foliar fertilization on some quantitative and qualitative characteristics of grapes and must of Graševina variety in the Baranja vineyards on carbonate soil and optimization of vineyard fertilization. The experiment was conducted in 2018 at the Zmajevac site on an 8 year old plantation. Fertilization treatments were set according to a random block design in three replications with the application of 70 kg N, 40 kg P<sub>2</sub>O<sub>5</sub> and 60 kg K<sub>2</sub>O. Basic fertilization was carried out by applying 200 kg/ha of complex NPK fertilizer (7-20-30) on all treatments, while top-dressing was done twice by applying nitrogen fertilizer in ammonium nitrate, ammonium sulfate, ammonium sulfonitrate and amide form with foliar treatment fertilization of B and Fe, which was carried out in three applications during the growing season. The research showed that fertilization with amide form of nitrogen had a significant increase in the number and weight of bunches per vine and an increase in the total acidity of the must (6.57 g/L). Ammonium nitrate treatment showed the highest cluster height (11.72 cm), and ammonium sulfate treatment showed the highest sugar level in the must (92.33 °Oe). Based on the research, we can conclude that choice of mineral nitrogen fertilizer different residual (physiological) reactions can significantly affect some quantitative and qualitative characteristics of grapes and must of Graševina variety in the first year of research, but that it is necessary to continue multiyear research.

**Key words:** nitrogen, yield and quality of grapes, Graševina

**Acknowledgments:** The work was funded by the Josip Juraj Strossmayer University in Osijek, through the project "Influence of physico-chemical properties of carbonate soils and nitrogen fertilization on the nutrition of vines in the Baranja vineyards" (UNIOS-ZUP 2018-38).

## Aromatski profil maslinovih ulja od milenijskih divljih maslina (*Olea Oleaster*) iz Vrtova Lunjskih maslina, otok Pag

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### Sažetak

U ovom radu analizirano je maslinovo ulje dobiveno od divljih milenijskih maslina iz Vrtova Lunjskih maslina koji se nalaze na samom sjevernom dijelu otoka Paga. Na ovom jedinstvenom lokalitetu nalazi se više od osamdeset tisuća stabala samoniklih maslina *Olea oleaster*, što ga čini najvećim parkom samoniklih maslina na svijetu. Cilj ovog istraživanja je karakterizacija hlapljivih spojeva maslinovih ulja iz divljih maslina te izrada njihovog aromatskog profila, kao osnove za izradu specifikacije za zaštitu izvornosti ovog jedinstvenog maslinovog ulja. Uzorci maslinovih ulja prikupljeni su direktno od maslinara koji imaju maslinike unutar Vrtova Lunjskih maslina, s tisućljetnim samoniklim divljim stablima maslina. Određivanje aromatskog profila ispitivanih maslinovih ulja provedeno je analizom sastava hlapljivih spojeva metodom plinske kromatografije GC-MS. Detektirani najzastupljeniji hlapljivi spojevi su bili *E*-2-heksanal, *Z*-3-heksen-1-ol i heksanol. Senzorsko ocjenjivanje djevičanskih maslinovih ulja proveo je profesionalni panel Instituta za jadranske kulture sastavljen od 10 stručnjaka senzorskih ocjenjivača. Kvantitativna deskriptivna senzorska analiza provedena je prema IOC metodologiji te je definiran aromatski profil analiziranih maslinovih ulja divljih maslina.

**Ključne riječi:** aromatski profil, *Olea oleaster*, maslinovo ulje, senzorne analize, divlje masline

## Aromatic profile of olive oils from millennial wild olive trees (*Olea oleaster*) from Lun Olive Grove gardens, island of Pag

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### Summary

In this paper, olive oil obtained from wild millennial olives from the Lun Olive Grove Gardens, which are located in the northern part of the island of Pag, is analyzed. There are more than eighty thousand wild olive trees *Olea oleaster* in this unique locality, which makes it the largest wild olive park in the world. The aim of this research is to characterize the volatile compounds of olive oils from wild olives and to define their aromatic profile, as a basis for the specifications for label protective designation of origin of this unique olive oil. Samples of olive oils were collected directly from olive growers who have olive groves within the Lun Olive Gardens, with millennial wild olive trees. Determination of the aromatic profile of the tested olive oils was performed by analysis of composition of volatile compounds by GC-MS gas chromatography. The most common volatile compounds detected were E-2-hexanal, Z-3-hexen-1-ol and hexanol. Sensory evaluation of virgin olive oils was conducted by a professional panel of the Institute of Adriatic Cultures composed of 10 experts sensory evaluators. Quantitative descriptive sensory analysis was performed according to the IOC methodology and the aromatic profile of the analyzed olive oils of wild olives was defined.

**Key words:** aromatic profile, *Olea oleaster*, olive oil, sensory analyses, wild olives





**Poljoprivredna  
tehnika**

**09**

**Agricultural  
Technics**



## Optimiranje roka žetve miskantusa za proizvodnju bioplina

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### Sažetak

Sektor proizvodnje bioplina u EU u zadnjem desetljeću bilježi značajan porast. Zbog rastućeg broja bioplinskih postrojenja te njihovih kapaciteta, no i zbog primarne potrebe proizvodnje hrane, prisutna je problematika povezana s uzgojem sirovine koja se najčešće koristi kao sirovina u proizvodnji bioplina – silažni kukuruz. Njegov uzgoj uglavnom je konvencionalan, zahtjeva veće količine sredstava za zaštitu bilja, česte prohode poljoprivredne mehanizacije te uzrokuje izravne i neizravne kompeticije s prehrambenim lancem. Iz navedenih razloga, postoji potreba za pronalaskom potencijalnih zamjenskih i održivih sirovina, pri čemu je energetska kultura miskantus (*Miscanthus x giganteus*) prepoznata kao visoko potencijalna i vrlo konkurentna. Žetva miskantusa tijekom vegetacijskog razdoblja značajno utječe na prinos i prikladnost sastava te prinos metana usporedivog sa silažnim kukuruzom. Kako žetva tijekom vegetacijskog razdoblja negativno utječe na prinose u narednim vegetacijskim razdobljima, u svrhu određivanja roka žetve miskantusa za proizvodnju bioplina važno je u obzir uzeti vegetacijski stadij nasada te tehnološke potrebe skladištenja i korištenja. Odgovarajuće razdoblje za obavljanje takve žetve jest nakon razdoblja cvatnje, pri optimalnom sadržaju vode za proces skladištenja siliranjem. Intenzivnim praćenjem temperature zraka, prinosa, sadržaja vode i stupnja cvatnje kroz vegetacijsku sezonu, određen je optimalni rok žetve s minimalnim negativnim utjecajem na nasad te pozitivnim na proizvodnju bioplina.

**Ključne riječi:** miskantus, bioplin, žetva

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## Optimizing harvest time of miscanthus for biogas production

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### Summary

The EU biogas sector has grown significantly over the last decade. Due to the growing number of biogas plants and their capacities, but also due to the primary need for food production, there are problems associated with the cultivation of the most common raw material of these plants - silage maize. Its cultivation is usually conventional, requires larger amounts of herbicides, frequent passes of agricultural machinery, and causes direct and indirect competition with the food chain. Because of this, there is a need for selection of alternative and sustainable raw materials, where the energy crop miscanthus (*Miscanthus x giganteus*) was recognized as a high potential and competitive crop. Harvest of miscanthus during vegetation period significantly affects the yield, compositional suitability, and methane yield comparable to silage maize. As harvest during the vegetation period negatively affects following years re-growth, to determine harvest date of miscanthus for biogas production, it is essential to take into account the vegetation stage of plantation and technological requirements for storage and utilization. The appropriate period for carrying out such harvest follows flowering, at a moisture content of biomass which is suitable for the ensiling conservation process. By intensive monitoring of air temperature, yield, water content, and flowering rate throughout the growing season, optimal harvest time with a minimal negative impact on the plantation and positive on biogas production was determined.

**Key words:** miscanthus, biogas, harvest

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## Primjena precizne poljoprivrede i tehnoloških traka u optimalizaciji poljoprivredne proizvodnje

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### Sažetak

Precizna poljoprivreda je moderan koncept upravljanja poljoprivredom koji koristi digitalne tehnike za praćenje i optimizaciju procesa poljoprivredne proizvodnje. Agroekološki pristup usredotočen je na interakcije između biljaka, životinja, organizama u tlu, ljudi i okoliša. Cilj mu je optimizirati upotrebu prirodnih resursa, poboljšati biološke procese u tlu i poboljšati cikluse biomase, hranjivih sastojaka, ugljika i vode. U radu se prikazuje pregled najnovije literature o opravdanosti korištenja precizne poljoprivrede na primjeru prosječnog OPG-a u RH. Nadalje, prikazuju se saznanja iz područja agroekologije u primjeni precizne poljoprivrede u svijetu i u Hrvatskoj, te uporaba precizne poljoprivrede na konkretnom primjeru OPG-a Ervačić i Poljoprivrednog obrta Doha. Temeljem analize izloženih podataka, mogu se navesti neka predviđanja za budućnost te će se evaluirati uspješnost ovakvog načina poljoprivredne proizvodnje. Također, daju se prijedlozi za implementaciju novih tehnologija koje mogu dodatno unaprijediti trenutnu proizvodnju. Sustav stalnih tragova ili tehnoloških traka predstavljaju paralelne linije koje omogućuju prohod poljoprivredne mehanizacije kroz polje radi obavljanja gnojidbe i zaštite bilja tijekom vegetacije, a formiraju se u sjetvi. Ovaj sustav omogućava preciznu gnojidbu i zaštitu bez preklapanja prohoda i predstavlja poboljšanje konvencionalne agrotehnike, što je prihvatljivo za manja poljoprivredna gospodarstva kod kojih nije moguće ili je neracionalno koristiti strojeve u sustavu digitalne ili precizne poljoprivrede.

**Ključne riječi:** precizna poljoprivreda, tehnološke trake, optimalizacija resursa

## Application of precision agriculture and technological tracks in the optimization of agricultural production

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### Summary

Precision agriculture is a modern concept of agricultural management that uses digital techniques to monitor and optimize the process of agricultural production. The agroecological approach focuses on the interactions between plants, animals, soil organisms, humans, and the environment. It aims to optimize the use of natural resources, improve biological processes in soil and improve cycles of biomass, nutrients, carbon and water. The paper presents an overview of the latest literature on the justification of the use of precision agriculture on the example of the average family farm in the Republic of Croatia. Furthermore, knowledge from the field of agroecology in the application of precision agriculture in the world and in Croatia is presented, as well as the use of precision agriculture on a specific example of the family farm Ervačić and the Agricultural Craft Doha. Based on the analysis of the presented data, some predictions for the future can be given and the success of this way of agricultural production will be evaluated. Also, suggestions are given for the implementation of new technologies that can further improve current production. The system of permanent tracks or technological tracks are parallel lines that allow the passage of agricultural machinery through the field to perform fertilization and plant protection during the growing season, and are formed in sowing. This system enables precise fertilization and protection without overlapping passages and represents an improvement of conventional agrotechnics, which is acceptable for smaller farms where it is not possible or irrational to use machines in the digital or precision agriculture system.

**Key words:** precision agriculture, technological strips, resource optimization

## Dostupnost i energetski potencijal ostataka proizvodnje maslinovog ulja u Zadarskoj i Šibensko-kninskoj županiji

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### Sažetak

Saznanja o dostupnosti ostataka proizvodnje maslinovog ulja u Zadarskoj i Šibensko-kninskoj županiji su značajni s aspekta procjene njihovog energetskog potencijala. Cilj ovog istraživanja bio je analizirati dostupnost biomase ostataka koji nastanu u proizvodnji maslinovog ulja, temeljem podataka o površinama maslinika i karakteristikama maslina. Istraživanjem su obuhvaćene tri proizvodne godine (2018.-2020.), pri čemu su obrađeni podaci o broju stabala, površinama, starosti nasada, uljarama kao i urodu maslina te proizvodnji maslinovog ulja. Utvrđeno je da su urod i proizvodnja ulja značajno viši u Zadarskoj županiji s obzirom da maslinici imaju bolji proizvodni potencijal, ali i zbog činjenice da su u toj županiji veće proizvodne površine. Površine pod maslinicima u Zadarskoj i Šibensko-kninskoj županiji imaju udjel od 30,74 % ukupnih površina maslinika u Hrvatskoj. Količina rezidbenih ostataka je 10.414,21 t/god, a komine 3.689,49 t/god, što ukazuje na visoki potencijal biomase koja je dostupna kao mogući alternativni izvor energije u istraživanim županijama.

**Ključne riječi:** maslina, ostaci, energetski potencijal, Zadarska županija, Šibensko-kninska županija

## Availability and energy potential of waste from olive oil production in Zadar and Šibenik-Knin county

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### Summary

Knowledge of the availability of waste from olive oil production in Zadar and Šibenik-Knin counties is significant from the aspect of assessing their energy potential. The aim of this study was to analyse the biomass availability of waste generated in olive oil production, based on the data on olive groves and olive characteristics. The research has covered three production years (2018-2020), namely data on the number of trees, areas, age of plantations, oil mills, olive yields, as well as olive oil production. It was found that the yield and oil production are significantly higher in Zadar County, given that olive groves have better production potential, but also due to the fact that this county has larger production areas. Areas under the olive groves in Zadar and Šibenik-Knin counties have a share of 30.74% of the total area of olive groves in Croatia. The amount of pruning residues is 10,414.21 t/yr, and pomace 3,689.49 t/yr, which indicates the high potential of biomass that is available as a possible alternative energy source in the observed counties.

**Key words:** olive, waste, energy potential, Zadar County, Šibenik-Knin county

## Modeli mješanja gnojovke, gnojnice i digestata u različitim tipovima spremnika

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### Sažetak

Tekuće i polutekuće materijale poput gnojovke, gnojnice i digestata koji nastaju kao nusproizvodi u stočarskoj proizvodnji i u proizvodnji bioplina, definira izuzetno visoka razina sedimentacijskih svojstava. Temeljem zakonskih regulativa koje su na snazi u zemljama članicama EU, obveza je proizvođača koji se bave stočarskom proizvodnjom i proizvođača koji se bave proizvodnjom bioplina osigurati kapacitet spremnika (nadzemnog/podzemnog) za period spremanja gnojovke, gnojnice ili digestata kroz period od minimalno šest mjeseci. Kroz navedeni period gnojovku, gnojnicu i digestat kao materijale koji kontinuirano sedimentiraju u spremnicima u kojima se skladište, neophodno je homogenizirati prije aplikacije na oranične površine kako bi se dobila adekvatna razina svih hranjivih komponenti (N, P, K, mikroorganizmi, organska tvar i dr.). Uspješnost homogenizacije definira se kroz postotak izmješanosti određenog tipa materijala (gnojovka, gnojnica, digestat). Izmješanost putem PPM–plutajuće platforme za mješanje, kreće se u rasponu od 80 % - 95 % izmješanosti ukupne mase materijala uz najbolji učinak po radnom satu u odnosu na volumen koji se homogenizira. Modeli mješanja elektromješačima ili pneumatski, putem kompresorskih mješača iskazuju manji učinak kroz povećanu potrošnju energije i vremena. Usporedno je prikazan odnos i uspješnost različitih modela mješanja kroz prikaz hidrauličkog mješanja u odnosu na mehaničko i pneumatsko mješanje materijala poput gnojovke, gnojnice i digestata.

**Ključne riječi:** gnojovka, digestat, mješanje, hidraulično

## Models of Mixing the various Type of Manures and Digestates in different Type of Storages

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### Summary

Liquid and semiliquid materials such as manures and digestates produced as by-products in livestock and biogas production are characterized as highly sedimented materials. Based on legal regulation introduced in EU countries, there is an obligation of the livestock and biogas producers to provide storage capacity (above ground/underground) for a period of storage of manure or digestate for a minimum of six months. During the storage period of different types of manures and digestates, the mentioned materials have a strong affinity for sedimentation and it is necessary to mix and homogenized it before the application on the arable land where nutrients such as N, P, K, microorganisms, organic matter, can be applicable for incorporation into the soil. Mixing of the mentioned materials with AFM – Agitation Floating Machine gives us about 80%-95% of homogenized material and it show the best efficiency per hour of mixing in correlation with the volume that we want to mix and homogenize. Models of mixing and stirring by using electric or pneumatic mixers, powered by electromotors or compressors show less efficiency through higher consumption of energy and time. Comparison of efficiency of the different models of mixing and stirring by using hydraulic mixing in comparison with the mechanical and pneumatic mixing of the materials such as different types of manures and digestates.

**Key words:** manure, digestate, mixing, hydraulic

## Microcapsules production with mathematical optimization coupled with CFD simulation and neural networks

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### Summary

Modern agricultural production uses more and more new and innovative methods for nutrition and protection of certain plant crops. One of the newer methods is the method of applying microcapsule formulations filled with bioactive components with time release. To achieve the production of microcapsule formulation with optimal properties and shape, it is necessary to optimize the preparation parameters (concentration, temperature, pressure-flow rate, nozzle size). We propose a method to select these parameters using a novel procedure. Firstly, a potentially promising parameter set will be chosen based on a neural network trained using previous data. Secondly, a mathematical optimization algorithm will refine the set using CFD simulations of the microcapsule equipment. This is all done to minimize the number of real-world experiments that need to be done. Lastly, the lab technician will receive instructions on which parameters to use and measure the results entering them into the algorithm which in turn will iteratively offer an improved set of parameters with regards to the chosen properties.

**Keywords:** microcapsules optimization, encapsulation, computational fluid dynamics, neural networks, mathematical optimization



