ZNANOŠĆU DO INOVACIJA
za održivi razvoj poljoprivrede i turizma

FROM SCIENCE TO INNOVATION
For Sustainable Development of Agriculture and Tourism

150
1875 – 2025

Znanstveni skup u povodu 150. obljetnice Instituta za poljoprivredu i turizam
„Znanošću do inovacija za održivi razvoj poljoprivrede i turizma“

Scientific Conference to mark the 150th anniversary of the Institute of Agriculture and Tourism
“From Science to Innovation for Sustainable Development of Agriculture and Tourism”

ZBORNIK SAŽETAKA
BOOK OF ABSTRACTS



Poreč, 8. i 9. svibnja 2025.
Poreč, 8–9 May, 2025

Znanstveni skup u povodu 150. obljetnice Instituta za poljoprivredu i turizam "Znanošću do inovacija za održivi razvoj poljoprivrede i turizma" (2025; Poreč)
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Poreč, 8. i 9. svibnja 2025.
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Organizatori / Organizers

Institut za poljoprivredu i turizam / Institute of Agriculture and Tourism
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Predsjednik Organizacijskog odbora Skupa / Chairman of the Organizing Committee of the Conference
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dr. sc. Igor Pasković, *predsjednik Znanstvenog skupa / Chairman of the Scientific Conference*

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Hrvatska akademija znanosti i umjetnosti / Croatian Academy of Sciences and Arts
Akademik Ferdo Bašić, *predsjednik Znanstvenog skupa / Chairman of the Scientific Conference*
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doc. dr. sc. Josip Haramija, predsjednik Hrvatskog agronomskog društva / President of the Croatian Society of Agronomists
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dr. sc. Kristina Brščić
dr. sc. Igor Pasković

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dr. sc. Anita Silvana Ilak Peršurić
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Katarina Breščić, mag. oec.
Nataly Milovan, univ. bacc. mariscient.

Tajništvo skupa / Conference secretariat

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Marija Polić Pasković, dipl. ing. agr.

Pozdravna riječ domaćina

Obljetnica postojanja i djelovanja našeg Instituta, kojom ove godine obilježavamo 150 godina, predstavlja mnogo više od same brojke. Ona je svjedočanstvo naše bogate povijesti, naše predanosti znanosti i istraživanju, kao i kontinuiteta sinergije održivog razvoja u području poljoprivrede i turizma – dvaju sektora koji čine samu srž gospodarskog identiteta Hrvatske.

Na osnovu odluke Istarskog sabora osnovana je Pokrajinska vinarsko-voćarska stanica te je započela s radom 1875. godine. Nitko tada nije mogao slutiti da će upravo na temeljima te ustanove izrasti institucija koja će danas, 150 godina kasnije, biti jedan od stupova hrvatske znanstveno-istraživačke zajednice. Institut je tijekom svoje povijesti mijenjao nazive, strukturu, područja djelovanja, ali mu je uvijek ostala zajednička jedna misija – unaprijediti znanje, stvoriti novu vrijednost i služiti zajednici.

Danas, više nego ikad, jasno je da održivost nije puka fraza, već ključ opstanka. Hrvatska ima golem potencijal u poljoprivredi – plodna tla, povoljnu klimu, vodne resurse, stručne ljude – i jednako značajne resurse u turizmu. Upravo u toj međupovezanosti, u toj dinamičnoj sinergiji, leži potencijal za budućnost. Institut za poljoprivredu i turizam prepoznaje i istražuje tu poveznicu kroz multidisciplinarna istraživanja koja spajaju znanje, praksu i inovacije.

Znanstveni skup "*Znanošću do inovacija za održivi razvoj poljoprivrede i turizma*" ima za cilj otvoriti prostor za raspravu o inovativnim rješenjima, povezivanju sektora, primjeni suvremenih znanstvenih spoznaja i tehnologija, ali i kreiranju strategija koje će oblikovati održivu budućnost. Izuzetno smo ponosni što se u organizaciju skupa uključilo više prestižnih znanstvenih i stručnih institucija, što dokazuje da je naš rad prepoznat i cijenjen na nacionalnoj i međunarodnoj razini.

Institut za poljoprivredu i turizam danas zapošljava više od 80 djelatnika a u posljednjem desetljeću objavili smo stotine znanstvenih radova, sudjelovali u brojnim projektima Hrvatske zaklade za znanost, EU programima kao što su Obzor 2020, Obzor Europa, Interreg, Erasmus+ i drugima, čime smo dodatno osnažili svoju poziciju i osigurali stabilan rast. Posebno bih istaknuo naš doprinos očuvanju i valorizaciji autohtonih sorata, kao i izgradnju suvremene znanstvene infrastrukture koja uključuje tehnološki napredne laboratorije i pokusno imanje. Institut je u posljednjih nekoliko godina višestruko povećao svoje kapacitete, i to zahvaljujući znanju, predanosti i entuzijazmu svih djelatnika.

Uspjeh se ne događa slučajno. On je rezultat vizije, timskog rada i potpore – kako institucija, osobito Ministarstva znanosti, obrazovanja i mladih, tako i naših partnera, suradnika i šire zajednice. U konačnici, zahvaljujem i svim sadašnjim i bivšim djelatnicima, znanstvenicima i prijateljima Instituta koji su u prošlosti i danas svojim znanjem i radom iz dana u dan činili ovu instituciju boljom.

dr. sc. Dean Ban
Predsjednik organizacijskog odbora Skupa
Ravnatelj Instituta za poljoprivredu i turizam

Pozdravna riječ akademika

STOLJEĆE I POL U NAPRETKU POLJOPRIVREDE I TURIZMA ISTRE

Ferdo Bašić, Frane Tomić
Hrvatska akademija znanosti i umjetnosti, Razred za prirodne znanosti

Kakav život! Najnevjerojatniji od svih hrvatskih romana, njemačko dijete i najljepši primjer naše asimilacione snage, „Eseker" i hrvatski domoljub, velikaš Crkve i pionir nauke, najomraženiji i najmiliji sin roda, bez sumnje najslavniji, „naša dika". Kao zvuk katedralnih zvona što zvuči nad salašima i u dubini šuma ubave Đakovštine, tako je njegov jaki glas učio Europu da nas još ima –„još Hrvata"…. Strossmayer je sebi sagradio kraljevski panteon… sunčajući se još za života na suncu besmrtnosti. Orlovi, oj gdje ste, visoki, sunčani, naši orlovi!

A.G. Matoš 1906.

U godini slave 1 100 godina Hrvatskog Kraljevstva, čestitajući Institutu za poljoprivredu i turizam u Poreču stoljeće i pol djelovanja na razvoju čije je ishodište fiziokratska gospodarska škola 18. stoljeća, svojim naučavanjem kako se izvori bogatstva i stvarne novostvorene vrijednosti i osnove gospodarskog napretka i razvoja svake zemlje stvaraju fotosintezom u poljoprivredi i šumarstvu. Tu postavku je prihvatio i na prostore Monarhije u praksu prenio Bečki dvor, pokrećući i na našim prostorima povijesne promjene - ukidanje kmetstva, katastar, zemljišne knjige, Zakon o šumarstvu… Glas vremena izvrsno je razumio i oslobođenu energiju naroda usmjerio Duhovni vođa hrvatskog naroda đakovačko-srijemski i bosanski biskup J.J. Strossmayer. Na valu istih vrijednosti pokreće utemeljenje Akademije, a za *učeću mladež* obnavlja Sveučilište u Zagrebu, operativno provodi osnivanje Kraljevskog gospodarskog i šumarskog učilišta u Križevcima i utire put nizu poljoprivrednih škola od Iloka do Dubrovnika.

Na globalnom planu razvoj gospodarske misli na osnovama fiziokratizma mijenja se, prilagođava i dopunjuje, da bi u našemu vremenu prerastao u nekovrsni neo-fiziokratizam - koncept gospodarski, socijalno i okolišno održivog razvoja. Početkom druge polovine 19. stoljeća Viziju toga razvoja biskup Strossmayer definira sintagmom *Hrvatska Toscana,* kako je vizionarski zamislio mjesto Hrvatske u (zbog atentata u Sarajevu) nikada ostvarenoj Austro-slavenskoj federaciji. Ove, 2025. god., valja nam obilježiti spomen 210 godina od rođenja, a 120 godina od preminuća toga lučonoše južnoslavenskog javnog života. Poljoprivredu i turizam, uz prateće djelatnosti vidimo kao neprijeporni temelj održivog razvoja danas, a vjerujemo i razvoja sutrašnjice na fotosintezi i neugljičnim, obnovljivim, izvorima energije. Hrvatska je opredijeljena za taj razvoj, a u Istri mu je čvrsta okosnica znanstveno-istraživačka, savjetodavna, i djelatnosti u obrazovanju Instituta za poljoprivredu i turizam u Poreču… Djelujući stoljeće i pol na ostvarenju vizije razvoja uvijek po mjeri vremena djelovanja, Institut – Slavljenik je po našoj ocjeni Istru ponajviše približio viziji označenoj sintagmom – *Hrvatska Toscana!* Hrvatsku budućnosti vidimo po mjeri našega Utemeljitelja: *Toscana od Iloka do Dubrovnika* - zemlja lišena uvoza, pače izvoznica hrane i na toj osnovi poželjni partner gospodarstvu europskih i izvaneuropskih država i destinacija najizbirljivije turističke klijentele, a Istru kao razvijeniji dio iz čijega iskustva s prijeđena puta valja učiti. Put je dug, zahtjevan i pun zamki i izazova.

Čestitajući 150. obljetnicu čelništvu Instituta, svim djelatnicama i svim djelatnicima želimo uspješan, miran, skladan rad u ozračju svijesti o svom značaju u znanosti i obrazovanja u općem napretku Istre i Republike Hrvatske.

Na tom putu, Institut kao i do sada može računati na otvorena vrata, nepodijeljenu i svesrdnu potporu Hrvatske akademije znanosti i umjetnosti.

PROGRAM ZNANSTVENOG SKUPA

8. svibnja 2025.

Dvorana Magnolija

10:00 – 10:40 Svečano otvaranje Skupa

10:40 – 11:20 Plenarna predavanja

Moderatori: *dr. sc. Kristina Brščić i dr. sc. Igor Pasković*

11:20 – 11:50 Pauza

11:50 – 13:30 Plenarna predavanja

Moderatori: *dr. sc. Kristina Brščić i dr. sc. Igor Pasković*

13:30 – 14:15 Pauza

15:00 – 15:50 Usmena izlaganja: Sekcija Povrćarstvo

Moderatori: *dr. sc. Smiljana Goreta Ban i dr. sc. Nevena Opačić*

15:55 - 17:00 Usmena izlaganja: Sekcija Održive strategije: od biostimulatora do mikrobioma i Sekcija Zaštita bilja

Moderatori: *dr. sc. Sara Godena i dr. sc. Nikola Major*

Dvorana Lovor

15:00 – 16:25 Usmena izlaganja: Sekcija Vinogradarstvo i vinarstvo i voćarstvo

Moderatori: *dr. sc. Sanja Radeka i dr. sc. Marijan Bubola*

16:30 – 17:10 Usmena izlaganja: Sekcija Maslinarstvo

Moderatori: *dr. sc. Karolina Brkić Bubola i dr. sc. Marin Krapac*

Dvorana Oleandar

14:15 – 15:00 Poster sekcija

Moderatori: *dr. sc. Anita Silvana Ilak Peršurić i dr. sc. Mario Franić*

OBZOR 2020, projekt SPRINT – Prezentacija rezultata i dijalog s dionicima

19:30 – 20:00 Okupljanje sudionika

20:00 – 00:00 Svečana večera u restoranu hotela

9. svibnja 2025.

Dvorana Magnolija

9:30 – 11:00 Prezentacija projekata

Moderatori: *dr. sc. Barbara Sladonja i dr. sc. Igor Lukić*

11:00 – 11:30 Pauza

11:30 – 13:10 Prezentacija projekata

Moderatori: *dr. sc. Danijela Poljuha i dr. sc. Igor Palčić*

Dvorana Lovor

9:30 – 11:00 Usmena izlaganja: Sekcija Turizam

Moderatori: *dr. sc. Ana Težak Damijanić i izv. prof. dr. sc. Nataša Kovačić*

11:00 – 11:30 Pauza

11:30 – 12:05 Usmena izlaganja: Sekcija Agrarna ekonomija

Moderatori: *prof. dr. sc. Marija Cerjak i dr. sc. Milan Oplanić*

12:10 – 13:20 Usmena izlaganja: Sekcija Upravljanje otpadom i Sekcija Agroekologija

Moderatori: *prof. dr. sc. Marko Černe i prof. dr. sc. Stjepan Husnjak*

HyPro4ST projekt – Dan otvorenih vrata

13:30 – 14:30 Ručak u hotelskom restoranu

14:30 – 15:30 Stručni posjet Institutu za poljoprivredu i turizam

15:30 – 16:30 Vođeni obilazak povijesne jezgre grada Poreča

PROGRAMME OF THE SCIENTIFIC CONFERENCE

8th May, 2025

Magnolia Hall

10:00 – 10:40 Official Opening of the Conference

10:40 – 11:20 Plenary Lectures

Moderators: *Kristina Brščić, PhD and Igor Pasković, PhD*

11:20 – 11:50 Break

11:50 – 13:30 Plenary Lectures

Moderators: *Kristina Brščić, PhD and Igor Pasković, PhD*

13:30 – 14:15 Break

15:00 – 15:50 Oral Presentations: Vegetable growing Section

Moderators: *Smiljana Goreta Ban, PhD and Nevena Opačić, PhD*

15:55 -17:00 Oral Presentations: Sustainable Strategies: From Biostimulants to the Microbiome Section

Moderators: *Sara Godena, PhD and Nikola Major, PhD*

Lovor Hall

15:00 – 16:25 Oral Presentations: Viticulture, Oenology and Pomology Section

Moderators: *Sanja Radeka, PhD and Marijan Bubola, PhD*

16:30 – 17:10 Oral Presentations: Olive Growing Section

Moderators: *Karolina Brkić Bubola, PhD and Marin Krapac, PhD*

Oleander Hall

14:15 – 15:00 Poster Section

Moderators: *Anita Silvana Ilak Peršurić, PhD and Mario Franić, PhD*

HORIZON 2020, SPRINT project – Results presentation and stakeholders discussion

19:30 – 20:00 Participant Gathering

20:00 – 00:00 Gala Dinner at the Hotel Restaurant

9th May, 2025

Magnolia Hall

09:30 – 11:00 Project Presentations

Moderators: *Barbara Sladonja, PhD and Igor Lukić, PhD*

11:00 – 11:30 Break

11:30 – 13:10 Project Presentations

Moderators: *Danijela Poljuha, PhD and Igor Palčić, PhD*

Lovor Hall

09:30 – 11:00 Oral Presentations: Tourism Section

Moderators: *Ana Težak Damijanić, PhD and Associate Professor Nataša Kovačić, PhD*

11:00 – 11:30 Break

11:30 – 12:05 Oral Presentations: Agro-economy Section

Moderators: Professor Marija Cerjak, PhD and Milan Oplanić, PhD

12:10 – 13:20 Oral Presentations: Waste management Section and Agroecology Section

Moderators: *Marko Černe, PhD and Professor Stjepan Husnjak, PhD*

HyPro4ST project – Open day

13:30 – 14:30 Lunch at the Hotel Restaurant

14:30 – 15:30 Study Visit - Institute of Agriculture and Tourism

15:30 – 16:30 Guided Walking Tour of the Historic Town of Poreč

Sekcije / Sections

1. Plenarna predavanja / Plenary lectures
2. Povrćarstvo / Vegetable growing
3. Održive strategije: od biostimulatora do mikrobioma / Sustainable Strategies: From Biostimulants to the Microbiome
4. Zaštita bilja / Plant protection
5. Vinogradarstvo, vinarstvo i voćarstvo / Viticulture, Oenology and Pomology
6. Maslinarstvo / Olive growing
7. Turizam / Tourism
8. Agrarna ekonomija / Agro-economy
9. Upravljanje otpadom / Waste management
10. Agroekologija / Agroecology
11. Predstavljanje projekata / Project presentation

Sadržaj

Zaštita bilja / Plant protection

Vinogradarstvo, vinarstvo i voćarstvo / Viticulture, Oenology and Pomology

Maslinarstvo / Olive growing

Turizam / Tourism

Agrarna ekonomija / Agro-economy

Upravljanje otpadom / Waste management

Agroekologija / Agroecology

Predstavljanje projekata / Project presentation

Plenarna predavanja

Plenary lectures

Erozija vjetrom u Čepić polju – analiza i izazovi 13 godina poslije

Ivica Kisić[1]*, Igor Bogunović[1]

[1] Sveučilište u Zagrebu Agronomski fakultet, Svetošimunska c. 25, Zagreb, *ikisic@agr.hr

Sažetak:
Erozija tla vjetrom štetna je pojava na poljoprivrednim tlima, čija se važnost u Europi naglo povećala u posljednjim desetljeća, primarno zbog sve veće učestalosti ove pojave uslijed klimatskih promjena i promjena vrsta uzgajanih kultura. Težište problema pomaklo se s direktnih učinaka (ekonomski učinci – štete na polju i na kulturama) na indirektne štetne učinke (utjecaj na okoliš, onečišćenje voda, vidljivost, ljudsko zdravlje – problemi dišnoga sustava, alergije). Što se tiče problema erozije tla vjetrom u Čepić polju, taj problem postoji od isušivanja Čepić jezera i formiranja obradivih površina prije II. svjetskog rata. Posljednja velika erozija zabilježena je u veljači 1984. godine kada je tlo bilo nošeno čak do Pule koja je udaljena oko 60 kilometara.
Krajem siječnja i početkom veljače 2012. godine posljedice erozije vjetrom bile su katastrofalnih razmjera. Temeljem uvida u stanje na području zahvaćenom ovom prirodnom katastrofom, Općina Kršan je 24. veljače 2012. godine proglasila elementarnu nepogodu uzrokovanu olujnim vjetrom. Procijenjeni iznos nastale štete iznosio je 2.45 milijuna eura. Izravna šteta uslijed uništenih zasijanih kultura procijenjena je na 384.051,62 eura, dok su šteta zbog privremeno onesposobljenog i oštećenog zemljišta te troškovi sanacije iznosili 2.017.698,59 eura. Prema procjeni Hrvatskih voda ukupno je utrošeno otprilike 172.539,65 eura na izmuljivanju kanalske mreže zatrpane plodnim tlom uslijed elementarne nepogode, pri čemu je očišćeno oko 22 km kanala II., III. i IV reda. Po završenoj sanaciji bilo je potrebno provesti hidrotehničke i agrotehničke mjere zaštite tla radi sprječavanja slične situacije u skorijoj budućnosti. Navedeno se primarno odnosilo na obnovu vjetrozaštitnih pojasa – drvoreda. Također, načini ublažavanja posljedica erozije tla vjetrom uključuju promjene načina gospodarenja tlom (konzervacijski načini i vrijeme obrade) te podizanju vjetrozaštitnih pojasa dominantno izrađenih od kanadske topole (Populus x canadensis Moench). Trenutno stanje topola u Čepić polju vrlo je nezadovoljavajuće. Dio nasada topola jako je nagnut od udara bure te postoji velika opasnost od njihova padanja. Neke topole uopće nemaju gornji dio krošnje, budući da ga je bura otpuhala. Na nekim stablima primijećeno je da se 50% volumena korijena nalazi iznad površine tla, što predstavlja opasnost za zakupce zemljišta i prolaznike. Tijekom cijele godine postoji velika vjerojatnost pada osušenih grana s debla topola na slučajne prolaznike. Važno je naglasiti da se u Čepić polju nalaze i staništa tartufa, koja su usko povezana s drvoredima. Radi njihove zaštite, poljoprivredna zadruga Čepić polje Kršan donijela je odluku o zaštiti staništa bijelog i crnog tartufa. Pri odabiru biljnih vrsta za vjetrozaštitne pojase trebalo bi uključiti što više okolišno prihvatljivih indikatora iz koda dobre poljoprivredne prakse, odnosno Zelene politike EU. U budućnosti, vjetrozaštitni pojasi trebali bi imati više funkcija, a ne samo sprječavanje erozije tla vjetrom. U samom polju sve veću zastupljenost trebala bi imati lucerna (kao što je bilo nekada), a hranu za stoku trebalo bi temeljiti na krmnim kulturama npr., lucerni, ljulju te stočnom grašku usijanom u ječam. Također, neke površine koje su bile najizloženije buri trebalo bi ponovno zatravniti i pretvoriti u livade ili pašnjake. Mjere poduzete u sanaciji Čepić polja u cilju ublažavanja posljedica buduće erozije vjetrom bit će prikazane u ovom radu.

Ključne riječi: erozija vjetrom, vjetrozaštita, dobra poljoprivredna praksa, zeleni plan EU

Wind erosion in Čepić polje – analysis and challenges 13 years later

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Abstract:
Wind erosion of soil is a harmful phenomenon affecting agricultural land, whose significance in Europe has sharply increased in recent decades. This rise is primarily due to the growing frequency of such occurrences, driven by climate change and shifts in cultivated crop types. The focus of the problem has shifted from direct impacts (economic damage to fields and crops) to indirect harmful effects, such as environmental impact, water pollution, reduced visibility, and negative effects on human health (respiratory issues, allergies). Regarding the problem of wind erosion in Čepić Field, this issue has existed since the drainage of Čepić Lake and the formation of arable land before World War II. The last major erosion event was recorded in February 1984, when soil was carried as far as Pula, approximately 60 kilometers away.
At the end of January and the beginning of February 2012, the consequences of wind erosion were catastrophic. Following an assessment of the affected area, the Municipality of Kršan declared a natural disaster caused by stormy winds on February 24, 2012. The estimated damage amounted to 2.45 million euros. The direct damage due to destroyed sown crops was estimated at 384.051,62 euros, while the damage from temporarily unusable and damaged land, along with remediation costs, amounted to 2.017.698,59 euros. According to the assessment of Croatian Waters, approximately 172.539,65 euros were spent on dredging the canal network, which had been buried under fertile soil due to the disaster, with about 22 km of II-, III-, and IV-order canals being cleared. After the remediation was completed, it was necessary to implement hydrotechnical and agrotechnical soil protection measures to prevent a similar situation in the near future. This primarily involved the restoration of windbreak belts – tree rows. Additionally, measures to mitigate the effects of wind erosion include changes in soil management (conservation tillage methods and timing) and the establishment of windbreak belts, predominantly made of Canadian poplar (Populus x canadensis Moench). The current state of poplars in Čepić Field is highly unsatisfactory. A portion of the poplar plantations is severely tilted due to strong bora winds, posing a significant risk of collapse. Some trees have completely lost their upper canopy, as it was blown away by the wind. In some cases, up to 50% of the root volume is above ground, creating a safety hazard for land leaseholders and passersby. Throughout the year, there is a high probability of dry branches falling from poplar trunks. It is important to emphasize that Čepić Field is also home to truffle habitats, which are closely linked to the tree rows. To protect these habitats, the Čepić Field Kršan Agricultural Cooperative has decided to safeguard the habitats of white and black truffles.
When selecting species for windbreak belts, it is essential to include as many environmentally friendly indicators as possible from the Code of Good Agricultural Practices and the EU Green Policy. In the future, windbreak belts should serve multiple functions beyond merely preventing wind erosion. Within the field, alfalfa should become increasingly prevalent (as it once was), and livestock feed should be based on forage crops such as alfalfa, ryegrass, and field peas sown with barley. Additionally, some areas that have been most exposed to the bora wind should be regrassed and converted into meadows or pastures.
The measures undertaken in the restoration of Čepić Field, aimed at mitigating the consequences of future wind erosion, will be presented in this study.
Keywords: wind erosion, windbreaks, good agricultural practices, EU Green policy

Održivi marketing za održivi turizam

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Sažetak:
Kako bi se spoznao utjecaj održivog marketinga na održivi turizam, a potom i njihova međusobna interaktivnost, potrebno je ponajprije odrediti pojam održivosti kako marketinga, tako i turizma. Pojam, ali i značenje održivosti možda je najjednostavnije razumjeti ako se upotrijebi negacija tog pojma, a to je neodrživost. Neodrživost očito niti kratkoročno niti dugoročno nije nešto prihvatljivo bez obzira iz kojeg rakursa se promatra, dok to održivost očito jest. Dakle, riječ je o sigurnosti u odnosu na neizvjesnost koja je, nažalost, gotovo vladajući pojam naše današnjice. Općepoznata definicija održivosti kazuje kako se održivost odnosi na zadovoljavanje sadašnjih potreba bez ugrožavanja sposobnosti budućih generacija da zadovolje svoje buduće potrebe. Održivi razvoj ostvaruje ravnotežu između njegove ekonomske sastavnice, koja se očituje kroz zahtjev za unapređivanjem kvalitete života, potom njegove socijalne sastavnice, koja se očituje zahtjevom za ostvarivanjem socijalne dobrobiti i mira za sve, te naposljetku i njegovom sastavnicom okoliša kao zahtjeva za očuvanjem prirodnih dobara o kojima ovise i sadašnje i buduće generacije. S druge strane, marketing se, kao znanstvena ali i praktična disciplina, prije svega, odnosi na zadovoljavanje potreba potrošača, ali i svih ostalih mogućih sudionika u razmjeni. Marketing, uvijek prati društveno-ekonomski razvoj i odraz je postojećih društveno-ekonomskih odnosa, te se sukladno tomu u konkretnim okolnostima javio i tzv. održivi marketing. Održivi marketing je nova vizija, orijentirana na učinkovito korištenje resursa usmjerenih ponudi najbolje vrijednosti za potrošače/korisnike i druge dionike, uzevši u obzir dugoročne interese društva i okoliša. Sve prethodno navedeno može se i mora odnositi i na turizam, odnosno konkretnije na održivi turizam, koji je slijedom toga primjenjiv kod svih subjekata u turizmu kao i u svim konkretnim destinacijama. Hrvatski turizam u poziciji je da ostvari značajnu konkurentsku prednost koja proizlazi iz činjenice da Republika Hrvatska posjeduje sve preduvjete za razvijanje održivog turizma temeljenog na zaštiti okoliša, a moderator prethodno navedenoga može i mora biti održivi marketing.

Ključne riječi: marketing, održivost, održivi marketing, održivi turizam

Sustainable marketing for sustainable tourism

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Abstract:
In order to understand the impact of sustainable marketing on sustainable tourism and their mutual interaction, it is first necessary to define the concept of sustainability in both marketing and tourism. The concept as well as the meaning of sustainability is perhaps easiest to understand if we use the negation of this concept, namely unsustainability. Unsustainability is obviously something that is unacceptable in the short or long term, regardless of which perspective you look at it from, whereas sustainability obviously is. So it's about certainty versus uncertainty, which unfortunately is almost the predominant concept of our time. The commonly accepted definition of sustainability is that sustainability refers to meeting present needs without jeopardising the ability of future generations to meet their future needs. Sustainable development strikes a balance between its economic component, which manifests itself in the demand to improve the quality of life, then its social component, which manifests itself in the demand for social well-being and peace for all, and finally its environmental component as the demand to preserve the natural resources on which both present and future generations depend. On the other hand, marketing as a scientific and practical discipline is primarily concerned with satisfying the needs of consumers, but also of all other possible participants in the exchange. Marketing always follows socio-economic development and is a reflection of existing socio-economic relations, and accordingly, in certain circumstances, so-called sustainable marketing has emerged. Sustainable marketing is a new vision that is orientated towards the efficient use of resources and aims to provide the best value to consumers/users and other stakeholders, taking into account the long-term interests of society and the environment. All this can and must also apply to tourism, more precisely to sustainable tourism, which consequently applies to all tourism stakeholders as well as to all specific destinations. Croatian tourism is able to achieve a significant competitive advantage resulting from the fact that the Republic of Croatia has all the prerequisites for the development of sustainable tourism based on environmental protection, and the moderator of the above can and must be sustainable marketing.

Keywords: marketing, sustainability, sustainable marketing, sustainable tourism

Zelena tranzicija poljoprivredno-prehrambenih sustava

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Sažetak:
Uslijed globalnih izazova s kojima se danas suočava čovječanstvo, izdvajaju se tri ključna koja se osobito snažno odražavaju na postojeće poljoprivredno-prehrambene sustave: klimatske promjene, rastući broj svjetskog stanovništva i očuvanje prirodnih resursa. Potrebe za hranom na svjetskoj razini sve su veće kao izravna posljedica porasta broja globalnog stanovništva. Time u vezi proizvodnja hrane morat će se neizbježno povećati što će zahtijevati daljnje povećanje obradivih poljoprivrednih površina i za potrebe uzgoja usjeva namijenjenih prehrani ljudi, ali i za ispašu stoke. Trenutno, otprilike 37 % kopnene površine koristi se za poljoprivrednu proizvodnju, a istovremeno poljoprivreda je najveći potrošač slatke vode na globalnoj razini, troši otprilike 70 % zaliha slatkovodne raspoložive vode. Osim navedenog, intenzivna poljoprivredna proizvodnja podrazumijeva i opterećivanje tla umjetnim gnojivima čime se značajno narušava kvaliteta i zdravlje tla, a i neposredno opterećuju podzemne vode. U konačnici, poljoprivreda i proizvodnja hrane značajno doprinose globalnoj emisiji stakleničkih plinova (GHG) pri čemu su prehrambeni sustavi odgovorni za otprilike 30 % GHG emisija, a zajedno s poljoprivrednim proizvodima čine čak 1/3 globalnih emisija. Prehrambeni sustavi suočavaju se i s problemom otpada od hrane, koji dodatno opterećuje okoliš i resurse. Prema procjenama, otprilike 1/3 proizvedene hrane na globalnoj razini godišnje se baci. U skladu s europskim strateškim ciljevima klimatske neutralnosti, poljoprivreda treba postati nositelj promjena prema zelenijem i otpornijem sustavu koji će podržavati zdravlje ljudi i planete. Stoga je cilj ovog rada pružiti pregled trenutnih poljoprivredno-prehrambenih praksi, istaknuti primjere kružnih i resursno učinkovitih sustava te predstaviti inovativna rješenja koja mogu pomoći u prevladavanju izazova u ovom sektoru. Tranzicija više nije opcija – ona je nužnost za budućnost održive poljoprivrede i sigurnosti opskrbe hranom.

Ključne riječi: Strategija od polja do stola, održiva poljoprivreda, kružno biogospodarstvo, sigurnost opskrbe hranom, otpad od hrane

Green transition of agricultural and food systems

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Abstract:
In view of the global challenges facing humanity today, three key challenges stand out as having a particularly strong impact on existing agricultural and food systems: climate change, the growing world population and the conservation of natural resources. The demand for food on a global scale is increasing as a direct result of the rise in the world's population. In this context, food production must inevitably increase, which requires a further increase in agricultural land for the cultivation of crops for human consumption, but also for livestock grazing. Currently, around 37% of land is used for agricultural production. At the same time, agriculture is the world's largest consumer of freshwater, consuming around 70% of available freshwater supplies. In addition, intensive agricultural production pollutes the soil with artificial fertilizers, which significantly impairs the quality and health of the soil and also directly pollutes the groundwater. Ultimately, agriculture and food production contribute significantly to global greenhouse gas emissions. Food systems are responsible for about 30% of greenhouse gas emissions, and together with agricultural products, they are responsible for up to 1/3 of global emissions. Food systems also face the problem of food waste, which puts further pressure on the environment and resources. It is estimated that around 1/3 of the food produced worldwide is thrown away every year. In line with the European strategic goals of climate neutrality, agriculture must become a driving force of change towards a greener and more resilient system that supports the health of people and the planet. The aim of this paper is therefore to provide an overview of current practices in the agri-food sector, highlight examples of circular and resource-efficient systems and present innovative solutions that can help address the challenges in the sector. Transition is no longer an option – it is a necessity for the future of sustainable agriculture and food security.

Keywords: Farm to Fork strategy, sustainable agriculture, circular bioeconomy, food security, food waste

Protein hydrolysates from agroindustrial by-products as biostimulants in sustainable agriculture

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Abstract:
A relatively new and promising approach to enchancing agricultural productivity, particularly in the context of global environmental change, is the development of new biostimulants. The main goal of biostimulants is to improve crop yield and quality by improving nutrient use efficiency and increasing tolerance to various stresses, without supplying nutrients or eradicating pests and diseases. They can be an effective tool in alleviating the negative effects of environmental stresses, such as drought, salinity, heavy metals and extreme temperatures. Biostimulants exert their effects through multiple mechanisms, including the modulation of gene expression, metabolic processes and phytohormone production, promoting the accumulation of compatible solutes and antioxidants to reduce oxidative stress.
Protein hydrolysates have been increasingly used as biostimulants. They are defined as a mixture of oligopeptides, peptides and free amino acids produced by partial or extensive hydrolysis of protein-rich sources. Moreover, protein hydrolysates can be derived from the by-products of agroindustry enhancing their economic attractiveness and supporting environmental sustainability by reducing waste. A wide range of animal and plant by-products have proven to be promising sources of protein hydrolysates. Animal by-products can vary from cow connective tissue, tanned leather waste, bones, casein, blood meal etc. Plant originated by-products are usually defatted meal, seeds, and flour with a protein composition of about 40-60 %. Oil seed cake, a by-product of oil production from seeds (especially pumpkin, sesame, flax, and rapeseed), as well as cereal grain, is also a rich source of proteins.
The most widely used methods for protein hydrolysate production, on an industrial scale, are chemical and biochemical methods. Unlike chemical methods which require harsh reaction conditions and result in a heterogeneous mixture of peptides and poor nutritional quality of the product, enzymatic hydrolysis is more effective, employing exogeneous enzymes for more precise control of peptide bond cleavage and yielding a more homogeneous final product, also having low energy requirements.

Keywords: protein hydrolysates, biostimulants, peptides, enzymatic hydrolysis, sustainable agriculture

Emerging Plant Diseases in Italy: New Challenges and Risks

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Abstract:
The Italian peninsula is located in the centre of the Mediterranean Sea, one of the areas most affected by climate change on a global scale. In addition to environmental stresses, Italian agricultural ecosystems have had to deal with an increasing number of new emerging diseases in recent decades. In particular, the production of both traditional and exotic crops such as olive, pomegranate, artichoke, avocado, kiwi, mango, papaya and pistachio has suffered a strong reduction due to new diseases caused by invasive pathogens. Among the most virulent species, several belong to the family *Botryosphaeriaceae* (fungi) and the genus *Phytophthora* (oomycetes). Although these two groups of pathogens are very distant from an evolutionary point of view, they share common characteristics such as invasiveness, polyphagia and rapid adaptability to new environments and host plants. One of the main causes of these "biological invasions" is related to the use of infected plant material from nurseries. The introduction of exotic pathogens in agriculture systems opens the way to undiscovered problems beyond the loss of yields, as these pathogens can progressively migrate towards forest ecosystems. To stop the introductions of exotic pathogens, it is necessary to increase phytosanitary surveillance systems and adopt diagnostic protocols common to all European countries.

Keywords: emerging crops, climate change, plant pathology, oomycetes, *Botryosphaeriaceae*

Procjena izloženosti pesticidima u poljoprivrednom okolišu: Rezultati studije slučaja Hrvatska u okviru Obzor 2020 projekta SPRINT

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Sažetak:
Projekt SPRINT provodi se u deset zemalja Europske Unije, uključujući Republiku Hrvatsku, s naglaskom na Istarsku županiju. U sklopu projekta, provedeno je sveobuhvatno istraživanje ostataka pesticida u različitim uzorcima iz okoliša i neposrednog životnog okruženja poljoprivrednika (tlo, voda, zrak, sediment, kućna prašina, mačke, šišmiši), kao i u biološkim uzorcima ispitanika (krv, urin, feces i brisevi sluznice nosa) i domaćih životinja (ovce – feces, mlijeko). U svakoj od 10 studija slučaja (CSS) bile su obuhvaćene različite poljoprivredne kulture i sustavi poljoprivredne proizvodnje (ekološki, konvencionalni i/ili integrirani). Cilj projekta je procijeniti izloženost ljudi i okoliša pesticidima te razviti smjernice za tranziciju koje omogućuju smanjenje primjene sredstava za zaštitu bilja uz istovremeno podizanje svijesti proizvođača i građana.
Uzorci tla iz istarskih maslinika pokazali su najmanji ukupni broj različitih ostataka pesticida i njihovih metabolita u odnosu na sve ostale studije slučaja. Međutim, detektirani su ostaci već desetljećima zabranjenih tvari poput DDT-a (diklorodifeniltrikloretan, u obliku metabolita diklorodifenildikloroetilena – DDE – u 85% uzoraka) što potvrđuje njihovu dugotrajnu prisutnost u okolišu. U uzorcima iz površinskih voda, Hrvatska se također istaknula najmanjim brojem detektiranih pesticida i njihovih metabolita u odnosu na sve ostale studije slučaja i to u nižim koncentracijama. Sedimenti su također pokazali da Hrvatska pripada skupini EU zemalja s najnižim razinama ukupne koncentracije ostataka pesticida i njihovih metabolita. U kućnoj prašini, uzorci iz kućanstava istarskih maslinara, iako u nižim koncentracijama i neovisno o sustavima uzgoja, otkrili su višestruku prisutnost pesticida. U većini analiziranih tipova uzoraka, postojale su značajne razlike u koncentracijama pesticida pronađenih u ekološkim i konvencionalnim/integriranim poljima/kućanstvima na razini cijelog projekta. Ovi rezultati pokazuju da Hrvatska, iako uglavnom s manjim brojem i nižom koncentracijom detektiranih pesticida i njihovih ostataka, nije izuzeta od prisutnosti istih u okolišu. Također, navedeno naglašava potrebu za daljnjim očuvanjem poljoprivrednog okoliša prijelazom na ekološki prihvatljivije zamjene sintetskih pesticida i strožom kontrolom njihove upotrebe. Projekt SPRINT financira Europska unija kroz program Obzor 2020 za istraživanje i inovacije, prema Ugovoru o dodjeli bespovratnih sredstava br. 862568.

Ključne riječi: Istra, masline, izloženost, održiva poljoprivreda, CSS6

Assessing Pesticide Exposure in Agricultural Environment: Insights from the Croatian Case Study of the HORIZON 2020 SPRINT Project

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Abstract:
The SPRINT project is being implemented in ten European Union countries, including the Republic of Croatia, with a particular focus on the Istrian region. As part of the project, comprehensive research was conducted on pesticide residues in various environmental samples and in the immediate living environment of farmers (soil, water, air, sediment, household dust, cats, and bats), as well as in biological samples from participants (blood, urine, feces, and nasal mucosa swabs) and domestic animals (sheep – feces, milk). Each of the ten case studies (CSS) covered different agricultural crops and farming systems (organic, conventional, and/or integrated). The aim of the project is to assess human and environmental exposure to pesticides and to develop transition guidelines that enable a reduction in the use of plant protection products, while simultaneously raising awareness among producers and the public.
Soil samples from Istrian olive groves showed the lowest overall number of different pesticide residues and their metabolites compared to all the other case studies. However, residues of substances banned for decades, such as DDT (detected in the form of its metabolite - DDE - in 85% of samples), were identified, indicating their long-term persistence in the environment. In surface water samples, Croatia also stood out by having the lowest number of detected pesticides and metabolites among the case studies. When present, they were found in low concentrations. Sediment samples also indicated that Croatia belongs to the group of EU countries with the lowest total concentrations of pesticide residues and their metabolites. In household dust, samples from Istrian olive farming households revealed the presence of multiple pesticides, although at lower concentrations, regardless of the production system.
In most analyzed sample types, significant differences were observed in pesticide concentrations between organic and conventional/integrated fields and households across the entire project. These results show that, although Croatia generally exhibits lower numbers and concentrations of the detected pesticides and residues, it is not exempt from their environmental presence. This further emphasizes the need to preserve the agricultural environment by transitioning to more ecologically friendly alternatives to synthetic pesticides and ensuring stricter control over their use. The SPRINT project is funded by the European Union's Horizon 2020 Programme for research & innovation under grant agreement no. 862568.

Key words: Istria, olives, exposure, sustainable agriculture, CSS6

Svilarska baština u Istri: Umijeće svilarstva kroz znanost, umjetnost i kulturu

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Sažetak:
Svilene tkanine sa uzorcima često izvedenima nitima od plemenitih metala bile su među najsugestivnijim simbolima luksuza i pokazateljima statusa pripadnika društvenih elita u razdoblju srednjega i novog vijeka. Namjena im je bila izrada reprezentativnih odjevnih predmeta ili u dekoraciji raskošnih unutarnjih prostora. Proizvodnja takvih luksuznih svila kompleksan je proces koji se sastoji od niza predradnji te je vezan isključivo uz najrazvijenija europska umjetnička središta. Završni proces proizvodnje odnosi se na samo tkanje koje je tehnološki i umjetnički najkompleksniji element zbog čega se gotovo redovito odvijao u obrtnički razvijenim, urbanim, središtima. Procesi vezani uz uzgoj dudova svilca i proizvodnju svilenih niti, s druge strane, često su se odvijali u ruralnim krajevima. U tom kontekstu možemo pratiti pokušaje uspostavljanja svilogojstva na području Istre.
Ciljevi ovoga izlaganja odnositi će se na sumiranje dosadašnjih spoznaja o uzgoju svile na području istarskog poluotoka od 15. do 20. stoljeća. Poseban će pritom biti naglasak na politici i metodama razvoja svilarstva u 18. stoljeću zahvaljujući poticajima carice Marije Terezije. Nesumnjivo najozbiljniji poduhvat iz djelatnosti svilogojstva na području Istre dogodio se u 19. stoljeću, a odnosi se na veliki vodnjanski pogon za uzgoj svile obitelji Sotto Corona, infrastrukturu kojega možemo vidjeti i danas.
Kao cilj ovoga izlaganja postavlja se i prezentacija do danas sačuvane svilarske baštine u Istri te njezine kulturološke i povijesno-umjetničke važnosti. U tom smislu izlaganjem će se pokušati dati osnovne povijesne pretpostavke o svilogojstvu kao i činjenice o važnosti istarske svilarske baštine te otvoriti pitanja vezana uz mogućnosti revitalizacije djelatnosti. Također, cilj izlaganja je poticanje dijaloga o interdisciplinarnim istraživačkim pristupima kojima bi se doprinijelo boljem poznavanju, prezentiranju i očuvanju, kako sačuvane spomeničke baštine, tako i nematerijalne baštine vezane uz prisutnost svile u Istri.

Ključne riječi: Istra, svila, svilogojstvo, Vodnjan, baština

Silk Heritage in Istria: The Art of Silk Weaving through Science, Art and Culture

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Abstract:
Silk fabrics woven with precious metal threads were among the most suggestive symbols of luxury and status during the Medieval period and the Modern Age. These exquisite textiles were used to create prestigious garments and to decorate lavish interior spaces. The production of such luxury silks was a highly complex process, involving a series of preliminary activities and exclusively associated with the most developed European art centres. The final stage of production, the weaving itself, was the most technologically and artistically complex aspect, which is why it almost always took place in artisanally developed urban centres. On the other hand, silkworm cultivation and silk thread production often occurred in rural areas. In this context, we can observe efforts to establish silk farming in the region of Istria.
This presentation aims to summarize the current knowledge on silk farming in the area of the Istrian peninsula from the 15th to the 20th century. Special attention will be given to the silk farming policies and development methods of the 18th century, and the incentives introduced by the Empress Maria Theresa. Undoubtedly, the most significant silk farming initiative in Istria took place in the 19th century, namely, the large silk farming plant in Vodnjan, led by the Sotto Corona family, which is still visible today.
This presentation will explore Istria's silk heritage, which has been preserved to this day, along with its cultural, historical and artistic importance. Therefore, it will present historical assumptions about silk farming, highlight the importance of Istria's silk heritage, and raise questions about the potential for revitalization of this activity. Furthermore, the presentation aims to encourage the dialogue on interdisciplinary research approaches that could contribute to a better knowledge, presentation and preservation of both the monumental and intangible silk-related heritage in Istria.

Keywords: Istria, silk, sericulture, Vodnjan, heritage

Povrćarstvo
Vegetable growing

Utjecaj temperature skladištenja na fizikalna i kemijska svojstva istarskih ekotipova češnjaka

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Sažetak:
Češnjak je važna poljoprivredna kultura s globalnom proizvodnjom od preko 28 milijuna tona u 2023. godini. U Hrvatskoj, Istarska županija je poznata po tradicijskim sortama kao što su Istarski crveni i bijeli češnjak. Kvaliteta češnjaka ovisi o uvjetima uzgoja prije berbe te uvjetima čuvanja nakon berbe. Uvjeti skladištenja su ključni za očuvanje nutritivne i ekonomske vrijednosti proizvoda.
Istraživanje je provedeno na češnjaku proizvedenom u pokusnom nasadu Instituta za poljoprivredu i turizam u Poreču. Istarski crveni (IPT013) i Istarski bijeli (IPT015) češnjak su uzgojeni u peterorednim gredicama s gustoćom od 38 biljaka po m². Češnjak je ubran krajem lipnja i sušen na sjenovitom mjestu prije uzorkovanja. Uzorci su skladišteni na dvije različite temperature: sobna temperatura (20°C) i hladnjak (4°C) s kontroliranim uvjetima vlage. Morfološka i fizikalna mjerenja (masa, promjer, visina, suha tvar, ukupno otopljena suha tvar, boja i čvrstoća) su obavljena u tri roka mjerenja. Biokemijske analize su uključivale određivanje ukupnih fenola (TPC) i antioksidacijskog kapaciteta (FRAP i DPPH). Ekotip Istarski bijeli imao je viši sadržaj TPC, dok je kod Istarskog crvenog zabilježena veća vrijednost DPPH i FRAP. Češnjak koji je čuvan u hladnjaku zadržao je više vrijednosti TPC, čvrstoće, boje i ukupno otopljene suhe tvari kod oba ekotipa tijekom skladištenja. Tijekom skladištenja smanjili su se visina i masa lukovice, pH, suha tvar i ukupno otopljena suha tvar kod oba ekotipa, dok su se FRAP, TPC povećali.
Ovo istraživanje ukazalo je na važnost uvjeta skladištenja kod ekotipova češnjaka te da tijekom skladištenja dolazi do promjena u fizikalnim i biokemijskim svojstvima češnjaka.

Ključne riječi: antioksidacijski kapacitet, Istarski crveni, Istarski bijeli, skladištenje, temperatura

The effect of storage temperature on the physical and chemical properties of Istrian garlic ecotypes

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Abstract:
Garlic is an important agricultural crop with global production exceeding 28 million tons in 2023. In Croatia, Istria County is known for traditional varieties such as Istrian red and white garlic. The quality of garlic depends on cultivation conditions before harvest and storage conditions after harvest. Storage conditions are crucial for preserving the nutritional and economic value of the product.
The research was conducted on garlic produced in an experimental field of the Institute of Agriculture and Tourism in Poreč. Istrian red (IPT013) and Istrian white (IPT015) garlic were grown in five-row beds with a density of 38 plants per m². The garlic was harvested at the end of June and dried in a shaded place before sampling. Samples were stored at two different temperatures: room temperature (20°C) and refrigerator (4°C) with controlled humidity conditions. Morphological and physical measurements (mass, diameter, height, dry matter, total dissolved solids, colour, and firmness) were performed at three measurement intervals. Biochemical analyses included the determination of total phenols (TPC) and antioxidant capacity (FRAP and DPPH). The Istrian white ecotype had a higher TPC content, while the Istrian red ecotype showed higher DPPH and FRAP values. Garlic stored in the refrigerator retained higher values of TPC, firmness, colour, and total dissolved solids in both ecotypes during storage. During storage, bulb height and mass, pH, dry matter, and total dissolved solids decreased in both ecotypes, while FRAP and TPC increased.
This research indicated the importance of storage conditions for garlic ecotypes and that changes in the physical and biochemical properties of garlic occur during storage.

Keywords: antioxidant capacity, Istrian red, Istrian white, storage, temperature

Strategije prilagodbe divljeg komorača (*Foeniculum vulgare*) na stres uzrokovan sušom

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Sažetak:
Porast temperature i sve duža sušna razdoblja povećavaju potrebu za razumijevanjem mehanizama otpornosti biljaka na sušu. Komorač (*Foeniculum vulgare*), aromatična biljka široke primjene u kulinarstvu i medicini, pokazuje dobru prilagodbu sušnim uvjetima mediteranskog podneblja.
Cilj ovog istraživanja bio je ispitati fiziološke i biokemijske odgovore različitih primki komorača na sušu. Jedanaest primki komorača prikupljenih u području Sjevernog Jadrana izloženo je tretmanu suše (zalijevanje nakon gubitka turgora kod 60% biljaka) tijekom 16 dana kroz tri ciklusa. Tretirane biljke razvile su značajne fiziološke promjene kao odgovor na sušu. Zabilježeno je smanjenje suhe tvari kod svih primki u usporedbi s kontrolnim biljkama koje su redovito zalijevane svaki dan. Suša nije jednako utjecala na razinu primarnih i sekundarnih metabolita kod različitih primki. Statistički značajna interakcija primke i tretmana uočena je za primarne metabolite metionin sulfoksid, alantoin i jantarnu kiselinu. Koncentracija prolina porasla je tijekom suše kod svih primki, od 10 do 58 puta više u odnosu na kontrolu, ovisno o primci. Slično tome, razine apscizinske kiseline značajno su povećane pod utjecajem suše, od 5 do 38 puta, što potvrđuje aktivaciju hormonskih obrambenih mehanizama. Primke IPT567 i IPT574 pokazale su najsnažniji biokemijski odgovor i najveću promjenu suhe tvari, sugerirajući potencijalno bolju prilagodbu na sušne uvjete.
Ovi rezultati ukazuju na postojanje značajne genetske varijabilnosti u odgovoru komorača na sušni stres, što može biti korisno u selekciji kultivara komorača s poboljšanom tolerancijom na sušu.

Ključne riječi: komorač, stres sušom, prolin, apscizinska kiselina, genetska varijabilnost

Adaptation Strategies of Wild Fennel (*Foeniculum vulgare*) to Drought Stress

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Abstract:
Rising temperatures and increasingly prolonged drought periods highlight the need to understand the mechanisms of plant drought resistance. Fennel (*Foeniculum vulgare*), an aromatic plant widely used in culinary and medicinal applications, demonstrates good adaptation to drought conditions typical of the Mediterranean climate.
This study aimed to examine the physiological and biochemical responses of different fennel accessions to drought. Eleven fennel accessions collected from the Northern Adriatic region were subjected to drought treatment (watering after 60% of plants lost turgor) for 16 days across three cycles. Treated plants developed significant physiological changes in response to drought. A decrease in dry matter was recorded in all accessions compared to control plants watered daily. Drought did not equally affect the levels of primary and secondary metabolites among different accessions. A statistically significant interaction between accession and treatment was observed for the primary metabolites methionine sulfoxide, allantoin, and succinic acid. Proline concentration increased during drought in all accessions, from 10 to 58 times higher compared to the control, depending on the accession. Similarly, abscisic acid levels were significantly increased under drought, from 5 to 38 times, confirming the activation of hormonal defence mechanisms. Accessions IPT567 and IPT574 showed the strongest biochemical response and the greatest change in dry matter, suggesting potentially better adaptation to drought conditions. These results indicate significant genetic variability in fennel's response to drought stress, which may be useful for the selection of fennel cultivars with improved drought tolerance.

Keywords: fennel, drought stress, proline, abscisic acid, genetic variability

Reakcija fluorescencije klorofila mjerene kod lokalne sorte slanutka u uvjetima stresa

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Sažetak:
Ova studija istražuje reakcije fluorescencije klorofila lokalne sorte slanutka (*Cicer arietinum*) u stresnim uvjetima okoliša, uključujući sušu i temperaturne fluktuacije. Razumijevanje fizioloških odgovora biljaka slanutka na te stresore ključno je za poboljšanje njihove otpornosti i povećanje prinosa usjeva. Parametri fluorescencije klorofila, kao što su Fv/Fm (maksimalna fotokemijska učinkovitost Photosystem II), Fm, Ft, Fo, mjereni su kako bi se procijenio utjecaj stresa na fotosintetske performanse među različitim tretmanima. Klorofil A, B, karotenoidi i SPAD indeks su komparirani sa sadržajima ukupnog dušika u listu i visinom prinosa. Rezultati pokazuju da je vrijeme uzorkovanja utjecalo na mjerene parametre, rezultirajući višim omjerima Fv/Fm u razdoblju drugog mjerenja kada je izražen porast prosječne temperature i smanjenja padalina, što ukazuje na nižu fotosintetsku učinkovitosti. Ovaj podatak potvrđuju niži sadržaji klorofila a (između dva mjerenja od 1,76-1,39 mg/g TM), te pomoćnih pigmenata klorofila b (1,22-0,82 mg/g TM) i karotenoida (0,89-0,71 mg/g TM). Korelacije između vrijednosti sadržaj dušika i prinosa pokazao je vrlo dobar i pozitivan *Pearsonov* koeficijent od r=0,81, dok je za parametre dušika i SPAD indeksa (r=0,53), dušika i klorofila A (r=0,62), dušika i karotenoidima (r=0,60), dušika i Fv/Fm (r=0,43) koeficijent bio umjeren i pozitivan. Nadalje, utvrdili smo da sadržaj dušika i optimalni okolišni parametri u sezoni doprinose učinkovitoj metrici fluorescencije klorofila i pokazuju poboljšani rast i potencijal prinosa. Ovi nalazi naglašavaju potencijal fluorescencije klorofila kao pouzdanog alata za utvrđivanje reakciju slanutka na stresne uvjete. Istraživanje naglašava važnost uključivanja metrike fluorescencije klorofila u poljoprivredu s ciljem utvrđivanja otpornosti sorti slanutka na klimatske faktore, čime se u konačnici pridonosi održivoj poljoprivrednoj praksi i sigurnosti hrane u uvjetima sve većih ekoloških izazova.

Ključne riječi: fluorescencija klorofila, SPAD indeks, slanutak, stres, prinos

Chlorophyll Fluorescence Responses of local Chickpea variety to Environmental Stress

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Abstract:
This study investigates the chlorophyll fluorescence responses of local chickpea (*Cicer arietinum*) genotype under environmental stress conditions, including drought and temperature fluctuations. Understanding the physiological responses of chickpea plants to these stressors is crucial for improving their resilience and enhancing crop yields. Chlorophyll fluorescence parameters, such as Fv/Fm (maximum photochemical efficiency of Photosystem II), Fm, Ft, Fo, were measured to assess the impact of stress on photosynthetic performance among different treatment. Chlorophyll A, B, Carotenoids and SPAD index for comparison with total nitrogen in leaf and yield. Results indicated that time of the sampling mostly have affected measured parameters, reflected in higher Fv/Fm ratios in period of second measurement when the average temperature increase and precipitation has fallen, suggesting lower maintenance of photosynthetic efficiency. This was also confirmed by lower content of the primary pigment chlorophyll a (ranging between the two measurement from 1.76-1.39 mg/g FW), and the accessory pigments chlorophyll b (1.22-0.82 mg/g FW) and carotenoids (0.89-0.71 mg/g FW). The correlation between the values of nitrogen content and yield showed a very good and positive Pearson coefficient of r=0.81, while for parameters nitrogen and SPAD index (r=0.53), nitrogen and chlorophyll A (r=0.62), nitrogen and carotenoids (r=0.60), nitrogen and Fv/Fm (r=0.43), the coefficient was moderate and positive. Furthermore, we identified that nitrogen content and optimal environmental parameter in the season contribute effective chlorophyll fluorescence metrics and displayed enhanced growth and yield potential. These findings highlight the potential of chlorophyll fluorescence as a reliable tool for screening chickpea variety for stress tolerance. The study underscores the importance of incorporating chlorophyll fluorescence metrics in agriculture aimed at developing climate-resilient chickpea varieties, ultimately contributing to sustainable agricultural practices and food security in the face of increasing environmental challenges.

Keywords: chlorophyll fluorescence, SPAD index, Chickpea, stress, yield

Utjecaj virusa na prinos i biokemijske parametre gomolja krumpira

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Sažetak:
Zbog nemogućnosti tretiranja te prenošenja na slijedeće generacije putem gomolja, virusne bolesti krumpira se smatraju vrlo opasnima. Osim toga, virusi imaju kompleksan inhibitorni učinak na biljke krumpira. Utječu na deformacija listova i gomolja te posljedično dovode do smanjenja prinosa i kvalitete gomolja. Cilj ovog rada bio je utvrditi kombinirani učinak M-virusa krumpira (PVM) i S-virusa krumpira (PVS) te pojedinačno samo M-virusa krumpira na prinos i biokemijske parametre tradicijskog kultivara krumpira 'Krušni žuti'. Tradicijski kultivar 'Krušni žuti' (accession number: IND00088), zaražen dvama virusima, PVM i PVS je uveden u *in vitro* kulturu. Nakon provedenog tretmana eliminacije virusa na ribavirinu u trajanju od 95 dana, dio biljaka oslobođen je od oba virusa (VF), a neke samo od S-virusa krumpira (PVM+). Zdravstveni status biljaka provjeren je RT-PCR analizom. Uz kontrolu (majčinske biljke zaražene s oba virusa; PVM+ PVS+), dvije linije krumpira iz tretmana s ribavirinom, VF i PVM+ korištene su u istraživanju o utjecaju virusa. Biljke su uzgajane u komori rasta u vegetacijskim posudama 90 dana. Na uzgojenim biljkama utvrđen je prinos gomolja po biljci, broj gomolja po biljci te biokemijski parametri gomolja (sadržaj suhe tvari, ukupnih proteina, škroba te reducirajućih šećera). Značajno veća masa gomolja, broj gomolja te sadržaj škroba u gomolju utvrđeni su kod virus-free biljaka (VF), dok je najveći sadržaj suhe tvari, proteina te reducirajućih šećera u gomolju utvrđen kod biljaka zaraženih s oba virusa (PVM+PVS+). Masa gomolja kao i sadržaj škroba direktno su povezani s lisnom površinom i s fotosinteskom aktivnošću biljke. PVM i PVS značajno utječu na deformaciju lista smanjujući lisnu površinu, a samim tim i fotosintetsku aktivnost što je rezultiralo smanjenjem navedenih svojstava za oko 30%.

Ključne riječi: PVM, PVS, virus-free, prinos, kvaliteta

The impact of viruses on yield and biochemical parameters of potato tubers

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Abstract:
Due to the inability to treat and the transmission to subsequent generations via tubers, potato viral diseases are considered very dangerous. In addition, viruses have a complex inhibitory effect on potato plants. They affect leaf and tuber deformation and consequently lead to a decrease in yield and tuber quality. The aim of this work was to determine the combined effect of potato M-virus (PVM) and potato S-virus (PVS) and individually only potato M-virus on the yield and biochemical parameters of the traditional potato cultivar 'Krušni žuti'. The traditional cultivar 'Krušni žuti' (accession number: IND00088), infected with two viruses, PVM and PVS, was introduced into *in vitro* culture. After a 95-day ribavirin virus elimination treatment, some plants were free from both viruses (VF), and some only from potato S-virus (PVM+). The health status of the plants was checked by RT-PCR analysis. In addition to the control (mother plants infected with both viruses; PVM+ PVS+), two potato lines from ribavirin treatment, VF and PVM+, were used in the study on the impact of the virus. The plants were grown in a growth chamber in vegetation pots for 90 days. The tuber yield per plant, the number of tubers per plant and the biochemical parameters of the tubers (dry matter, total protein, starch and reducing sugar content) were determined on the grown plants. Significantly higher tuber mass, number of tubers and starch content in the tuber were determined in virus-free plants (VF), while the highest content of dry matter, protein and reducing sugars in the tuber was determined in plants infected with both viruses (PVM+PVS+). The tuber mass and starch content are directly related to the leaf area and the photosynthetic activity of the plant. PVM and PVS significantly affect the deformation of the leaf, reducing the leaf surface, and thus the photosynthetic activity, which resulted in a reduction of the mentioned properties around 30%.

Keywords: PVM, PVS, virus-free, yield, tuber quality

Dinamika metaboličkog puta GABA-e pod sušom i povišenom temperaturom u češnjaku

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Sažetak:
Ovo istraživanje nastoji identificirati ključne biokemijske mehanizme koji pridonose prilagodbi biljke češnjaka da se prilagodi i izdrži nepovoljne okolišne uvjete. U eksperimentu provedenom u klimatskim komorama proučavan je utjecaj kombiniranog stresa suše i povišene temperature na razine 4 metabolita mjerenih pomoću LC/MS metode. Dvofaktorijalni pokus uključivao je 4 grupe tretmana: W+/T-, W+/T+, W-/T-, W-/T+. Nakon 8 dana izlaganja tretmanu suše u uvjetima ambijentalne temperature (W-/T-), utvrđena je usporediva razina 2-ketoglutarata i jantarne kiseline naspram zalijevanih biljaka (W+/T-). Nadalje, nakon 8 dana izlaganja tretmanu suše, ali u uvjetima povišene temperature (W-/T+), utvrđena je usporediva razina 2-ketoglutarata u odnosu na zalijevane biljke (W+/T+), dok u slučaju razine jantarne kiseline nije uočena statistički značajna razlika među tretmanima. Prilikom tretmana povišenom temperaturom u uvjetima dostupne vode (W+/T+), nakon 8 dana izlaganja, uočena je usporediva razina 2-ketoglutarata i jantarne kiseline u odnosu na biljke na ambijentalnoj temperaturi (W+/T-). Nakon 8 dana izlaganja tretmanu povišene temperature u uvjetima suše (W-/T+), utvrđena je usporediva razina 2-ketoglutarata te značajno viša razina jantarne kiseline u odnosu na biljke na ambijentalnoj temperaturi (W-/T-). U niti jednom od navedenih slučajeva nije utvrđen statistički značajan utjecaj tretmana suše i povišene temperature na razinu glutamata i GABA-e. Pearsonova korelacijska analiza (N = 128; $r > 0.173623$; $p < 0.05$) pokazala je pozitivne korelacije između 2-ketoglutarata i GABA-e ($r = 0.2175$), te jantarne kiseline ($r = 0.3398$), dok s glutamatom nije bilo značajne povezanosti. Glutamat je negativno korelirao s GABA-om ($r = -0.3246$) i jantarnom kiselinom ($r = -0.2028$), a GABA pozitivno s jantarnom kiselinom ($r = 0.3470$). Značajan utjecaj tretmana suše i/ili povišene temperature na razine 2-ketoglutarata na početku i jantarne kiseline na kraju metaboličkog puta GABA-e, u sprezi s značajnom pozitivnom korelacijom 2-ketoglutarata i jantarne kiseline, sugeriraju aktivaciju metaboličkog puta GABA-e kao odgovora na stres uzrokovan sušom i/ili povišenom temperaturom.

Ključne riječi: abiotski stres, fitokemija, adaptacija, biokemijski mehanizam, metabolizam

GABA Shunt Dynamics Under Drought and Elevated Temperature in Garlic

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Abstract:
This research explores key biochemical mechanisms behind garlic's adaptation to adverse environmental conditions. In an experiment conducted in climate chambers, the effect of combined drought and elevated temperature stress on the levels of 4 metabolites was investigated using the LC/MS method. A two-factorial design included 4 treatment groups: W+/T−, W+/T+, W−/T−, and W−/T+. After 8 days of drought under ambient temperature conditions (W−/T−), the levels of 2-ketoglutarate and succinic acid were comparable to those in well-watered plants (W+/T−). Similarly, after 8 days of drought under elevated temperature (W−/T+), the level of 2-ketoglutarate remained comparable to that in well-watered plants (W+/T+), while no significant difference in succinic acid levels was observed. In the elevated temperature treatment under well-watered conditions (W+/T+), after 8 days, the levels of 2-ketoglutarate and succinic acid were also comparable to those in plants under ambient temperature (W+/T−). However, after 8 days of drought combined with elevated temperature (W−/T+), the level of 2-ketoglutarate remained unchanged, while succinic acid levels were significantly higher compared to drought-treated plants at ambient temperature (W−/T−). No significant effect of drought and/or elevated temperature was observed on glutamate or GABA levels. Pearson correlation analysis (N = 128; $r > 0.173623$; $p < 0.05$) showed positive correlations between 2-ketoglutarate and GABA ($r = 0.2175$), and succinic acid ($r = 0.3398$), with no significant correlation with glutamate. Glutamate negatively correlated with GABA ($r = -0.3246$) and succinic acid ($r = -0.2028$), while GABA positively correlated with succinic acid ($r = 0.3470$). The significant effect of drought and/or elevated temperature treatments on the levels of 2-ketoglutarate at the entry point and succinic acid at the end point of the GABA shunt, combined with the significant positive correlation between the 2 metabolites, suggests an activation of the GABA shunt as a response to drought and/or elevated temperature stress.

Keywords: abiotic stress, adaptation, biochemical mechanism, metabolism, phytochemistry

Unaprjeđenje hidroponskog uzgoja koprive (*Urtica dioica* L.) u svrhu povećanja prinosa i funkcionalnih svojstava

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Sažetak:
Kopriva (*Urtica dioica* L.) je višegodišnja biljna vrsta poznata po visokoj nutritivnoj vrijednosti i bogatom sadržaju specijaliziranih metabolita s brojnim pozitivnim učincima na ljudsko zdravlje. Iako prirodno raste kao samonikla biljka, sve je izraženiji interes za njezinu kontroliranu proizvodnju s ciljem dobivanja standardiziranog biljnog materijala visoke kvalitete.
Hidroponski uzgoj koprive omogućuje preciznu kontrolu abiotskih čimbenika tijekom uzgoja, pri čemu sve više raste interes za tehniku dotjecanja i otjecanja, koja do sada nije dovoljno istražena za ovu kulturu. Kontrolirani vodni stres, koji se može postići upravljanjem intervalima dostupnosti hranive otopine pri uzgoju tehnikom dotjecanja i otjecanja, može značajno utjecati na sadržaj specijaliziranih metabolita u biljkama.
Stoga je cilj ovog istraživanja bio ispitati utjecaj dvaju različitih intervala opskrbe hranivom otopinom (svakih 48 i 72 sata) na prinos, sadržaj askorbinske kiseline, ukupnih fenola, flavonoida, neflavonoida i antioksidacijski kapacitet svježeg lista koprive tijekom šest uzastopnih vegetacijskih ciklusa. Rezultati su pokazali kako interval opskrbe hranivom otopinom svakih 48 sati pozitivno utječe na ukupni prinos (čak 41,9 kg/m² kumulativno), dok je rjeđa opskrba (svakih 72 sata) pogodovala akumulaciji specijaliziranih metabolita i većim antioksidacijskim kapacitetom, uključujući askorbinsku kiselinu (98,80 mg/100 g svježe tvari), ukupne fenole (245,73 mg GAE/100 g), neflavonoide (128,33 mg GAE/100 g), flavonoide (117,40 mg GAE/100 g) uz prosječnu vrijednost antioksidacijskog kapaciteta od 2331,80 µmol TE/L.
Interval opskrbe hranivom otopinom svaka 72 sata pri korištenju tehnike dotjecanja i otjecanja može se preporučiti kao održiva agrotehnička mjera za povećanje funkcionalne kvalitete koprive uz prihvatljiv gubitak prinosa. Općenito, ova tehnika pokazuje veliki potencijal za primjenu u uzgoju samoniklih biljnih vrsta, s ciljem povećanja njihove nutritivne vrijednosti i doprinosa održivom razvoju poljoprivrede te sigurnosti opskrbe hranom.

Ključne riječi: *Urtica dioica*, dotjecanje i otjecanje, prinos, specijalizirani metaboliti, održiva poljoprivreda

Improvement of hydroponic cultivation of stinging nettle (*Urtica dioica* L.) to increase yield and functional quality

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Abstract:
Stinging nettle (*Urtica dioica* L.) is a perennial plant species known for its high nutritional value and its rich content of specialized metabolites with numerous positive effects on human health. Although it grows wild in nature, there is a growing interest in its controlled cultivation in order to obtain standardized, high-quality plant material.
Hydroponic cultivation of stinging nettle allows precise control of abiotic factors during growth, with growing interest in the ebb and flow technique, which has not yet been sufficiently explored for this species. Controlled water stress, achieved by adjusting the nutrient solution supply intervals in the ebb and flow technique, can significantly affect the accumulation of specialized metabolites in plants.
Therefore, the aim of this study was to investigate the effects of two different nutrient solution supply intervals (every 48 and 72 hours) on the yield and content of ascorbic acid, total phenols, flavonoids, non-flavonoids and antioxidant capacity of fresh nettle leaves over six consecutive vegetation periods. The results showed that a nutrient solution supply interval every 48 hours positively influenced the total yield (cumulative 41.9 kg/m²), while less frequent nutrient solution supply (every 72 hours) promoted the accumulation of specialized metabolites and increased the antioxidant capacity, including ascorbic acid (98.80 mg/100 g fresh weight), total phenols (245.73 mg GAE/100 g), non-flavonoids (128.33 mg GAE/100 g), flavonoids (117.40 mg GAE/100 g), with an average antioxidant capacity of 2331.80 µmol TE/L.
A nutrient solution supply interval of 72 hours using the ebb and flow technique can be recommended as a sustainable agrotechnical practice for enhancing the functional quality of stinging nettle with an acceptable yield reduction. In general, this technique shows great potential for application in the cultivation of wild plant species, with the aim of enhancing their nutritional value and contributing to the sustainable development of agriculture and food security.

Keywords: *Urtica dioica*, ebb and fow, yield, specialized metabolites, sustainable agriculture

Divlji kupus (*Brassica incana*) kao potencijalni izvor „dobrih gena“ za adaptaciju kupusnjača na klimatske promjene

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Sažetak:
Kupusnjače spadaju među najčešće konzumirano povrće zbog svoje visoke nutritivne vrijednosti i bogatstva raznim vrijednim spojevima koji promiču zdravlje (polifenoli, glukozinolati, karotenoidi itd.). Klimatske promjene imaju značajan utjecaj na biološku raznolikost i poljoprivrednu proizvodnju diljem svijeta, negativno utječući na rast i razvoj biljaka te posljedično na prinose i kvalitetu. Suša, visoka temperatura i povećana slanost tla su važni čimbenici abiotskog stresa za mnoge usjeve, uključujući kupusnjače, osobito u mediteranskoj regiji. Stoga je ključno istražiti mehanizme tolerancije i identificirati metabolite i gene odgovorne za toleranciju na čimbenike klimatskih promjena. Divlji predstavnici kupusnjača koji rastu u prirodi u ekstremnim uvjetima okoliša mogu poslužiti kao izvrsne modelne biljke i potencijalni genski fond za strategije uzgoja kultura prilagođenih često nepovoljnim klimatskim uvjetima. Kako bi se istražili mehanizmi otpornosti na abiotski stres u kupusnjača, nekoliko populacija divljih kupusa (*B. incana*) identificiranih na jadranskim otocima bile su izložene suši, visokoj temperaturi, povišenom salinitetu i kombiniranim čimbenicima stresa. Markeri oksidativnog stresa kao što su prolin i peroksidacija lipida određeni su spektrofotometrijski, specijalizirani metaboliti analizirani su koristeći instrument UPLC-ESI-QqQ, a odabrani geni koji reagiraju na stres (NAC, DREB, HSF) analizirani su RT-qPCR-om. Odgovor na određeni abiotski stres specifičan je za populaciju. U osjetljivim ekopopulacijama primijenjeni faktori stresa rezultirali su snažnijim odgovorom i značajno većom promjenom izmjerenih markera stresa kao što su prolin, MDA, hormoni stresa nego u tolerantnijim ekopopulacijama. Salinitet i osmotski stres uzrokovali su drastičnije promjene u usporedbi s temperaturnim stresom. U uvjetima kombiniranog stresa, visoka temperatura može ublažiti štetne učinke saliniteta i suše. Tolerantnije populacije akumulirale su više polifenolnih spojeva u uvjetima stresa što je u skladu s njihovim antioksidativnim djelovanjem.

Ključne riječi: abiotski stres, divlji kupus, tolerancija, metaboliti, geni koji reagiraju na stres

Wild cabbage (*Brassica incana*) as a potential source for „good genes“ for climate change adaptation in *Brassica* crops

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Abstract:
Brassicas are among the most commonly consumed vegetables due to their high nutritional value and richness in various valuable health-promoting compounds (polyphenols, glucosinolates, carotenoids, etc.). Climate change has a significant impact on biodiversity and agricultural production worldwide, negatively affecting plant growth and development and consequently yields and crop quality. Drought, high temperature and increased soil salinity have become important abiotic stress factors for many crops, including brassicas, especially in the Mediterranean region. Therefore, it is crucial to learn more about tolerance mechanisms and identify metabolites and genes responsible for abiotic stress tolerance. Wild representatives of brassicas growing in nature under extreme environmental conditions can serve as an excellent model and a potential gene pool for breeding strategies for crops adapted to often adverse climatic conditions. To investigate the mechanisms of resistance to abiotic stress in brassicas, several populations of wild cabbage (*B. incana*) identified on Adriatic islands were exposed to drought, high temperature, elevated salinity and combined stress factors. Oxidative stress markers such as proline and lipid peroxidation were determined spectrophotometrically, specialized metabolites were analysed using a UPLC-ESI-QqQ instrument, and selected stress-responsive genes (NAC, DREB, HSF) were analysed by RT-qPCR. The response to a particular abiotic stress is population-specific. In sensitive eco-populations, the applied stress factors resulted in a stronger response and a significantly greater change in measured stress markers such as proline, MDA, stress hormones than in more tolerant eco-populations. Salinity and osmotic stress caused more drastic changes compared to temperature stress. Under conditions of combined stress, high temperature can mitigate the detrimental effects of salinity and drought. More tolerant populations accumulated more polyphenolic compounds under stress conditions, which is consistent with their antioxidant activity.

Keywords: abiotic stress, wild cabbage, tolerance, metabolites, stress responsive genes

Probiranje za varijaciju u koncentracijama elemenata u listu između hrvatskih autohtonih primki raštike (*Brassica oleracea* L. var. *acephala*)

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Sažetak:
Raštika (*Brassica oleracea* L. var. *acephala*) ima dugu povijest uzgoja te je njezina važnost kao izvora hranjivih tvari posebno istaknuta. Probiranje (eng. *screening*) divljih populacija raštike, kao i očuvanje genetskog materijala, važno je jer su takvi izvori bioraznolikosti ključni faktor za primjenu u oplemenjivanju. Cilj ovog istraživanja bio je ispitati varijacije u usvajanju elemenata u listovima 23 autohtone primke raštike iz jadranskog priobalnog područja. Pokus s dva faktora, primka i vrijeme berbe, proveden je u poljskim uvjetima. U listovima su analizirane koncentracije elemenata te su određene korelacije između elemenata. Analiza podataka pokazala je da je primka IPT 418 usvojila najveće količine Ca, Ni i Li, dok je IPT 401 bila najučinkovitija u usvajanju Mg i Zn. Primke IPT 411, IPT 384 i IPT 390 imale su najviše koncentracije P, Mn i Cr. Uzimajući u obzir raspon između najviših i najnižih koncentracija, razlike u usvajanju su se kretale do 4 puta za Ca, 1,8 puta za Mg, 1,5 puta za P, 1,5 puta za Mn, 2,5 puta za Ni, 2 puta za Zn, 2,2 puta za Cr i 1,7 puta za Li. Razlike između vremena berbe bile su specifične za pojedinu primku i element. Prema korelacijskoj matrici, nakupljanje elemenata u biljci uglavnom je bilo pod utjecajem sinergijskog odgovora između makro- i mikroelemenata, dok je među makroelementima u većini slučajeva bio prisutan antagonizam. Zaključno, primke koje su bile najučinkovitije u nakupljanju makro- i mikroelemenata mogu se potencijalno koristiti za borbu protiv nutritivnih nedostataka i proizvodnju hranjivije raštike.

Ključne riječi: fitoakumulacija elemenata, lisna koncentracija, *Brassica*, primka, vrijeme berbe

Screening for variation in leaf elemental concentrations between Croatian autochthonous kale (*Brassica oleracea* L. var. *acephala*) accessions

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Abstract:
Kale (*Brassica oleracea* L. var. *acephala*) has a long history of cultivation and its importance as a source of mineral nutrients has received particular attention. Screening of wild kale populations, as well as maintenance of the genetic material is important since this biodiversity source is a key factor for plant breeding applications. This study aims to investigate the variations in elemental leaf accumulation between 23 Croatian autochthonous kale accessions from Adriatic basin. A two-factorial experiment, with accession and harvest time as the main factors, was conducted under field conditions. Concentrations of elements in leaves were analysed, and correlations between the elements were determined. Analysis of the data revealed that accession IPT 418 accumulated the highest contents of Ca, Ni and Li, while IPT 401 was most effective in Mg and Zn accumulation. The accessions, such as IPT 411, IPT 384 and IPT 390 had the highest concentrations of P, Mn, and Cr. Considering the range within the highest and lowest concentration, the accumulation varied by 4-fold for Ca, 1.8-fold for Mg, 1.5-fold for P, 1.5-fold for Mn, 2.5-fold for Ni, 2-fold for Zn, 2.2-fold for Cr, and 1.7-fold for Li. Differences between harvest times depended on the accession and the element. According to the correlation matrix, the elemental phytoaccumulation was mainly affected by synergistic response between macro and micronutrients, while an antagonistic effect among the macronutrients was observed in most cases. In conclusion, the accessions most efficient in accumulating macro and micronutrients may be potentially used to cope with nutrient malnutrition and production of more nutritionally valuable kale.

Keywords: element phytoaccumulation, leaf concentration, *Brassica*, accession, harvest time

Održive strategije: od biostimulatora do mikrobioma

Sustainable Strategies: From Biostimulants to the Microbiome

Proteinski hidrolizati u voćarstvu: znanstveni uvidi i praktična primjena

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Sažetak:
Ovaj pregledni rad analizira postojeće znanstvene spoznaje o primjeni proteinskih hidrolizata u voćarstvu, s naglaskom na njihov učinak na morfološke i fiziološke odgovore te agronomske pokazatelje različitih voćnih vrsta.
Fokus je stavljen na folijarne tretmane proteinskim hidrolizatima kako bi se procijenio njihov potencijal kao biostimulatora u održivoj voćarskoj proizvodnji. Brojna istraživanja ukazuju na to da primjena proteinskih hidrolizata može značajno povećati prinos, poboljšati kvalitetu plodova te ublažiti negativne učinke abiotskog stresa poput suše i visokih temperatura. Tretirane biljke često pokazuju bolju iskorištenost hranjiva, višu fotosintetsku aktivnost te izraženije morfološke karakteristike, uključujući razvoj korijena i vegetativni rast. Međutim, učinkovitost se razlikuje ovisno o voćnoj vrsti, fenofazi rasta i učestalosti tretiranja, što ukazuje na potrebu za preciznijim pristupom primjeni.
Zaključno, literatura potvrđuje da proteinski hidrolizati predstavljaju učinkovit alat za poboljšanje otpornosti i produktivnosti voćarskih kultura, iako su potrebna daljnja istraživanja za optimizaciju protokola primjene u različitim agroekološkim uvjetima.

Ključne riječi: proteinski hidrolizati, biostimulatori, voćarstvo, održiva proizvodnja, fiziološki odgovor biljaka

Protein Hydrolysates in Fruit Growing: Scientific Insights and Practical Applications

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Abstract:
This review paper summarizes current scientific knowledge on the use of protein hydrolysates in fruit growing, with a focus on their effects on morphological and physiological responses as well as agronomic performance across various fruit species. Particular attention is given to foliar applications of protein hydrolysates and their potential as biostimulants in sustainable fruit production systems. A broad range of studies report that protein hydrolysates can significantly enhance yield, improve fruit quality, and mitigate the adverse effects of abiotic stresses such as drought and high temperatures. Treated plants often exhibit improved nutrient uptake, increased photosynthetic efficiency, and enhanced morphological traits, including better root development and vegetative growth. However, the effectiveness of these biostimulants varies depending on the fruit species, developmental stage, and application frequency, indicating the need for more tailored and crop specific protocols. In conclusion, the literature confirms the promising role of protein hydrolysates in enhancing resilience and productivity in fruit crops, while highlighting the need for further research to optimize their use under diverse agroecological conditions.

Keywords: protein hydrolysates, biostimulants, fruit growing, sustainable production, plant physiological response

Povećanje sadržaja sekundarnih metabolita u listu masline kroz kombiniranu folijarnu primjenu biougljena i fenolnog ekstrakata iz lista masline

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Sažetak:
Maslina je jedna od najstarijih i najvažnijih poljoprivrednih kultura u području Mediterana. Prerada maslina u maslinovo ulje proizvodi značajne količine otpada i nusproizvoda koji su uglavnom slabo iskorišteni. Ovo istraživanje fokusira se na dodatnu valorizaciju lišća masline kao nusproizvoda redovite rezidbe maslina kroz povećanje sadržaja sekundarnih metabolita kombiniranom primjenom biougljena i fenolnog ekstrakata iz lista masline. Suspenzija biougljena dobivenog pirolizom ostataka obrezivanja vinove loze dobivena je njegovim miješanjem u demineraliziranoj vodi (1,5 g; 5 L; 24 sata). Fenolni ekstrakt dobiven je ekstrakcijom liofiliziranog i usitnjenog lista masline u demineraliziranoj vodi (50 g; 5 L; 24 sata), dok je kombinirani pripravak dobiven na analogan način (1,5 g biougljena; 50 g praha lista masline; 5 L vode; 24 sata). Tretmani su provedeni početkom srpnja, uključujući: kontrolni tretman (demineralizirana voda), suspenzija biougljena, otopinu fenolnog ekstrakta te kombinirani vodeni pripravak biougljena i fenolnog ekstrakta. Stabla sorti maslina Leccino i Istarska bjelica prskana su odgovarajućim pripravkom do ocjeđivanja. Listovi maslina uzorkovani su tri tjedna nakon tretiranja te su nakon pranja i sušenja pripremljeni za HPLC analizu. Utvrđene su razlike između tretmana, s najjasnijim utjecajem oba tretmana koja su sadržavala biougljen i to za obje sorte maslina. Sorte su pokazale suprotan odgovor na spomenuta dva tretmana za većinu parametara, posebno koncentracije apigenina, apigenin-7-*O*-glukozida, apigenin-4-*O*-glukozida, hidroksitirosola, luteolin-7-rutinozida i oleaceina. Kombinirani tretman s biougljenom i fenolnim ekstraktom pokazao je najveći potencijal za modulaciju fenolnog sastava lista masline, posebno flavonoida, iako je učinak značajno ovisio o sorti.

Ključne riječi: maslina, nusproizvod, biougljen, fenoli, folijarna primjena

Increasing the content of secondary metabolites in olive leaves through combined foliar application of biochar and phenolic extract from olive leaves

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Abstract:
The olive tree is one of the oldest and most important agricultural crops in the Mediterranean region. The processing of olives into olive oil produces significant amounts of waste and by-products, which are mostly underutilized. This research focuses on the additional valorization of olive leaves, a by-product of regular olive pruning, by increasing the content of secondary metabolites through the combined application of biochar and phenolic extract from olive leaves. A suspension of biochar, obtained by the pyrolysis of grapevine pruning residues, was prepared by mixing it in demineralized water (1.5 g; 5 L; 24 hours). The phenolic extract was obtained by extracting lyophilized and ground olive leaves in demineralized water (50 g; 5 L; 24 hours), while the combined preparation was obtained in an analogous manner (1.5 g biochar; 50 g olive leaf powder; 5 L water; 24 hours). Treatments were carried out at the beginning of July and included: a control treatment (demineralized water), a biochar solution, a phenolic extract solution, and a combined aqueous preparation of biochar and phenolic extract. Trees of the olive cultivars Leccino and Istarska bjelica were sprayed with the corresponding preparation until runoff. Olive leaves were sampled three weeks after treatment and, after washing and drying, were prepared for HPLC analysis. Differences between treatments were observed, with the most pronounced effects seen in both treatments that included biochar, for both olive cultivars. The cultivars showed opposite responses to the two mentioned treatments for most parameters, especially the concentrations of apigenin, apigenin-7-*O*-glucoside, apigenin-4-*O*-glucoside, hydroxytyrosol, luteolin-7-rutinoside, and oleacein. The combined treatment with biochar and phenolic extract showed the greatest potential for modulating the phenolic composition of olive leaves, particularly flavonoids, although the effect was significantly cultivar-dependent.

Keywords: olive, by-product, biochar, phenols, foliar application

Unlocking the Potential: Microbial Degradation of Pollutants through Niche Formation and Controlled Aggregation – A Literature Review

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Abstract:
Effective bioremediation of pollutants is often constrained by the limited use of microbial spatial organization and niche formation. Spatial organization significantly influences microbial interactions, enabling the coexistence of diverse microenvironments such as aerobic and anaerobic niches, along with gradients in pH, concentrations of hydrogen, toxic compounds, metabolic products, and substrates. In many polluted environments, we can observe combined contamination of organic contaminants as well as toxic metals. Accordingly, the coexistence of these niches provides multiple benefits, including enhanced metal reduction and precipitation under anaerobic conditions, thereby detoxifying the environment and enabling complete degradation pathways for organic pollutants. The ability to control the structuring of these microenvironments through the synthetic construction of aggregates offers a powerful tool for regulating the initiation of bacterial growth within a single aggregate, facilitating the cultivation of otherwise difficult-to-grow bacteria reliant on interspecies interactions. Based on the literature review presented here, further studies can be directed toward additional progress in the field. Since methods have been developed for the spatial distribution of cells and microgeographic structuring of communities, various structures can be produced by optimally placing microbes within micrometer-scale proximity to establish effective interactions, as well as by immobilizing bacteria on inorganic or organic particles. Proposed methodologies for controlled aggregation include the use of polyelectrolytes and optimization of parameters such as bacterial surface charge, ion type, ionic strength, cell concentration, inorganic particle incorporation, temperature, pH, and mixing conditions. Advanced techniques such as flow cytometry and confocal fluorescence microscopy can be applied to study these dynamics comprehensively. Additionally, fluorescence in situ hybridization (FISH), microsensors (for oxygen, redox potential, and hydrogen), and omics analyses can be employed to investigate microbial interactions, gene expression, and metabolic profiles within microbial communities, enhancing our understanding of their interactions and stability. Therefore, this review underscores the substantial potential of controlled microbial aggregation and niche formation strategies, guiding future research toward more effective and targeted biotechnological solutions.

Keywords: microbial aggregation, spatial organization, polyelectrolytes, environmental biotechnology, colloid biology

Electrostatic Aggregation Unlocks Synergistic PGP Combinations for Sustainable Agriculture

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Abstract:
Plant-associated microbiota play a crucial role in agricultural practices, with many bacterial species exhibiting plant growth-promoting (PGP) traits. Recent advances have revealed the complex and unique structures of these microbial communities, highlighting tight interconnections, reciprocal relationships, and cross-feeding interactions among species. To efficiently leverage these PGP properties for agriculture, selecting optimal bacterial strain combinations is essential. However, the high diversity of strains within a single rhizosphere increases interaction complexity, making it difficult to determine which isolated strains can function together.
Here, we propose interspecies Aggregation Combinatorics Microfluidics & Entrapment (iACME), our newly developed method. iACME optimizes bacterial aggregation, producing aggregates of varying sizes. Larger aggregates facilitate species coexistence and complex interactions, while smaller aggregates reduce interaction complexity by containing fewer strains. To develop this method, we used 34 PGP rhizobacteria isolated from beetroot. For this case, we optimized aggregation protocols to generate bacterial aggregates of different sizes, resulting in 96 unique combinations as potential PGP consortia. Each combination was further examined for efficiency in utilizing environmental carbon sources—specifically, water extracts from beetroot seeds or soil. We employed a high-throughput spectrophotometric assay to measure respiration via resazurin reduction. This enabled us to perform clustering analysis and determine community structures using Denaturing Gradient Gel Electrophoresis (DGGE) and near-full-length 16S rRNA sequencing. Our results revealed variations in bacterial interactome diversity, influenced by nutrient sources used during selection and aggregate formation.
This method improves the isolation of native plant microbiota, enabling rapid, cost-effective selection of bacterial strain combinations with high plant growth-promoting potential. By providing a framework to harness PGPR interactions, iACME offers a promising tool for advancing sustainable agriculture through the targeted selection of bacterial consortia.

Keywords: colloid biology, PGP, aggregates, beet root, biofertilization

Utjecaj folijarne primjene bora na koncentraciju fenolnih spojeva u listovima različitih sorti masline

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Sažetak:
Nedostatak bora kod masline može uzrokovati smanjeno zametanje plodova i posljedično niže prinose. Također, ranija istraživanja pokazala su kako bor može utjecati na biosintezu sekundarnih metabolita u listovima masline, što je osobito važno za valorizaciju lista kao nusproizvoda s potencijalnom primjenom u farmaceutskoj industriji i industriji nutraceutika. Budući da sorta značajno određuje fenolni sastav lista, cilj ovog istraživanja bio je ispitati učinak folijarne primjene bora na koncentraciju ključnih fenolnih spojeva u listovima triju sorti masline: Leccino, Istarska bjelica i Rošinjola.
Pokus je postavljen prema potpuno slučajnom rasporedu s osam ponavljanja. Tretmani su uključivali primjenu bora (B+) i kontrolu bez bora (B-), a primijenjeni su 50 dana nakon pune cvatnje. Uzorkovanje listova provedeno je tijekom berbe maslina, sa srednjeg dijela jednogodišnjih mladica.
Rezultati su pokazali da su koncentracije verbaskozida i luteolina-7-*O*-glukozida bile značajno više u listovima B+ biljaka sorti Istarska bjelica i Leccino, dok kod Rošinjole nije zabilježena značajna razlika između tretmana. Sadržaj apigenin-7-*O*-glukozida povećao se isključivo kod B+ biljaka Leccina. Razlike u koncentracijama sekoiridoida nisu bile jednoznačno povezane sa sortom – zabilježeni su porast za oleuropein i sniženje za oleacein kod B+ biljaka u odnosu na kontrolu B-. Buduća istraživanja bit će usmjerena na procjenu utjecaja bora na sastav i kvalitetu maslinova ulja različitih sorti masline uzgajanih u Istri, Hrvatska.

Ključne riječi: Leccino, Istarska bjelica, Rošinjola, oleuropein, oleacein

Effect of Foliar Boron Application on the Phenolic Profile in Leaves of Different Olive Cultivars

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Abstract:
Boron deficiency in olive trees can lead to poor fruit set and reduced yields. Previous studies have also indicated that boron may influence the biosynthesis of secondary metabolites in olive leaves, which is of particular interest for valorizing leaves as a by-product with potential pharmaceutical and nutraceutical applications. Given that phenolic composition is highly cultivar-dependent, the objective of this study was to assess the effect of foliar boron application on the concentration of key phenolic compounds in the leaves of three olive cultivars: Leccino, Istarska bjelica, and Rošinjola.
The experiment was designed as a completely randomized trial with eight replications. Treatments included boron application (B+) and a control without boron (B-), applied 50 days after full bloom. Leaf sampling was performed at olive harvest from the middle section of one-year-old shoots.
The results showed that verbascoside and luteolin-7-*O*-glucoside concentrations were significantly higher in B+ plants of Istarska bjelica and Leccino, while no statistically significant differences were observed for Rošinjola. An increase in apigenin-7-*O*-glucoside concentration was recorded only in B+ Leccino plants. Secoiridoid levels were apparently not cultivar-dependent under boron treatment - oleuropein concentration increased, whereas oleacein concentration decreased in B+ plants compared to the B- control. Future research will focus on evaluating the impact of boron application on the composition and quality of olive oil of both autochthonous and allochthonous cultivars grown in the Istrian region of Croatia.

Keywords: Leccino, Istarska bjelica, Rošinjola, oleuropein, oleacein

Utjecaj hidroliziranih proteina pogače bundeve na maslinu, u kontroliranim uvjetima

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Sažetak:
U uvjetima klimatskih promjena i sve većeg pritiska na održivost poljoprivrede, primjena biostimulatora, poput hidroliziranih proteina, predstavlja važnu strategiju za povećanje otpornosti I produktivnosti biljaka. Hidrolizati proteina, dobiveni enzimskom razgradnjom proteinskih izvora, sve se češće istražuju zbog svojih pozitivnih učinaka na metabolizam biljaka, apsorpciju hranjiva i toleranciju na stres.
U ovom istraživanju ispitivan je učinak različito hidroliziranih proteina dobivenih od bučine pogače (*Cucurbita pepo* L.), nusproizvoda proizvodnje bučina ulja, na rast i fiziološke karakteristike masline (*Olea europaea* L.), jedne je od najvažnijih mediteranskih kultura, u kontroliranim uvjetima vegetacijske komore. Pokus je proveden prema shemi potpuno slučajnog rasporeda, na jednogodišnjim sadnicama maslina sorte Leccino s tri tretmana s hidrolizatima dobivenima korištenjem različitih kombinacija enzima i kontrolom (kontrola, H1, H2, H3), s ukupno šest folijarnih aplikacija u razmacima od osam dana. Hidrolizat H1 dobiven je enzimatskom razgradnjom izoliranih proteina uz pomoć enzima Alcalase® Pure, H2 kombinacijom enzima Alcalase® Pure + Flavourzyme® te H3 kombinacijom enzima Alcalase® Pure + Protana™ Prime.
Praćeni su rast mladica, razvoj korijenskog sustava te promjene u refleksijskim indeksima listova (CNDVI, WBI, PSRI, PRI, G i SIPI), uz primjenu spektroskopskih i kemijskih analiza lišća. Rezultati su pokazali statistički značajne razlike između tretmana (ANOVA, $p < 0,05$), pri čemu su H2 i H3 imali najpovoljniji učinak na rast i fiziološke pokazatelje.
Dobiveni podaci potvrđuju potencijalnu vrijednost hidrolizata proteina kao održive i učinkovite agrotehničke mjere u uzgoju masline.

Ključne riječi: hidrolizirani proteini, *Olea europaea* L., Alcalase® Pure, Protana™ Prime, Flavourzyme®

Olive (*Olea europaea* L.) Response to Foliar Application of Hydrolyzed Pumpkin Seed Cake Proteins under Controlled Conditions

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Abstract:
In the context of climate change and increasing pressure on agricultural sustainability, the use of biostimulants such as hydrolyzed proteins represent an important strategy for enhancing plant resilience and productivity. Protein hydrolysates, obtained through the enzymatic degradation of protein sources, are increasingly being studied for their positive effects on plant metabolism, nutrient uptake, and stress tolerance.
This study investigated the effects of various hydrolyzates of proteins derived from pumpkin seed cake (*Cucurbita pepo* L.), a by-product of pumpkin oil production, on the growth and physiological characteristics of olive (*Olea europaea* L.), one of the most important Mediterranean crops, under controlled conditions in a growth chamber. The experiment was conducted on one-year-old seedlings of the Leccino cultivar, using three treatments with hydrolyzates produced by different combinations of enzymes and a control treatment (control, H1, H2, H3). A total of six foliar applications were performed at eight-day intervals.
Monitored parameters included shoot growth, root system development, and changes in leaf reflectance indices (CNDVI, WBI, PSRI, PRI, G, and SIPI), using spectroscopic and chemical leaf analyses. The results showed statistically significant differences between the treatments (ANOVA, $p < 0.05$), with H2 and H3 demonstrating the most favorable effects on growth and physiological indicators. These findings confirm the potential value of protein hydrolysates as a sustainable and effective agrotechnical practice in olive cultivation.

Keywords: hydrolyzed proteins, *Olea europaea* L., Alcalase® Pure, Protana™ Prime, Flavourzyme®

Utjecaj biofortifikacije selenom na primarni i sekundarni metabolizam biljaka

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Sažetak:
Selen (Se) je esencijalni metaloid važan za ljudsko i životinjsko zdravlje, no njegova dostupnost u tlu, a posljedično i u prehrambenom lancu, često je ograničena. U poljoprivredi se sve više istražuje njegova upotreba kao biostimulatora, zbog sposobnosti pozitivnog utjecaja na rast, metabolizam i otpornost biljaka. Osim povećanja koncentracije selena, biljke na njegovu primjenu odgovaraju promjenama u primarnom i sekundarnom metabolizmu te time mijenjaju biokemijski sastav, fiziološke funkcije i adaptivne mehanizme.
Biofortifikacija – agronomska praksa usmjerena na povećanje apsorpcije i akumulacije specifičnih hranjivih tvari u biljkama, s ciljem poboljšanja njihove nutritivne vrijednosti – prepoznata je kao održiv pristup u borbi protiv nutritivnih deficita. Biofortifikacija selenom može se provesti putem tla, hidroponskim sustavima, namakanjem sjemena ili folijarnom aplikacijom, pri čemu se folijarna primjena pokazuje najučinkovitijom zbog bolje apsorpcije i minimalnog rizika od kontaminacije tla.
Istraživanje su pokazala da selen u optimalnim koncentracijama, potiče sintezu fenolnih spojeva u zeljastim biljkama poput kadulje (*Salvia officinalis* L.), bosiljka (*Ocimum basilicum* L.), matovilca (*Valerianella locusta* L. Laterr.) origana (*Origanum vulgare* L.), luka (*Allium cepa* L.), i soje (*Glycine max* L.), ali i u voćnim kulturama poput jagoda (*Fragaria ananassa* L.), kivija (*Actinidia chinensis*) i masline (*Olea europea* L.). Također, povećava koncentraciju aminokiselina u krumpiru (*Solanum tuberosum* L.), riži (*Oryza sativa* L.) i vinovoj lozi (*Vitis vinifera* L.). Osim navedenoga, poboljšava fotosintezu kukuruza (*Zea mays* L.) i kvinoje (*Chenopodium quinoa* Wild.), potiče rast breskve (*Prunus persica* Batch.), manga (*Mangifera indica* L.), krastavca (*Cucumis sativus* L.) i paprike (*Capsicum annuum* L.) te smanjuje oksidativni stres šećerne trske (*Saccharum spp. hybrids*) i pšenice (*Triticum aestivum* L.). Modulacijom metabolizma primarnih i sekundarnih metabolita, selen povećava otpornost biljaka na abiotičke i biotičke stresove, uključujući sušu (sirak (*Sorghum bicolor* L.), maslina (*Olea europea* L.) kukuruz (*Zea mays* L.)), zaslanjenje (rajčica (*Solanum lycopersicum* L.), pšenica (*Triticum aestivum* L.), luk (*Allium cepa* L.)) zagađenje teškim metalima (duhan (*Nicotiana tabacum* L., korijandar (*Coriandrum sativum* L.) kukuruz (*Zea mays* L.)) i napade štetnika (Unshiu mandarina (*Citrus unshiu*)).
Stoga, biofortifikacija selenom, otvara nove mogućnosti za poboljšanje funkcionalne kvalitete biljaka i jačanje održivosti proizvodnje u uvjetima klimatskih izazova.

Ključne riječi: biostimulator, fenoli, aminokiseline, biotički i abiotički stresovi

Selenium-Mediated Modulation of Primary and Secondary Metabolism in Plants

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Abstract:
Selenium (Se) is an essential metalloid crucial for human and animal health, yet its availability in soil—and consequently in the food chain—is often limited. In agriculture, its use as a biostimulant is increasingly being explored due to its ability to positively influence plant growth, metabolism, and stress tolerance. In addition to increasing selenium concentrations in plants, its application also triggers changes in primary and secondary metabolism, thereby altering the biochemical composition, physiological functions, and adaptive mechanisms of plants.
Biofortification—an agronomic practice aimed at enhancing the uptake and accumulation of specific nutrients in plants to improve their nutritional value—has been recognized as a sustainable approach to combating micronutrient deficiencies. Selenium biofortification can be achieved through soil supplementation, hydroponic systems, seed soaking, or foliar application. Among these, foliar application has proven to be the most effective due to improved absorption and minimal risk of soil contamination.
Research has shown that selenium, when applied in optimal amounts, stimulates the synthesis of phenolic compounds in herbaceous plants such as sage (*Salvia officinalis L.*), basil (*Ocimum basilicum L.*), lamb's lettuce (*Valerianella locusta L. Laterr.*), oregano (*Origanum vulgare L.*), onion (*Allium cepa L.*), and soybean (*Glycine max L.*), as well as in fruit crops such as strawberry (*Fragaria × ananassa L.*), kiwifruit (*Actinidia chinensis*), and olive (*Olea europaea L.*). Moreover, selenium increases amino acid concentrations in crops like potato (*Solanum tuberosum L.*), rice (*Oryza sativa L.*), and grapevine (*Vitis vinifera L.*). It also enhances photosynthesis in maize (*Zea mays L.*) and quinoa (*Chenopodium quinoa Willd.*), promotes growth in peach (*Prunus persica Batsch*), mango (*Mangifera indica L.*), cucumber (*Cucumis sativus L.*), and pepper (*Capsicum annuum L.*), and reduces oxidative stress in sugarcane (*Saccharum spp. hybrids*) and wheat (*Triticum aestivum L.*).
Through modulation of primary and secondary metabolism, selenium increases plant resilience to abiotic and biotic stressors, including drought (e.g., sorghum (*Sorghum bicolor L.*), olive (*Olea europaea L.*), maize (*Zea mays L.*)), salinity (e.g., tomato (*Solanum lycopersicum L.*), wheat (*Triticum aestivum L.*), onion (*Allium cepa L.*)), heavy metal contamination (e.g., tobacco (*Nicotiana tabacum L.*), coriander (*Coriandrum sativum L.*), maize (*Zea mays L.*)), and pest attacks (e.g., Unshiu mandarin (*Citrus unshiu*)).
Therefore, selenium biofortification presents new opportunities for enhancing the functional quality of plants and strengthening the sustainability of agricultural production in the face of climatic challenges.

Key words: biostimulants, phenolic compounds, abiotic and biotic stressors

Synthetic nodules: Bacterial aggregated structures for nitrogen fixation

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Abstract:
Microbial nitrogen fixation is the key process in the nitrogen cycle and ensures the source of bioavailable nitrogen in the soil. Plants have for this reason entered symbiotic relationships with N_2-fixing bacteria and have developed root nodules, special structures, where they stimulate these bacteria, leading to increased efficiency in diazotrophy and, consequently, enhanced N_2 supplementation for plants. Recent studies have shown that bacterial diversity in nodules is higher than previously thought, demonstrating that several bacterial species are spatially functionally arranged forming functional aggregates within these plant-root structures. Additionally, free-living diazotrophs also have to enter different types of associations with other microbes within aggregated communities to ensure the establishment of micro-environments suitable for diazotrophic metabolism.
Using single or multiple species, we show that bacteria can be efficiently aggregated *in vitro* into suspended 3D structures and that different niches, aerobic and anaerobic, are formed within the aggregated systems. The process of aggregation can be further optimised to control the spatial arrangement of cells through precise placement of cells or through random aggregation and the spontaneous succession of the metabolically governed multispecies system. In either case, the established aerobic/anaerobic micro-environments can be demonstrated through the visualization of metal reduction or spatially mapping parameters like pH, oxygen availability or redox potential.
Selecting the right bacterial consortium and using bacterial aggregation and classical approaches of matrix entrapment and cell immobilization, we can now provide the platform for the optimisation of N_2-fixation. Functioning synthetic structures can first be used as an *in vitro* tool to understand the N_2-fixation process and second, it can be incorporated as part of a functionally broader fertilizer agricultural application, which also incorporates other plant growth promoting bacteria.

Keywords: bacteria, aggregate, nitrogen fixation, ecological niches, N_2 fertilizer

Effect of humic acids on yield quality and quantity of sweet peppers (*Capsicum annuum* L.)

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Abstract:
The quality of sweet pepper plants is crucial for ensuring optimal growth and maximizing both yield and fruit quality. This study evaluates the effects of two commercially available humic acid-based biostimulants applied to the snack-type sweet pepper *Capsicum annuum* L. on the growth, yield, and fruit quality of "Cuccino Orange".
The findings indicate that applying the first biostimulant (Humic Blast) significantly enhanced yield by 108.4% and increased the number of fruits per plant by 123.9% compared to the control. Additionally, treated plants produced fruits with 10–18% higher glucose and fructose levels than untreated plants. However, other fruit characteristics, including length, width, and pericarp thickness, remained unaffected by the biostimulant treatments.
These findings underscore the importance of choosing an optimal biostimulant. Applying biostimulants to peppers has been shown to enhance fruit growth and development, ultimately leading to increased yield. Overall, this study offers valuable insights into the effective use of humic acid-based biostimulants in pepper production and provides practical recommendations for growers aiming to maximize crop productivity.

Keywords: biostimulants, peppers, yield, growth, quality

Selenium species in selected leafy vegetables sprayed with Se(VI) in the growing period

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Abstract:
Dandelion, salad rocket, wild rocket and two cultivars of common chicory were foliarly sprayed twice (at 5 days interval) with nutrient selenium solution of various concentrations (1+1; 2+2; 5+5; 10+0; 10+10 and 10+50 mg Se L^{-1}), where the numbers refer to the concentrations used in the first and second spraying, in the form of Na_2SeO_4 to evaluate the effects of foliarly application on the biomass responses as well as on the transformation of selenate in the plants treated under the same conditions. Selenium compounds were determined by HPLC-UV-HG-AFS in extracts obtained after enzymatic hydrolysis of the leaves of the selected plants. The reliability of the results was checked by an independent detection method, HPLC-ICP-MS. Separation of Se(VI), Se(IV), SeMet, SeMeSeCys and $SeCys_2$ was made by a combination of anion and cation exchange chromatography. Se accumulated efficiently in plant leaves up to 102 µg Se g^{-1} dry mass (rocket), mostly as Se(VI), i.e. the form of Se in the foliar solution.
Beside inorganic selenium (about 20%), in plants sprayed with 2+2 and 5+5 mg Se L^{-1} SeMet (7–40%) was found. In plants foliarly sprayed with 10+50 mg Se L^{-1}, Se(VI) content was higher (above 40%) while on the other hand SeMet was present in small amounts (2–4%) and SeMeSeCys was found in traces (<1%). Some unidentified peaks (<3%) were also observed in the chromatograms obtained.
What should be emphasised is that, to the author's knowledge, it has never been reported that the SeMet synthesis is decreasing with increasing Se concentration in leaves.

Keywords: leafy vegetables, selenium species, HPLC-UV-HG-AFS, HPLC-ICP-MS

Zaštita bilja

Plant protection

Antagonistički potencijal *Trichoderma* spp. protiv različitih zemljišnih patogena

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Sažetak:

Gljive roda *Trichoderma* spp. su učinkoviti biološki agensi koji suzbijaju biljne patogene koristeći različite mehanizme djelovanja. Njihova primjena u biološkoj kontroli može smanjiti potrebu za kemijskim fungicidima i pridonijeti održivoj poljoprivredi, no njihova učinkovitost varira ovisno o patogenu, uvjetima okoliša i vrsti roda *Trichoderma*. Cilj ovog istraživanja bio je ispitati antagonistički potencijal triju vrsta *Trichoderma* (*Trichoderma gamsii* Samuels & Druzhin., *Trichoderma atroviride* P. Karst. i *Trichoderma harzianum* Rifai) protiv pet zemljišnih patogena (*Macrophomina phaseolina* (Tassi) Goid., *Sclerotinia sclerotiorum* (Lib.) de Bary, *Botrytis cinerea* Pers., *Fusarium culmorum* (Wm.G. Sm.) Sacc. i *Alternaria solani* (Ellis & G. Martin) L.R. Jones. Ovi patogeni uzrokuju značajne biljne bolesti, uključujući trulež korijena i stabljike, nekrotične lezije te propadanje plodova, što dovodi do velikih gubitaka u poljoprivrednoj proizvodnji. Ispitivane vrste *Trichoderma* izolirane su iz tla i testirane zbog njihovog potencijala u biološkoj kontroli patogena. Antagonistički učinak procijenjen je *in vitro* dualnim testom, pri čemu se rast micelija patogena mjerio 2., 4. i 7. dan nakon inokulacije, a inhibicija rasta izračunata je u odnosu na kontrolne uzorke. Najveća inhibicija zabilježena je 7. dana, dok su razlike među vrstama bile najizraženije 4. dana. Vrsta *T. atroviride* pokazala je najjači antagonistički učinak s prosječnom inhibicijom rasta od 75,37% na 7. dan. *T. harzianum* također je pokazao visoku učinkovitost (74,6%), dok je *T. gamsii* imao nešto slabiji učinak (69,23–75,38%). Najosjetljiviji na djelovanje *Trichoderma spp.* bili su *B. cinerea* i *S. sclerotiorum*, dok je *M. phaseolina* pokazala najmanju osjetljivost. Rezultati ukazuju na visok potencijal primjene ispitanih vrsta *Trichoderma* u biološkoj kontroli, osobito protiv *B. cinerea* i *S. sclerotiorum*. Korištenjem ovih bioloških agensa moguće je ograničiti uporabu kemijskih fungicida i potaknuti održivije pristupe u zaštiti bilja. Daljnja istraživanja trebala bi uključiti analizu mehanizama djelovanja, kao i testiranje učinkovitosti u različitim agroekološkim uvjetima kako bi se mogle koristiti u biološkoj kontroli patogena.

Ključne riječi: biološka kontrola, dualni test, inhibicija rasta, *Trichoderma* spp., zemljišni patogeni

Antagonistic potential of *Trichoderma* spp. against various soil-borne pathogens

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Abstract:

Fungi of the genus *Trichoderma* spp. are effective biological agents that suppress plant pathogens using different mechanisms of action. Their application in biological control can reduce the need for chemical fungicides and contribute to sustainable agriculture, but their effectiveness varies depending on the pathogen, environmental conditions, and *Trichoderma* species. This study aimed to examine the antagonistic potential of three *Trichoderma* species (*Trichoderma gamsii* Samuels & Druzhin., *Trichoderma atroviride* P. Karst. and *Trichoderma harzianum* Rifai) against five soil-borne pathogens (*Macrophomina phaseolina* (Tassi) Goid., *Sclerotinia sclerotiorum* (Lib.) de Bary, *Botrytis cinerea* Pers., *Fusarium culmorum* (Wm.G. Sm.) Sacc. and *Alternaria solani* (Ellis & G. Martin) L.R. Jones. These pathogens cause significant plant diseases, including root and stem rot, necrotic lesions, and fruit decay, leading to sizeable agricultural production losses. The *Trichoderma* species were isolated from the soil and tested for their potential to control pathogens biologically. The antagonistic effect was assessed *in vitro* by a dual assay, where the growth of pathogen mycelium was measured on days 2, 4, and 7 after inoculation, and the growth inhibition was calculated for the control samples. The highest inhibition was recorded on day 7, while the differences between the species were most pronounced on day 4. The species *T. atroviride* showed the strongest antagonistic effect, with an average growth inhibition of 75.37% on day 7. *T. harzianum* also showed high efficiency (74.6%), while *T. gamsii* had a slightly weaker effect (69.23–75.38%). The most sensitive to the action of *Trichoderma* spp. were *B. cinerea* and *S. sclerotiorum*, while *M. phaseolina* showed the least sensitivity. The results indicate a high potential for applying the tested *Trichoderma* species in biological control, especially against *B. cinerea* and *S. sclerotiorum*. These biological agents may limit the use of chemical fungicides and encourage more sustainable approaches to plant protection. Further research should include analysis of the mechanisms of action and testing of efficacy in different agroecological conditions so that they can be used in the biological control of pathogens.

Keywords: biological control, dual test, growth inhibition, soil pathogens, *Trichoderma* spp.

In vitro evaluation of natural compounds against Verticillium wilt of olive

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Abstract:
Verticillium wilt, caused by the soil-borne fungus *Verticillium dahliae*, poses a significant threat to olive trees (*Olea europaea*) globally, leading to substantial economic losses. Its persistence in soil makes management challenging. This study isolated two *V. dahliae* isolates (AN1, AN2) from diseased olive trees in Cerignola, Italy. An *in vitro* study was conducted to evaluate antimicrobial activities in contact phase of COS (chito-oligosaccharides)-OGA (oligo-galacturonides), chitosan hydrochloride, *Urtica* spp., and *Equisetum arvense* were all evaluated at 0.2% concentration. Five essential oils (EOs) – *Rosmarinus officinalis*, *Rosmarinus officinalis* var. *verbenone*, *Lavandula hybrida*, *Origanum majorana*, and *Thymus vulgaris* were evaluated at 0.1% concentration in the contact phase and at two distinct concentrations/EO in the vapor phase. *Urtica* spp. showed the highest mycelial growth inhibition (92.9% for AN1, 82.6% for AN2), followed by COS-OGA (74.8% and 76.0%) and chitosan hydrochloride (65.8% and 63.4%). *E. arvense* was the least effective. In contact assays, *T. vulgaris* completely inhibited mycelia growth of both isolates, and *L. hybrida* completely inhibited AN1. *O. majorana* showed 89.4% (AN1) and 63.3% (AN2) inhibition. In vapor phase, *T. vulgaris* was most effective, achieving 99.0% and 82.5% inhibition at 90.9 µL/L and 45.4 µL/L, respectively against AN1. *In vivo* investigations are required to validate the prospective application of these treatments for Verticillium wilt disease management.

Keywords: environmentally friendly, sustainability, *Thymus vulgaris*, *Urtica* spp., *Verticillium dahliae*

Effect of protein hydrolysates on the fungal microbiome of olive leaves

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Abstract:
The olive tree (*Olea europaea* L.) is one of the oldest cultivated plants in the world and has important economic and historical value. Like all plants, olives host various microorganisms that can significantly impact their host through mutual interactions. Among the most essential microbes are fungi, which can be divided into epiphytes, which live on the surface of plant organs, and endophytes, which colonise the interior tissues. The aim of our research was to determine the effects of protein hydrolysates obtained from defatted pumpkin seed cake applied foliarly on the fungal microbiome of olive leaves.
One-year-old olive seedlings (cv. Leccino) were kept in the growth chamber and treated foliarly six times with three different hydrolysates (referred to as H1, H2 and H3) or with water only (Control). Each treatment had four repetitions. Eight days after the final treatment, leaf samples were collected, and epiphytic and endophytic fungi were isolated from leaves of each treatment using established protocols. After incubation at room temperature in the dark (5 days for epiphytes and up to 3 weeks for endophytes), fungi were divided into distinct morphotypes based on their morphology. Two representatives of each morphotype were selected for further molecular identification (DNA extraction, PCR and sequencing at Macrogen Inc., Amsterdam). The results showed that treatment H2 decreased the overall colonisation of olive leaves with epiphytic fungi by 50%. The effect was even greater in endophytic fungi, as their abundance was only around 1/3 of the Control group. Genus *Rhizopus* was the most abundant epiphytic fungal group in all treatments. Fungi from the genus *Alternaria*, common plant pathogens, were also frequently isolated as epiphytes and endophytes in all treatments except H2. This indicates that H2 treatment could potentially alter the fungal colonisation and community structure of olive leaves.

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Keywords: leaf microbiome, epiphytes, endophytes, pumpkin seed cake

Protugljivični utjecaj otpadnih biljnih voda masline na fitopatogene gljive iz razreda *Sordariomycetes*

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Sažetak:
Otpadna biljna voda masline (OBVM) je nusproizvod procesa proizvodnje maslinovog ulja. Karakterizira ju složeni kemijski sastav, a privukla je pažnju kao potencijalna prirodna alternativa za suzbijanje biljnih patogena. Ovo istraživanje ispituje protugljivični potencijal OBVM, izdvojene iz žitke komine, odnosno nusproizvoda dvofazne centrifuge, dobivene od različitih sorti maslina. OBVM je testirana protiv fitopatogenih gljiva iz razreda *Sordariomycetes*, uključujući vrste *Biscogniauxia mediterranea* (De Not.) Kuntze, *B. nummularia* (Bull.) Kuntze, *Cytospora pruinosa* Défago, *Nigrospora gorlenkoana* Novobr., *N. osmanthi* Mei Wang & L. Cai, *N. philosophiae-doctoris* M. Raza, Qian Chen & L. Cai, *Phaeoacremonium iranianum* L. Mostert, Grafenhan, W. Gams & Crous te *Sordaria fimicola* (Roberge ex Desm.) Ces. & De Not. Nadalje, mikroorganizmi izolirani iz OBVM, uključujući *Bacillus velezensis* Ruiz-Garcia et al., *Rhodotorula mucilaginosa* (A. Jörgensen) F.C. Harrison, *Nakazawaea molendiniolei* (N. Cadez, B. Turchetti & G. Peter) C.P. Kurtzman & C.J. Robnett te *Penicillium crustosum* Thom, testirani su na njihov antagonistički potencijal protiv navedenih patogena. Protugljivična učinkovitost OBVM testirana je pri različitim koncentracijama, zajedno s fenolima hidroksitirozolom i vanilinskom kiselinom. Među testiranim patogenima, *N. philosophiae-doctoris* pokazala se najosjetljivijom vrstom, dok su na vrstu *N. gorlenkoana* svi tretmani s OBVM imali stimulativni učinak. Iako su rezultati značajno varirali među vrstama, OBVM dobivena od sorte Rosinjola pokazala je najveću učinkovitost u inhibiciji rasta micelija gljiva, dok je OBVM dobivena od sorte Leccino bila najmanje učinkovita. U pogledu antagonističke aktivnosti mikroorganizama, uočene su značajne razlike u njihovim utjecajima na gljive. Ni bakterija ni kvasci nisu uspjeli inhibirati rast *B. mediterranea*. Također, zabilježene su varijacije u antagonističkoj aktivnosti među izolatima iste vrste. U nekim slučajevima, mikroorganizmi izolirani iz OBVM imali su stimulativan učinak na rast patogena. S obzirom na sve veću potražnju za ekološki prihvatljivim strategijama kontrole gljivičnih bolesti, tretmani na bazi OBVM mogli bi predstavljati inovativan pristup njihovoj kontroli u poljoprivredi.

Ključne riječi: antagonizam, bakterija, ekologija, zaštita bilja, kvasci

The antifungal efficacy of olive mill wastewater on phytopathogenic fungi from the class *Sordariomycetes*

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Abstract:
Olive mill wastewater (OMWW) is a byproduct of olive oil production, characterised by a complex composition and has gained attention as a potential natural alternative for controlling plant pathogens. This study investigates the antifungal potential of OMWW, extracted from olive pomace, a by-product of the two-phase centrifugation process, obtained from different olive cultivars. OMWW was tested against phytopathogenic fungi from the *Sordariomycetes* class, including *Biscogniauxia mediterranea* (De Not.) Kuntze, *B. nummularia* (Bull.) Kuntze, *Cytospora* pruinosa Défago, *Nigrospora gorlenkoana* Novobr., *N. osmanthi* Mei Wang & L. Cai, *N. philosophiae-doctoris* M. Raza, Qian Chen & L. Cai, *Phaeoacremonium iranianum* L. Mostert, Grafenhan, W. Gams & Crous, and *Sordaria fimicola* (Roberge ex Desm.) Ces. & De Not. In addition, microorganisms isolated from OMWW, *Bacillus velezensis* Ruiz-Garcia et al., *Rhodotorula mucilaginosa* (A. Jörg.) F.C. Harrison, *Nakazawaea molendiniolei* (N. Cadez, B. Turchetti & G. Peter) C. P. Kurtzman & C. J. Robnett, and *Penicillium crustosum* Thom, were tested for their antagonistic potential against these pathogens. The antifungal efficacy of OMWW was evaluated at different concentrations, alongside phenols hydroxytyrosol and vanillic acid. Among the tested pathogens, *N. philosophiae-doctoris* was the most sensitive, whereas in the case of *N. gorlenkoana*, all OMWW treatments exhibited a stimulatory effect. Although the results varied significantly between species, OMWW from Rosinjola demonstrated the highest efficacy in inhibiting mycelial growth, while OMWW from Leccino was the least effective. Regarding the antagonistic activity of microorganisms, substantial differences were observed in their effects on different fungal species. Neither bacteria nor yeasts successfully inhibited the growth of *B. mediterranea*. Additionally, variations in antagonistic activity were detected among isolates of the same species. In some cases, microbial isolates from OMWW even had a stimulatory effect on pathogen growth. Given the increasing demand for eco-friendly disease management strategies, OMWW-derived treatments could represent an innovative approach to mitigating fungal infections in agriculture.

Key words: antagonism, bacteria, ecology, plant protection, yeast

Pollination strategies affect the microbiome of buckwheat flowers

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Abstract:
Buckwheat species are valued as a functional crop worldwide, as they are exceptionally rich in antioxidants, phenols and flavonoids. Common buckwheat is a cross-pollinated pseudocereal, while Tartary buckwheat is a self-pollinated species. The main aim of our research was to uncover the impact of differences in pollination strategies on the structure and function of the microbiome in buckwheat.
Common and Tartary buckwheat plants were collected at the production field near Ljubljana in 2022. Whole-community DNA was extracted and sequenced using the Illumina HiSeqX platform at Macrogene. Operational taxonomic units (OTUs) were defined at the level of genus. ORF prediction and annotation are retrieved by homology search using KEGG.
The primary colonisers of buckwheat grain are *Proteobacteria* and Ascomycetes (*Alternaria*). Flowers had the most unique OTUs among plant organs analysed (grain, leaves, flower) in both buckwheat species. However, a significantly higher diversity of bacteria and fungi was found on the flowers of the common buckwheat compared to Tartary buckwheat. Similar trends were also observed in the specific microbial functional genes. Differences in the structure and diversity of both buckwheat microbiome and microbial gene activities were attributed to differences in the pollination strategy in common and Tartary buckwheat.
The work was supported by ARIS P1-0212, J1-3014, J7-60126, and N4-0346.

Ključne riječi: flower microbiome, metagenomics, fungal diversity, bacterial diversity, secondary metabolites

Wilt and dieback of young olive trees caused by *Fusarium solani* (Mart.) Sacc. in Herzegovina

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Abstract:
Olive (*Olea europaea* L.) is a very important crop grown in the Mediterranean part of Bosnia and Herzegovina. In the past decade, the number of olive trees has increased significantly. Currently, Bosnia and Herzegovina have 144,000 olive trees. Leaf drop, wilt, and mortality of one- to two-year-old olive trees were observed in September 2023 at the sites of Studenci (Ljubuški) and Jasoč (Stolac). Symptoms of young seedlings dieback were recorded in locations where the pre-culture was immortelle (*Helichrysum italicum* (Roth) G. Don). The samples from symptomatic trees were collected and brought for analysis to the Phytosanitary Laboratory of the Federal Agromediterranean Institute in Mostar. Based on their morphological characterization, isolated fungi were identified as *Fusarium* sp. For molecular identification, two isolates were used in PCR to amplify the internal transcribed spacer (ITS) region and the partial translation elongation factor tef1-α gene, using primers EF1 and EF2. On the basis of molecular data, the isolates were confirmed to be species *Fusarium solani* (Mart.) Sacc. Koch's postulate was verified in the one-year-old olive tree of the variety 'Oblica', inoculated with *F. solani*.

Keywords: *Fusarium solani*, fungal disease, *Olea europaea* L., Bosnia and Herzegovina

Vinogradarstvo, vinarstvo i voćarstvo

Viticulture, Oenology and Pomology

Utjecaj folijarne primjene biougljena na fiziologiju vinove loze sorte 'Malvazija istarska'

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Sažetak:
Primjena biougljena privukla je značajnu pozornost u vinogradarstvu zbog svog potencijala za poboljšanje usvajanja biogenih elemenata i unaprjeđenje fiziologije vinove loze. Ovo istraživanje prikazuje učinke folijarne primjene biougljena u koncentracijama od 300 mg/L (B300), 600 mg/L (B600) i 1200 mg/L (B1200) na fiziologiju vinove loze sorte 'Malvazija istarska' (*Vitis vinifera* L.), uz kontrolni tretman (K). Istraživanje je obuhvatilo ključne fiziološke parametre: fotosintetsku aktivnost, vodni potencijal lista, sadržaj elemenata u lišću te prinos grožđa. Pokus je proveden u komercijalnom vinogradu, a folijarne aplikacije primijenjene su tri puta tijekom vegetacijske sezone. Rezultati pokazuju da su više koncentracije biougljena (B600 i B1200) poboljšale fotosintetsku učinkovitost, vodni potencijal lista te sadržaj kalija (K) i kalcija (Ca) u listu. Međutim, količina magnezija (Mg) u listu smanjivala se s porastom koncentracije biougljena. Najviši prinos ostvaren je pri koncentraciji B600, što ukazuje na optimalnu ravnotežu između fiziološki pozitivnog učinka i dostupnosti hraniva. Dobiveni rezultati ukazuju na potencijal folijarne primjene biougljena kao održive prakse za povećanje produktivnosti i otpornosti vinograda.

Ključne riječi: biomasa, gnojivo, kružno gospodarstvo, ostaci rezidbe, piroliza

Influence of Biochar Foliar Application on 'Malvazija istarska' Grapevine Physiology

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Abstract:
Biochar has gained attention in viticulture due to its potential to enhance nutrient uptake and improve grapevine physiology. This study investigates the effects of foliar-applied biochar at concentrations of 300 mg/L (B300), 600 mg/L (B600), and 1200 mg/L (B1200) on the physiology 'Istrian Malvasia' grapevine (*Vitis vinifera* L.), including a control treatment (K). The study focused on key physiological parameters: photosynthetic activity, leaf water potential, element content in leaves, and grape yield. The experiment was conducted in a commercial vineyard, with foliar applications administered three times during the growing season. Results indicate that higher concentrations of biochar (B600 and B1200) improved photosynthetic efficiency, leaf water potential, and potassium (K) and calcium (Ca) content in leaves. However, magnesium (Mg) levels declined with increasing biochar concentrations. Yield was the highest in B600, demonstrating the optimal balance between physiological enhancement and nutrient availability. These findings support the application of foliar biochar as a sustainable practice to improve vineyard productivity and resilience.

Keywords: biomass, circular economy, fertilizer, pruning residues, pyrolysis

Raznolikost aromatskog profila vina sorte Malvazija istarska kao posljedica fermentacije s različitim ne-*Saccharomyces* starter kvascima u dvije godine berbe

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Sažetak:
Ne-*Saccharomyces* kvasci privlače sve veći interes u suvremenom vinarstvu zbog njihovog utjecaja na različite aspekte kvalitete vina, osobito na fizikalno-kemijske i senzorske karakteristike. Njihova primjena pruža mogućnosti za povećanje senzorne raznolikosti i stvaranje vina s posebnijim aromatskim profilima. Tijekom dvije godine berbe (2021., 2022.) provedena je fermentacija mošta kultivara Malvazija istarska s različitim vrstama kvasaca: *Torulaspora delbrueckii*, *Metschnikowia pulcherrima*, *Pichia kluyveri*, *Lachancea thermotolerans*, *Schizosaccharomyces pombe* i hibrid *Saccharomyces paradoxus* × *Saccharomyces cerevisiae*, uz *S. cerevisiae* kao kontrolni kvasac, s ciljem istraživanja njihovog utjecaja na aromu vina. Eksperiment je proveden u spremnicima od nehrđajućeg čelika na temperaturi od 17 °C u tri ponavljanja. Kada je razina alkohola u fermentacijama s ne-*Saccharomyces* kvascima dosegla 2 % vol., dodan je kvasac *S. cerevisiae* za dovršetak fermentacije, dok su tretman s hibridom *S. paradoxus* × *S. cerevisiae* i kontrolni *S. cerevisiae* tretman fermentirani kao monokulture. Analiza hlapljivih spojeva arome provedena je korištenjem suvremenih analitičkih tehnika, uključujući dvodimenzionalnu plinsku kromatografiju u sprezi sa spektrometrijom masa s analizatorom na osnovi mjerenja vremena preleta iona (GC×GC/TOF-MS), te je identificirano više od 400 spojeva. Statistička analiza, uključujući analizu varijance (ANOVA) i multivarijatne metode, rezultirala je izdvajanjem markera karakterističnih za pojedine kvasce u obje berbe, što je potvrdilo određeni stupanj ponovljivosti njihovog utjecaja na aromu vina. Međutim, za brojne hlapljive spojeve zabilježene su i razlike između vina iz dvije različite godine, što je naglasilo značajnu ulogu uvjeta berbe u ishodima fermentacije. Ovo istraživanje pokazalo je da ne-*Saccharomyces* kvasci mogu značajno utjecati na aromatsku kompleksnost vina, s određenim trendovima koji se održavaju unatoč promjenjivim uvjetima u različitim godinama berbe. Dobiveni rezultati omogućit će bolje razumijevanje učinaka većine najvažnijih ne-*Saccharomyces* kvasaca koji se koriste u suvremenom vinarstvu, uzevši u obzir i godinu berbe kao važan čimbenik. Ovaj rad je financirala Hrvatska zaklada za znanost projektima HRZZ-IP-2020-02-4551 i HRZZ-DOK-2021-02-5500.

Ključne riječi: ne-*Saccharomyces* kvasci, sekvencijalna fermentacija, godina berbe, aroma vina, dvodimenzionalna plinska kromatografija

Diversity of the aromatic profile of Malvazija istarska wine as a result of fermentation with different non-*Saccharomyces* starter yeasts across two harvest years

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Abstract:
Non-*Saccharomyces* yeasts have garnered growing interest in modern enology due to their capacity to modulate various aspects of wine quality, particularly its physico-chemical and sensory characteristics. Their application offers opportunities to enhance sensory diversity and create wines with distinctive aromatic profiles. In this study, conducted over two harvest years (2021, 2022), fermentations of Malvazija istarska grape must with different yeast species, such as *Torulaspora delbrueckii*, *Metschnikowia pulcherrima*, *Pichia kluyveri*, *Lachancea thermotolerans*, *Schizosaccharomyces pombe*, and a *Saccharomyces paradoxus* × *Saccharomyces cerevisiae* hybrid, alongside a *S. cerevisiae* control, were employed to investigate their impact on wine aroma. Fermentations were performed in stainless steel tanks at 17 °C in triplicate. When the alcohol level of non-*Saccharomyces* ferments reached 2% vol., *S. cerevisiae* was added to complete fermentation, while treatments with the *S. paradoxus* × *S. cerevisiae* hybrid and *S. cerevisiae* were fermented in monoculture. Volatile aroma compounds in the resulting wines were comprehensively profiled using advanced analytical techniques, including two-dimensional gas chromatography with time-of-flight mass spectrometry (GC×GC/TOF-MS), leading to the identification of more than 400 compounds. Statistical analysis, comprising ANOVA and multivariate techniques, revealed consistent patterns in the effects of specific yeast species across the two harvest years, suggesting a degree of reproducibility in their influence on wine aroma. However, differences between harvest years were also observed for a number of volatile compounds, underscoring the significant role of vintage conditions in shaping fermentation outcomes. Overall, this study demonstrated that non-*Saccharomyces* yeasts can effectively modulate the aromatic complexity of wine, with certain trends persisting across varying conditions. These findings highlight the potential of selected non-*Saccharomyces* and other investigated yeast species as valuable tools for enhancing wine aroma, while also emphasizing the importance of environmental and vintage-related factors in determining their effects. This work was supported by the Croatian Science Foundation under the projects HRZZ-IP-2020-02-4551 and HRZZ-DOK-2021-02-5500.

Keywords: non-*Saccharomyces* yeasts, sequential fermentation, harvest year, wine aroma, two-dimensional gas chromatography

Primjena vodikovog peroksida u zaštiti vinove loze (*Vitis vinifera* L.) od bolesti drva

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Sažetak:
Bolesti drva vinove loze predstavljaju jedan od glavnih čimbenika smanjenja produktivnosti vinograda, uzrokujući progresivno propadanje trsova i gubitak prinosa. Dosadašnja istraživanja ukazuju na potrebu za učinkovitim alternativnim metodama zaštite, s obzirom na ograničenja konvencionalnih kemijskih sredstava. Vodikov peroksid (H_2O_2) prepoznat je kao potencijalni tretman zbog svojih antimikrobnih svojstava, međutim, istraživanja o njegovoj primjeni u zaštiti vinove loze su ograničena. Stoga je cilj ovog istraživanja bio ispitati učinkovitost primjene vodikovog peroksida na simptomatične trsove vinove loze u kontekstu smanjenja simptoma bolesti drva te utjecaj na prinos i kvalitativne parametre mošta. Eksperiment je proveden tijekom vegetacije 2021. godine na sortama Malvazija istarska i Cabernet Sauvignon. Vodikov peroksid (10%) u količini 5ml injektiran je u trsove, a učinkovitost tretmana ocijenjena je temeljem vizualne procjene zdravstvenog stanja trsova te analize prinosa, sadržaja šećera, pH vrijednosti i ukupnih kiselina mošta. Rezultati pokazuju da primjena vodikovog peroksida smanjuje simptome bolesti drva i potiče oporavak trsova. Trsovi tretirani u ranoj fazi bolesti pokazali su određeni stupanj oporavka u odnosu na one tretirane u fazi s uznapredovalim simptomima. Nisu utvrđene značajne razlike u prinosu, sadržaju šećera, pH vrijednosti i ukupnim kiselinama mošta. Daljnja istraživanja su potrebna za optimiziranje uvjeta primjene i razjašnjenje mehanizma djelovanja vodikovog peroksida u zaštiti vinove loze.

Ključne riječi: vodikov peroksid, bolesti drva vinove loze, zaštita vinograda, Malvazija istarska, Cabernet Sauvignon

Application of hydrogen peroxide in the protection of grapevine (*Vitis vinifera* L.) against grapevine trunk diseases

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Abstract:
Grapevine trunk diseases (GTDs) are among the major factors contributing to vineyard productivity decline, leading to progressive vine deterioration and yield loss. Existing research highlights the need for effective alternative protection methods due to the limitations of conventional chemical treatments. Hydrogen peroxide (H_2O_2) has been recognized as a potential treatment due to its antimicrobial properties; however, studies on its application in grapevine protection remain limited. Therefore, this study aimed to evaluate the effectiveness of hydrogen peroxide application on symptomatic grapevines in reducing GTD symptoms and its impact on yield and qualitative must parameters. The experiment was conducted during the 2021 growing season on the grapevine cultivars Malvazija istarska and Cabernet Sauvignon. Hydrogen peroxide (10%) in quantity of 5 ml was injected into the vines, and treatment efficacy was assessed based on a visual evaluation of vine health, as well as analyses of yield, sugar content, pH, and titratable acidity of grape must. The results indicate that hydrogen peroxide application reduced GTD symptoms and promoted vine recovery. Vines treated in the early stages of the disease showed a certain degree of recovery compared to those treated in advanced symptomatic stages. No significant differences were observed in yield, sugar content, pH value, or titratable acidity of the must. Further research is needed to optimize treatment conditions and elucidate the mechanisms of hydrogen peroxide action in grapevine disease management.

Keywords: hydrogen peroxide, grapevine trunk diseases, vineyard protection, Malvazija istarska, Cabernet Sauvignon

Raznolikost polifenolnog profila tradicionalnih sorti jabuka kao obrambeni mehanizam protiv plave plijesni

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Sažetak:
Jabuke su jedna od ekonomski najvažnijih vrsta voća u svijetu, kako u proizvodnji tako i u konzumaciji. Osim velike proizvodnje i konzumacije, jabuke su također cijenjene zbog svog nutritivnog sastava i prisutnosti raznih bioaktivnih spojeva kao što su polifenoli. Polifenoli su raznolika skupina kemijskih spojeva koji igraju važnu ulogu u obrani biljaka od različitih patogena, uključujući i plavu plijesan koju uzrokuje *Penicillium expansum*. Plijesan *P. expansum* izaziva veliku zabrinutost proizvođača s obzirom da uz proizvodnju mikotoksina, naročito patulina, dovodi i do smanjenje kvalitete ploda jabuka. Navedeno istraživanje ima za cilj istražiti raznolikosti u polifenolnim profilima četiri hrvatskih tradicionalnih sorti jabuka (´Crvenka´, ´Božićnica´, ´Winter Banane´ i ´Bobovec´) i usporediti ih sa četiri komercijalnih sorti jabuka (´Idared´, ´Fuji´, ´Jonagold´ i ´Golden Delicious´). Uspoređen je ukupni udio polifenola i flavonoida, kao i antioksidacijska aktivnost i udio patulina. Istraživanjem navedenih raznolikosti potaknut će se razvoj novih strategija koje će unaprijediti proizvodnju jabuka s višim razinama polifenola, što će u konačnici dovesti do poboljšanja kvalitete voća i smanjenja gubitaka nakon berbe nastalih djelovanjem plijesni. Navedeno istraživanje imati će značajan utjecaj kako za proizvodnju tradicionalnih i komercijalnih sorti jabuka tako i za razvoj programa oplemenjivanja usmjerenog poboljšavanju otpornosti jabuka na infekcije uzrokovane plijesni *P. expansum*. Rezultati navedenog istraživanja pokazali su da tradicionalne sorte jabuka imaju veći udio polifenola i flavonoida od komercijalnih sorti, posebice polifenola kao što su procijanidin B1, floridzin i epikatehin koji predstavljaju jedne od ključnih polifenola odgovornih za otpornost jabuka na gljivične infekcije. Tradicionalna sorta ´Winter Banane´ (16 µg/kg) i komercijalna sorta ´Idared´ (327 µg/kg) pokazale su povećanu biosintezu patulina nakon inokulacije što ukazuje na veću osjetljivost navedenih sorti na gljivične infekcije. Dobiveni rezultati doprinijeti će povećavanju sigurnosti hrane te sprječavanju ekonomskih gubitaka uzorkovanih plijesni *P. expansum*.
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Ključne riječi: polifenoli, *Penicillium expansum*, patulin, antioksidacijska aktivnost

Diversity in the polyphenol profile of traditional apple cultivars as a defence mechanism against blue mould

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Abstract:
Apples are one of the most economically important continental fruits worldwide, both in terms of consumption and production. Besides their large production and consumption, apples are highly regarded for their nutritional value and the presence of various bioactive compounds, such as polyphenols. Polyphenols are a diverse group of chemical compounds that play an important role in plant defence against a range of pathogens, including blue mould caused by *Penicillium expansum*. *P. expansum* is a significant concern because it can reduce the apple quality and produce several mycotoxins, particularly patulin. This study aims to investigate the diversity in the polyphenolic profile of four Croatian traditional apple cultivars (´Crvenka´, ´Božićnica´, ´Winter Banane´ and ´Bobovec´) and compare them with four conventional apple cultivars (´Idared´, ´Fuji´, ´Jonagold´ and ´Golden Delicious´). The total polyphenol and flavonoid content were compared as well as antioxidant activity and patulin content. Exploring this diversity will lead to strategies that promote the production of apples with higher levels of anti-mould polyphenols, ultimately enhancing fruit quality and reducing post-harvest losses. This will have significant implications for both, traditional and conventional apple production, as well as for the development of breeding programs focused on improving disease resistance in apple cultivars. The results of this study showed that Croatian traditional apple cultivars had higher content of polyphenols and flavonoids than conventional ones, especially polyphenols such as procyanidins B1, phloridzin and epicatechin, which could be responsible for apple resistance to fungal infections. The traditional apple cultivar ´Winter Banane´ (16 µg/kg) and conventional cultivar ´Idared´ (327 µg/kg) showed increased patulin biosynthesis after inoculation, indicating higher susceptibility to fungal infection. The obtained results should add to food safety and prevention of economic losses caused by *P. expansum*.
Funding: This research has been supported by Croatian Science Foundation under the project ‘The possibility of exploiting traditional apple cultivars for the production of apples and apple juice with the reduced patulin content’ (UIP-2020-02-8461).

Keywords: polyphenols, *Penicillium expansum*, patulin, antioxidant activity

Smjernice za potvrdu i održavanje vjerodostojnosti autohtonih i stranih udomaćenih sorata voćaka i vinove loze

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Sažetak:
Podizanje mnogih kolekcijskih nasada raznih voćnih vrsta pri našim javnim institutima za poljoprivredu, kao i podizanje većine matičnih nasada, prethodilo je eri genomike. Nekoliko nedavnih istraživanja upućuje na opravdanu zabrinutost oko vjerodostojnosti genotipa primki u kolekcijama, domaćim rasadnicima, a posljedično i u proizvodnim nasadima. Na sreću, primjenom suvremenih metoda genotipizacije ova situacija je danas lako rješiva. Međutim, osiguranje visokokvalitetnog sadnog materijala za voćare i vinogradare podrazumijeva i dodatnu dijagnostiku zdravstvenog stanja, naprednu tehnologiju razmnožavanja i odgovoran stručni nadzor. Kao neophodnu potporu razvoju voćarstva i vinogradarstva u Hrvatskoj potrebno je osigurati provjeru genotipa i potvrdu vjerodostojnosti autohtonih i stranih udomaćenih sorata voćaka i vinove loze. Ovo je moguće ostvariti suradnjom znanstvenih i stručnih ustanova koje bi izradile cjelovit protokol za samoodrživu proizvodnju visokokvalitetnog certificiranog sadnog materijala najvažnijih sorata voćaka i vinove loze. Nacionalne bi kolekcije, održavane od strane znanstvenika, trebale služiti kao pouzdana baza potvrđenih genotipova prema kojoj bi matičnjaci svih rasadnika morali biti usklađeni i službeno potvrđeni. Time bi se pružila neophodna sigurnost rasadničarima i uzgajivačima trajnih nasada kod kojih pogreška prilikom sadnje najčešće postaje vidljiva tek u fazi prvog roda do kojeg nerijetko prođe i nekoliko godina. U konačnici, to rezultira štetom koju je teško nadoknaditi i mogućim sudskim procesom. Predlagane smjernice predviđaju: (1) sveobuhvatni pristup evaluaciji autohtonih i stranih udomaćenih sorata, (2) podizanje novih ili dopunu postojećih kolekcija te (3) provedbu multilokacijskih istraživanja. Zbirni rezultati vodili bi ka boljem poznavanju proizvodnih svojstava predmetnih sorata i implementaciji tih rezultata u poljoprivrednu praksu.
U ovom radu daje se pregled aktualnog stanja temeljem rezultata dosadašnjih istraživanja i iskustava na nekoliko poljoprivrednih vrsta kako bi se vizualizirala problematika te se predlažu univerzalne smjernice za unapređenje ponude i kvalitete sadnog materijala i s njima zasnovanih proizvodnih nasada.

Ključne riječi: kultivar, genotip, kolekcije, matični nasadi, autentičnost

Guidelines to confirm and maintain "true-to-type" of autochthonous and foreign-domesticated varieties of fruits and grapes

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Abstract:
The establishment of many germplasm collections of various fruit species at Croatian public agricultural institutes, as well as the establishment of most of the mother blocks, preceded the era of genomics. Several recent studies point to justified concerns about the authenticity of genotypes (true-to-type) of accessions in collections, domestic nurseries, and consequently also in production plantations. Fortunately, with the application of modern genotyping methods, this situation can be easily solved today. However, ensuring high-quality planting material for fruit growers and winegrowers also implies additional sanitary status diagnostics, advanced propagation technology, as well as responsible supervision. As a necessary support for the development of fruit growing and viticulture in Croatia, it is necessary to ensure true-to-type autochthonous and foreign-domesticated varieties. This can be achieved through cooperation between scientific and professional institutions that would develop a comprehensive protocol for the sustainable production of high-quality certified planting material of the most important fruit tree and grapevine varieties.
National collections, maintained by scientists, should serve as a reliable database of confirmed genotypes according to which all nursery mother blocks should be aligned and officially confirmed. This would provide the necessary security to nurseries and producers of perennial species, where mistakes during planting usually become visible only in the phase of the first harvest, which often takes several years. Ultimately, that could lead to damage that is difficult to compensate and eventually to legal disputes. The proposed guidelines envisage: (1) a comprehensive approach to the evaluation of autochthonous and foreign-domesticated varieties, (2) raising new or supplementing existing germplasm collections, and (3) carrying out multi-location field experiments. The summary results would lead to a better knowledge of the production characteristics of the above-mentioned varieties and the implementation of these results in agricultural practice.
This paper provides an overview of the current situation based on the results of previous research and experiences on several agricultural species to visualize the problem, and universal guidelines are proposed for improving the supply and quality of planting material and production plantations based on them.

Keywords: cultivar, genotype, germplasm collections, mother blocks, authenticity

Ultrazvučni tretmani kao predfermentacijska tehnika u funkciji poboljšanja fenolnog profila vina Malvazije istarske

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Sažetak:
Cilj ovog istraživanja bio je utvrditi utjecaj predfermentacijskih ultrazvučnih tretmana različitih amplituda i trajanja na fenolni profil vina autohtone hrvatske sorte vinove loze Malvazije istarske (*Vitis vinifera* L.). U sklopu istraživanja provedeno je šest različitih vinifikacijskih tretmana. Četiri su se temeljila na primjeni predfermentacijske ultrazvučne tehnike na hlađenom kriomaceriranom masulju (10 °C) kako slijedi: ultrazvučni tretmani amplitude 70% trajanja 80 minuta (US80-70%) i 160 minuta (US160-70%) te ultrazvučni tretmani amplitude 100% istog trajanja kao i prethodni (US80-100% i US160-100%). Uz navedene tretmane, istraživanje je uključivalo i kontrolni tretman – C (vino proizvedeno standardnom tehnologijom proizvodnje bijelih vina – „brza prerada grožđa“) te tretman kriomaceracije u trajanju od jednog dana na temperaturi od 10 °C (CRIO). Za provođenje istraživanja korišten je industrijski ultrazvučni procesor UIP2000hdT-230 (20 kHz, 2000 W). Ukupni sadržaj fenola (TPC) analiziran je Folin-Ciocalteau kolorimetrijskom metodom i UV/VIS spektrofotometrijom. Antioksidacijska aktivnost (FRAP metoda) kao i analize kromatografskih karakteristika vina također su određeni spektrofotometrijski. Pojedinačni fenolni spojevi iz skupine flavonola, hidroksibenzojevih i hidroksicimetnih kiselina analizirani su tekućinskom kromatografijom visoke djelotvornosti (HPLC). Iz rezultata analize vidljivo je kako je ukupni sadržaj fenola statistički značajno veći u svim ultrazvučnim tretmanima (367,20 – 418,27 mg/l GAE) u odnosu na kontrolni (248,90 mg/l GAE). Svi tretmani pokazali su i značajno višu antioksidacijsku aktivnost u usporedbi s kontrolom, pri čemu su najveće vrijednosti određene kod ultrazvučnih tretmana amplitude 100% neovisno o duljini trajanja. Analiza kromatografskih karakteristika također je pokazala značajan utjecaj svih primijenjenih tretmana u odnosu na kontrolni tretman. Sume hidroksibenzojevih i hidroksicimetnih kiselina bile su značajno veće u svim tretmanima u odnosu na kontrolni. Najveća suma hidroksibenzojevih kiselina zabilježena je kod ultrazvučnih tretmana u trajanju od 160 minuta neovisno o amplitudi. Dobiveni rezultati potvrđuju značajan potencijal ultrazvučnih tretmana kao predfermentacijske tehnike za povećanje koncentracije fenolnih bioaktivnih spojeva u vinu Malvazije istarske. Ovaj rad financiran je od strane HRZZ projekta VinNutriVit (IP-2022-10-9128) i projekta „Projekt razvoja karijera mladih istraživača – izobrazba novih doktora znanosti“ (NPOO-DOK-2023-10-2768).

Ključne riječi: ultrazvučni tretmani, predfermentacijski tretmani, fenolni profil, fenolni bioaktivni spojevi, vina Malvazije istarske

Exploring ultrasound treatments as a pre-fermentative technique to enhance the phenolic profile of Malvazija istarska wines

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Abstract:
The aim of this research was to determine the influence of pre-fermentative ultrasound treatments of different amplitudes and durations on the phenolic profile of wines obtained from the autochthonous Croatian grape variety Malvazija istarska (*Vitis vinifera* L.). As part of the study, six different vinification treatments were carried out. Four of them were based on the application of a prefermentative ultrasound technique on cooled cryomacerated mash (10 °C) as follows: ultrasound treatments of 70% amplitude for 80 minutes (US80-70%) and 160 minutes (US160-70%) and ultrasound treatments of 100% amplitude for the same durations as the previous (US80-100% and US160-100%). In addition to these treatments, the research also included a control treatment – C (wine produced using standard white winemaking technology – "fast grape processing") and a cryomaceration treatment lasting one day at 10 °C (CRIO). The research was conducted using an industrial ultrasonic processor, UIP2000hdT-230 (20 kHz, 2000 W). The total phenolic content (TPC) was determined using the Folin–Ciocalteu colorimetric method and a UV/VIS spectrophotometer. The same instrument was used to assess antioxidant activity (FRAP method) and to analyze the wines' chromatographic characteristics. Individual phenolic compounds, including flavonols, hydroxybenzoic acids, and hydroxycinnamic acids, were analyzed by high-performance liquid chromatography (HPLC). The results showed that the total phenolic content was significantly higher in all ultrasound treatments (367.20–418.27 mg/L GAE) compared to the control (248.90 mg/L GAE). All treatments also exhibited significantly higher antioxidant activity compared to the control, with the highest values observed in the ultrasound treatments of 100% amplitude, regardless of duration. Analysis of chromatographic characteristics also showed a significant impact of all applied treatments compared to the control treatment. The total amounts of hydroxybenzoic and hydroxycinnamic acids were significantly higher in all treatments compared to the control. The highest level of hydroxybenzoic acids was recorded in treatments lasting 160 minutes, regardless of amplitude. The results confirm the significant potential of ultrasound treatments as a prefermentative technique for increasing the concentration of phenolic bioactive compounds in Malvazija istarska wine. This work has been funded by the HRZZ project VinNutriVit (IP-2022-10-9128) and the project "Young Researchers' Career Development Project – Training New Doctoral Students" (NPOO-DOK-2023-10-2768).

Keywords: ultrasound treatments, prefermentative treatments, phenolic profile, phenolic bioactive compounds, Malvazija istarska wines

Istraživanje utjecaja pretfermentacijskih i poslijefermentacijskih tehnologija na koncentraciju hlapljivih aromatskih spojeva i senzorni profil vina sorte Teran (*Vitis vinifera* L.)

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Sažetak:
Cilj ovog istraživanja je istražiti učinak pretfermentacijskih i poslijefermentacijskih tehnologija na koncentraciju hlapljivih aromatskih spojeva i senzorni profil crnog vina autohtone hrvatske sorte Teran (*Vitis vinifera* L.). U berbi 2020. godine provedeno je šest različitih vinifikacijskih tretmana, uključujući kontrolni tretman (standardna maceracija u trajanju od 7 dana) kako bi se ispitali učinci: 48-satnog pretfermentacijskog hlađenja masulja (na 8 °C) i produljenih poslijefermentacijskih maceracija od 13 dana (C15) i 28 dana (C30), te saignée postupka (otakanje mošta) i poslijefermentacijske maceracije od 13 dana (CS15); kao i učinak 48-satnog zagrijavanja masulja (na 50 °C) i produljenih poslijefermentacijskih maceracija od 13 dana (H15) i 28 dana (H30), na aromatski profil vina Terana. Hlapljivi aromatski spojevi izolirani su iz uzoraka vina primjenom mikroekstrakcije na čvrstoj fazi (SPME), dok su identifikacija i kvantifikacija provedene pomoću sustava plinske kromatografije s masenom spektrometrijom (GC–MS). Senzorna analiza aromatskog profila provedena je metodom kvantitativne deskriptivne analize (QDA), pri čemu je vino ocjenjivano pomoću grupiranih deskriptora (voćni, suho/prosušeno voće, pekmez/džem, orašasto voće, biljni, začinski, likerski) na strukturiranoj ljestvici od 10 bodova, u rasponu od 0 (nije primjetno) do 10 (snažno izraženo). Statistički najviša koncentracija monoterpena, spojeva primarne (sortne) arome, sadržanih većinom u kožici bobice, zabilježena je u CS15 tretmanu (213,22 µg/l), najvjerojatnije kao rezultat većeg omjera čvrstog dijela masulja u odnosu na tekući, tijekom saignée postupka. Najviša koncentracija acetatnih estera, spojeva sekundarne (fermentacijske) arome, utvrđena je u tretmanima s pretfermentacijskim hlađenjem masulja (C15 i C30), neovisno o duljini trajanja maceracije (2301,46 i 2108,14 µg/l). Iz rezultata kvantitativne deskriptivne analize (QDA) vidljiv je signifikantan utjecaj svih primjenjenih tehnologija na povećanje voćnog karaktera mirisa (intenziteta 7,02 – 7,62 bodova), u odnosu na kontrolni tretman u kojem je utvrđen signifikantno najmanji intenzitet voćnog mirisa (5,76 bodova). Primijenjene vinifikacije tehnologije rezultirale su visokokvalitetnim vinima Terana, s visokom koncentracijom hlapljivih aromatskih spojeva i poboljšanih senzornih svojstava, naglašavajući potencijal sorte Teran u proizvodnji vrhunskih crnih vina. Ovaj rad financiran je od strane HRZZ projekta VINUM SANUM (IP-2018-01-5049) i projekta “Projekt razvoja karijera mladih istraživača - izobrazba novih doktora znanosti” (DOK-2021-02-6937).

Ključne riječi: Teran, pretfermentacijske tehnologije, poslijefermentacijske tehnologije, hlapljivi spojevi arome, kvantitativna deskriptivna analiza (QDA)

Investigating the effect of pre-fermentative and post-fermentative technologies on the concentration of volatile aromatic compounds and sensory profile of Teran red wine

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Abstract:
This study aimed to investigate the effect of pre-fermentative and post-fermentative technologies on the concentration of volatile aromatic compounds and sensory profile of red wine obtained from *cv*. Teran (*Vitis vinifera* L.) autochthonous Croatian grape variety. During the 2022 harvest, six different vinification treatments, including the control treatment (7-day standard maceration), were performed to study the effects of: 48-hour pre-fermentative mash cooling (8 °C) followed by prolonged post-fermentative maceration of 13 days (C15), 28 days (C30), and saignée technique (juice runoff) proceeded with prolonged post-fermentative maceration of 13 days (CS15); and effect of 48-hour heating (50 °C) followed by prolonged post-fermentative maceration of 13 days (H15) and 28 days (H30) on sensory profile of wine. Respectively, macerations lasted 15 and 30 days in total, including either pre-fermentative cooling or heating. Volatile aroma compounds were isolated from wine samples using solid-phase microextraction (SPME), and identification and quantification were conducted using a gas chromatograph–mass spectrometer (GC–MS) system. The sensory analysis of the aromatic profile was conducted using the Quantitative Descriptive Analysis (QDA) method, which evaluated the wine through grouped descriptors (fruity, dried fruit, jammy, nutty, herbaceous, spicy, liqueur-like) on a structured 10-point scale, ranging from 0 (not perceptible) to 10 (strongly perceptible). Significantly the highest concentration of monoterpenes, primary (varietal) aroma compounds, contained mostly in the berry skin, was found in CS15 treatment (213.22 µg/l), possibly due to the higher skin to juice ratio during the saignée treatment. Significantly the highest concentration of acetate esters, secondary (fermentation) aroma compounds was found in treatments where pre-fermentative cooling was performed (C15 and C30), regardless of maceration duration (2301.46 – 2108.14 µg/l). The results of the quantitative descriptive analysis (QDA) showed a significant impact of all applied technologies on the fruity aroma (intensity 7.02 – 7.62 points), compared to the control treatment, which had significantly the lowest intensity of the fruity aroma (5.76 points). Applied vinification technologies resulted in high-quality Teran wines, characterized by high concentration of volatile aromatic compounds and enhanced sensory properties, highlighting the potential of Teran variety in production of premium red wines. This work has been funded by the HRZZ project VINUM SANUM (IP-2018-01-5049) and the project "Young Researchers' Career Development Project—Training New Doctoral Students" (DOK-2021-02-6937).

Keywords: Teran, pre-fermentative technologies, post-fermentative technologies, volatile aromatic compounds, quantitative descriptive analysis (QDA)

Vino Malvazije istarske sadrži aminokiseline i oligopeptide odgovorne za umami okus i kokumi učinak: utjecaj različitih tehnoloških zahvata

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Sažetak:
Cilj ovog istraživanja bio je ispitati utjecaj različitih tehnoloških zahvata u proizvodnji vina na sadržaj aminokiselina i oligopeptida u vinu kultivara grožđa Malvazija istarska, posebno onih odgovornih za umami okus i kokumi učinak. U prvom pokusu ispitivan je utjecaj fermentacije s različitim kvascima: ko-inokulacija kvascima *Torulaspora delbrueckii* i *S. cerevisiae* (TDSC) te sekvencionalna inokulacija kvascima *Torulaspora delbrueckii* (TD), *Pichia kluyveri* (PC) i *Schizosaccharomyces pombe* (SP), uz dovršetak fermentacije sa *S. cerevisiae*. Mošt kontrolnog tretmana bio je inokuliran sa *S. cerevisiae* u monokulturi (SC). U drugom pokusu ispitivan je utjecaj tretmana mošta ultrazvukom (US), enzimom aspergilopepsinom I (E) te njihovom kombinacijom (US+E), uz netretirani mošt kao kontrolu (K). Uzorci vina svih tretmana iz drugog pokusa dodatno su odležavali na finom talogu uz miješanje 3 i pol mjeseca. Analiza aminokiselina i oligopeptida provedena je tekućinskom kromatografijom ultra-visoke djelotvornosti i spektrometrijom masa (UHPLC-MS/MS). U okviru prvog pokusa, vino TD sadržavalo je najniže koncentracije većine identificiranih amino spojeva. Svi ne-*Saccharomyces* tretmani rezultirali su porastom razine L-glutaminske kiseline odgovorne za ispoljavanje umami okusa u odnosu na kontrolni SC tretman. Među mogućim kokumi oligopeptidima, kontrolno vino SC sadržavalo je najviše razine Ala-Asp, Ala-Pro, Ala-Lys, Asp-Gly-Leu i L-glutationa, dok je vino SP imalo najviše Gly-Val. U drugom pokusu, tretmani E i US+E rezultirali su najvišim razinama većine analiziranih aminokiselina i oligopeptida. Tretman E povisio je koncentraciju L-glutaminske kiseline u odnosu na vina K i US te ukupnu koncentraciju kokumi oligopeptida u odnosu na kontrolno vino K. Odležavanje na talogu vina E i US+E uzrokovalo je brojne različite promjene u razinama analiziranih amino spojeva, a za ukupne tripeptide i kokumi oligopeptide utvrđeno je sniženje koncentracija. U oba pokusa nisu uočene razlike u koncentracijama γ-Glu-Val-Gly, tripeptida s najvećim kokumi učinkom. Dobiveni rezultati upućuju na potencijal primjene ne-*Saccharomyces* kvasaca, kao i tretmana ultrazvukom te enzimom aspergilopepsin I, za regulaciju koncentracija aminokiselina i oligopeptida odgovornih za umami okus i kokumi učinak u vinu. Ovaj rad je financirala Hrvatska zaklada za znanost projektima HRZZ-IP-2020-02-4551 i DOK-NPOO-2023-10-5136.

Ključne riječi: ne-*Saccharomyces* kvasci, ultrazvuk, aspergilopepsin I, umami okus, kokumi učinak

Malvazija istarska wine contains amino acids and oligopeptides responsible for the umami taste and kokumi effect: influence of different technological interventions

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Abstract:
The aim of this study was to investigate the effect of different technological interventions on the levels of amino acids and oligopeptides responsible for umami flavor and kokumi effect in Malvazija istarska wine. In the first experiment, the impact of fermentation with different yeasts was evaluated: co-inoculation with *Torulaspora delbrueckii* and *Saccharomyces cerevisiae* (TDSC), as well as sequential inoculation with *T. delbrueckii* (TD), *Pichia kluyveri* (PC), and *Schizosaccharomyces pombe* (SP), followed by *S. cerevisiae*. Monoculture *S. cerevisiae* served as a control (SC). In the second experiment, must was treated with ultrasound (US), Aspergillopepsin I enzyme (E), and their combination (US+E), with untreated must as a control (K). All wines in the second experiment were additionally aged on fine lees with stirring for 3.5 months. Amino acid and oligopeptide analysis was conducted using ultra-high-performance liquid chromatography-mass spectrometry (UHPLC-MS/MS). In the first experiment, TD wine showed the lowest concentrations of most identified amino compounds. All non-*Saccharomyces* treatments increased the concentration of umami-imparting L-glutamic acid compared to SC. Among putative kokumi oligopeptides, SC wine contained the highest levels of Ala-Asp, Ala-Pro, Ala-Lys, Asp-Gly-Leu, and L-glutathione, while SP wine showed the highest concentration of Gly-Val. In the second experiment, E and US+E treatments resulted in the highest concentrations of most analyzed amino acids and oligopeptides. E treatment significantly increased L-glutamic acid levels compared to K and US, while also raising the total kokumi oligopeptide concentration compared to K. Aging on lees induced several changes in amino compound levels in E and US+E wines, including a decrease in total tripeptides and kokumi oligopeptides. No significant differences in γ-Glu-Val-Gly, the most potent kokumi compound, were observed in either experiment. The obtained results indicate that the use of non-*Saccharomyces* yeasts, ultrasound, and Aspergillopepsin I has a potential for regulating the levels of amino acids and oligopeptides responsible for umami flavor and kokumi effect in wine. This work was supported by the Croatian Science Foundation under the projects HRZZ-IP-2020-02-4551 and DOK-NPOO-2023-10-5136.

Keywords: non-*Saccharomyces* yeasts, ultrasound, Aspergillopepsin I, umami flavor, kokumi effect

The Impact of Yeast Combination (*Lachancea thermotolerans* and *Saccharomyces cerevisiae*) and Maceration Length on the Composition and Sensory Properties of *cv*. Trnjak Wine

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Abstract:
This study examines how sequential fermentation with *Lachancea thermotolerans* and *Saccharomyces cerevisiae* yeasts, compared to *S. cerevisiae* alone and epiphytic flora (spontaneous fermentation), affects the sensory and chemical properties of *cv.* Trnjak red wine. Grapes from the Dubrave position (Mostar wine-growing region, Bosnia and Herzegovina) underwent three fermentation treatments with two maceration lengths (8 and 12 days). The study explores their impact on aroma compounds, polyphenolic content, and sensory characteristics. *Lachancea thermotolerans* is a valuable non-*Saccharomyces* yeast known for its ability to acidify wine, enhance aroma complexity, and stabilize color. Its role is particularly relevant in warm-climate regions, where accelerated grape ripening reduces natural acidity, posing challenges for wine stability. This is especially important for Trnjak, a red grape variety from the warm climates of Dalmatia and Herzegovina, where lower acidity and higher pH can affect wine quality. HS-SPME-Arrow-GC-MS analysis showed that sequential fermentation increased fruity and floral aromas (*e.g.*, ethyl lactate, *β*-damascenone, linalool) while reducing the levels of higher alcohols and fatty acids. *Lachancea thermotolerans* improved the volatile profile, leading to enhanced sensory attributes determined by Quantitative Descriptive Sensory Analysis. High-Performance Liquid Chromatography (HPLC) analysis revealed lower levels of anthocyanins and flavan-3-ols, affecting color stability and mouthfeel, while extended maceration increased hydroxybenzoic acids, further enhancing structure. These findings highlight the significant role of sequential fermentation and extended maceration in shaping Trnjak wine aromatic depth and more structured body, ultimately improving its balance and quality.

Keywords: descriptive sensory evaluation, GC-MS, HPLC, non-*Saccharomyces*, spontaneous fermentation

Yeasts proteins: studies for sustainable protein stability of white wines

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Abstract:
Yeast protein extracts (YPEs) are authorized by the OIV for fining purposes with a maximum dosage limit of 60 g/hL for red wines, and 30 g/hL for musts, white and rosè wines. Some authors highlighted that some yeast proteins showed an isoelectric point below wine pH. Given this feature, a possible colloidal interaction between YPEs and positively charged wine proteins is worth exploring.
Qualitative analysis of YPE was carried out by the determination of some colloidal parameters (ξ potential and electrical charge). The effect of YPE addition at different dosages and times was evaluated considering several analytical parameters: turbidity, protein stability tests, and protein content by HPLC.
Different experiments were carried out in small laboratory volumes and in real cellar conditions on aromatic white wines in two wineries in Croatia. All experiments and analyses were performed in triplicate, and the results were elaborated by one-way ANOVA.
The experimental trials on unstable Malvasia and Graševina wines, performed with different dosages and treatment times, confirmed the effectiveness of YPE, and the results showed a potential reversible interaction with haze-related PR-proteins. The addition of YPE was significant after 4-6 hours, while the effect appeared to diminish with extended exposure times. The best results were obtained in general at 20-30 g/hL of YPE and 4 hours, which induced a significant decrease (40 to 50 %) of initial PR-protein concentration, in particular for chitinase fractions.
The yeast protein extract increased the protein stability of white wines, but it did not allow their complete stabilization. The addition of YPE could be considered a combined treatment with the conventional ones, aimed at decreasing the dose of conventional fining agents (e.g bentonite) and preserving wine aroma. The YPE could represent a new tool for protein stabilization, focused on sustainable and precision enology.

Keywords: yeast proteins, white wine, aroma, protein stability, precision enology

Maslinarstvo
Olive growing

Utjecaj roka uzorkovanja na koncentraciju fenolnih spojeva i minerala u listovima masline sorte Leccino

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Sažetak:
Maslina (*Olea europaea* L.) predstavlja jednu od najvažnijih poljoprivrednih kultura mediteranskog područja. U Republici Hrvatskoj sorta Leccino najzastupljenija je introducirana sorta u novim nasadima maslina. Najpoznatiji proizvod masline je maslinovo ulje, koje se ističe visokim udjelom mononezasićenih masnih kiselina te nizom korisnih bioaktivnih tvari, osobito fenolnih spojeva. Osim ulja i plodova, listovi masline od davnina se koriste u tradicionalnoj medicini, ponajprije zbog spojeva poput oleuropeina, hidroksitirozola, tirozola i luteolina, poznatih po antioksidativnim, protuupalnim i antitumorskim svojstvima. Na koncentraciju fenola u listovima značajno utječu različiti agroekološki čimbenici, a ona je ujedno povezana i s koncentracijama hraniva u biljci. Cilj ovog istraživanja bio je utvrditi utjecaj različitih rokova uzorkovanja (80 dana nakon pune cvatnje, 110 dana nakon pune cvatnje, 140 dana nakon pune cvatnje, u rezidbi) na koncentraciju fenola i minerala u listovima masline sorte Leccino. Pokus je postavljen prema shemi potpuno slučajnog rasporeda, s četiri ponavljanja, na ukupno 16 stabala. Rezultati su pokazali značajan utjecaj roka uzorkovanja na koncentraciju oleuropeina, oleaceina, oleanolne kiseline, kao i elemenata P, K, Ca, Mg, Fe, Mn, S, Si i Zn. Najviše koncentracije navedenih fenolnih spojeva zabilježene su u travnju, u vrijeme rezidbe, dok je u istom razdoblju utvrđena najniža koncentracija kalija (K) i najviša koncentracija magnezija (Mg). Daljnja istraživanja bit će usmjerena na iste parametre u listovima sorte Leccino, s ciljem praćenja njihove dinamike u različitim regijama Republike Hrvatske.

Ključne riječi: maslina, Leccino, uzorkovanje, list, fenoli

Effect of Sampling Time on the Concentration of Phenolic Compounds and Minerals in the Leaves of the Leccino Olive Cultivar

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Abstract:
Olive (*Olea europaea* L.) is one of the most significant agricultural crops in the Mediterranean region. In Croatia, the Leccino cultivar is the most widely introduced variety in new olive plantations. The most prominent olive product is olive oil, notable for its high content of monounsaturated fatty acids and various beneficial bioactive compounds, particularly phenolic substances. In addition to olive oil and fruits, olive leaves have long been used in traditional medicine, primarily due to compounds such as oleuropein, hydroxytyrosol, tyrosol, and luteolin, recognized for their antioxidant, anti-inflammatory, and antitumor properties. The concentration of phenolic compounds in leaves is significantly influenced by different agroecological factors and is also correlated with nutrient concentrations within the plant. The aim of this research was to determine the impact of different sampling dates (80 days after full bloom, 110 days after full bloom, 140 days after full bloom, and during pruning) on the concentration of phenolic compounds and minerals in the leaves of the olive cultivar Leccino. The experiment was designed as a completely randomized layout with four replicates, involving a total of 16 trees. The results indicated a significant effect of sampling date on concentrations of oleuropein, oleacein, oleanolic acid, and the elements P, K, Ca, Mg, Fe, Mn, S, Si, and Zn. The highest concentrations of these phenolic compounds were recorded in April, during pruning, when the lowest potassium (K) and highest magnesium (Mg) concentrations were also observed. Further research will focus on monitoring these parameters in Leccino leaves to track their dynamics across different regions in Croatia.

Keywords: olive, Leccino, sampling, leaf, phenols

Utjecaj načina berbe maslina na kvalitetu i sastav maslinovog ulja sorte Buža

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Sažetak:
Velika konkurentnost na tržištu maslinovog ulja kao i problem nedostatka radne snage jednim dijelom rješavaju se uvođenjem mehanizacije i automatizacije u berbi maslina. Oštećenja plodova koja nastaju tijekom mehanizirane berbe mogla bi naškoditi kvaliteti maslinovog ulja, odnosno uzrokovati oksidacijsko i hidrolitičko kvarenje ulja. Cilj ovog istraživanja bio je ispitati utjecaj različitih načina berbe maslina sorte Buža na kvalitetu proizvedenog maslinovog ulja. Sorta Buža, jedna od najzastupljenijih istarskih autohtonih sorti maslina, ima plodove koji su zbog svoje građe posebno osjetljivi na udarce. S obzirom na osjetljivost ove sorte na mehanička oštećenja, proučavana su tri načina berbe: ručna berba uz korištenje ručnih češljeva te dvije metode mehanizirane berbe – berba uz pomoć ručnih tresača i berba uz pomoć samohodnog tresača debla. Plodovi su prerađeni u ulje unutar 24 sata nakon berbe. Istraživanje je obuhvatilo analizu osnovnih kemijskih parametara kvalitete ulja, senzornih svojstava te koncentracije fenolnih spojeva.
Rezultati su pokazali da način berbe nije imao značajan utjecaj na osnovne kemijske parametre kvalitete ulja, uključujući kiselost, peroksidni broj i koeficijente specifične ekstinkcije u ultraljubičastom području. Također, senzorna analiza nije ukazala na značajnije razlike u senzornim svojstvima ulja proizvedenog iz maslina ubranih različitim metodama, te prerađenih nakon 24 sata. Nadalje, analiza fenolnog profila pokazala je da način berbe nije značajno utjecao na koncentraciju pojedinačnih niti ukupnih fenolnih spojeva kao ni na podskupinu sekoiridoida, koji su ključni za antioksidacijska svojstva i oksidacijsku stabilnost ulja.
Unatoč ovim rezultatima, pretpostavlja se da bi mehanička oštećenja plodova mogla negativno utjecati na kvalitetu ulja ako se plodovi skladište dulje vrijeme prije prerade, što ukazuje na potrebu za dodatnim istraživanjima. Ovi rezultati doprinose boljem razumijevanju utjecaja mehanizirane berbe na kvalitetu maslinovog ulja i čine podlogu za izradu smjernica za optimizaciju tehnoloških postupaka u proizvodnji visokokvalitetnog maslinovog ulja.

Ključne riječi: berba maslina, maslinovo ulje, kvaliteta, senzorna svojstva, fenolne tvari

The influence of olive harvesting methods on the quality and composition of Buža olive oil

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Abstract:
The high competitiveness in the olive oil market and the problem of labor shortage are partly solved by introducing mechanization and automation in olive harvesting. Damage to the fruit that occurs during mechanized harvesting could harm the quality of the olive oil, or cause oxidative and hydrolytic spoilage of the oil. The aim of this research was to examine the influence of different harvesting methods of Buža olives on the quality of the produced olive oil. Buža variety, one of the most common Istrian autochthonous olive varieties, has fruits that are particularly sensitive to impacts due to their structure. Given the sensitivity of this variety to mechanical damage, three harvesting methods were studied: manual harvesting using hand-held combs and two mechanized harvesting methods – harvesting with the hand-held shakers and harvesting with a self-propelled trunk shaker. The fruits were processed into oil within 24 hours after harvesting. The research included the analysis of the basic chemical parameters of oil quality, sensory properties and the concentration of phenolic compounds.
The results showed that the harvesting method had no significant effect on the basic chemical parameters of oil quality, including acidity, peroxide value and specific extinction coefficients in the ultraviolet region. Also, sensory analysis did not indicate significant differences in the sensory properties of the oil produced from olives harvested by different methods and processed after 24 hours. Furthermore, the analysis of the phenolic profile showed that the harvesting method did not significantly affect the concentration of individual or total phenolic compounds, nor the subgroup of secoiridoids, which are key to the antioxidant properties and oxidative stability of the oil.
Despite results obtained, it is assumed that mechanical damage to the fruit could negatively affect the quality of the oil if the fruit is stored for a longer period before processing, which indicates the need for further research. These results contribute to a better understanding of the impact of mechanized harvesting on olive oil quality and form the basis for the development of guidelines for the optimization of technological processes in the production of high-quality olive oil.

Keywords: olive harvesting, olive oil, quality, sensory properties, phenolic compounds

Fenolni i mineralni sastav listova masline kao odgovor na sustav uzgoja, sortu i sezonske varijacije

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Sažetak:
Listovi masline predstavljaju vrijedan nusproizvod uzgoja masline, bogat fenolnim spojevima i mineralima. Dok je utjecaj sorte na fenolni sastav dobro istražen, kombinirani učinci strategije uzgoja i sezonskih promjena još uvijek su nedovoljno razjašnjeni.
Cilj ovog istraživanja bio je procijeniti utjecaj ekološkog i integriranog sustava uzgoja maslina, sorte te vremena uzorkovanja na fenolni i mineralni sastav listova tijekom vegetacijske sezone. Uzorci listova više sorata maslina prikupljani su u različitim terminima unutar oba sustava uzgoja. Koncentracije ključnih fenolnih spojeva, uključujući oleuropein, rutin te glukozide luteolina i apigenina, kao i minerala poput kalija (K), fosfora (P), magnezija (Mg), cinka (Zn), silicija (Si), molibdena (Mo), mangana (Mn), bakra (Cu) i bora (B), određene su pomoću tekućinske kromatografije visoke djelotvornosti (HPLC), odnosno optičke emisijske spektroskopije s induktivno spregnutom plazmom (ICP-OES).
Rezultati su pokazali značajne varijacije u fenolnom i mineralnom profilu kao odgovor na sva tri promatrana faktora. Oleuropein je bio najzastupljeniji fenolni spoj, a njegova koncentracija, kao i koncentracije rutina i flavonoidnih glukozida, snažno su ovisile o sustavu uzgoja, sorti i vremenu uzorkovanja. Sličan obrazac varijabilnosti primijećen je i za makro- i mikroelemente. Ovi razultati doprinose boljem razumijevanju biokemijske prilagodljivosti listova maslina i predstavljaju temelj za njihovu ciljanju valorizaciju u održivoj poljoprivredi i kao izvora nutraceutika. Buduća istraživanja bit će usmjerena na primjenu biostimulatora kao obećavajuće strategije za dodatno poboljšanje funkcionalne kvalitete i fitokemijskog obiljaa listova masline unutar različitih sustava uzgoja.

Ključne riječi: list masline, fenolni spojevi, ekološka proizvodnja, integrirani uzgoj, sorte

Phenolic and Mineral Composition of Olive Leaves in Response to Cultivation Strategy, Cultivar, and Seasonal Variation

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Abstract:
Olive leaves are a valuable by-product of olive cultivation, rich in phenolic compounds and mineral elements. While the influence of cultivar on phenolic composition is well established, the combined effects of cultivation strategy and seasonal variation remain insufficiently investigated.
This study aimed to evaluate the impact of organic and integrated pest management (IPM) cultivation systems, olive cultivar, and sampling time on the phenolic and mineral composition of olive leaves throughout the growing season. Leaf samples from multiple olive cultivars were collected at several time points under both cultivation systems. The concentrations of key phenolic compounds, including oleuropein, rutin, and the glucosides of luteolin and apigenin, as well as mineral elements such as potassium (K), phosphorus (P), magnesium (Mg), zinc (Zn), silicon (Si), molybdenum (Mo), manganese (Mn), copper (Cu), and boron (B), were determined using high-performance liquid chromatography (HPLC) and inductively coupled plasma optical emission spectroscopy (ICP-OES), respectively.
The results revealed significant variation in phenolic and mineral profiles in response to cultivation strategy, cultivar, and sampling time. Oleuropein was the most abundant phenolic compound, with its concentration, along with those of rutin and flavonoid glucosides—strongly affected by all three factors. A similar pattern of variability was observed for both macro- and micronutrients.
The obtained findings contribute to a better understanding of the biochemical plasticity of olive leaves and provide a basis for their targeted valorization in sustainable agricultural and nutraceutical applications. Future research will focus on the application of biostimulants as a promising approach to further enhance the functional quality and phytochemical richness of olive leaves under different cultivation systems.

Keywords: olive leaf, phenolic compounds, organic farming, IPM, cultivar

Lokalizacija elemenata u listu masline nakon primjene biostimulatora selena i silicija

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Sažetak:
List masline (*Olea europaea* L.) značajan je i neizbježan nusproizvod proizvodnje maslina te se veće količine prikupljaju tijekom berbe i rezidbe. Bogat je mineralima i bioaktivnim komponentama te danas ima široku uporebu u raznim industrijskim granama. Primjena različitih biostimulatora koji imaju značajan pozitivan utjecaj na otpornost masline na različite stresore postaje imperativ održive proizvodnje. Pri tome, folijarna upotreba neesecijalnih, korisnih elemenata, kao što su selen i silicij, dobiva sve značajniju ulogu.
Cilj ovog istraživanja bio je ispitati učinkovitost folijarne primjene selena (Se) i silicija (Si) te utvrditi razlike u ukupnoj koncentraciji i akumulaciji selena, silicija kao i makro i mikroelemenata u različitim tkivima lista masline. Pokus je postavljen kao potpuno slučajni raspored na sorti Leccino u poljskim uvjetima. Korištenjem analitičke tehnike visoke preciznosti, istražila se njihova prostorna distribucija u listu masline. Micro-particle-induced X-ray emission (micro-PIXE) jedina je potpuno kvantitativna tehnika koja detektira pojedine elemente s osjetljivosti od 1 mg/kg ST (suhe tvari) i lateralnoj rezoluciji ispod jednog μm.
Rezultati su pokazali značajno višu koncentraciju selena u većini promatranih tkiva lista masline kod tretiranih (Se+Si) u odnosu na netretirane masline. Kod tretiranih (Se+Si) biljaka više koncentracije silicija bile su vidljive u epidermi. Mikrolelementi mangan i željezo pokazali su višu koncentraciju kod netretiranih maslina u svim promatranim tkivima dok je koncentacija cinka u ksilemu i floemu bila značajno viša pri primjeni Se+Si tretmana. Rezultati pružaju temelje za razvoj strategija ciljane mineralne biofortifikacije lista masline. Time se otvara mogućnost dodatne valorizacije lista kao sirovine za izradu dodataka prehrani i povećanje nutritivne vrijednosti u proizvodima biljnog podrijetla, uz istovremenu promociju održivih poljoprivrednih praksi.
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Ključne riječi: micro-PIXE, biljna tkiva, održiva poljoprivreda, mangan, željezo, cink

Elemental Mapping of Olive Leaves in Response to Foliar Application of Selenium and Silicon

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Abstract:
Olive (*Olea europaea* L.) leaf is a significant and unavoidable by-product of olive production, with large quantities collected during harvest and pruning. It is rich in minerals and bioactive compounds and is increasingly used across various industries. The application of different biostimulants, which have a positive impact on olive resistance to various stressors, is becoming essential for sustainable production. In this context, the foliar use of non-essential but beneficial elements, such as selenium (Se) and silicon (Si), is gaining increasing importance.
The aim of this study was to evaluate the effectiveness of foliar application of Se and Si and to determine differences in total concentration and accumulation of Se, Si, as well as macro- and microelements in different olive leaf tissues. The field experiment was set up as a completely randomized design using the Leccino cultivar. Using a highly precise analytical technique, the spatial distribution of elements in the olive leaf was investigated. Micro-particle-induced X-ray emission (micro-PIXE) is a fully quantitative technique that enables the detection of individual elements with a sensitivity of 1 mg/kg dry weight and a lateral resolution around one micrometer.
The results showed significantly higher Se concentrations in most examined olive leaf tissues in treated plants (Se+Si) compared to untreated ones. In leaf epidermis of Se+Si treated plants, higher concentrations of Si were observed compared to other tissues. Micronutrients Mn and Fe were more concentrated in all observed tissues of untreated plants compared to treated leaves, while Zn concentrations in the xylem and phloem were significantly higher following Se+Si treatment than in untreated leaves.
The results highlight the potential for targeted mineral biofortification, particularly with elements like selenium, and open a new possibility for the valorization of olive leaves as a raw material for dietary supplements and for enhancing the nutritional value of plant-based products, while promoting sustainable agricultural practices.
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Key words: micro-PIXE, plant tissues, sustainable agriculture, manganese, iron, zinc

Turizam

Tourism

Analiza održivog konjičkog turizma u istočnoj Hrvatskoj – primjer Državne ergele Đakovo

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Sažetak:

Specifični oblik turističke ponude u istočnoj Hrvatskoj jest konjički turizam, kojem su osnova jedinstvena prirodna bogatstva te kulturna i tradicijska baština. Ova vrsta turističke ponude uključuje aktivnosti u kojima turisti aktivno sudjeluju (rekreativno i terensko jahanje, vožnja zapregama) kao i pasivne oblike sudjelovanja (promatranje konjičkih predstava, folklornih i kulturno-povijesnih manifestacija). Uzgoj konja, osobito autohtonih i sportskih pasmina, ima višestruku funkciju – osim što doprinosi očuvanju biološke i kulturne raznolikosti, predstavlja temelj agroturizma i ekoturizma te integrira sektore važne za održivi ruralni razvoj. Za održivi konjički turizam nužni su visoko specijalizirani kadrovi koji zarad svojih vještina i znanja u radu s konjima, kreiraju usluge različitih razina atraktivnosti i tržišne vrijednosti. U kontekstu tradicijske baštine istočne Hrvatske, posebno se ističe uzgoj lipicanske pasmine koja je uvrštena na UNESCO-ov popis nematerijalne kulturne baštine čovječanstva. Državna ergela Đakovo prepoznatljivi je brend grada Đakova i Slavonije, te više od dva stoljeća za svrhu ima sprovođenje sistematičnog uzgoja konja lipicanske pasmine. Od 2003. godine, kada je zabilježeno 4478 posjetitelja, prisutan je kontinuiran trend rasta broja posjetitelja. Rekordna godina u razdoblju 2003.-2024. godine bila je 2017., kada je ergelu posjetilo 20.212 posjetitelja. Nakon privremenog pada u 2020. godini, uzrokovanog pandemijom COVID-19, trend oporavka bilježi se 2023. godine, kada je zabilježeno 17.771 posjetitelja. U 2024. godini, ukupno je zabilježeno 15.225 posjetitelja, pri čemu je najveći broj posjeta ostvaren tijekom proljetnih mjeseci. Demografska struktura posjetitelja ukazuje na ujednačenu zastupljenost odraslih osoba (46 %) i učenika (46 %), dok umirovljenici čine manji udio od 8 %. S obzirom na zemlju podrijetla, prevladavaju domaći posjetitelji koji čine 88,98 % ukupnog broja posjetitelja, dok su među inozemnim gostima najzastupljeniji posjetitelji iz Slovenije (5,97 %) i Sjedinjenih Američkih Država (1,90 %). Cilj je ovoga rada analizirati konjički turizam u okviru usluga i turističke ponude te održivosti istih na primjeru Državne ergele Đakovo.

Ključne riječi: konjički turizam, održivost, ergela Đakovo, lipicanac, istočna Hrvatska

Analysis of Sustainable Equestrian Tourism in Eastern Croatia – The State Stud Farm Đakovo as a Key Example

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Abstract:

A specific form of tourism in Eastern Croatia is equestrian tourism, which is based on the region's unique natural assets as well as its rich cultural and traditional heritage. This form of tourism encompasses both active participation by tourists (recreational and trail riding, carriage driving) and passive experiences (viewing equestrian shows, folkloric and cultural-historical events). The breeding of indigenous and sport horse breeds underpins agro-tourism and eco-tourism and fosters integration between key sectors important for sustainable rural development. Sustainable equestrian tourism requires highly specialised professionals who, through their skills and expertise in working with horses, develop services of varying levels of attractiveness and market value. An important element of the traditional heritage of Eastern Croatia is the breeding of Lipizzaner horses, which has earned the breed a place on UNESCO's Representative List of the Intangible Cultural Heritage of Humanity. The State Stud Farm Đakovo, a recognised symbol of the city of Đakovo and Eastern Croatia, has been systematically breeding Lipizzaner horses for over two centuries. Since 2003, when 4,478 visitors were recorded, a continuous upward trend in visitor numbers has been observed. The peak year in the period from 2003 to 2024 was 2017, with 20,212 visitors. Following a temporary decline in 2020 caused by the COVID-19 pandemic, a recovery was evident in 2023 with 17,771 recorded visits. In 2024, the total number of visitors amounted to 15,225, with the highest influx occurring during the spring months. The demographic structure of visitors reveals a balanced distribution between adults (46%) and schoolchildren (46%), while senior citizens account for a smaller share (8%). Regarding countries of origin, domestic visitors make up the majority (88.98%), followed by tourists from Slovenia (5.97%) and the United States (1.90%). The aim of this paper is to analyse equestrian tourism in terms of service provision, overall tourist offerings, and their sustainability, using the example of the State Stud Farm Đakovo.

Keywords: equestrian tourism, sustainability, stud farm Đakovo, lipizzaner, Eastern Croatia

Održivost ponašanja cikloturista

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Sažetak:
Višegodišnji trendovi na turističkom tržištu ukazuju na važnost cikloturizma, kao tržišne niše koja na osnovi fizičke aktivnosti na otvorenom valorizira lokalnu turističku ponudu, uvažava prirodni ambijent, te kulturu i način života u destinaciji. U postojećim znanstvenim istraživanjima ponašanja cikloturista nedostaju istraživanja koja uključuju mjerenje održivosti njihova ponašanja, kao i cjeloviti pristup održivosti. S obzirom na to da se cikloturizam smatra održivim oblikom turizma, pratiti i mjeriti održivost ponašanja cikloturista postaje imperativ u nastojanju da se cikloturizam razvija u funkciji održivog razvoja turizma u destinaciji.
S obzirom na adresirani istraživački jaz, glavni cilj ovog rada je utvrditi razinu održivosti ponašanja cikloturista u Istarskoj županiji te, na temelju dobivenih rezultata, predložiti aktivnosti u turističkoj destinaciji koje će poticati održivost ponašanja cikloturista. U ovom je istraživanju primijenjena „ljestvica drugog reda“ (engl. *second order scale*), a veličina uzorka (297 ispitanih cikloturista u Istarskoj županiji) omogućava donošenje adekvatnih zaključaka.
Rezultati provedenog istraživanja pokazuju da cikloturisti svojim ponašanjem podupiru održivi razvoj u destinaciji, a posebno su spremni poduprijeti lokalnu zajednicu. Evidentno je i to da cikloturisti nisu dovoljno upoznati s konceptom održivog turizma, što može potencijalno utjecati na njihovo ponašanje.

Ključne riječi: održivi turizam, cikloturizam, održivo ponašanje (ciklo)turista, Istarska županija

Sustainability of cycling tourists' behaviour

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Abstract:
Long-term trends in the tourism market indicate the importance of cycling tourism as a market niche that, based on outdoor physical activity, valorises the local tourist offer, respects the natural environment and respects the culture and lifestyle of the destination. Existing scientific research on the behaviour of cycling tourists lacks research that includes measuring the sustainability of their behaviour, as well as a comprehensive approach to sustainability. Given that cycling tourism is considered a sustainable form of tourism, monitoring and measuring the sustainability of cycling tourists' behaviour becomes imperative in the effort to develop cycling tourism in the function of sustainable tourism development in the destination.
Given the addressed research gap, the main goal of this paper is to determine the level of sustainability of cycling tourists' behaviour in Istria County and, based on the results obtained, propose activities in the tourist destination that will encourage the sustainability of cycling tourists' behaviour. In this research, a "second order scale" was applied, and the sample size (297 surveyed cycling tourists in Istria County) allows for adequate conclusions to be drawn.
The results of the research show that cycling tourists support sustainable development in their destination through their behaviour and are particularly willing to support the local community. It is also evident that cycling tourists are not sufficiently familiar with the concept of sustainable tourism, which can potentially influence their behaviour.

Keywords: sustainable tourism, cycling tourism, sustainable (cycling) tourist behaviour, Istria County

Percepcija i primjena održivih praksi u turizmu: perspektiva lokalne zajednice

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Sažetak:
Lokalne zajednice važni su dionici održivog razvoja turizma. Uspješnost održivog razvoja turizma nekog područja uvelike ovisi o tome kako lokalni dionici u turizmu percipiraju održivost i u kojoj mjeri je primjenjuju. Ciljevi ovog rada su utvrditi kako lokalni stanovnici, koji ostvaruju prihod od turizma, percipiraju održive prakse u turizmu, koje prakse najčešće primjenjuju u svom poslovanju i što ih pri tome motivira. Također, rad analizira stavove stanovnika o tome koje aspekte bi na lokalnoj razini trebalo poboljšati, kako bi primjena održivih praksi bila uspješnija. Empirijsko istraživanje je provedeno na području općina Kanfanar i Svetvinčenat u ožujku i travnju 2025. godine. Podaci su analizirani pomoću kvalitativne analize podataka korištenjem tematske analize (TA). Interpretacija rezultata uključuje usporedbu s postojećim teorijskim okvirima i ranijim istraživanjima, kako bi se utvrdilo na koji način se dobiveni rezultati uklapaju u postojeće spoznaje. Analizirani su aspekti održivosti koje ispitanici najviše ističu u svojim odgovorima, te je identificirano da li je motivacija ispitanika za primjenu održivih praksi više povezana s okolišnim, ekonomskim ili socio-kulturnim razlozima. Rezultati istraživanja impliciraju kako postoji različita percepcija pojma održivih praksi od strane ispitanika, te kako implementacija održivih praksi značajno ovisi o individualnom razumijevanju važnosti tih praksi u turističkoj ponudi. U radu se, temeljem analize rezultata, navode i preporuke koje mogu poslužiti DMO-u i lokalnim vlastima u unapređenju održivosti turizma u zajednici.

Ključne riječi: održivi turizam, održive turističke prakse, lokalna zajednica, percepcija lokalne zajednice, kvalitativna analiza

Perception and Implementation of Sustainable Practices in Tourism: The Perspective of the Local Community

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Abstract:
Local communities are important stakeholders in the sustainable development of tourism. The success of sustainable tourism development in a particular area largely depends on how local tourism stakeholders perceive sustainability and the extent to which they implement it. The objectives of this paper are to determine how local residents who derive income from tourism perceive sustainable tourism practices, which practices they most commonly implement in their businesses, and what motivates them in this regard. Furthermore, the study analyses residents' perspectives on which aspects should be improved at the local level to ensure the more successful implementation of sustainable practices. The empirical research was conducted in the municipalities of Kanfanar and Svetvinčenat in March and April 2025. Data were analysed using qualitative data analysis through thematic analysis (TA). Interpretation of the results includes a comparison with existing theoretical frameworks and previous research in order to determine how the obtained results align with existing knowledge. The aspects of sustainability that respondents emphasize the most in their answers were analysed, and it was identified whether the respondents' motivation for applying sustainable practices is more related to environmental, economic or socio-cultural reasons. The research results imply that there is a varied perception of the concept of sustainable practices among respondents, and that the implementation of sustainable practices significantly depends on the individual understanding of the importance of these practices in the tourism offering. Based on the analysis of the results, the paper also provides recommendations that can serve DMOs and local authorities in improving tourism sustainability within the community.

Keywords: sustainable tourism, sustainable tourism practices, local community, local community perception, qualitative analysis

Perspektive OPG-a u funkciji održivog turizma

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Sažetak:
Poljoprivreda je zbog svoje strateške važnosti jedna od temeljnih gospodarskih djelatnosti svake države, a posebno Republike Hrvatske s obzirom na njezin geografski položaj zahvaljujući kojem ima razvijen turizam i odličnu klimu za bavljenje poljoprivredom. Suvremeni trendovi u proizvodnji, stalni tehnološki napredak, globalizacija i klimatske promjene neki su od izazova s kojima se poljoprivrednici suočavaju, a potencijalno dovode do pada konkurentnosti i održivosti, posebice malih obiteljskih gospodarstava. Osim toga, poljoprivrednici u Republici Hrvatskoj susreću se s nizom specifičnih izazova, poput malog, fragmentiranog poljoprivrednog zemljišta, neuređenosti zemljišnih knjiga, odlaska mladih iz ruralnih područja te nedostatka radne snage, što dodatno otežava njihovo poslovanje. Rezultat ovih i drugih izazova je smanjenje obujma poljoprivredne proizvodnje u zadnjih 15 godina. Istodobno, velika većina hrvatskih subjekata u poljoprivredi je registrirana kroz formu obiteljskog poljoprivrednog gospodarstva (OPG) te je opstanak I mogućnost razvoja OPG-a posebno važan. Cilj ovog rada je istražiti mišljenje hrvatskih potrošača o hrvatskim poljoprivrednim proizvodima lokalnih obiteljskih gospodarstava te važnost dodatne turističke ponude obiteljskih gospodarstava. U prvom dijelu istraživanja provedena je strukturirana online anketa kojom su se istraživale preferencije hrvatskih potrošača. U drugom dijelu istraživanja provedena je ordinalna logistička regresija kako bi se procijenio utjecaj karakteristika ispitanika na njihovu sklonost kupnji proizvoda ili posjeti obiteljskim poljoprivrednim gospodarstvima. Rezultati istraživanja mogu pomoći hrvatskim proizvođačima da razviju strategiju razvoja OPG-a i osmisle ponudu koja će zadovoljiti potražnju tržišta i poboljšati njihovu konkurentsku prednost i financijske rezultate.

Ključne riječi: obiteljsko poljoprivredno gospodarstvo, preferencije potrošača, konkurentnost

Perspectives of family farm in the function of sustainable tourism

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Abstract:
Due to its strategic importance, agriculture is one of the fundamental economic activities of every country and especially of the Republic of Croatia, which, thanks to its geographical position, has developed tourism and an excellent climate for agriculture. Modern trends in production, constant technological progress, globalization and climate change are some of the challenges for farmers, which can lead to a decline in competitiveness and sustainability, especially for small family farms. In addition, farmers in the Republic of Croatia face a number of specific challenges, such as small, fragmented agricultural land, irregular land registration, the exodus of young people from rural areas and labour shortages, which further complicates their activities. The result of these and other challenges is a decline in agricultural production over the last 15 years. At the same time, the vast majority of Croatian businesses in agriculture are registered as family farms (OPG), and the survival and development opportunities of OPG are particularly important. The aim of this work is to investigate the opinion of Croatian consumers about Croatian agricultural products from local family farms and the importance of the additional tourist offer of family farms. In the first part of the study, a structured online survey was conducted to explore the preferences of Croatian consumers. In the second part of the study, an ordinal logistic regression was conducted to assess the influence of respondents' characteristics on their willingness to buy products or visit family farms. The results of the research can help Croatian producers to develop a strategy for the development of OPG and design an offer that meets market demand and improves their competitive advantage and financial results.

Keywords: family farm, consumer preferences, competitiveness

Revitalizacija unutrašnjih mediteranskih područja s novim poslovnim modelom za otporne zajednice

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Sažetak:
Posljednjih desetljeća, unutrašnja područja Mediterana doživjela su značajnu depopulaciju zbog sve veće koncentracije gospodarskih aktivnosti i stanovništva u obalnim urbanim središtima. Taj je trend doveo do demografskog starenja, povećanih rizika od siromaštva i socijalne isključenosti te posljedičnog pada broja javnih usluga, mogućnosti zapošljavanja i zaštite baštine. Kako bi se odgovorilo na te izazove, ova studija predstavlja okvir Teritorijalnog poslovnog modela (TBM), kao inovativan pristup za poboljšanje teritorijalnih specifičnosti, te podršku regeneraciji područja u nepovoljnom položaju, rješavanjem ekonomskih, društvenih i okolišnih pitanja.
TBM se temelji na pristupu poslovnog modela, razvijenom 1950-ih kao alat za definiranje načina na koji organizacije stvaraju vrijednost i povećavaju konkurentnost. Poslovni model sadrži elemente kao što su ponuda vrijednosti, operativni mehanizmi i ekonomske koristi te se pokazao primjenjivim u javnom i privatnom sektoru. Zahvaljujući svojoj svestranosti, sve se više prilagođavao kao podrška teritorijalnog razvoja. Kombinirajući ovaj pristup s literaturom o revitalizaciji područja, TBM uključuje četiri temeljna stupa - suradnju, održivost, inovaciju i digitalizaciju - i stavlja lokalne zajednice u središte stvaranja vrijednosti, potičući aktivno sudjelovanje u proizvodnji i potrošnji dobara i usluga za poticanje zajedničke dobrobiti.
Rezultat je sustavni model strukturiran u sedam faza: (i) razumijevanje BM koncepta; (ii) analiziranje potencijalnih koristi i izazova; (iii) definiranje ciljeva i razlikovnih obilježja TBM-a; (iv) razvoj praktičnog alata temeljenog na Canvas poslovnom modelu za prostorno planiranje; (v) uspostavljanje ključnih pokazatelja uspješnosti za praćenje ishoda; (vi) podupiranje kooperativa (zadruga) u zajednici kroz inovativne modele; (vii) utvrđivanje i širenje najboljih praksi.
TBM se trenutno provodi u unutrašnjosti sedam mediteranskih područja (Cipra, Hrvatske, Grčke, Italije, Sjeverne Makedonije, Slovenije i Španjolske) u okviru projekta Interreg Euro-MED REVIVE, kako bi se područjima pomoglo da se otvore i povećaju svoju vrijednost. Trenutačni rezultati predloženog modela su sedam akcijskih planova razvijenih za određena pilot područja. Ovaj holistički pristup nudi strateški alat za promicanje integriranog, dugoročnog razvoja prilagođenog složenim izazovima u unutrašnjosti mediteranskih regija.

Ključne riječi: teritorijalni poslovni model, ruralna područja, održivi razvoj, društvene inovacije, mediteranska regija

Revitalising inland Mediterranean areas with a new business model for resilient communities

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Abstract:
In recent decades, Mediterranean inland areas have experienced significant depopulation due to the concentration of economic activities and population in coastal urban centres. This trend has led to demographic ageing, heightened risks of poverty and social exclusion, and a consequent decline in public services, employment opportunities, and heritage protection. To address these challenges, this study presents the Territorial Business Model (TBM) framework as an innovative approach to support the economic, social, and environmental regeneration of disadvantaged areas.
The TBM builds on the business model approach, developed in the 1950s as a tool to define how organizations create value and enhance competitiveness. Comprising elements such as value proposition, operational mechanisms, and economic benefits, the business model has proven applicable across both public and private sectors. Thanks to its versatility, it has been increasingly adapted to support territorial development. By combining this approach with literature on area revitalization, the TBM incorporates four core pillars - **collaboration, sustainability, innovation, and digitalization** – and places local communities at the heart of the value creation, encouraging active participation in producing and consuming goods and services to foster collective well-being.
The result is a systemic model structured into seven phases: (i) understanding the BM concept; (ii) analysing its potential benefits and challenges; (iii) defining goals and distinctive features of the TBM; (iv) developing a practical tool based on the Business Model Canvas for territorial planning; (v) establishing key performance indicators to monitor outcomes; (vi) supporting community cooperatives through innovative models; (vii) identifying and disseminating best practices.
The TBM is currently being implemented in seven Mediterranean inland areas (Cyprus, Croatia, Greece, Italy, North Macedonia, Slovenia and Spain) within the Interreg Euro-MED REVIVE project, to help territories unlock and maximise their value. The current results of the proposed model are seven action plans developed for specific pilot areas. This holistic approach offers a strategic tool for promoting integrated, long-term development tailored to the complex challenges of Mediterranean inland regions.

Keywords: territorial business model, rural areas, sustainable development, social innovation, Mediterranean region

Uloga osjetilnog marketinga u kreiranju turističkog iskustva gorskih kuća za odmor

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Sažetak:
Kao okosnica hrvatskog turizma, privatni smještaj je razvijen i uspješan poslovni model, ali u gorskim destinacijama tek se razvija jedan njegov specifičan oblik, kuće za odmor. Obično na osami i bogato opremljene sadržajima, one privlače rastući segment turista koji najveći dio svog boravka planiraju i ostvaruje u i oko njih. No, iako nude visoku vrijednost te ostvaruju visoku cijenu, njihovi vlasnici još istražuju kako produljiti boravke gostiju i kreirati profitabilne poslovne modele. Cilj je ovog istraživanja utvrditi ulogu koju osjetilni marketing ima u tom smislu, odnosno utvrditi koji osjetilni podražaji u i oko gorskih kuća za odmor povećavaju vrijednost turističkog iskustva. Rezultati kvalitativnog istraživanja pokazuju da vlasnici i posjetitelji jasno definiraju specifične podražaje ovih objekata povezane sa svih pet osjetila (npr. miris drva i pokošene trave, pjev ptica i pucketanje vatre, sezonske dekoracije i zalazak sunca, kuhano vino i špek, te borove iglice i toplina saune). Važna je spoznaja da kao dio osjetilnog okruženja ispitanici navode i „odsustvo podražaja“; npr. tišinu (odsustvo zvuka), svjež zrak (odsustvo mirisa), ili urednost i čistoću (odsustvo vizualnih podražaja). Osvrćući se na Pine i Gilmoreov model potrošačkog iskustva kao i Iso-Aholinu teoriju motivacije, zaključuje se da je bitan motiv posjeta gorskih kuća za odmor bijeg (od podražaja). Rezultati kvantitativnog istraživanja ukazuju da tijekom boravka u ovim objektima posjetitelji najviše doživljavaju vizualne, zvučne i dodirne podražaje. Istovremeno, estetika i zabava (prema Pine i Gilmoreovom modelu pasivna iskustava) više su doživljena nego bijeg i obrazovanje (aktivna iskustva). Iako je gorski turizam baziran na ideji bijega od grada u prirodu, rezultati pokazuju da postoji prostor za jasniju primjenu „manje je više“ pristupa, odnosno kreiranja kuća za odmor koje su interesantne zbog odsustva podražaja. Buduća istraživanja bi trebala istražiti načine kreiranja takve ponude. Također, trebalo bi ispitati povezanost pojedinih podražaja ili njihovog odsustva s turističkim iskustvom i duljinom boravka.

Ključne riječi: osjetilni marketing, turističko iskustvo, kuće za odmor, gorski turizam, duljina boravka

Role of Sensory Marketing in Creating the Tourist Experience of Mountain Holiday Homes

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Abstract:
As the backbone of Croatian tourism, private accommodation is a well-developed and successful business model, but in mountain destinations its specific form, holiday homes, only begin to develop. Typically, secluded and well-equipped, they attract a growing segment of tourists who plan and spend most of their stay in and around them. Despite their high value and prices, their owners are still exploring how to extend guest stays and create profitable business models. This research aims to examine the role of sensory marketing in this context, i.e., identify which sensory stimuli in and around mountain holiday homes enhance the tourist experience. Qualitative research findings reveal that owners and visitors clearly define these properties' specific sensory stimuli across all five senses (e.g., scent of wood and cut grass, birdsongs and fire cracking, seasonal decorations and sunsets, mulled wine and smoked bacon, and pine needles and sauna warmth). An important insight is that as part of the sensory environment, respondents also mention the "absence of stimuli"; e.g., silence (absence of sound), fresh air (absence of smell), or orderliness and cleanliness (absence of visual stimuli). Referring to Pine and Gilmore's consumer experience model and Iso-Ahola's motivation theory, we conclude that an important motivation for visiting mountain holiday homes is escape (from stimuli). Quantitative research results indicate that during their stay, visitors primarily experience visual, auditory, and tactile stimuli. Simultaneously, aesthetics and entertainment (passive experiences in Pine and Gilmore's model) are perceived stronger than escape and education (active experiences). While mountain tourism is rooted in the idea of escaping urban life for nature, the findings suggest that there is space for a clearer application of the "less is more" approach, i.e., creating holiday homes that are attractive due to stimuli absence. Future research should explore ways to develop such offerings. Additionally, it should examine the relationship between specific stimuli or their absence and the tourist experience and length of stay.

Keywords: sensory marketing, tourist experience, holiday homes, mountain tourism, length of stay

Ruralni turizam kao pokretač održivog razvoja: evaluacija doprinosa SDG ciljevima

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Sažetak:
Ovo istraživanje imalo je cilj analizirati na koji način ruralni turizam doprinosi ostvarenju ciljeva održivog razvoja – SDG ciljevi. Identificirani su okolišni doprinosi, izmjeren je utjecaj sociokulturnih aktivnosti, te prepoznate prakse koje omogućuju ekonomske doprinose ostvarenju SDG ciljeva. U anketnom je istraživanju sudjelovalo 46 ruralnih turističkih subjekata na području Baranje. Uz socioekonomske i socio-demografske pokazatelje, upitnik je sadržavao 3 instrumenta - okolišni, sociokulturni i ekonomski doprinosi - s po 15 indikatora (ukupno 45) koje su ispitanici evaluirali na Likertovoj ljestvici (1-5). Analize su uključivale deskriptivnu statistiku, te analizu glavnih komponenti (PCA) sva 3 instrumenta, uz provjeru pouzdanosti (Cronbach's alpha). Analiza okolišnih doprinosa pokazala je da se najznačajnija postignuća nalaze u zaštiti prirodnih resursa, uključujući ekološku poljoprivredu, očuvanje zelenih površina i zaštitu bioraznolikosti. U sociokulturnim doprinosima istaknula se praksa nazvana zajedničkim nazivom: sociokulturna revitalizacija, koja obuhvaća sudjelovanje u lokalnim manifestacijama, očuvanje tradicijske arhitekture i osiguranje kontinuiteta obiteljskih turističkih poslovanja. Ekonomski doprinosi analizirani su kroz 3 razine: makro - utjecaj eksternog okruženja, mezzo - interakcija poslovanja s eksternim i internim činiteljima i mikro - poduzetničke i inovativne aktivnosti ruralnih turističkih entiteta. Rezultati su pokazali da je lojalnost posjetitelja ključan faktor ekonomske održivosti, dok se turistička ponuda istaknula kao glavni oblik ostvarivanja ekonomskih doprinosa SDG ciljevima. Ovakva istraživanja pružaju sustavan okvir za identifikaciju, mjerenje i evaluaciju utjecaja ruralnog turizma na održivi razvoj te predstavljaju važan alat za unapređenje održivih praksi.

Ključne riječi: ruralni turizam, održivi razvoj, SDG ciljevi, Baranja

Rural tourism as a driver of sustainable development: evaluation of contribution to SDGs

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Abstract:
This research aimed to analyse how rural tourism contributes to the achievement of sustainable development goals - SDGs. Environmental contributions were identified, the impact of socio-cultural activities was measured, and practices that enable economic contributions to the achievement of SDGs were recognized. In the area of Baranja, 46 rural tourism entities participated in the research. Socio-economic and socio-demographic indicators were analysed. The questionnaire contained 3 instruments - environmental, socio-cultural and economic contributions - with 15 indicators (total 45) that respondents evaluated on a Likert scale (1-5). The analyses included descriptive statistics and principal component analysis (PCA) of all 3 instruments, with reliability checks (Cronbach's alpha). An analysis of environmental contributions showed that the most significant achievements are found in the protection of natural resources, including organic agriculture, preservation of green spaces, and protection of biodiversity. In socio-cultural contributions, a practice called the common name: socio-cultural revitalization stood out, which includes participation in local events, the preservation of traditional architecture and ensuring the continuity of family tourism businesses. Economic contributions were analysed through 3 levels: macro - the influence of the external environment, mezzo - the interaction of business with external and internal factors and micro - entrepreneurial and innovative activities within rural tourism entities. The results showed that visitor loyalty is a key factor in economic sustainability, while the tourism offer stood out as the main form of achieving economic contributions to the SDGs. Such research provides a systematic framework for identifying, measuring and evaluating the impact of rural tourism on sustainable development and represents an important tool for improving sustainable practices.

Keywords: rural tourism, sustainable development, SDGs, Baranja

Održive turističke prakse: koristi i izazovi implementacije

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Sažetak:
Iako turizam može pozitivno utjecati na turističku destinaciju njegovi negativni utjecaji nisu zanemarivi, a očituju se kroz ekonomske, okolišne i društvene aspekte. Utjecaj turizma na okoliš i klimatske promjene su sve raširenji predmet znanstvenih istraživanja upravo zbog njegovih negativnih učinaka. Kako bi turistički sektor smanjio svoje negativne učinke, potrebno je prilagoditi turističku ponudu, a implementacije održivih praksi mogu biti jedan od načina prilagodbe. Za uspješnu prilagodbu, potrebno je razmotriti implikacije koje takve aktivnosti imaju na poduzeća u turizmu. Cilj ovog rada je identificirati, sistematizirati i kvantificirati najčešće održive prakse u hotelima, te koristi i ograničavajuće faktore implementacije održivih praksi koje su predmet istraživanja u području turizma. Istraživanje obuhvaća znanstvene radove objavljenje od 2008. do 2025. godine u časopisima indeksiranim u Web of Science i Scopus bazama podataka. Prilikom pretraživanja baza podataka korištena je ključna riječ „održive prakse u turizmu“ što je rezultiralo s 4834 radova, stoga je pretraga sužena proširenjem na riječi „hotel“ (831), „hotel izazovi“ (152) i „hotel koristi“ (115). Najčešće identificirane održive prakse odnose se na edukaciju zaposlenika i poticanje gostiju na ekološki odgovorna ponašanja. Po razini učestalosti slijede održive prakse kojima se smanjuju negativni učinci na okoliš, a to su upravljanje energijom, vodom i otpadom. Najčešće koristi u hotelima vezane su za okoliš, a uključuju smanjenu potrošnju i efikasniju uporabu vode i energije, te smanjenje stvaranja otpada. Na drugom mjestu su ekonomske koristi, koje uključuju financijske uštede, povećanje profitabilnosti i konkurentske prednosti. Iako održive prakse rezultiraju različitim koristima, u znanstvenim radovima je identificirano više ograničenja u njihovoj implementaciji. Kao najčešća identificirana ograničenja su financijski izazovi, potrebni resursi za implementaciju i izostanak podrške državnih i upravljačkih tijela.

Ključne riječi: održive prakse, turizam, koristi i izazovi implementacije

Sustainable tourism practices: benefits and challenges of implementation

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Abstract:
Although tourism can positively impact a tourist destination, its negative effects are not negligible, as they manifest through economic, environmental, and social aspects. The impact of tourism on the environment and climate change is increasingly studied in science due to its negative effects. In order for the tourism sector to reduce the negative effects, adjusting the tourism offer is required, which could be done through the implementation of sustainable practices. For the successful implementation, it is necessary to consider the implications which such activities will have on tourism businesses. The goal of this study is to identify, systematise and quantify the most common sustainable practices in hotels, together with benefits and limiting factors that are the subject of research in the field of tourism. The research included scientific papers published from 2008 to 2025 in journals indexed in the Web of Science (WoS)" and "Scopus" databases. The keywords used for database searches were "sustainable practices in tourism", which resulted in 4834 papers; therefore, the search was narrowed down by expanding the initial keyword "sustainable practices" with "hotel" (831), "hotel challenges" (152), and "hotel benefits" (115). The most common sustainable practices in hotels focus on employee education and encouraging guests to adopt environmentally friendly behaviours. These are followed by sustainable practices in energy, water, and waste management. The most common benefits in hotels were about reducing the negative impacts on the environment, including reduced consumption and more efficient use of water and energy together with less waste generation. Economic benefits come in second place for hotels, which include financial savings, increased profitability and competitive advantages. Although sustainable practices result in various benefits, scientific papers identify several limiting factors for their implementation. The most commonly identified limiting factors for hotels include financial challenges, required resources for implementation, and the lack of government support.

Keywords: sustainable practices, tourism, benefits and challenges of implementation

Stavovi turističkih dionika o klimatskim promjenama

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Sažetak:
Klimatske promjene predstavljaju jedan od ključnih izazova suvremenog turizma. Turizam je izuzetno ovisan o vremenskim prilikama, zbog čega klimatske promjene predstavljaju izazov njegovom razvoju. Kako bi se turistički sektor bolje prilagodio ovom izazovu, nužna je suradnja svih ključnih dionika, posebice nositelja politika. Ciljevi rada su bili: utvrditi stavove i mišljenja turističkih dionika o utjecaju klimatskih promjena na turizam i važnosti pojedinih politika i mjera koje imaju za cilj umanjenje negativnih efekata turizma na klimatske promjene te utvrditi statistički značajne razlike između pojedinih dionika. Istraživanje je provedeno na uzorku turističkih dionika koji su identificirani kao provoditelji politika (županije, gradovi, općine i turističke zajednice). Podaci su prikupljeni putem online upitnika u razdoblju od veljače do listopada 2022. godine, a uzorak je obuhvaćao 309 ispitanika. U analizi su korištene deskriptivna (aritmetička sredina, standardna devijacija i postotci) i bivarijatna (jednostrana ANOVA) statistička metoda. Rezultati pokazuju kako većina turističkih dionika smatra da su klimatske promjene izazvane većinom ljudskim djelovanjem. Oko 75 % smatra kako se već sada osjećaju posljedice klimatskih promjena u Hrvatskoj, dok gotovo 90 % misli kako se klimatske promjene već očituju na globalnoj razini. Kao tri najpoželjnije mjere politike za prilagodbu klimatskim promjena, identificirane su mjere sufinanciranja od strane države (bolja energetska učinkovitost objekata i obnovljivi izvori energije) te usmjeravanje javnog novca za investicije koje imaju za cilj umanjiti negativne učinke klimatskih promjena. S druge strane, nisu bili skloni povećanju cijene električne energije u cilju smanjenja njezine potrošnje. Razmatrajući različite izvore energije, ispitanici su pretežito izrazili veliku važnost uključivanja različitih obnovljivih izvora energije u energetski mix, dok su izjavili neslaganje s uporabom neobnovljivih izvora energije. Statistički značajne razlike u mišljenjima utvrđene su među dionicima po pitanju porasta cijene električne energije, povećanja poreza na upotrebu fosilnih goriva te uključivanje ugljena u energetski miks.

Ključne riječi: klimatske promjene, politike i mjere prilagodbe, energetski miks, turistički dionici

Policies and measures for climate change – Attitudes of tourism stakeholders

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Abstract:
Climate change is one of the key challenges of contemporary tourism. Tourism is particularly dependent on weather conditions, which is why climate change presents a significant challenge to its development. In order for the tourism sector to adapt to this challenge, collaboration among all key stakeholders, especially policymakers, is necessary. The goals of this paper were to determine the attitudes and opinions of tourism stakeholders about the impacts of climate change on tourism and to assess statistically significant differences between specific stakeholders. Research was conducted on the sample of tourism stakeholders which were identified as policy makers (counties, cities, municipalities and tourist boards). The data was collected through the administration of an online survey from February to October 2022, with the sample consisting of 309 respondents. For analysis, descriptive (mean values, standard deviation and percentages) and bivariate (one-way ANOVA) statistical methods were used. The results show that most tourism stakeholders consider that climate change is mostly caused by human activity. Around 75% believe that the effects of climate change are already being felt in Croatia, while nearly 90% think that climate change is already evident on a global level. As the top three preferred policy measures for climate change adaptation were government co-financing measures (improved energy efficiency of buildings and renewable sources of energy) and allocating public funds for investments which aim to mitigate negative effects of climate change. On the other hand, respondents were not inclined towards increasing prices of electricity in order to reduce its consumption. When considering different sources of energy, respondents expressed a great deal of importance towards the inclusion of different renewable energy sources into the energy mix, while negative attitudes were about using non-renewable energy sources. Statistically significant differences in opinions were found between stakeholders regarding increasing prices of electricity, increasing taxes on the use of fossil fuel, and including coal in the energy mix.

Keywords: climate change, policies and measures for adaptation, energy mix, tourism stakeholders

Povezivanje tradicije i poljoprivrede s turističkom ponudom

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Sažetak:
Sve više seoskog stanovništva u Slavoniji i Baranji okreće se povezivanju poljoprivrede i turizma i modelu „cirkularnog gosta“ kojemu se uz osnovnu ponudu smještaja uz tradicionalni doručak kod jednog domaćina nudi i niz drugih aktivnosti. Uz ponudu smještaja uključeni su i drugi subjekti u selu (Karanac, Zmajevac i dr.) koji nude tradicionalna jela za ručak i večeru, izlet i upoznavanje sa znamenitostima, krajobrazom i arhitekturom Baranje i Slavonije, kušaonice poljoprivrednih proizvoda i prerađevina (pekmeza, sirupa, vina, rakija i sl). Gostu je pružena mogućnost sudjelovanja u poljoprivrednim poslovima, upoznavanje sa životom tradicijskog baranjskog i slavonskog sela, kao i sudjelovanje u učenju tradicijske glazbe i plesova. Takav model zajedničke turističke ponude i cirkularnog gosta, u Slavoniji i Baranji povećao je turistički rast od 8,6 posto u dolascima i 6,6 posto u noćenjima u 2024. godini. Tematske turističke rute (vjerski turizam, aroma farme, radionice starih obrta i zanata, kulinarske radionice) samo su neke od aktivnosti kojima se mogu privući gosti. Organizacijom cirkularnog gosta, tematskih turističkih ruta i radionica koje traju od tri do 6 dana, mogu se privući kosti koji žele zdrav, opušten, ali aktivan odmor.
U radu je prikazan model cirkularnog gosta i model tematskih programa koji mogu poslužiti kao novi vid turističke ponude, ali i nova djelatnost koja će transformirati selo, ali i zadržati njegovu tradiciju.

Ključne riječi: poljoprivreda, turizam, tradicija, transformacija

Connecting tradition and agriculture with the tourist offer

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Abstract:
Increasingly, rural residents in Slavonia and Baranja are turning to tourism and the "circular guest" model, which, in addition to the introductory offer of accommodation with a traditional breakfast at a host, also provides a range of other activities. In addition to the accommodation offer, other entities in the village (Karanac, Zmajevac, etc.) are also included, offering traditional meals for lunch and dinner, excursions and introductions to the sights, landscape and architecture of Baranja and Slavonia, and tasting rooms for agricultural products and processed products (jam, syrup, wine, brandy, etc.). The guest is allowed to participate in agricultural work and get acquainted with the life of a traditional Baranja and Slavonian village, as well as participate in learning traditional music and dances. Such a model of joint tourist offers and circular guests in Slavonia and Baranja increased tourism growth by 8.6 percent in arrivals and 6.6 percent in overnight stays in 2024. Thematic tourist routes (religious tourism, aroma farms, workshops of old crafts and trades, and culinary workshops) are just some of the activities that can attract guests. By organising a circular guest experience, thematic tourist routes and workshops lasting from three to 6 days, you can attract those who want a healthy, relaxed but active vacation.
The paper presents a model of a circular guest and a model of thematic programmes that can serve as a new form of tourist offer but also a new activity that will transform the village but also maintain tradition.

Keywords: agriculture, tourism, tradition, transformation

Suvremeni izazovi razvoja poljoprivrede i turizma u Republici Hrvatskoj u kontekstu znanstvene misli akademika Mije Mirkovića

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Sažetak:
U radu se predstavljaju suvremeni izazovi razvoja poljoprivrede i turizma u Republici Hrvatskoj u odnosu na promišljanje poljoprivredne politike i ekonomike turizma u radovima Mije Mirkovića. Znameniti istarski polihistor i ekonomski povjesničar veliki dio svog mnogostranog opusa posvetio je problematici razvoja poljoprivrede i agrarnoj politici, a važan je i njegov doprinos razvoju turizma kroz pokretanje prvog poslijediplomskog studija Ekonomike turizma 1961. godine na Ekonomskom fakultetu u Zagrebu. Uz analizu aktualnih izazova poticanja i povezivanja domaće poljoprivredne proizvodnje s turističkim sektorom, autorice će predstaviti ključne studije Mije Mirkovića posvećene izazovima agrarnog razvoja i usporediti ih s aktualnim poljoprivrednim i turističkim politikama na europskom i nacionalnom nivou. Detaljnom komparativnom analizom poljoprivrednog razvoja, ali i agrarnih politika i znanstvenih pristupa te organizacije poljoprivrednih istraživanja kroz specijalizirane institute u europskim zemljama, Mirković je ukazivao na probleme niske produktivnosti domaće poljoprivrede, između ostalog i zbog usitnjenosti zemljišnih posjeda. Rješavanje agrarnog problema još je u svojoj „Agrarnoj politici“ iz 1940. vidio u proširenju carinskog područja i stvaranju carinskog saveza s industrijaliziranim zapadnim zemljama ili susjednim agrarnim zemljama, industrijalizaciji kao nužnom uvjetu unapređenja poljoprivrede, stvaranju ekonomski svrhovitije strukture gospodarstva te dugoročnom strateškom planiranju agrarne politike. Zagovarao je važnost poznavanja regionalnih specifičnosti svake poljoprivredne regije, isticao ulogu znanstvenih istraživanja stanja i mogućnosti razvitka poljoprivrede te važnost obrazovanja i stručnosti poljoprivrednika. Temeljem komparativnog pristupa u fokusu kojeg je bio uspješan zadružni pokret u Italiji, prepoznavao je moguće dugoročne učinke zadružnog pokreta i na području Hrvatske. U brojnim je radovima naglašavao važnost dinamiziranja izvoza poljoprivrednih proizvoda, ali i plasmana domaće poljoprivredne proizvodnje u turizmu. Hrvatska se poljoprivreda i nadalje suočava s brojnim razvojnim ograničenjima (rascjepkanost gospodarstva, nepovoljna demografska obilježja poljoprivrednika, sve veća uvozna ovisnost poljoprivrednih proizvoda i dr.), tako da je cilj ovoga rada ukazati na aktualnost Mirkovićevih preporuka nositeljima ekonomskih politika te preispitati mogućnost efikasnijeg strateškog promišljanja razvoja i suradnje sektora poljoprivrede i turizma u Istri u Hrvatskoj u kontekstu aktualnih europskih politika i turbulentnih globalnih trendova.

Ključne riječi: poljoprivreda, turizam, održivi razvoj, Mijo Mirković

Contemporary challenges of agricultural and tourism development in the Republic of Croatia in the context of the scientific thought of Mijo Mirković

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Abstract:
The paper presents contemporary challenges of agricultural and tourism development in the Republic of Croatia in relation to the reflection on agricultural policy and tourism economics in the works of the academician Mijo Mirković. The famous Istrian polymath and economic historian dedicated a large part of his multifaceted oeuvre to the issues of agricultural development and agrarian policy. His contribution to the development of tourism is also important through the launch of the first postgraduate study in Tourism Economics in 1961 at the Faculty of Economics in Zagreb. In addition to the analysis of current challenges in encouraging and connecting domestic agricultural production with the tourism sector, the authors will present key studies by Mijo Mirković dedicated to the challenges of agrarian development and compare them with current agricultural and tourism policies at the European and national levels. Through a detailed comparative analysis of agricultural development, but also of agrarian policies and scientific approaches and the organization of agricultural research through specialized institutes in European countries, Mirković pointed out the problems of low productivity of domestic agriculture, among other things due to the fragmentation of land holdings. In his "Agrarian Policy" from 1940, he saw the solution of the agrarian problem in the expansion of the customs area and the creation of a customs union with industrialized western countries or neighboring agrarian countries, industrialization as a necessary condition for the improvement of agriculture, the creation of a more economically purposeful structure of the economy and long-term strategic planning of agrarian policy. He advocated the importance of knowing the regional specifics of each agricultural region, emphasized the role of scientific research into the state and possibilities of agricultural development, and the importance of the education and expertise of farmers. On the basis of the comparative approach, which focused on the successful cooperative movement in Italy, he recognized the possible long-term effects of the cooperative movement on the territory of Croatia as well. In numerous works, he emphasized the importance of dynamizing the export of agricultural products, as well as the placement of domestic agricultural production in tourism. Croatian agriculture continues to face numerous development constraints (fragmentation of the economy, unfavorable demographic characteristics of farmers, increasing import dependence of agricultural products, etc.), so the aim of this paper is to point out the relevance of Mirković's recommendations to economic policy makers and to review the possibility of more efficient strategic thinking of the development and cooperation of the agricultural and tourism sectors in Istria in Croatia in the context of current European policies and turbulent global trends.

Keywords: agriculture, tourism, sustainable development, Mijo Mirković

Tourism and the Importance of Its Potentials for Economic Development in Kosovo's Five Regions

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Abstract:
Kosovo has rich tourist resources that enable the development of various forms of tourism, as well as the preservation of cultural and natural heritage. These opportunities create a solid foundation for investment and the development of an attractive tourism product for visitors. From a tourism perspective, Kosovo is divided into five main regions: the Bjeshkët e Nemuna region, the Sharri Mountains region, the Gollak region, the Shala e Bajgora region, and the Anamorava region. The Bjeshkët e Nemuna and Sharri Mountains regions are well-known not only in Kosovo but also in the region for the opportunities they offer for the development of mountain tourism, especially winter and sports tourism.
This paper will examine the importance of the tourist potentials of these five regions for Kosovo's economic development. The "onion ring" method will be used to collect and interpret combined data, providing a clear overview of the impact of tourism on the economic development of the regions.

Keywords: tourist attractions, regional development, economic, tourism, economic impact

Agrarna ekonomija

Agro-economy

Utjecaj oznaka kvalitete i načina proizvodnje na hedonističku percepciju i namjeru kupnje meda u Hrvatskoj

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Sažetak:
Cilj ovog istraživanja bio je ispitati utječu li oznaka kvalitete i način proizvodnje meda, konkretno oznake „Dokazana kvaliteta“ i "Ekološki proizvod", na hedonističku percepciju i namjeru kupnje meda kod potrošača u Hrvatskoj. Istraživanje je provedeno s tri vrste bagremovog meda (ORG – ekološki, PQ – s oznakom „Dokazana kvaliteta“ i NL – bez oznake) kroz četiri evaluacijska tretmana (1. vizualno i 2. senzorno bez oznaka, 3. vizualno i 4. senzorno sa oznakama) među 100 ispitanika.
Rezultati pokazuju da oznake kvalitete značajno utječu na percepciju potrošača. ORG med je u svim tretmanima imao više ocjene u odnosu na PQ i NL med. Nakon pružanja informacija o oznakama, ocjene i namjere kupnje za ORG i PQ med su porasle, dok je ocjena za NL med pala. Statistički značajne razlike u ocjenama pojavljuju se i u odnosu na spol i učestalost konzumacije meda – žene i osobe koje češće konzumiraju med iskazale su višu razinu sviđanja. Na temelju usporede ocjena i namjere kupnje između 1. i 3. tretmana, možemo reći da oznaka "Dokazana kvaliteta" povećava subjektivnu privlačnost meda (Odds ratio=0.32; p-value<0,05) i namjeru kupnje meda. Rezultati upućuju na važnost označavanja i potencijal oznaka kvalitete u pozicioniranju domaćeg meda na tržištu.

Ključne riječi: oznake kvalitete, ekološka proizvodnja, pčelarstvo

The Influence of the Quality Label and Organic Product Label on Hedonic Perception and Purchase Intention of Honey in Croatia

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Abstract:
The aim of this study was to examine whether quality labels and production methods of honey—specifically the "Proven Quality" and "Organic Product" labels—affect the hedonic perception and purchase intention of honey among consumers in Croatia. The research was conducted using three types of acacia honey (ORG – organic, PQ – labelled "Proven Quality", and NL – without any label) across four evaluation treatments (1. visual and 2. sensory without labels, 3. visual and 4. sensory with labels) among 100 participants.
The results show that quality labels significantly influence consumer perception. ORG honey received higher ratings in all treatments compared to PQ and NL honey. After the label information was provided, both ratings and purchase intentions increased for ORG and PQ honey, while the rating for NL honey declined. Statistically significant differences in ratings were also found in relation to gender and frequency of honey consumption—women and frequent honey consumers expressed higher levels of liking.
Based on the comparison of ratings and purchase intentions between treatments 1 and 3, we can conclude that the "Proven Quality" label increases the subjective appeal of honey (Odds ratio = 0.32; p-value < 0.05) and the intention to purchase. The results highlight the importance of labelling and the potential of quality labels in positioning domestic honey in the market.

Keywords: quality labels, organic production, beekeeping

Stavovi i motivi odabira lokalnih craft piva u Istri

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Sažetak:
Pivo je jedno od najpopularnijih alkoholnih pića u svijetu, a globalno tržište bilježi stalni rast, kako u količini potrošnje, tako i u raznolikosti ponude. Uz velike industrijske proizvođače, posljednjih tridesetak godina sve veću pažnju potrošača privlače male nezavisne pivovare, tzv. craft pivovare, koje nude raznolike stilove piva, naglašavaju kvalitetu sastojaka, lokalni identitet i inovativnost u proizvodnji. Sličan trend prisutan je i u Hrvatskoj, osobito od 2013. godine, kada se pojavljuje prva domaća craft pivovara, a u posljednjim godinama značajan porast bilježi i broj craft pivovara u Istri. Cilj rada bio je analizirati stavove i preferencije istarskih potrošača prema lokalnim craft pivima. Istraživanje je provedeno anketnim ispitivanjem tijekom 2022. godine putem online platforme 1KA na uzorku od 328 ispitanika. U anketi su ispitivani čimbenici poput važnosti obilježja piva pri kupnji u ugostiteljskim objektima, znanja i stavova o craft pivu, motiva za odabir craft piva, kao i razina izraženosti etnocentrizma i lokalpatriotizma među ispitanicima. Prikupljeni podaci analizirani su jednovarijatnom i dvovarijatnom analizom. Dobiveni rezultati ukazuju na pozitivan stav istarskih potrošača prema lokalnim craft pivima te ukazuju na dobru tržišnu perspektivu ovih proizvoda. Nalazi istraživanja mogu poslužiti kao temelj za oblikovanje učinkovitijih marketinških strategija usmjerenih na jačanje prepoznatljivosti i potrošnje lokalnih craft piva.

Ključne riječi: stavovi, motivi, craft piva, Istra

Attitudes and motives for choosing local craft beers in Istria

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Abstract:
Beer is one of the most popular alcoholic beverages in the world, with the global market showing continuous growth both in terms of consumption and diversity of offerings. Alongside large industrial producers, over the past thirty years, small independent breweries - known as craft breweries - have been increasingly attracting consumer attention. These breweries emphasize product quality, local identity, and innovation. A similar trend has been observed in Croatia, especially since 2013, when the first domestic craft brewery was established. In recent years, the number of craft breweries has significantly increased, particularly in the Istrian region.
The aim of this paper was to analyze the attitudes and preferences of Istrian consumers toward local craft beers. The research was conducted in 2022 by means of a survey via the online platform 1KA with a sample of 328 respondents. The questionnaire examined factors such as the importance of beer attributes when purchasing in hospitality establishments, consumer knowledge and attitudes about craft beer, motives for choosing craft beer, as well as levels of ethnocentrism and local patriotism among respondents. The collected data were analyzed using univariate and bivariate analysis.
The results indicate a generally positive attitude of Istrian consumers toward local craft beers and point to a promising market potential. The findings provide a valuable basis for developing more effective marketing strategies aimed at increasing the visibility and consumption of local craft beer products.

Keywords: attitudes, motives, craft beers, Istria

Održiva konzumacija maslinovog ulja i zdravstveni atributi

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Sažetak:
Ponašanje potrošača prema konzumaciji maslinovog ulja u ovom radu ispitano je na uzorku potrošača maslinovog ulja putem samostalno popunjenog upitnika. Obrada podataka uključivala je statističke metode koje se sastoje od univarijantne statistike, multivarijantne analize i modeliranja strukturnih jednadžbi. Rad je imao za cilj testirati odnose između zdravog ponašanja, potencijalnih zdravstvenih tvrdnji o maslinovom ulju i percepcije zdravstvenih koristi, te motiva konzumiranja maslinovog ulja i svojstava proizvoda te procijeniti modificiranu ljestvicu koja mjeri percepciju zdravstvenih koristi maslinovog ulja.
Model potrošnje uključivao je ukupno sedam faktora, dva faktora koji mjere motive konzumiranja maslinovog ulja (kultura/tradicija i užitak), jedan faktor koji mjeri „zdravo“ ponašanje, jedan faktor koji mjeri percepciju zdravstvenih koristi maslinovog ulja, jedan faktor koji mjeri zdravstvene tvrdnje o maslinovom ulju i dva faktora koja mjere atribute maslinovog ulja. Općenito, kultura/tradicija kao motivi su bile relativno manje konzumacije maslinovog ulja, dok je užitak bilo prilično bitan motiv konzumacije maslinovog ulja. Zdravstvene koristi maslinovog ulja, „zdravo“ ponašanje, dobrobiti maslinovog ulja za zdravlje i atributi maslinovog ulja bili su donekle važni ispitanicima. Poveznice u modelu su pozitivno podržane između zdravog ponašanja i podrijetla maslinovog ulja; zdravstvene dobrobiti maslinovog ulja i motivi za atribute maslinovog ulja (podrijetlo i osjetilna svojstva).
Implikacije istraživanja potiču percepciju maslinovog ulja kao zdravog poljoprivrednog proizvoda koji će se zbog zdravstvenih svojstava i drugih atributa konzumirati u budućnosti. Nalazi podupiru održivost proizvodnje maslinovog ulja kao i moguće buduće aspekte označavanja maslinovog ulja zdravim svojstvima važnim za ljudsko zdravlje.

Ključne riječi: maslinovo ulje, konzumacija, atributi, ponašanje potrošača, zdravstvene koristi.

Olive oil sustainable consumption and health related attributes

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Abstract:
Consumers' behavior toward olive oil consumption in this paper was surveyed on a sample of olive oil consumers with a self-completed questionnaire. Data processing included statistical methods consisting of univariate statistics, multivariate analysis and structural equation modelling. The paper aimed to test the relationships among healthy behaviour, potential olive oil health claims and health benefits perception, olive oil consumption motives and product attributes and to assess a modified scale measuring olive oil health benefits perception.
The model of consumption included a total of seven factors, two factors measuring olive oil consumption motives (culture/tradition and pleasure), one factor measuring healthy behaviour, one factor measuring olive oil health benefits perception, one factor measuring olive oil health claims and two factors measuring olive oil product attributes. In general, culture/tradition were relatively less important for olive oil consumption, while pleasure was rather important olive oil consumption motive. Olive oil health perception benefits, healthy behaviour, olive oil health benefits and olive oil product were somewhat important to responders. The links in the model were positively supported among healthy behaviour and olive oil origin; olive oil health benefits and motives to olive oil attributes (origin and sensorial attributes).
Implications of the study encourage the perception of olive oil as a healthy agricultural product, that will be consumed in the future due to health and origin attributes. The findings support the sustainability of olive oil production as well the possible future aspects of labelling olive oil with healthy attributes important for human health.

Keywords: olive oil, consumption, attributes, consumer behavior, health benefits

Mišljenja dionika u poljoprivrednom i turističkom sektoru o klimatskim promjenama

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Sažetak:
Cilj ovog istraživanja bio je utvrditi razlike između dionika u turizmu i poljoprivredi u pogledu mišljenja o utjecaju klimatskih promjena na poslovanje. Ciljana populacija obuhvatila je dionike iz dvaju sektora: turizma (predstavnici županija, gradova, općina i turističkih zajednica) i poljoprivrede (predstavnici nacionalnih upravnih tijela, predstavnici lokalnih zajednica i županija, predstavnici udruga te predstavnici iz znanstvenih i obrazovnih institucija). Rezultati su prikupljeni u jadranskoj Hrvatskoj (uključujući Istarsku županiju, Primorsko-goransku županiju, Zadarsku županiju, Šibensko-kninsku, Splitsko-dalmatinsku županiju i Dubrovačko-neretvansku županiju). Podaci o turističkom sektoru prikupljeni su od veljače do listopada 2022., dok su podaci o dionicima poljoprivrede prikupljeni od listopada 2020. do lipnja 2021. Ispitanici su zamoljeni da izraze svoja mišljenja o utjecaju klimatskih promjena na njihovo poslovanje koristeći Likertovu skalu s ocjenama od 1 (potpuno neslaganje) do 5 (potpuno slaganje). Podaci su obrađeni korištenjem univarijantne (frekvencije i postotci) i bivarijantne (t-test) statistike. Općenito, smatraju da klimatske promjene imaju određeni utjecaj na njihovo poslovanje, ali je taj utjecaj relativno nizak i ne bi ih motivirao da prestanu s poslovnom aktivnošću. Statistički značajne razlike utvrđene su između dvaju tipova dionika u vezi s njihovim mišljenjem da klimatske promjene često uzrokuju značajne štete u njihovoj regiji, da se poslovni rizik povećava svake godine zbog klimatskih promjena te da se poduzeća moraju prilagoditi klimatskim promjenama. Kod navedenih tvrdnji dionici u poljoprivredi izrazili su značajno veću zabrinutost nego dionici u turizmu. Analiza mišljenja o utjecaju klimatskih promjena na njihovo poslovanje pokazala je da, iako nema statistički značajnih razlika među županijama, određene razlike ipak postoje. U poljoprivrednom sektoru najveću zabrinutost pokazali su dionici na području Zadarske županije, dok su u turističkom sektoru za klimatske promjene najzabrinutiji dionici na području Šibensko-kninske županije.

Ključne riječi: poljoprivreda, turizam, klimatske promjene, utjecaj, mišljenje dionika

Stakeholders' Opinions in the Agricultural and Tourism Sectors on Climate Change

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Abstract:
The aim of this research was to determine the differences between stakeholders in tourism and agriculture with respect to opinions regarding the influence of climate change on business. The target population included stakeholders in two sectors: tourism (representatives of counties, towns, municipalities and tourist boards) and agriculture (national governing bodies representatives, local communities and counties representatives, association representatives, and scientific and education representatives). The results were collected in Adriatic Croatia (incl. Istria County, Primorje-Gorski Kotar County, Zadar County, Split-Dalmatia County, Dubrovnik-Neretva County). Data regarding the tourism sector was collected from February through October 2022, while data on agriculture stakeholders was collected from October 2020. to June 2021. Data was processed using univariate (frequencies and percentages) and bivariate (t-test) statistics. Responders were asked to express their opinions on climate change's influence on their business. In general, they believe climate change has a certain impact on their business, but that impact is relatively low and would not encourage them to discontinue their business activity. Statistically significant differences were determined between the two types of stakeholders concerning their opinion that climate change causes significant damage in their region frequently, the business risk increases every year due to climate change, and businesses must adapt to climate change. Regarding the above statements, stakeholders in agriculture expressed significantly greater concern than stakeholders in tourism. Analysis of opinions on the impact of climate change on their business showed that, although there are no statistically significant differences between counties, certain differences do exist. In the agricultural sector, stakeholders in Zadar County expressed the greatest concern, while in the tourism sector, stakeholders in Šibenik-Knin County were the most concerned about climate change.

Keywords: agriculture, tourism, climate change, influence, stakeholders' opinion

Izazovi ekološke poljoprivrede na obiteljskim poljoprivrednim gospodarstvima u kontekstu održivog razvoja

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Sažetak:
Svijest potrošača o prednostima konzumacije ekoloških poljoprivrednih proizvoda sve se više razvija, posebno u smislu njihovog pozitivnog utjecaja na zdravlje, te se ekološki proizvodi dobro trže. Razvidno je da postoji veliki potencijal u širenju ekološke poljoprivredne proizvodnje, a posebno u segmentu prerade primarnih ekoloških proizvoda, čime bi obiteljska poljoprivredna gospodarstva stvorila novu dodanu vrijednost.
Cilj ovog istraživanja je uvidjeti motive za bavljenje ekološkom proizvodnjom na obiteljskim poljoprivrednim gospodarstvima u Požeško-slavonskoj županiji, probleme s kojima se suočavaju ekološki proizvođači i stavove prema inovacijama. Anketni upitnik dostavljen je svim registriranim ekološkim proizvođačima u županiji, kojih je ukupno 50, a stopa odgovora bila je 30%. Rezultati su pokazali da su nositelji gospodarstva pretežno visokoobrazovane osobe srednje životne dobi koje se bave ekološkom proizvodnjom duže od 4 godine. Glavni motivi za ekološku proizvodnju su želja za proizvodnjom zdrave hrane i briga za zdravlje i okoliš. Svi proizvođači prijavljuju manje prinose u odnosu na konvencionalnu proizvodnju, a samo polovina proizvođača povećala je cijene proizvoda. Većina ispitanika ocjenjuje prelazak na ekološku poljoprivredu neprofitabilnim te je razmišljala o prestanku bavljenja ekološkom poljoprivrednom proizvodnjom. Kao najčešće probleme ispitanici spominju zaštitu protiv bolesti i štetnika te borbu protiv korova, manji prihod i zahtjevnu papirologiju. Većina ispitanika smatra da su potrebne mjere potpore proizvodnji i osiguranje plasmana proizvoda kroz javnu nabavu. 93% ispitanika smatra važnim uvoditi inovativne proizvode u svoje poslovanje, ali ih većina nije uvela te ne smatraju da posjeduju inovativan duh. Niski državni poticaji, zahtjevna papirologija, povećanje troškova proizvodnje uz borbu sa nelojalnom konkurencijom doveli su do smanjenja interesa proizvođača za bavljenjem ekološkom proizvodnjom.
Da bi se ispunili ciljevi Strateškog plana zajedničke poljoprivredne politike do 2027., koji predviđaju širenje ekološke proizvodnje s 8 %, na 12 % ukupne poljoprivredne proizvodnje, odnosno Akcijskog plana razvoja ekološke proizvodnje do 2030. godine, koji predviđa povećanje ekološke proizvodnje na 14 % ukupne poljoprivredne proizvodnje, potrebno je pojednostaviti zakonsku regulativu te uvesti nove poticajne politike od strane države.

Ključne riječi: ekološka poljoprivreda**,** inovacije, OPG

Challenges of organic farming on family farms in the context of sustainable development

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Abstract:
Consumer awareness of the benefits of consuming organic agricultural products is increasingly developing, especially in terms of their positive impact on health, and organic products are in good demand. It is clear that there is great potential in expanding organic agricultural production, especially in the segment of processing primary organic products, which would allow family farms to create new added value.
The aim of this research is to understand the motives for engaging in organic production on family farms in Požega-Slavonia County, the problems faced by organic producers and attitudes towards innovation. The questionnaire was delivered to all registered organic producers in the county, 50 in total, and the response rate was 30%. The results showed that the owners of the farm are predominantly highly educated middle-aged people who have been engaged in organic production for more than 4 years. The main motives for organic production are the desire to produce healthy food and concern for health and the environment. All producers report lower yields compared to conventional production, and only half of the producers have increased product prices. The majority of respondents consider the transition to organic agriculture unprofitable and have considered ceasing organic agricultural production. The most common problems mentioned by respondents are protection against diseases and pests and the fight against weeds, lower income and demanding paperwork. The majority of respondents believe that measures to support production and ensuring product placement through public procurement are necessary. 93% of respondents consider it important to introduce innovative products into their business, but most have not introduced them and do not believe that they have an innovative spirit. Low state incentives, demanding paperwork, increased production costs, and the fight against unfair competition have led to a decrease in producers' interest in engaging in organic production.
In order to meet the goals of the Strategic Plan of the Common Agricultural Policy until 2027, which envisage the expansion of organic production from 8% to 12% of total agricultural production, and the Action Plan for the Development of Organic Production until 2030, which envisage growth of organic production to 14% of total agricultural production, it is necessary to simplify legal regulations and introduce new incentive policies by the state.

Keywords: organic production, innovation, family farm

Upravljanje otpadom

Waste management

Role of Agricultural Waste in Compost Production: A Step Towards a Green and Sustainable Economy

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Abstract:
The global agricultural sector generates over 5 billion tons of organic waste annually, much of which is underutilized, contributing to pollution and soil degradation. Composting offers a sustainable solution by converting organic residues into nutrient-rich amendments. Studies show that composting can increase soil organic matter by 20-30% and reduce reliance on synthetic fertilizers by up to 50%, helping to mitigate greenhouse gas emissions and promote carbon sequestration. Economically, composting reduces fertilizer costs and improves soil health, leading to higher crop yields and long-term profitability for farmers. The effectiveness of composting is influenced by factors such as the carbon-to-nitrogen (C: N) ratio (25–30:1), moisture content (40–60%), aeration levels, and microbial composition. While initial costs, feedstock variability, and limited farmer awareness pose challenges to widespread adoption, composting offers economic benefits through reduced fertilizer expenditures and enhanced soil productivity. The initial investment in composting infrastructure can be offset by these savings, and as composting becomes more integrated into a circular economy, new markets for compost products may emerge, providing additional revenue streams. This study evaluates composting's role in agricultural waste management, its contributions to a circular economy, and its economic potential. Future advancements, including microbial inoculants, biochar amendments, and improved policy frameworks, are key to optimizing composting processes, reducing costs, and supporting sustainability efforts. By embracing composting, agriculture can contribute to global sustainability while strengthening economic resilience within farming communities.

Keywords: composting, circular economy, environmental pollution, green economy, waste, sustainability

The cytological and morpho-physiological effects of olive pomace residue on *Vicia faba* L.

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Abstract:
The olive oil industry, while economically significant, generates a large volume of lignocellulosic residues, such as olive pomace (OP), which presents environmental challenges for its valorisation. This study is aimed to evaluate the phytotoxic effects of olive pomace filtrate on hydroponically cultivated broad bean (*Vicia faba*) plants, utilizing LC-MS/MS, cytological, and physio-biochemical analyses. The results demonstrated a dose-dependent reduction in shoot and root biomass with increasing OP concentrations, with an 80% decrease at 20% v/v. Concurrently, photosynthetic pigment and carotenoid levels, as well as relative water content, decreased significantly. An elevation in malondialdehyde, a marker of oxidative stress, was observed. Notably, the accumulation of soluble sugars (sucrose, fructose, inulin) and 12 free amino acids indicated a metabolic stress response. Cytological examination revealed a significant reduction in the mitotic index and the induction of chromosomal aberrations (adhesion, fragmentation, delayed and damaged chromosomes, c-mitoses, and micronuclei) at concentrations exceeding 10%, confirming genotoxic effects. These findings emphasize the potential phytotoxicity of OP and the importance of implementing appropriate treatment strategies prior to its environmental disposal or agricultural application, essential for achieving sustainable waste management.

Keywords: *Vicia faba*, amino acid profile, chromosome damage, olive mill waste, polyphenols

Utjecaj kultivara na fizikalno-kemijska svojstva biougljena dobivenog iz ostataka rezidbe vinove loze

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Sažetak:
Valorizacija poljoprivrednog otpada u svrhu pretvorbe biomase u materijale s dodanom vrijednošću posljednjih je godina privukla značajnu pozornost. U tom kontekstu, ostaci rezidbe vinove loze predstavljaju vrijedan resurs koji se najčešće zbrinjava malčiranjem, inkorporacijom u tlo ili spaljivanjem, pri čemu se gubi njihov potencijal za daljnju primjenu. Procesom pirolize, ovi se ostaci mogu transformirati u biougljen – materijal s izraženim kapacitetom sekvestracije ugljika te potencijalnom primjenom kao poboljšivač tla.
U ovom istraživanju, ostaci rezidbe vinove loze prikupljeni su tijekom fenofaze mirovanja na području priobalne Hrvatske s ciljem ispitivanja utjecaja različitih kultivara vinove loze na kemijska i fizikalna svojstva dobivenog biougljena. Istraživanje je obuhvatilo dvanaest kultivara, uključujući šest svjetskih i šest hrvatskih autohtonih sorata. Biougljen je proizveden laboratorijskom pirolizom u mufolnoj peći pri kontroliranim uvjetima.
Radi usporedbe kemijsko-fizikalnih svojstava početnog materijala i dobivenog biougljena, provedene su analize pH vrijednosti, električne vodljivosti (EC), udjela pepela, dušika (N) metodom Kjeldahla te ugljika (C) pomoću TOC-L + SSM metode. Dodatno su određene koncentracije makro- i mikroelemenata primjenom ICP-OES tehnike, specifična površina (BET metoda) i mikrostruktura materijala analizirana skenirajućim elektronskim mikroskopom (SEM).
Rezultati su pokazali značajne razlike u kemijsko-fizikalnim svojstvima između početnog materijala i dobivenog biougljena. Utvrđeno je povećanje pH vrijednosti, udjela ugljika i koncentracija elemenata u uzorcima biougljena, dok je analiza SEM-om potvrdila strukturne promjene uslijed pirolize. Također, utvrđena je statistički značajna varijabilnost među kultivarima u parametrima poput pH, udjela pepela, sadržaja ugljika i dušika te koncentracije makro- i mikroelemenata. Dobiveni biougljen, zahvaljujući svojim kemijsko-fizikalnim karakteristikama, pokazuje značajan potencijal za primjenu u poboljšanju kvalitete tla.

Ključne riječi: biougljen, vinova loza, kultivar, ostaci rezidbe, valorizacija

Cultivar effect on physicochemical properties of biochar derived from grapevine-pruning residues

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Abstract:
The valorisation of agricultural waste via the conversion of biomass into value-added materials has gained significant attention in recent years. In this context, grapevine pruning residues represent a valuable resource that is most commonly managed through mulching and incorporation into the soil or field burning, thereby losing their potential for further utilization. Through the process of pyrolysis, these residues can be transformed into biochar, a material with a high carbon sequestration capacity and potential application as a soil amendment.
In this study, grapevine pruning residues were collected during the dormancy phase in the coastal region of Croatia to investigate the influence of different grapevine cultivars on the chemical and physical properties of the resulting biochar. The study encompassed twelve cultivars, including six global and six Croatian autochthonous cultivars. Biochar was produced using laboratory-scale pyrolysis in a muffle furnace under controlled conditions.
To compare the chemical and physical properties of the raw material and the resulting biochar, several analyses were conducted, including pH value, electrical conductivity (EC), ash content, nitrogen (N) using the Kjeldahl method, and carbon (C) using the TOC-L + SSM method. Additionally, the concentrations of macro- and microelements were determined using the ICP-OES technique, while specific surface area (BET method) and material microstructure were analysed using a scanning electron microscope (SEM).
The results revealed significant differences in the chemical and physical properties between the pruning residues and the produced biochar. An increase in pH, carbon content, and elemental concentrations was observed in the biochar samples, while SEM analysis confirmed structural modifications due to pyrolysis. Moreover, statistically significant variability among cultivars was identified in parameters such as pH, ash content, carbon and nitrogen content, and macro- and microelement concentrations. Given its chemical and physical properties, the obtained biochar demonstrates strong potential for application as a soil amendment, contributing to soil quality improvement.

Keywords: biochar, grapevine, cultivar, pruning residues, valorisation

Otpadne biljne vode masline: Kemijska analiza i protugljivični utjecaj na *Botryosphaeriaceae*

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Sažetak:
Zbrinjavanje otpadnih biljnih voda masline (OBVM) predstavlja značajan ekološki izazov zbog visokog udjela fitotoksičnih i onečišćujućih spojeva. Cilj ovog istraživanja bio je analizirati kemijski sastav OBVM dobivenih iz različitih sorti maslina (Buža, Buža puntoža, Istarska bjelica, Leccino i Rosinjola) te ispitati njihov protugljivični utjecaj na fitopatogene gljive iz porodice *Botryosphaeriaceae*. Uzorcima OBVM analizirana su fizikalno-kemijskih svojstva, određen je njihov fenolni sastav primjenom LC-MS/MS metode te je ispitan protugljivični utjecaj na vrste *Botryosphaeria dothidea* (Moug. ex Fr.) Ces. & De Not., *Diplodia mutila* (Fr.) Fr., *D. seriata* De Not., *Dothiorella iberica* A.J.L. Phillips, J. Luque & A. Alves, *Do. sarmentorum* (Fr.) A.J.L. Phillips, Alves & Luque i *Neofusicoccum parvum* (Pennycook & Samuels) Crous, Slippers & A.J.L. Phillips. Protugljivični utjecaj ispitan je pri različitim koncentracijama, uz dodatak fenola hidroksitirozola i vanilinske kiseline. Rezultati su pokazali značajnu varijabilnost u sastavu OBVM, pri čemu je Istarska bjelica imala najviše koncentracije fenola, šećera, suhe tvari te sadržaja ugljika i dušika. Protugljivični utjecaj razlikovao se među vrstama gljiva i koncentracijama OBVM. Niže koncentracije OBVM inhibirale su rast micelija kod pojedinih gljiva, dok su više koncentracije često imale stimulativan učinak. Od dva ispitana fenola, vanilinska kiselina pokazala je veću učinkovitost u suzbijanju rasta micelija gljiva. Dodatno, mikroorganizmi izolirani iz OBVM, uključujući *Bacillus velezensis* Ruiz-Garcia et al., *Rhodotorula mucilaginosa* (A. Jörg.) F.C. Harrison, *Nakazawaea molendiniolei* (N. Cadez, B. Turchetti & G. Peter) C.P. Kurtzman & C.J. Robnett i *Penicillium crustosum* Thom pokazali su antagonistički potencijal prema određenim gljivičnim fitopatogenima, pri čemu je *B. velezensis* imao najjači inhibicijski učinak. Navedeno ukazuje na potencijal OBVM kao održive alternative kemijskim fungicidima, čime se istodobno doprinosi gospodarenju otpadom i zaštiti bilja u skladu s načelima kružnog gospodarstva.

Ključne riječi: antagonizam, *Bacillus velezensis*, biološka kontrola, fenoli, kvasci

Olive mill wastewaters: Chemical analysis and antifungal efficacy on *Botryosphaeriaceae*

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Abstract:
The disposal of olive mill wastewater (OMWW) poses significant environmental challenges due to its high content of phytotoxic and pollutant compounds. This study aims to explore the chemical composition of OMWW derived from various olive varieties (Buža, Buža puntoža, Istarska bjelica, Leccino, and Rosinjola) and assess its antifungal potential against phytopathogenic fungi from the *Botryosphaeriaceae* family. OMWW samples were analysed for physicochemical properties, phenolic composition via LC-MS/MS, and antifungal activity against *Botryosphaeria dothidea* (Moug. ex Fr.) Ces. & De Not., *Diplodia mutila* (Fr.) Fr., *D. seriata* De Not., *Dothiorella iberica* A.J.L. Phillips, J. Luque & A. Alves, *Do. sarmentorum* (Fr.) A.J.L. Phillips, Alves & Luque, and *Neofusicoccum parvum* (Pennycook & Samuels) Crous, Slippers & A.J.L. Phillips. Antifungal efficacy was tested at varying concentrations, alongside phenolic compounds hydroxytyrosol and vanillic acid. The results demonstrated significant variability in OMWW composition, with Istarska bjelica exhibiting the highest concentrations of phenolic compounds, sugars, dry matter, and carbon and nitrogen content. Antifungal activity varied across fungal species and OMWW concentrations. Lower OMWW concentrations inhibited mycelial growth in some pathogens, while higher concentrations often had a stimulatory effect. Among the two compounds, vanillic acid showed greater efficacy than hydroxytyrosol. In addition, microorganisms isolated from OMWW, including *Bacillus velezensis* Ruiz-Garcia et al., *Rhodotorula mucilaginosa* (A. Jörg.) F.C. Harrison, *Nakazawaea molendiniolei* (N. Cadez, B. Turchetti & G. Peter) C. P. Kurtzman & C. J. Robnett, and *Penicillium crustosum* Thom demonstrated antagonistic potential against fungal pathogens, with *B. velezensis* showing the strongest inhibitory effect. The findings highlight the potential of OMWW as a sustainable alternative to chemical fungicides, simultaneously contributing to the management of waste and protection of plants through circular economy principles.

Key words: antagonism, *Bacillus velezensis*, biological control, phenols, yeast

Valorization of Olive Pomace Through Composting for Agricultural Applications

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Abstract:
Olive pomace (OP), a by-product of olive -processing, contains potentially phytotoxic substances that can impair plant development and soil health. Composting serves as an effective strategy to mitigate these adverse effects and enhance OP's potential as a soil amendment. This study evaluates the phytotoxicity effects of raw OP filtrate on seed germination of radish (*Raphanus sativus* L.) and barley (*Hordeum vulgare* L.), along with the influence of olive pomace compost (OP) on radish growth. The OP filtrate was tested at different concentrations (0%, 1%, 3%, 5%, 10%, 20%, and 100%). Further, composting was performed using three pilot-scale bioreactors containing distinct initial mixture formulations: BR1 (OP + barley straw), BR2 (OP + barley straw + urea), and BR3 (OP + barely straw + sheep manure). The results revealed, that regarding seed exposure to raw OP, increasing its concentrations led to a significant decline in germination rates, dropping from 90% in the control to 20% at 5% of OP concentration, with complete inhibition observed at 10% and higher, likely due to phenolic compounds, and elevated salinity. Among the compost treatments, BR2 yielded compost with improved nutrient availability (C/N ratio of 19), while B3 exhibited high salinity (EC 9632 µS/cm). In growth trials, barley dry biomass was significantly lower in B2 and B3 treatments compared to the control, with reductions of 28.65% and 22.52%, respectively, whereas no substantial difference was noted for B1. For radish, biomass was significantly lower across all compost treatments (BR1, BR2, and BR3) compared to the control, with BR2 and BR3 showing toxic effects (relative growth <80%) in both crops. These results highlight the necessity for optimizing composting techniques to reduce the potential phytotoxicity and improve OP's suitability for agricultural applications. Further research is needed to refine composting methods to enhance soil fertility and promote sustainable farming practices.

Keywords: agricultural potential, composting stability, phytotoxicity, physicochemical characteristics, plant growth

Agroekologija
Agroecology

Rizik od erozije tla vodom na flišu Istarske županije-prilog zaštiti tla od erozije vodom

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Sažetak:
Erozija tla vodom jedan je od najopasnijih procesa koji uzrokuje nepovratna oštećenja i gubitke tla. Negativne posljedice erozije posebno su vidljive u poljoprivredi, šumarstvu i vodnom gospodarstvu. Na Istarskom poluotoku, područje geomorfološke cjeline Sive Istre, izuzetno je podložno erozijskim procesima, zbog dominantne zastupljenosti vrlo erodibilnog matičnog supstrata kojeg čini fliš, te zbog izraženog nagiba terena i erozivnosti oborina koje se na tom području javljaju.
Procjena rizika od erozije tla vodom izvršena jeprema metodologiji CORINE programa. Navedena metodologija je kvalitativna kartografska metoda koja se temelji na preklapanju većeg broja karata. U konačnici izrađena je karta potencijalnog i stvarnog rizika od erozije tla vodom, uvažavajući pri tome način korištenja zemljišta.
Izrađene karte rizika od erozija tla vodom mogu predstavljati važne podloge u planiranju daljnje zaštite tla i voda od erozije na području Sive Istre.

Ključne riječi: erozija tla**,** Istra, fliš, rizik od erozije, zaštita tla

The risk of soil erosion by water on the flysch of the Istrian County - a contribution to the protection of soil from water erosion

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Abstract:
Soil erosion by water is one of the most dangerous processes, causing irreversible damage and soil loss. The negative consequences of erosion are particularly visible in agriculture, forestry and water management. On the Istrian peninsula, the area of the Grey Istria geomorphological unit is extremely susceptible to erosion processes due to the predominant occurrence of the highly erodible flysch parent substrate, the pronounced slope of the terrain and the erosiveness of the precipitation occurring in this area.
The assessment of the risk of soil erosion by water is carried out according to the methodology of the CORINE programme. This method is a qualitative cartographic method based on the overlay of a large number of maps. Ultimately, a map of the potential and actual risk of soil erosion by water is created, taking into account the type of land use.
The created maps of the risk of soil erosion by water can be an important basis for planning the further protection of soil and water from erosion in the area of Grey Istria.

Keywords: soil erosion, Istria, flysch, risk of soil erosion, soil protection

Uloga izvornih pasmina Istre u očuvanju ruralnog prostora i krajobraza

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Sažetak:
U Istri je stočarstvo stoljećima bilo, uz uzgoj maslina i vinove loze, glavna poljoprivredna grana. Iako se radilo o relativno malom prostoru, u Istri su uzgojene četiri izvorne pasmine: istarska ovca, istarska koza, istarski magarac i istarsko govedo. Cilj istraživanja bio je utvrditi važnost izvornih pasmina u razvoju i očuvanju ruralnih prostore Istre. Utvrđeno je da je ovčarstvo bilo glavna stočarska grana zbog velikih pašnih površina koje su se tada nalazile na području Istre. Ovce su se uzgajale uz tradicionalno nomadsko napasivanje – transhumancu. Prema dostupnim podatcima u 19. stoljeću na području Istre se uzgajalo 160 000 ovaca, 40 000 goveda, 16 000 magaraca (tovara) i 20 000 koza. Iako ne postoji točan podatak pretpostavka je da su za navedenu populaciju domaćih životinja trebalo osigurati minimalno 20 000 hektara pašnjaka i livada. Utvrđeno je da je smanjenje stočarske proizvodnje dovelo do zapuštanja pašnih površina, zaraštanja u makiju i šikaru, a u značajnoj mjeri i u šume. Danas istarska ovca, istarska koza i istarski magarac spadaju u kritično ugrožene pasmine dok istarsko govedo spada prema kriterijima FAO u visoko ugrožene. U tijeku je program revitalizacije svih pasmina s ciljem povećanja populacije iznad broja kritične ugroženosti. Populacija istarskih goveda bilježi stalni rast, a također i istarskih koza. Najveći problem je u populaciji istarske ovce, životinje koja je dala značaj doprinos ruralnom razvoju Istre. Utvrđeno je da je smanjenje stočarske proizvodnje dovelo i do promijene krajobraza. Na temelju rezultata istraživanja možemo zaključiti da revitalizacija uzgoja izvornih pasmina ima višestruku važnost za Istru. Pored očuvanja genetske raznolikosti s rastom populacije izvornih pasmina, u prvom redu ovaca i koza, mogu se ponovno u funkciju staviti zapušteni pašnjaci i livade. Poseban doprinos očuvanju ruralnih prostora mogu dati i proizvodi izvornih pasmina kao što su meso, mlijeko, sir i skuta kao dio gastronomske ponude Istre.

Ključne riječi: Istra, izvorne pasmine, ruralni prostor

The role of local breeds of Istria in the preservation of rural areas and landscapes

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Abstract:
For centuries, livestock breeding in Istria, along with olive and grape cultivation, was one of the main branches of agriculture. Despite its relatively small area, Istria is home to four local breeds: the Istrian sheep, Istrian goat, Istrian donkey, and Istrian cattle. The aim of this research was to determine the importance of indigenous breeds in the development and preservation of Istria's rural areas. It was found that sheep farming was the predominant livestock activity due to the vast grazing areas that once existed in the region. Sheep were traditionally raised through nomadic grazing – transhumance. According to available data, in the 19th century, Istria had a population of 160,000 sheep, 40,000 cattle, 16,000 donkeys, and 20,000 goats. Although there is no exact figure, it is estimated that at least 20,000 hectares of pastures and meadows were needed to support this livestock population. A decline in livestock production has led to the abandonment of pastures, which have since become overgrown with shrubland and eventually forest. Today, the Istrian sheep, goat, and donkey are considered critically endangered breeds, while the Istrian cattle is classified by FAO criteria as highly endangered. A revitalization program is currently underway for all these breeds with the goal of increasing their populations above critical endangerment levels. The Istrian cattle population is steadily growing, as is the population of Istrian goats. The greatest challenge lies with the Istrian sheep, an animal that made a significant contribution to the rural development of Istria. It has also been established that the decline in livestock farming has contributed to changes in the landscape. Based on the research results, we can conclude that the revitalization of indigenous breed farming is of great importance for Istria. In addition to preserving genetic diversity, the increased population of indigenous breeds primarily sheep and goats would allow for the reactivation of abandoned pastures and meadows. Products derived from local breeds, such as meat, milk, cheese, and whey cheese (skuta), also contribute to the preservation of rural areas as part of Istria's gastronomic offerings.

Keywords: Istria, indigenous breeds, rural area

Agrošumarstvo u trajnom nasadu oraha u Hrvatskoj: utjecaj na strukturu zajednice nematoda u tlu

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Sažetak:
Nematode u tlu su osjetljive na ljudske intervencije i odražavaju bilo kakvu vrstu poremećaja, kvalitetu i zdravlje tla. U ovom istraživanju proučavane zajednice nematoda poslužile su kao bioindikatori zdravlja i stanja tla u agrošumarskim ekosustavima u kojima koegzistiraju drvenaste biljke i poljoprivredni usjevi. Kako bi se proučio takav ekosustav, u Đakovu (Hrvatska) je proveden pokus u tri različita ekosustava: ekosustav konsocijacije s trajnim nasadima oraha i poljoprivrednim kulturama (W+C), ekosustav s poljoprivrednim kulturama (C) i ekosustav s trajnim nasadima oraha (W). Poljoprivredne kulture bile su: pšenica (2017. - 2018.), uljana repica kao zelena gnojidba (2018. - 2019.) i heljda (2019. - 2019.). Uzorci tla prikupljani su 12 puta u 4 ponavljanja, nematode su izdvojene, pripremljene na trajnim preparatima i determinirane, izračunati su nematološki indeksi i podaci su statistički obrađeni. Vrijednosti indeksa zrelosti zajednice nematoda (MI i MI 2-5) pokazale su statistički značajno bolji utjecaj ekosustava W+C u odnosu na ekosustav C, dok su najbolje vrijednosti PPI zabilježene u ekosustavima C i C+W, a najviše u ekosustavu W. Ekosustav W pokazao je najveće vrijednosti indeksa puteva razgradnje organske tvari (CI) te najveću aktivnost gljiva u odnosu na ostale ekosustave (W+C i C). Najbolje vrijednosti bazalnog indeksa (BI) utvrđene su u ekosustavu W+C. Najviše vrijednosti indeksa obogaćenja (EI) zabilježene u ekosustavima W+C i C te ukazuju na visoku plodnost tla u tim ekosustavima. Najviše vrijednosti indeksa strukture (SI) u ekosustavima C i W+C ukazuju na srednju do visoku razvijenost hranidbene mreže u tlu. Općenito se može zaključiti da ekosustavi s konsocijacijom poljoprivrednih kultura i trajnih nasada pozitivno utječu na indekse, posebno MI, MI 2-5, PPI, BI, EI i SI kroz smanjivanje negativnih klimatskih utjecaja, boljeg zadržavanja vlage u tlu te stvaranja nove mikroklime koja pogoduje povećanju bioraznolikosti u tlu.

Ključne riječi: konsocijacija, bioindikatori, indeksi, zdravlje tla, hranidbena mreža tla

Walnut agroforestry in Croatia: impact on nematode community structure in soil ecosystem

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Abstract:
In this study, the nematode communities served as bioindicators of soil health and condition in agroforestry ecosystems where woody plants and agricultural crops coexist. To study such an ecosystem, an experiment was conducted in Đakovo (Croatia) in three different ecosystems: the intercropped ecosystem with permanent walnut plantations and agricultural crops (W+C), the ecosystem with agricultural crops (C) and the ecosystem with permanent walnut plantations (W). The agricultural crops were: Wheat (2017 - 2018), rapeseed as green manure (2018 - 2019) and buckwheat (2019 - 2019). Soil samples were taken 12 times in four replicates. Nematodes were extracted, prepared on permanent preparations and determined, nematological indices were calculated and the sampling data were statistically processed. The Maturity Index values (MI and MI 2-5) values showed a statistically significant better effect of ecosystem W+C compared to ecosystem C, while the best PPI values were recorded in ecosystems C and C+W and the highest in ecosystem W. Ecosystem W had the highest Channel Index (CI) values and the highest fungal activity compared to the other ecosystems (W+C and C). The best Basal Index (BI) values were recorded in ecosystem W+C. The highest Enrichment Index (EI) values were found in ecosystems W+C and C, indicating high soil fertility in these ecosystems. The highest Structure Index (SI) values in the C and W+C ecosystems indicate a medium to high development of the food web in the soil. In general, it can be concluded that ecosystems with intercropping of agricultural crops and permanent plantations have a positive effect on nematological indices, especially MI, MI 2-5, PPI, BI, EI and SI, by reducing negative climatic impacts, improving moisture retention in the soil and creating a new microclimate that promotes soil biodiversity.

Keywords: intercropping, bioindicators, indices, soil health, food web

„Istra Porc“ – Idejni prijedlog razvoja svinjogojske proizvodnje na području Istarske županije

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Sažetak:
Idejni prijedlog projekta „Istra Porc“ temelji se na razvoju održivog proizvodnog sustava za proizvodnju vrhunske svinjetine za potrošnju u tradicionalnim i ekskluzivnim restoranima („Gourmet svinjetina“) te kao osnovu za finalizaciju u visoko kvalitetne tradicionalne suhomesnate proizvode na području Istre. Predloženi sustav bi se temeljio na kontroli proizvodnih procesa i sljedivosti u dva lanca proizvodnje: proizvodnja svježeg svinjskog mesa i proizvodnja tradicionalnih proizvoda. Kvalitativna specifičnost proizvoda proizlazila bi iz proizvodnog procesa koji bi u sebi sadržavao specifični pasminski sastav svinja, specifične proizvodne uvjete te specifični tehnološki proces (hranidba u kombinaciji s dobi životinja). Sustav/brend „Istra Porc“ temeljio bi se na strategiji „Od polja do stola“ („From Farm to Fork“) koja je sastavni dio europskog Zelenog plana. Obuhvatio bi specifičnu genetsku osnovu svinja (tropasminski križanac veliki jorkšir x landras x durok), specifični način držanja (držanje na dubokoj stelji), produženi tov (do većih završnih težina; 180-200 kg i do dobi svinja od minimalno 12 mjeseci) te specifične kvalitativno-tehnološke parametre svinjetine. Primarni dio sustava bi činili repro-centar i proizvodne farme, a sekundarni dio klaonica, mesoprerada, mesnice i restorani. Repro-centar na bazi 200 rasplodnih krmača osiguravao bi proizvodnju od 5.000 tovljenika koji bi se tovili na 25 malih farmi kapaciteta 200 tovljenika u jednogodišnjem turnusu. Sustav hranidbe temeljio bi se na pšenici i kukuruzu kao osnovnom krmivu. Potrebne količine hrane, kao i slama za stelju, osigurale bi se dijelom iz proizvodnje na području Istre, a dijelom na tržištu. Previđena ulaganja po jednom objektu (tovilištu) iznosila bi 250.000 eura. Sustav/brend „Istra Porc“ bi bio označen specifičnom oznakom kvalitete koja bi jamčila da je proizvod pod ovom oznakom proizveden u Istri na način koji je u suglasju s kriterijima održive svinjogojske proizvodnje, koji ima pozitivan učinak na okoliš, koji osigurava opstojnost ljudi i razvoj ruralnog područja te koji je u skladu s kriterijima dobrobiti i zdravlja svinja kao i dobre stočarske prakse. Navedeni kriteriji i predloženi proizvodni sustav svojom provedbom osiguravaju da se Istra pozicionira kao područje proizvodnje i konzumacije najkvalitetnije svinjetine i proizvoda od iste, bez premca i konkurencije.

Ključne riječi: svinje, duboka stelja, Zeleni plan, dobrobit, tradicionalni proizvodi

"Istra Porc" - Conceptual proposal for the development of pig production in the Istria County

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Abstract:
The conceptual proposal of the "Istra Porc" project is based on the development of a sustainable production system for the production of premium pork for consumption in traditional and exclusive restaurants ("Gourmet pork") and as a basis for finalization into high-quality traditional cured meat products in the area of Istria. The proposed system would be based on the control of production processes and traceability in two production chains: production of fresh pork and production of traditional products. The qualitative specificity of the product would result from the production process, which would contain a specific breed composition of pigs, specific production conditions and a specific technological process (feeding in combination with the age of the animals). The "Istra Porc" system/brand would be based on the "From Farm to Fork" strategy, which is an integral part of the European Green Plan. It would include the specific genetic basis of pigs (three-breed crossbreed Large Yorkshire x Landrace x Duroc), specific housing method (housing on deep litter), extended fattening (to higher final weights; 180-200 kg and to the age of pigs of at least 12 months) and specific qualitative and technological parameters of pork. The primary part of the system would consist of a reproduction center and production farms, and the secondary part would consist of slaughterhouses, meat processing plants, butcher shops and restaurants. The repro-center based on 200 breeding sows would ensure the production of 5,000 fattening pigs that would be fattened on 25 small farms with a capacity of 200 fattening pigs in a one-year cycle. The feeding system would be based on wheat and corn as the basic feed. The necessary amounts of food, as well as straw for bedding, would be provided partly from production in the area of Istria, and partly from the market. The anticipated investments per facility (fattening) would amount to 250,000 euros. The system/brand "Istra Porc" would be marked with a specific quality mark that would guarantee that the product under this mark was produced in Istria in a manner that is in accordance with the criteria of sustainable pig production, which has a positive impact on the environment, which ensures the survival of people and the development of rural areas, and which is in accordance with the criteria of pig welfare and health as well as good livestock farming practices. The above criteria and the proposed production system, through their implementation, ensure that Istria is positioned as an area of production and consumption of the highest quality pork and pork products, without equal or competition.

Keywords: pigs, deep litter, Green Deal, welfare, traditional products

New microbial based carrier solution for bioremediation of petroleum oil polluted soils

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Abstract:
Soil pollution with long-chain hydrocarbons (LCHCs) and polycyclic aromatic hydrocarbons (PAHs) arising from petroleum oil poses health, environmental and economic risks. While low molecular weight hydrocarbons can be relativelly effectively removed by bioremediation approaches, the LCHCs and PAHs are challenging to remove mostly due to the high hydrophobic physochemical properties which drive them to get strongly adsorbed to soil particles, resulting in decreased availability for community cappable of their degradation. Therefore, the main objective was, therefore, to design a solution that would promote desorption and degradation of hydrocarbons. Novel carriers were developed, composed of (1) organic porous solid support material, (2) hydrocarbons degrading bacterial biomass, (3) hydrophobic hydrogel coating and (4) auxiliary bacterial biomass – celluloyitic, ligninolytic and diazotrophic. Prepared carriers were incubated in the polluted soil and the degradation rate was measured using gas chromatogpaphy (GC) with flame ionization detector (FID).
Degradation rates of up to 92 ± 19 % were observed with the addition of the carriers to the polluted soil, compared to only 19 ± 2 % in the control sample without any additions. Hydrophobic coating on the carrier contributed to 50 ± 9 % removal of hydrocarbons from the soil, indicating to the desorption effects. Additionally, higher metabolic activity of the hydrocarbons degradation was achived when carriers were prepared using more porous organic material (wood sawdust, cellulose, biochar) and auxiliary bacteria in combination with bacteria capable degrading hydrocarbons.
In conclusion, novel hydrophobic microbial carriers significantly enhanced hydrocarbon degradation in polluted soil, achieving up to 92 % removal. The hydrophobic hydrogel coating facilitated desorption, while the porous organic support and auxiliary bacteria improved microbial activity. This approach offers a promising bioremediation strategy for persistent petroleum hydrocarbon contamination in soils.

Keywords: bioremediation, hydrocarbons, bacteria, hydrophobic carrier

Predstavljanje projekata

Project presentation

Razvijanje inovativnih poslovnih modela temeljenih napotrebama zajednica za oživljavanje unutarnjih područja na Mediteranu - REVIVE

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Sažetak:
U posljednjim desetljećima ruralna područja diljem Mediterana suočavaju se s različitim izazovima, poput napuštanja stanovništva i resursa iz unutrašnjih područja i odlazak u urbanizirana područja, što je počelo ugrožavati njihovu dugoročnu održivost. Kao odgovor na ove izazove, osmišljen je projekt Interreg Euro-MED REVIVE (Euro-MED0200256). Cilj projekta Interreg Euro-MED REVIVE je kreacija inovativnog poslovnog modela kako bi se revitalizirala ruralna područja Mediterana. Kroz participativne pristupe, izgradnju kapaciteta, osnaživanje zajednice te suradnju među lokalnim dionicima, osmislit će se inovativna i integrirana rješenja za rješavanje ključnih izazova s kojima se suočavaju ruralna područja Mediterana, poput depopulacije, niske gospodarske aktivnosti, nezaposlenosti, nedostatka digitalnih vještina, poteškoća u očuvanju kulturne i prirodne baštine te manjak suradnje i umrežavanja među lokalnim poslovnim dionicima. Kroz transnacionalnu suradnju i koordinaciju, projektni partneri nastoje osnovati Inovativne zajednice/Inovativne zadruge s ciljem stvaranja međusobno povezanih proizvoda i usluga koje će unaprijediti lanac vrijednosti gospodarskih sektora. Nadalje, projekt će se usmjeriti na razvoj inovativnog digitalnog rješenja prilagođenog pilot području, inovativno digitalno rješenje razvijat će se uz podršku Digitalnih inovacijskih centara. U sklopu projekta uspostavit će se okvir za prijenos rezultata, omogućujući njihovu širu primjenu, jačanje suradnje među lokalnim dionicima te poticanje tranzicije prema konkurentnim, inovativnim i otpornim ekosustavima u ruralnim područjima obuhvaćenim transnacionalnom suradnjom. Projekt sveukupno okuplja devet partnera iz sedam mediteranskih zemalja te pet pridruženih partnera, a vodeći partner je ANETEL, Larnaca and Famagusta Districts Development Agency s Cipra. Ukupni proračun projekta iznosi 2.380.000 €, od čega je 80 % financirano iz Interreg fonda. Projekt traje ukupno 33 mjeseca, od 1. siječnja 2024. do 30. rujna 2026.

Ključne riječi: Inovativni poslovni model, ruralna područja, Mediteran, zadruga zajednice, inovativno digitalno rješenje

Developing Community Based Innovative Business Models for the Revival of the Internal Areas in the Mediterranean - REVIVE

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Abstract:
In the last decades, rural areas across the Mediterranean have faced different challenges, such as the abandonment of population and resources from inland territories to urbanised areas, this started threatening their long-term sustainability. In response to these pressing issues, the Interreg Euro-MED REVIVE (Euro-MED0200256) project was launched. The goal of the Interreg Euro-MED REVIVE project is to create an innovative business model to revitalise rural areas in the Mediterranean. Through participatory and capacity building approaches, strengthening the community and collaboration among local stakeholders, innovative and integrated solutions will be designed to solve common challenges of rural areas in the Mediterranean, including depopulation, low economic activity, unemployment, lack of digital skills, difficulties in preserving cultural and natural heritage, and lack of collaboration and networking among local business stakeholders. Through the transnational cooperation and coordination, project partners aim to establish Innovative Community Cooperatives, with the goal of creating interconnected products and services that will enhance existing economic sector supply chains. Furthermore, the project will focus on the development of an innovative digital solution, tailored for the designated pilot area. Digital solution will be created with the support of Digital Innovation Hubs. The project will establish a transfer framework to facilitate upscaling of results, strengthen the cohesion among local stakeholders, and support the transition towards competitive, innovative and resilient ecosystems within the internal territories of the transnational cooperation area. The project involves nine partners from seven Mediterranean countries, along with their five associated partners, with the lead partner being the ANETEL, the Larnaca and Famagusta Districts Development Agency from Cyprus. The total project budget is €2,380,000 (80% financed by Interreg fund), and its duration is set for 33 months, from 1st January, 2024, to 30th September, 2026.

Key words: Innovative business model, rural areas, Mediterranean, community cooperation, innovative digital solution

Upotreba oligonukleotida za editiranje ekspresije gena *BPM2* u uročnjaku *Arabidopsis thaliana*

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Sažetak:
Genom biljke *Arabidopsis thaliana* sadrži šest gena MATH-BTB (*BPM1-6*) koji sudjeluju u regulaciji ciljanih proteina, uglavnom putem njihove ubikvitinacije i razgradnje na proteasomu. Jedan od protein reguliran BPM proteinima je transkripcijski faktor WRINKLED1 (WRI1), koji je glavni regulator biosinteze biljnih masnih kiselina i ulja te je važna meta u genetičkom inženjerstvu usjeva za proizvodnju prehrambenih ulja i biogoriva. Proteini BPM reguliraju razgradnju WRI1 i neizravno utječu na metabolizam masnih kiselina te razvoj i rast sjemena. Već su razvijene transgenične biljke sa smanjenom ekspresijom proteina BPM ili s prekomjernom ekspresijom WRI1 koje proizvode veće količine masnih kiselina. Međutim, zbog stroge i kompleksne regulative o genetički modificiranih organizmima takve transgenične biljke nisu prihvatljive u poljoprivrednoj proizvodnji unutar Europske Unije. S druge strane, nove genomske tehnike editiranja genoma su prihvatljive i imaju potencijal za buduću primjenu. Jedana od tehnika za editiranje genoma podrazumijeva upotrebu antisens oligonukleotida (ASO) za ciljanu razgradnju mRNA ili modulaciju prekrajanja pre-mRNA. Cilj projekta "Alternativno prekrajanje gena *BPM2* kao mehanizam uspostave funkcionalne raznolikosti porodice proteina MATH-BTB u uročnjaku *Arabidopsis thaliana*" (IP-2022-10-7874), koji financira Hrvatska zaklada za znanost, jest istražiti mehanizam alternativnog prekrajanja gena *BPM2* te ulogu alternativnih *BPM2* proteina u razvoju biljaka i u odgovoru na stres. Toplinski stres značajno utječe na ekspresiju *BPM2*, a specifično dizajnirani ASO koristit će se za razgradnju mRNA gena *BPM*, posljedičnu indukciju nakupljanja WRI1 proteina te povećanje proizvodnje masnih kiselina u biljci *A. thaliana*. Raspravit će se mogućnost korištenja ASO za stabilizaciju WRI1 i povećanje prinosa ulja u poljoprivrednim kulturama.

Ključne riječi: Antisens oligonukleotidi, Editiranje genoma, Ekspresija gena *BPM2*, Prinos sjemena, Sinteza masnih kiselina

Editing of *BPM2* gene expression in *Arabidopsis thaliana* using antisense oligonucleotides

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Abstract:
The *Arabidopsis thaliana* genome contains six *MATH-BTB* genes (*BPM1-6*) involved in target protein regulation, mainly by their ubiquitination and subsequent degradation. The target of BPM proteins is the ethylene-responsive transcription factor WRINKLED1 (WRI1), a master regulator of plant oil biosynthesis and a major objective in crop genetic engineering for biofuels and food oils. BPM proteins regulate the degradation of WRI1 and indirectly influence fatty acid metabolism, seed development and growth, having the potential for application in agriculture. Transgenic plants with down-regulated BPM proteins or overexpressed WRI1 that produce more fatty acids are already produced. However, due to strict and complex regulation of genetically modified organisms, transgenic plants are not welcome in agricultural production in the European Union. On the other hand, new genomic techniques of genome editing are acceptable and have great potential for agriculture implementation. One such genome editing approach utilizes antisense oligonucleotides (ASO) used for targeted mRNA degradation or modulation of pre-mRNA splicing. The scope of the project: *Alternative splicing of BPM2 as a mechanism for establishing a functional diversity of MATH-BTB protein family in Arabidopsis thaliana*_(IP-2022-10-7874), financed by Croatian Science Foundation is evaluation of *BPM2* gene alternative splicing mechanism and the role of BPM2 alternative proteins in plant development and stress response. Heat stress significantly influences *BPM2* expression and in the scope of the Project ASO will be used for degradation of *BPM* mRNA and consequent induction of WRI1 protein and seed oil production in *A. thaliana*. The results obtained by the Project will be presented and the possibility of using ASO for the stabilization of WRI1 and increment of oil yield in crops discussed.

Keywords: Antisense oligonucleotides, *BPM2* expression, Fatty acids synthesis, genome editing, seed yield

CIRCOLIVE - Razvoj vještina za uvođenje kružnih poslovnih modela za valorizaciju ostataka i nusproizvoda u sektoru maslinova ulja

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Sažetak:
Održivo maslinarstvo ključno je za zaštitu okoliša i dugoročnu konkurentnost sektora, a iskorištavanje ostataka maslinarske proizvodnje, poput komine, koštica, ostataka nakon rezidbe i otpadnih voda, ima važnu ulogu u tom procesu. Primjenom kružnih poslovnih modela za valorizaciju nusproizvoda smanjuje se količina otpada, a istovremeno se povećava učinkovitost proizvodnje stvarajući dodanu vrijednost kroz inovativne pristupe recikliranju i ponovnoj upotrebi resursa. Projekt CIRCOLIVE usmjeren je na jačanje kapaciteta europskog maslinarskog sektora za prelazak na kružnu ekonomiju putem razvoja vještina i integracije digitalnih tehnologija. U projektu sudjeluje devet partnera iz pet europskih zemalja (Grčka, Italija, Španjolska, Portugal i Hrvatska), a projekt je sufinanciran od strane Europske unije kroz program Erasmus+ Partnerships for Innovation – Alliances.
Glavni cilj projekta je podrška tranziciji EU prema kružnoj ekonomiji unutar maslinarskog sektora kroz jačanje poduzetničkih i digitalnih vještina. Specifični ciljevi uključuju: i) prilagodbu obrazovnih programa za strukovno obrazovanje i osposobljavanje kako bi se odgovorilo na rastuće zahtjeve za kružnim poslovnim modelima; ii) osnaživanje malih proizvođača za implementaciju kružnih poslovnih modela te unaprjeđenje digitalnih kompetencija i inovativnosti, te iii) olakšavanje suradnje između akademskih institucija, istraživačkih centara, poslovnog i javnog sektora radi razvoja i implementacije kružnih modela u maslinarskom sektoru. Institut za poljoprivredu i turizam iz Hrvatske predvodi radni paket WP2, koji se fokusira na identifikaciju kružnih potreba maslinarskog sektora i definiranje novih vještina i zanimanja potrebnih za njegovu transformaciju. Ovaj radni paket omogućava razvoj transnacionalnih nastavnih planova i programa prilagođenih zahtjevima kružne ekonomije.
CIRCOLIVE će rezultirati inovativnim edukativnim alatima, smjernicama za implementaciju kružnih poslovnih modela te strategijama za prijelaz maslinarskog sektora na održivo gospodarstvo. Očekuje se da će projekt imati dugoročan učinak na unapređenje konkurentnosti maslinarskog sektora, smanjenje otpada i poboljšanje resursne učinkovitosti kroz kružne prakse.

Ključne riječi: kružna ekonomija, maslinarstvo, proizvodnja maslinova ulja, valorizacija nusproizvoda, obrazovanje

Developing Skills for Introducing Circular Business Models and Digital Technologies in the Olive Oil Sector (CIRCOLIVE)

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Abstract:
Sustainable olive farming is essential for the protection of the environment as well as the long-term competitiveness of the sector, and the valorization of olive production residues, such as pomace, pits, pruning residues and wastewater, plays an important role in this process. The application of circular business models for the valorization of by-products reduces waste while increasing production efficiency by creating added value through innovative approaches to recycling and reusing resources. The CIRCOLIVE project aims to strengthen the capacity of the European olive sector to transition to circular economy through skills development and the integration of digital technologies. The project involves nine partners from five European countries (Greece, Italy, Spain, Portugal and Croatia) and is co-financed by the European Union through the Erasmus+ Partnerships for Innovation – Alliances programme.
The main objective of the project is to support the EU transition towards circular economy within the olive sector by strengthening entrepreneurial and digital skills. The specific objectives include: i) adapting vocational education and training curricula to respond to the growing demands for circular business models; ii) equipping small producers with skills to implement circular business models and improve digital competences and innovation, and iii) facilitating cooperation between academic institutions, research centers, business and public sector for the development and implementation of circular models in the olive sector. The Institute of Agriculture and Tourism from Croatia leads the work package WP2, which focuses on identifying the circular needs of the olive sector and defining the new skills and occupations necessary for its transformation. This work package enables the development of transnational curricula adapted to the requirements of the circular economy.
CIRCOLIVE will result in innovative educational tools, guidelines for the implementation of circular business models and strategies for the transition of the olive sector to a sustainable economy. It is expected that the project will have a long-term effect on improving the competitiveness of the olive sector, reducing waste and improving resource efficiency through circular practices.

Keywords: circular economy, olive growing, olive oil production, by-products valorization, education

Interreg Euro - MED - Misija Održivi turizam: Dialogue4Tourism. Institucionalni dijalog o održivom turizmu i upravljanju na Euro-Med području

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Sažetak:
Upravljanje turizmom, kao složenim fenomenom sa značajnim ekonomskim, socio-kulturnim i okolišnim utjecajima, u današnjem dinamičnom okruženju zahtijeva usmjerenost prema održivom razvoju. Turizam se, naime, suočava s različitim izazovima poput nedostatka čvrste suradnje među javnim vlastima i donositeljima politika, nedostatka multidisciplinarnog i multisektorskog dijaloga između dionika u turizmu o održivosti, prekomjernog turizma, sezonalnosti, klimatskih promjena, kriza, nedovoljne razine digitalizacije itd. Kako bi se ovi izazovi učinkovito riješili, nužno je osnažiti suradnju između razina upravljanja, sektora i teritorija. Dialogue4Tourism (ID projekta: Euro-MED0300642) je projekt programa Interreg Euro-MED, a uz Community4Tourism predstavlja upravljački projekt Interreg Euro-MED misije Održivi turizam. Glavni cilj projekta Dialogue4Tourism je povećati razinu koordinacije i institucionalne kapacitete javnih vlasti, višerazinskih tijela, programa, strategija i inicijativa u Euro-MED području, s ciljem transformacije turizma u zeleniji, pametniji i otporniji turizam. Pri ostvarivanju cilja, slijedi se četverostruki pristup misije: kružnost turističkih usluga, ekološka neutralnost, održive usluge ekosustava te očuvanje kulturnih i prirodnih resursa. Budući da su donositelji politika u turizmu ključni akteri u njegovoj tranziciji, Dialogue4Tourism bavi se prekograničnom koordinacijom upravljanja na području cijelog Mediterana, radi jačanja vidljivosti rezultata Euro-MED tematskih projekata koji se sufinanciraju u okviru misije Održivog turizma. Glavne aktivnosti projekta uključuju takozvani „Bijeli papir“ o održivom turizmu, Međumrežnu alijansu za održivi turizam, Mrežu opservatorija održivog turizma te Laboratorij za politike održivog turizma. Projekt traje 81 mjesec, započeo je 1. siječnja 2023. godine i trajat će do 30. rujna 2029. godine. Ukupni budžet projekta iznosi 4.000.000 €, od čega je 80%, odnosno 3.200.000 € sufinancirano iz Interreg fonda. Vodeći partner na projektu je El legado andalusi Andalusian Public Foundation - ELA FPA (Španjolska), a projekt okuplja ukupno 10 partnera iz različitih zemalja Mediterana te 25 pridruženih partnera.

Ključne riječi: održivi turizam, institucionalni dijalog, Mediteran, Interreg Euro-MED

Interreg Euro - MED - Sustainable Tourism Mission: Dialogue4Tourism. Institutional Dialogue on Sustainable Tourism and Governance in the Euro-Med Area

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Abstract:
The governance of tourism, as a complex phenomenon with significant economic, socio-cultural, and environmental impacts, in today's dynamic environment requires a focus on sustainable development.
Tourism, in fact, faces various challenges, such as the lack of solid cooperation among public authorities and policy makers, the lack of multidisciplinary and multisectoral dialogue between tourism stakeholders on sustainability, overtourism, seasonality, climate change, crises, insufficient digitalization, etc. To effectively address these challenges, it is necessary to strengthen cooperation between governance levels, sectors, and territories. Dialogue4Tourism (project ID: Euro-MED0300642) is a project of the Interreg Euro-MED programme, and along with Community4Tourism, represents a governance project of the Interreg Euro-MED Sustainable Tourism Mission. The main objective of the Dialogue4Tourism project is to increase the level of coordination and institutional capacity of public authorities, multi-level bodies, programmes, strategies, and initiatives in the Euro-MED area, with the aim of transforming tourism into a greener, smarter, and more resilient tourism. In achieving this goal, the project follows the fourfold approach of the mission: circularity of tourism services, environmental neutrality, sustainable ecosystem services, and the preservation of cultural and natural resources. Since policy makers in tourism are key actors in its transition, Dialogue4Tourism focuses on cross-border governance coordination in the entire Mediterranean area, aiming to enhance the visibility of results of Euro-MED thematic projects co-financed under the Sustainable Tourism Mission. The main actions of the project include The White Papers on Sustainable Tourism, The Cross Network Alliance on Sustainable Tourism, The Network of Sustainable Tourism Observatories, and The Sustainable Tourism Policy Labs. The project lasts 81 months, having started on 1 January 2023 and continuing until 30 September 2029. The total project budget is €4.000.000, of which 80%, or €3.200.000, is co-financed by the Interreg fund. The lead partner in the project is El legado andalusi Andalusian Public Foundation - ELA FPA (Spain), and project brings together 10 partners from different Mediterranean countries and 25 associated partners.

Keywords: sustainable tourism, institutional dialogue, Mediterranean, Interreg Euro-MED

Valorizacija ostataka iz prerade maslina pomoću mikrobnog viševrstnog biokatalitičkog agregata - VALOLIVEWASTE

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Sažetak:
Povećana potražnja za proizvodnjom maslinovog ulja rezultirala je s više od 30 milijuna m^3 poljoprivrednog nusprodukta poput komine maslina (KM) svake godine u području Mediterana. Potencijalna fitotoksičnost svježe KM, uzrokovana prisutnošću polifenola i ostataka ulja, može se smanjiti ili spaljivanjem otpada ili njegovim valoriziranjem. U sklopu ovog projekta istražili smo mogućnosti valorizacije KM pomoću dvaju pristupa: (i) kompostiranjem s ciljem proizvodnje organskog gnojiva i (ii) biotransformacijom, s ciljem proizvodnje spojeva s dodanom vrijednošću koji se mogu koristiti u prehrambenoj i farmaceutskoj industriji. U svrhu kompostiranja bili su korišteni aerobni biorekatori sa prisilnim prozračivanjem u sklopu kojeg su bili upotrjebljeni konvencionalni (urea i ovčji gnoj su bili primijenjeni kao izvor N) i napredni pristup (apliciran je bio mikrobni inokulum koji može razgraditi fitotoksične i rekalcitrantne komponente). U zadnjem pristupu je bio navedeni otpad obogaćen s konzorcijima odabranih mikroba s namjerom pravilnog kruženje elemenata potrebnih mikroorganizmima i prilagodbe mikroba teškim fizikalno-kemijskim uvjetima. Nadalje, kako bi se povećala učinkovitost biotransformacije KM, razvijen je sustav nosača i imobilizirana je najučinkovitija sintetička zajednica koja se koristila u pilotskim postavkama kompostiranja. Rezultati projekta pokazuju da su tretmani komposta s dodatkom uree ili ovčjeg gnoja učinkoviti kod razgradnje KM. Nadalje, tijekom kompostiranja koncentracije fenola smanjile su se 60% međutim sadržaj ulja smanjio se 99%. Na temelju našeg pristupa korištenjem sintetskog strukturiranja mikrobnih zajednica dobili smo 1152 jedinstvena mikrobna konzorcija iz ključnog izvora C za mikrobni rast uključujući strukturni biljni materijal kao i ulje i ključne spojeve koji inhibiraju rast biljaka kao što su p-kumarinska i trans-cinaminska kiselina. Štoviše, za valorizaciju KM dobiveno je 300 izolata koji proizvode polihidroksi alkanoate. Stoga KM nije samo organski ostatak, već može biti i vrijedan izvor biotehnološki važnih sojeva.

Ključne riječi: ostaci iz prerade maslina, kompostiranje, sintetička mikrobna zajednica, prostorni raspored mikroorganizama, proizvodi s dodanom vrijednošću, lignin

Valorisation of olive mill waste material by microbial multispecies biocatalytic aggregates – VALOLIVEWASTE

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Abstract:
Increased demands for olive oil production results in large amounts of agricultural by-products, such as olive pomace (OP) per year in the Mediterranean basin. The potentially phytotoxic nature of OP, caused by the presence of polyphenols and remaining oils, can be reduced either by burning the waste or by valorising it. In this project, we explored valorisation of OP by two approaches: (i) composting, aiming to produce fertilizers and (ii) biotransforming, aiming to produce added value compounds that can be used in food and pharmaceutical industries. For composting, three pilot-scale bioreactors with forced aeration were used. For this purpose, the conventional (considering urea and sheep manure as a nitrogen source), and the advanced approach (OP was amended with microbial inoculum capable of degrading phytotoxic and recalcitrant compounds) were employed. In the latter approach, the OP was bioaugmented with consortia of microbes to enable proper cycling of elements through cross feeding process and to be adapted to the harsh physicochemical conditions. Therefore, to increase the efficiency of OP biotransformation the carrier system has been developed and the most efficient synthetic community was immobilized and used in the pilot-scale composting setups. The project results showed that composting treatments containing urea or sheep manure resulted in efficient OP decomposition. Further, during composting levels of phenolic compounds and oil residues decreased up to 60% and 99%, respectively. Based on our approach using synthetic structuring of microbial communities we obtained 1152 unique microbial consortia from key C source for microbial growth including structural plant material as well as oil and key plant growth inhibiting compounds such as p-Coumaric and trans-cinnamic acids. Moreover, for valorization and upcycling the OP, 300 isolates producing polyhydroksi alkanoates were obtained. Therefore, OP is not just a residue but also can be a valuable source of biotechnologically important strains.

Keywords: olive mill waste, co-composting, synthetic microbial community, spatial distribution of microorganisms, value added products, lignin

Projekt SITE- Shaping inclusive Tourist Experiences

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Sažetak:
Projekt SITE (Shaping Inclusive Tourist Experiences) je prekogranični projekt financiran od strane Europske unije u okviru programa Interreg Italija – Hrvatska 2021. – 2027. Vodeći partner na projektu je Sveučilište u Trstu, a ostali partneri su Grad Šibenik, Dubrovačka razvojna agencija, Zračna luka Dubrovnik, Sveučilište u Rijeci, Fakultet za menadžment u turizmu i ugostiteljstvu, Central Marketing Intelligence – Arcadya, VEASYT i Općina Fano. Projekt se bavi zajedničkim teritorijalnim izazovom diverzifikacije turističkih tokova kroz promicanje inkluzivnijeg turističkog ekosustava. Cilj projekta je povećati atraktivnost turističkih destinacija u programskom području (Hrvatske i Italije) putem poticanja univerzalnog dizajna kao pristupa kojim se kroz nediskriminirajuća rješenja omogućava sudjelovanje u turizmu i socijalna inkluzija ne samo osoba s invaliditetom, već i obitelji s malom djecom, trudnica, starijih osoba i ostalih osoba koje imaju različite privremene, trajne ili situacijske poteškoće. Projekt će kroz sveobuhvatno istraživanje i testiranje različitih alata i rješenja doprinijeti smanjenju arhitektonskih, osjetilnih i komunikacijskih prepreka koje ograničavaju osobama s invaliditetom odnosno osobama s drugačijim potrebama pristup informacijama o turističkoj ponudi, snalaženje u turističkim destinacijama, te uživanje u turističkim sadržajima. Tijekom projekta provodit će se aktivnosti istraživanja o primjeni univerzalnog dizajna u turizmu, testiranja predloženih rješenja kroz pilot-projekte, edukacije o prednostima univerzalnog dizajna kao i implementacije uključivosti i pristupačnosti u razvoju turističke ponude, te sveobuhvatna promocija i javna objava postignutih rezultata. Ideja je da zahvaljujući projektu što veći broj dionika iz turističke prakse, ali i akademskog sektora osvijesti važnost korištenja univerzalnog dizajna u oblikovanju održivog i uključivog turizma koji donosi značajne koristi turističkim destinacijama.

Ključne riječi: uključivi turizam, pristupačni turizam, univerzalni dizajn

Project SITE- Shaping inclusive Tourist Experiences

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Abstract:
The SITE project (Shaping Inclusive Tourist Experiences) is a cross-border project funded by the European Union under the Interreg Italy-Croatia 2021-2027 program. The leading partner in the project is University of Trieste, and other partners include City of Šibenik, Dubrovnik Development Agency, Dubrovnik Airport, University of Rijeka, Faculty of Tourism and Hospitality Management, Central Marketing Intelligence – Arcadya srl, VEASYT srl, and the Municipality of Fano. The project addresses the common territorial challenge of diversifying tourist flows by promoting a more inclusive tourism ecosystem. The goal of the project is to enhance the attractiveness of tourist destinations in the program area (Croatia and Italy) by encouraging universal design as an approach that, through non-discriminatory solutions, enables participation in tourism and social inclusion not only for people with disabilities but also for families with young children, pregnant women, elderly people, and others who face various temporary, permanent, or situational disabilities. Through comprehensive research and testing of various tools and solutions, the project will contribute to reducing architectural, sensory, and communication barriers that limit access to information about tourist offerings, wayfinding in tourist destinations, and enjoying the tourism activities for people with disabilities. Throughout the project, activities will include research on the application of universal design in tourism, testing proposed solutions through pilot projects, trainings on the benefits of universal design, as well as implementing accessible and inclusive tourism offer, and comprehensive promotion of the project results. The idea is that, thanks to the project, as many stakeholders as possible from both the tourism industry and the academic sector will become aware of the importance of using universal design to shape sustainable and inclusive tourism, which brings significant benefits to tourist destinations.

Keywords: accessible tourism, inclusive tourism, universal design

Razvoj autonomnog robotskog flotnog sustava za prepoznavanje i ekološko tretiranje korova

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Sažetak:
Cilj ovog projekta bio je razviti autonomni robotski flotni sustav za prepoznavanje i ekološko tretiranje korova, koji će biti učinkovit, prihvatljive cijene i široko primjenjiv u ratarskoj proizvodnji. Rad ovog sustava temelji se na korištenju flote manjih robota opremljenih naprednim navigacijskim sustavima i dimenzijama koje omogućuju kretanje između redova usjeva, uzimajući u obzir konfiguraciju tla i potencijalne prepreke. Prilikom razvoja robota za suzbijanje korova bilo je potrebno naći rješenje za tri glavne komponente takvog robotskog sustava: sustav za kretanje i navođenje robota, sustav za prepoznavanje korova i sustav za tretiranje korova. Sustav za kretanje robota mora omogućiti lako kretanje unutar različitih usjeva, a prilikom odabira izvedbe uređaja za kretanje treba uzeti u obzir sposobnost manevriranja u ograničenom prostoru i stabilnost na neravninama. Napravljeni su prototipovi robota s dvije različite izvedbe uređaja za kretanje robota s kotačima i s gusjenicama i nakon provedenih testiranja izabrana je izvedba s gusjenicama. Zbog male veličine usjeva u optimalno vrijeme za tretiranje korova, preciznost navođenja robota je ključni preduvjet uspješnosti automatiziranih sustava za suzbijanje korova te je korištena tehnologija za precizno navođenje robota unutar usjeva pomoću GPS sustava u stvarnom vremenu. Za prepoznavanje korova koristi se sustav strojnog vida i softver za analizu slika koji uspoređuje konture svake pojedine biljke. Biljke koje se prepoznaju kao korov uništavaju se pomoću laserskih zraka koje se usmjeravaju direktno na središte rasta biljke, a njihov intenzitet se prilagođava vrsti i visini korova, čime se osigurava precizno i selektivno uništavanje korova bez oštećenja usjeva. Projekt predstavlja inovativno rješenje za održivo suzbijanje korova, kombinirajući najnovije tehnologije u području robotike, umjetne inteligencije i precizne poljoprivrede. Razvoj i primjena takvih rješenja značajno doprinosi smanjenju korištenja kemijskih sredstava u poljoprivredi, a time i očuvanju okoliša za buduće generacije. Robotski sustavi također omogućavaju brže i učinkovitije obavljanje poslova čime se štedi vrijeme i smanjuje potreba za ljudskim radom.

Ključne riječi: korovi, robot, strojni vid, laser, ekologija

Development of an autonomous robotic fleet system for weed recognition and ecological treatment

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Abstract:
The aim of this project was to develop an autonomous robotic fleet system for weed recognition and ecological treatment, which will be efficient, affordable and widely applicable in crop production. The operation of this system is based on the use of a fleet of smaller robots equipped with advanced navigation systems and dimensions that allow movement between crop rows, taking into account the soil configuration and potential obstacles. When developing a robot for weed control, it was necessary to find a solution for three main components of such a robotic system: a robot movement and guidance system, a weed recognition system and a weed treatment system. The robot movement system must enable easy movement within different crops, and when choosing the design of the movement device, the ability to maneuver in a limited space and stability on uneven surfaces should be taken into account. Robot prototypes were made with two different designs of the robot movement device with wheels and with tracks, and after testing, the track version was selected. Due to the small size of the crop at the optimal time for weed treatment, the precision of robot guidance is a key prerequisite for the success of automated weed control systems, and technology was used to precisely guide the robot within the crop using a real-time GPS system. A machine vision system and image analysis software are used to identify weeds, which compare the contours of each individual plant. Plants that are recognized as weeds are destroyed using laser beams that are directed directly to the center of plant growth, and their intensity is adjusted to the type and height of the weeds, ensuring precise and selective destruction of weeds without damaging the crop. The project represents an innovative solution for sustainable weed control, combining the latest technologies in the field of robotics, artificial intelligence and precision agriculture. The development and application of such solutions significantly contributes to reducing the use of chemical agents in agriculture, and thus preserving the environment for future generations. Robotic systems also enable faster and more efficient work, saving time and reducing the need for human labor.

Keywords: weeds, robot, machine vision, laser, ecology

Anti-Mikrobi-OL: Prirodni bioaktivni spojevi kao izvor potencijalnih antimikrobnih tvari u suzbijanju bakterijskih i drugih gljivičnih patogena masline

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Sažetak:
Projekt financira Hrvatska zaklada za znanost (HRZZ) u okviru nacionalnog istraživačkog programa Uspostavni istraživački projekt UIP-2020-02-7413 punog naziva „Prirodni bioaktivni spojevi kao izvor potencijalnih antimikrobnih tvari u suzbijanju bakterijskih i drugih gljivičnih patogena masline“ (Anti-Mikrobi-OL). U projekt Anti-Mikrobi-OL uključeno je ukupno pet država, odnosno pet partnera. Najvažniji ciljevi istraživanja na projektu Anti-Mikrobi-OL su utvrditi prisutnost i različitim metodama identificirati fitopatogenu bakteriju uzročnika bolesti raka masline (*Pseudomonas savastanoi* pv. *savastanoi*. *Pss*) na različitim sortama masline u Hrvatskoj, Sloveniji i Portugalu, kao i utvrditi različite fitopatogene gljive, koje uzrokuju djelomično ili potpuno sušenje stabala masline u Hrvatskoj, Bosni i Hercegovini i Italiji. Dodatno, jedan od ciljeva je i utvrditi antimikroban učinak kompleksnih bioaktivnih spojeva (eterična ulja i njihove komponente, biljne otpadne vode i fenoli) na sojeve bakterije *Pss* i izolate različitih fitopatogenih gljiva. U testu patogenosti cilj je utvrditi tolerantnije sorte masline na ove patogene. Od 2021. do 2024. godine prikupljeni su uzorci simptomatičnog biljnog materijala, a izolati bakterije i fitopatogenih gljiva okarakterizirani su i identificirani. Najjači inhibitorni učinak na bakteriju i fitopatogene gljive pokazala su pojedina eterična ulja i njihove glavne komponente, U testu patogenosti utvrđeno je da su udomaćene autohtone sorte ujedno i najtolerantnije i najosjetljivije na ove patogene. Zabilježen je prvi nalaz pojedinih vrsta fitopatogenih gljiva kao biljni patogeni uopće, ujedno na maslini su prvi put utvrđene neke vrste, a zabilježeni su i prvi nalazi u Republici Hrvatskoj i Bosni i Hercegovini. Ukupno trajanje projekta je pet godina (od 01.01.2021. – 31.12.2025.), a u dosadašnje četiri godine trajanja projekta, ostvareno je osam usavršavanja u Hrvatskoj, Sloveniji i Italiji, objavljeno je 11 znanstvenih radova indeksiranih u WoSCC-u, uspostavljeno je nekoliko inozemnih suradnja i učestvovalo se na devet konferencija u Hrvatskoj i Sloveniji.

Ključne riječi: bioaktivni spojevi, eterična ulja, fitopatogene gljive, maslina (*Olea europaea* L.), *Pseudomonas savastanoi* pv. *savastanoi*

Anti-Mikrobi-OL: Natural bioactive compounds as a source of potential antimicrobial agents in the control of bacterial and other fungal pathogens of olives

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Abstract:
The project is funded by the Croatian Science Foundation (HRZZ/CSF) within the framework of the national research program Installation Research Project UIP-2020-02-7413 entitled "Natural bioactive compounds as a source of potential antimicrobial agents in the control of bacterial and other fungal pathogens of olives" (Anti-Mikrobi-OL). A total of five countries and five partners are involved in the project Anti-Mikrobi-OL. The most important research objectives of the Anti-Mikrobi-OL project are to determine the presence and identify by different methods the phytopathogenic bacteria causing olive canker disease (*Pseudomonas savastanoi* pv. *savastanoi. Pss*) on different varieties of olives in Croatia, Slovenia and Portugal, as well as to determine various phytopathogenic fungi that cause partial or complete decline of olive trees in Croatia, Bosnia and Herzegovina and Italy. In addition, one of the objectives is to determine the antimicrobial effect of complex bioactive compounds (essential oils and their components, olive mill wastewaters and phenols) on strains of the bacterium *Pss* and on isolates of various phytopathogenic fungi. The aim of the pathogenicity test is to identify olive varieties that are more tolerant to these pathogens. From 2021 to 2024, samples of symptomatic plant material were collected, and isolates of bacteria and phytopathogenic fungi were characterized and identified. The strongest inhibitory effect on bacteria and phytopathogenic fungi was shown by certain essential oils and their main components. In the pathogenicity test, it was determined that domesticated indigenous varieties are both the most tolerant and the most susceptible to these pathogens. The first finding of certain species of phytopathogenic fungi as plant pathogens has been recorded, at the same time some species have been identified on olive trees for the first time, and some first findings have also been recorded in the Republic of Croatia and Bosnia and Herzegovina. The total duration of the project is five years (from1/1/2021 to 31/12/2025), and in the four years of the project so far, eight training courses have been completed in Croatia, Slovenia and Italy, 11 scientific papers indexed in WoSCC have been published, several foreign collaborations have been established and nine conferences have been attended in Croatia and Slovenia.

Keywords: bioactive compounds, essential oils, phytopathogenic fungi, olive (*Olea europaea* L.), *Pseudomonas savastanoi* pv. *savastanoi*

Hrvatske api rute

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Sažetak:
CAR (eng. *Croatian api routes*) projekt je promocije hrvatske ponude apiturizma kao dio razvoja suvremenog pčelarstva. Apiturizam je specifičan oblik ruralnog i ekoturizma s autentičnom turističkom ponudom. Temeljen je na pčelarstvu i prirodnim proizvodima i posjetitelju omogućuje autentičan doživljaj neposrednog uživanja u pčelinjem svijetu kroz aktivnosti poput apiterapije, boravka u pčelinjacima i degustacija pčelinjih proizvoda. Apiturizam osim turističke uključuje i zdravstvenu, edukativnu, kulturnu i društvenu dimenziju, te utječe na razvoj šire lokalne zajednice. Apiturističke usluge su raznovrsne te jedno pčelarsko gospodarstvo može pružati veći broj povezanih usluga. Najčešće se nudi usluga posjete pčelinjaku koje prate edukacija, rekreacija, apiterapija u pčelinjaku (apiinhalacija, relaksacija, spavanje uz košnice), kušanje meda i pčelinjih proizvoda. Dio usluga može se pružati i izvan pčelinjaka, kao što su apiterapija, relaksacija (apiness – api wellness) i apigastronomija. U apiturizmu su izletnički objekti i dio turističke infrastrukture pčelinjaci, a u apituristička ponudu može biti uključen puno širi krug pružatelja usluga poput ugostiteljskih objekata, ustanova zdravstvenog turizma, suvenirnice, kozmetički saloni i slično. Apiturizam se u Hrvatskoj intenzivno razvija posljednjih pet godina kao dio inovativne turističke ponude koja u svijetu i u zemljama okruženja već privlači brojne turiste. Prednjači Istarska županija u kojoj je 9 registriranih pružatelja usluga apiturizma i Karlovačka županija u kojoj je 6 registriranih usluga apiturizma. Obje županije su u suradnji s Hrvatskim apiterapijskim društvom napravile strategiju razvoja apiturizma. U drugim županijama djeluju pčelari koji se bave apiturizmom u sklopu ponude ruralnog turizma. Projektom Croatian Api Routes Hrvatsko apiterapijsko društvo promovira Hrvatsku kao destinaciju apiturizma s ponudom turističkih ruta privlačnih suvremenom turistu u potrazi za doživljajem autentične prirode. Glavni rezultat projekta je povećana potražnja za boravkom u pčelinjacima u Hrvatskoj kao i interes za dodatnom ponudom u apiturizmu (radionicama, apiinhalacijama i raznim drugim edukacijama), povećana prodaja pčelinjih proizvoda te proizvoda umreženih dionika uz produženi boravak gostiju i produljenje turističke sezone.

Ključne riječi: apiturizam, apigastronomija, apiterapija, apikultura, apiinhalacije

Croatian Api Routes

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Abstract:
CAR (Croatian api routes) is a project to promote the Croatian apitourism offer as part of the development of modern beekeeping. Apitourism is a specific form of rural and ecotourism with an authentic tourist offer. It is based on beekeeping and natural products and allows visitors to have an authentic experience of direct enjoyment of the bee world through activities such as apitherapy, staying in apiaries and tasting bee products. In addition to tourism, apitourism also includes a health, educational, cultural and social dimension and influences the development of the wider local community. Apitourism services are diverse, and one beekeeping farm can provide a number of related services. The most common service offered is a visit to an apiary, accompanied by education, recreation, apitherapy in the apiary (api inhalation, relaxation, sleeping by the hives), and tasting honey and bee products. Some services can also be provided outside the apiary, such as apitherapy, relaxation (apiness – api wellness) and apigastronomy. In apitourism, excursion facilities and apiaries are part of the tourist infrastructure, and the apitourism offer can include a much wider range of service providers, such as catering facilities, health tourism institutions, souvenir shops, beauty salons, etc. Apitourism has been developing intensively in Croatia in the last five years as part of an innovative tourist offer that has already attracted numerous tourists in the world and in neighbouring countries. The leading ones are the Istrian County, which has 9 registered apitourism service providers, and the Karlovac County, which has 6 registered apitourism services. Both counties, in cooperation with the Croatian Apitherapy Society, have developed a strategy for the development of apitourism. In other countries, beekeepers who engage in apitourism operate as part of the rural tourism offer. With the Croatian Api Routes project, the Croatian Apitherapy Society promotes Croatia as an apitourism destination with an offer of tourist routes attractive to modern tourists in search of an authentic nature experience. The main result of the project is an increased demand for stays in apiaries in Croatia as well as interest in additional apitourism offers (workshops, api-inhalations and various other education), increased sales of bee products and products of networked stakeholders with extended stays of guests and an extension of the tourist season.

Keywords: apitourism, apigastronomy, apitherapy, apiculture, apiinhalations

Uspostavljanje Agrivoltaics sustava u proizvodnji jabuke – od eko fizioloških istraživanja prema inovacijama za jačanje zelene tranzicije

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Sažetak:
Uvođenje fotonaponskih sustava (FS) u agroekosustav omogućuje istovremenu proizvodnju hrane i obnovljive energije, optimizirajući korištenje zemljišta te smanjujući gubitak vode i utjecaj ekstremnih vremenskih uvjeta. Projekt „Agricultura Next Generation“ ima za cilj uspostaviti funkcionalan i održiv FS prilagođen rastu i razvoju jabuka, uz maksimalnu iskoristivost generirane energije.
Istraživanja će biti provođena tijekom tri godine na pokušalištu Tenja, Fakulteta agrobiotehničkih znanosti Osijek, gdje će iznad nasada jabuka biti postavljena tri tipa FS: čvrsti, poluprozirni i dinamički solarni paneli. U prvoj fazi istraživanja bit će određene fenološke faze nekoliko sorti jabuke prema BBCH ljestvici, sadržaj fotosintetskih pigmenata u lišću (klorofil a i b, karotenoidi) te će s kontinuirano biti praćene vlažnost tla, temperatura i relativna vlažnost zraka. Mjerit će se fotosintetsko aktivno zračenje (PAR) na različitim visinama krošnje, a praćenjem biokemijskih pokazatelja stresa bit će analiziran sadržaj prolina, ukupnih fenola, fenolnih kiselina i flavonoida te antioksidativna aktivnost (FRAP metoda). Standardne analize tla uključivat će određivanje pH, humusa, fosfora i kalija te fizikalnih svojstava poput zbijenosti, poroznosti i propusnosti tla za vodu. Također, bit će ispitan kationski izmjenjivački kapacitet tla te koncentracija Ca^{2+}, Mg^{2+}, K^{+} i Na^{+}, dok će mikrobiološke analize obuhvatiti dehidrogenaznu i proteolitičku aktivnost tla. Drugi aspekti utjecaja FV na plod kao na primjer obojanost te agroekosustav kao biološka raznolikost će biti uzeti u obzir tijekom istraživanja.
Očekuju se značajne razlike u fiziološkim i morfološkim pokazateljima jabuke pod različitim FS sustavima, a dobiveni rezultati poslužit će kao smjernice za održivu poljoprivredu na malim površinama u različitim klimatskim uvjetima.

Ključne riječi: Fotonaponske ćelije, kvaliteta jabuke, održiva proizvodnja, solarna energija, tlo

Establishing Agrivoltaics systems in apple production – from eco-physiological research to innovations to strengthen the green transition

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Abstract:
The introduction of photovoltaic systems (PV) into the agroecosystem enables the simultaneous production of food and renewable energy, optimizing land use and reducing water loss and the impact of extreme weather conditions. The "Agriculture Next Generation" project aims to establish a functional and sustainable PV adapted to the growth and development of apples, with maximum utilization of the generated energy.
Research will be conducted over three years at the Tenja experimental site, Faculty of Agrobiotechnical Sciences Osijek, where three types of PV will be placed above the apple orchards: solid, semi-transparent and dynamic solar panels. In the first phase of the research, the phenological phases of several apple varieties will be determined according to the BBCH scale, the content of photosynthetic pigments in the leaves (chlorophyll a and b, carotenoids) and soil moisture, temperature and relative air humidity will be continuously monitored. Photosynthetically active radiation (PAR) will be measured at different canopy heights, and by monitoring biochemical stress indicators, the content of proline, total phenols, phenolic acids and flavonoids, and antioxidant activity (FRAP method) will be analyzed. Standard soil analyses will include determination of pH, humus, phosphorus and potassium, as well as physical properties such as compaction, porosity and water permeability of the soil. Also, the cation exchange capacity of the soil and the concentration of Ca^{2+}, Mg^{2+}, K^{+} and Na^{+} will be examined, while microbiological analyses will include soil dehydrogenase and proteolytic activity. Other aspects of the impact of FV on the fruit such as coloration and agroecosystem such as biodiversity will be taken into account in the study.
Significant differences in physiological and morphological indicators of apple are expected under different FS systems, and the obtained results will serve as guidelines for sustainable agriculture on small areas in different climatic conditions.

Keywords: apple quality, photovoltaic cells, soil, solar energy, sustainable production,

Prilagodba vinogradarstva klimatskim promjenama kroz valorizaciju i implementaciju adaptabilnih genotipova vinove loze

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Sažetak:
Cilj projekta je kroz sveobuhvatno istraživanje, predložiti mjere prilagođene izazovima koje donose klimatske promjene, s posebnim fokusom na rizike od suše. Zajednički izazov s kojim se ovaj prekogranični projekt bavi je ranjivost vinogradarstva u regijama istočne kontinentalne Hrvatske i zapadne Srbije na utjecaj klimatskih promjena, posebice stresa uzrokovanog sušom. Suša je izravna prijetnja vinovoj lozi, utječe na njen rast, razvoj i urod. Nedovoljna dostupnost vode zbog promjenjivih klimatskih uvjeta može rezultirati smanjenom produktivnošću vinove loze i smanjenom kvalitetom grožđa. Kroz projekt će se ispitati nedovoljno istražene novostvorene sorte vinove loze, kao i njihov implementacijski potencijal u prekograničnom području. Također će se s obje strane granice izgraditi centri za prevenciju negativnih utjecaja klimatskih promjena u vinogradarstvu, potrebni za sustavno praćenje klimatskih uvjeta i poticanje istraživanja otpornih sorti vinove loze. Izgradnja modernih i tehnološki izvrsno opremljenih centara dat će snažan doprinos vinogradarstvu i vinarstvu, jer će centar služiti ne samo za istraživanje, već i za usavršavanje studenata, mladih istraživača, te vinogradara i vinara. Projekt je sufinanciran sredstvima Interreg IPA Prekograničnog programa suradnje Hrvatska - Srbija 2021. - 2027.

Ključne riječi: Adaptvitis, vinova loza, klimatske promjene

Adaptation of viticulture to climate change through valorization and implementation of adaptable grapevine genotypes

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Abstract:
The aim of the project is to propose measures adapted to the challenges brought by climate change, with a special focus on drought risks, through comprehensive research. The common challenge that this cross-border project addresses is the vulnerability of viticulture in the regions of eastern continental Croatia and western Serbia to the impact of climate change, especially drought stress. Drought is a direct threat to grapevines, affecting their growth, development and yield. Insufficient water availability due to changing climate conditions can result in reduced grapevine productivity and reduced grape quality. The project will examine insufficiently researched newly created grapevine varieties, as well as their implementation potential in the cross-border area. Centers for the prevention of negative impacts of climate change in viticulture will also be built on both sides of the border, necessary for systematic monitoring of climate conditions and encouraging research into resistant grapevine varieties. The construction of modern and technologically excellently equipped centers will make a strong contribution to viticulture and winemaking, as the center will serve not only for research, but also for the training of students, young researchers, and winegrowers and winemakers. The project is co-financed by the Interreg IPA Cross-Border Cooperation Programme Croatia - Serbia 2021 - 2027.

Keywords: Adaptvitis, grapevine, climate change

Predstavljanje projekta „Inovativna rješenja za racionalizaciju upotrebe bentonita u postizanju proteinske stabilnosti bijelih vina – INNOSTAB“ (HRZZ-IP-2020-02-4551)

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Sažetak:
Bijela vina s razvijenim proteinskim zamućenjem koje potječe od agregacije tzv. proteina povezanih s patogenezom (PR proteini) nisu utrživa. Standardni, općeprihvaćeni postupak za prevenciju proteinskog zamućenja je uklanjanje proteina adsorpcijom na bentonit prije punjenja u boce kojeg odlikuju bitni nedostaci, uključujući gubitke količina i kvalitete vina. Do danas predložene alternative bentonitu uglavnom su se pokazale nepraktičnim, skupim, s negativnim nuspojavama, još uvijek se istražuju ili su pokušaji obustavljeni. Glavni cilj projekta INNOSTAB je razvoj inovativnih tehnoloških rješenja za smanjenje količine bentonita potrebne za postizanje proteinske stabilnosti bijelog vina, uz očuvanje ili poboljšanje njegove kvalitete. Ciljevi uključuju istraživanje: uzroka potreba za velikim količinama bentonita u bistrenju vina kultivara Malvazija istarska, mogućnosti poboljšanja proteinske stabilnosti vina različitim postupcima u pred-fermentativnoj preradi grožđa, mogućnosti sniženja koncentracije PR proteina uporabom nekonvencionalnih kvasaca u fermentaciji te mogućnosti sniženja potrebne doze bentonita iskorištenjem komplementarnog djelovanja različitih bentonita. Rezultati projekta pokazali su da su vina Malvazije istarske značajno bogatija PR proteinima od vina usporedivih kultivara te da njihova koncentracija raste prema kasnijim terminima berbe. Utvrđeno je da pred-fermentacijski tretmani poput kratkotrajne maceracije i oksigenacije povisuju, dok upotreba pektolitičkih enzima i produljena maceracija snižavaju koncentraciju PR proteina. Značajna poboljšanja u učinkovitosti bistrenja, kvaliteti vina i oksidacijskoj stabilnosti postignuta su primjenom bentonita tijekom fermentacije u odnosu na standardno bistrenje prije punjenja u boce. Identificirani su bentoniti s komplementarnim afinitetima prema specifičnim PR proteinima te su njihovom kombiniranom uporabom postignuta određena poboljšanja u postizanju proteinske stabilnosti. Dobiveni rezultati pokazuju da predložena rješenja, koja su u skladu sa zakonom i ekološki održiva te uglavnom ne uključuju dodatna značajna ulaganja, imaju potencijal za praktičnu uporabu u suvremenom vinarstvu. Ovaj rad je financirala Hrvatska zaklada za znanost projektima HRZZ-IP-2020-02-4551, HRZZ-DOK-2015-10-2570 i HRZZ-DOK-2021-02-5500.

Ključne riječi: Malvazija istarska, proteinska stabilnost, bentonit, bistrenje, kvaliteta

Presentation of the project "Innovative solutions for rationalising the use of bentonite in white wine protein stabilisation – INNOSTAB" (HRZZ-IP-2020-02-4551)

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Abstract:
White wines with developed protein haze caused by the aggregation of so-called pathogenesis-related (PR) proteins are not marketable. The standard method for preventing haze formation involves the removal of these proteins by adsorption onto bentonite prior to bottling. While effective, bentonite use has notable drawbacks, including wine volume loss and aroma stripping. To date, proposed alternatives to bentonite have generally proven impractical, costly, associated with side effects, still under research, or ultimately abandoned. The INNOSTAB project aims to develop innovative technological solutions to reduce the bentonite dosage required for protein stabilization in white wines, while maintaining or enhancing their quality. The focus is on understanding the high bentonite demand in wines from the Malvazija istarska cultivar, evaluating the impact of pre-fermentative grape processing on protein stability, exploring the use of non-conventional yeasts during fermentation to reduce PR protein levels, and assessing how different bentonites might act synergistically to lower bentonite needs. Results show that Malvazija istarska wines contain significantly higher PR protein levels than comparable white cultivars, with concentrations increasing at later harvest dates. Pre-fermentative treatments like short maceration and oxygenation increased PR protein levels, whereas pectolytic enzymes and extended maceration decreased them. Applying bentonite during fermentation, as opposed to standard pre-bottling fining, improved fining efficiency, wine quality, and oxidative stability. Bentonites with complementary affinities for specific PR proteins were identified and their combined use has resulted in certain improvements in achieving protein stability. The findings suggest that the proposed solutions, which comply with current regulatory frameworks, are economically viable, environmentally sustainable, and largely require no significant additional investments, making them promising for practical application in modern winemaking. This work was supported by the Croatian Science Foundation (HRZZ-IP-2020-02-4551, HRZZ-DOK-2015-10-2570, HRZZ-DOK-2021-02-5500).

Keywords: Malvazija istarska, protein stability, bentonite, fining, quality

Predstavljanje projekta Zadarske županije CENTRAL – BIC:_Central Europe Biodiversity Innovative Communities

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Sažetak:
Zadarsku županiju obilježava višestoljetni uzgoj maslina za proizvodnju ulja. Tijekom tog razdoblja maslinarska proizvodnja prolazila je kroz uspone i padove. Sorta maslina je temelj za proizvodnju autentičnih maslinovih ulja jer je ona glavni čimbenik koji utječe na sastav i kvalitetu ploda, a time i ulja. Zadarska županija, kao jedan od projektnih partnera, sudjeluje u provedbi projekta *CENTRAL-BIC_Central Europe Biodiversity Innovative Communities* u sklopu Programa prekogranične suradnje Interreg CENTRAL EUROPE 2021.-2027.
Cilj projekta CENTRAL-BIC je podržati participativni pristup koji vodi promjeni ponašanja među potrošačima i ruralnim proizvođačima, povezati lokalne zajednice s vrijednostima njihovog područja, ekološkom i socio-ekonomskom vrijednošću prirodnog kapitala i uslugama ekosustava s ciljem prepoznavanja novih zelenih mogućnosti te razviti plan zaštite bioraznolikosti kako bi se postigla kolektivna svijest o zajednicama koje upravljaju biološkom raznolikošću.
Aktivnosti Zadarske županije unutar zadanih ciljeva su evaluacija i opisivanje lokalnih eko tipova masline. Istraživanje se provodi uz pomoć proizvođača jer su oni te sorte masline zbog svojih gospodarskih vrijednosti kao što su na primjer redovita rodnost, otpornost prema suši i/ili krupnoća ploda, proširili u lokalnim područjima. Kako bi se stekli preduvjeti za proizvodnju sadnica, evaluaciju i očuvanje autohtonih (lokalnih ekotipova) sorata masline potrebno je podignuti nasad u kojem će se očuvati lokalne (autohtone) sorte maslina Zadarske županije.

Ključne riječi: bioraznolikost, ekotipovi, nasadi, sorte maslina

Presentation of the Zadar County project CENTRAL – BIC:_Central Europe Biodiversity Innovative Communities

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Abstract:
Zadar County has a long history of olive cultivation for oil production, spanning centuries of both prosperity and decline. The choice of olive variety is fundamental to the production of authentic olive oils, as it directly affects the fruit's composition, quality, and ultimately the oil itself. Zadar County, as one of the project partners, is participating in the implementation of the CENTRAL-BIC_Central Europe Biodiversity Innovative Communities project as part of the Interreg CENTRAL EUROPE Cross-Border Cooperation Programme 2021-2027.
The aim of the CENTRAL-BIC project is to support a participatory approach that leads to behavioral change among consumers and rural producers, to connect local communities with the values of their territory, the ecological and socio-economic value of natural capital and ecosystem services with the aim of recognizing new green opportunities, and to develop a biodiversity protection plan in order to achieve collective awareness of communities that manage biodiversity.
As part of these objectives, Zadar County is engaged in evaluating and documenting local olive ecotypes. This research is being carried out in collaboration with producers who have cultivated these olive varieties in local areas due to their economic benefits, such as consistent yield, drought resistance, and large fruit size. To create the necessary conditions for seedling production and ensure the preservation of indigenous olive varieties, it is essential to establish a dedicated plantation where these local ecotypes of Zadar County can be conserved.

Keywords: biodiversity, ecotypes, plantations, olive varieties

LIFE OrnamentalIAS: Ukrasni „bjegunci“

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Sažetak:
Strane invazivne biljne vrste (IAS) predstavljaju značajnu prijetnju bioraznolikosti, posebno ugroženim staništima od europske važnosti. Mnoge IAS su na područje EU unesene kao ukrasne vrste, a danas s obzirom na potencijal širenja sve više ugrožavaju prirodne ekosustave i autohtone vrste. Cilj projekta LIFE OrnamentalIAS je spriječiti i ublažiti negativne posljedice IAS kroz prevenciju, sustav ranog upozoravanja i brzog odgovora (EWRR), razviti učinkovite metode za upravljanje IAS u zaštićenim područjima mreže Natura 2000 te istražiti potencijal korištenja biomase IAS u energetske i funkcionalne svrhe.
Prevencija daljnjeg širenja IAS planira se ostvariti kroz aktivnosti edukacije, podizanja svijesti javnosti i aktivnim uključivanjem relevantnih dionika kako bi se ograničilo unošenje novih, potencijalno invazivnih vrsta te spriječilo daljnje širenje istih. U sklopu projekta, inventarizirat će se ukrasne biljke dostupne na tržištu, kategorizirati ovisno o potencijalu invazivnosti te će se izraditi smjernice za njihovo odgovorno korištenje. Također, bit će predložene mogućnosti zamjene ukrasnih IAS i potencijalno invazivnih vrsta autohtonim biljnim vrstama.
Nadalje, istražit će se mogućnosti iskorištavanja biomase IAS unutar kružnog biogospodarstva za proizvodnju komposta i drugih proizvoda dodane vrijednosti. Također, razvit će se model odgovornog upravljanja vrtnim otpadom koji sadrži IAS, a kako bi se spriječio njihov potencijalan „bijeg“ u prirodna staništa te time smanjio rizik za ekosustave. Valorizirat će se i potencijalno korištenje IAS u energetske i funkcionalne svrhe, razvojem učinkovitih metoda proizvodnje zelene energije iz biomase IAS te proizvoda visoke dodane vrijednosti s potencijalom korištenja u agroindustriji, farmaceutskoj, kozmetičkoj i drugim industrijama. Osim multidisciplinarne suradnje na više sektorskih razina, uključujući širu javnost, lokalne vlasti, vladine, nevladine organizacije, privatne tvrtke te akademsku zajednicu, dodatna specifičnost projekta ogleda se u međunarodnoj partnerskoj suradnji, što će omogućiti razmjenu znanja i koordinirane aktivnosti za zaštitu ugroženih staništa i vrsta te očuvanju bioraznolikosti u Europskoj uniji uz značajan doprinos zelenom gospodarstvu.

Ključne riječi: ukrasne vrste, invazivne biljne vrste, bioraznolikost, otpad, kružno gospodarstvo

LIFE OrnamentalIAS: Ornamental "Escapees"

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Abstract:
Invasive alien plant species (IAS) pose a significant threat to biodiversity, especially to threatened habitats of European importance. Many IAS were introduced into the EU as ornamental plants, but today, they increasingly threaten natural ecosystems and native species due to their dispersal potential.
The LIFE OrnamentalIAS project aims to prevent and mitigate the negative impacts of IAS through prevention, an Early Warning and Rapid Response (EWRR) system, the development of effective IAS management practises in protected areas of the Natura 2000 network and research into the utilisation of IAS biomass for energy and functional purposes.
Preventing the further spread of IAS will be achieved through education, public awareness initiatives and the active involvement of relevant stakeholders to limit the introduction of new potentially invasive species and prevent their further spread. As part of the project, ornamental plants available on the market will be inventoried and categorised based on their invasive potential and guidelines for their responsible use will be developed. In addition, alternative native plant species will be proposed to replace invasive ornamentals and potentially invasive species.
In addition, the project will investigate the potential use of IAS biomass in the circular economy to produce compost and other value-added products. A responsible model for the disposal of garden waste will also be developed to prevent the potential "escape" of IAS into natural habitats, thus reducing the risks to ecosystems. The potential utilisation of IAS biomass for energy and functional purposes will be assessed by researching efficient methods to generate green energy from IAS biomass and to produce high-value products with potential applications in agriculture, pharmaceuticals, cosmetics and other industries.
In addition to multidisciplinary collaboration across different sectors, including the public, local authorities, governmental and non-governmental organisations, private companies and the academic community, a key feature of the project is international partnership collaboration. This will facilitate knowledge exchange and coordinated action to protect threatened habitats and species, conserve biodiversity in the European Union and make an important contribution to the green economy.

Keywords: ornamental species, invasive plant species, biodiversity, waste, circular economy

PRiroda kao SAVEZnik: Strane biljne invazivne vrste kao izvor farmaceutika

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Sažetak:
Fitokemijski sastav invazivnih stranih biljnih vrsta ima ključnu ulogu u njihovom invazivnom potencijalu, čineći ga jednim od glavnih čimbenika njihova negativnog utjecaja na okoliš. No, ta ista fitokemijska raznolikost predstavlja velik, još uvijek nedovoljno iskorišten potencijal za izolaciju bioaktivnih spojeva i njihovu primjenu u fitofarmaciji. Istraživački projekt „PRiroda kao SAVEZnik: Strane biljne invazivne vrste kao izvor farmaceutika – NATURALLY“ (IP-2020-02-6899), financiran od strane Hrvatske zaklade za znanost, istražuje fitofarmaceutski potencijal četiri strane invazivne biljne vrste (*Ailanthus altissima* (Mill.) Swingle, *Solidago canadensis* L., *Helianthus tuberosus* L. i *Robinia pseudoacacia* L.) u Istri. U ovom će izlaganju biti predstavljeni ključni rezultati istraživanja provedenih u sklopu projekta, uključujući procjenu utjecaja ovih vrsta na okoliš, fitokemijsku analizu ekstrakata listova i cvjetova te procjenu njihove biološke aktivnosti. Sve ispitane vrste bogate su bioaktivnim fenolnim spojevima, pri čemu je identificirano 116 specijaliziranih metabolita. Ekstrakti su pokazali antioksidacijsko djelovanje u *in vitro* testovima, nisu imali citotoksične ni genotoksične učinke na ljudske jetrene stanice pri koncentracijama manjim od 1 mg/mL, a odlikovali su se i antibakterijskim i protugljivičnim svojstvima, u nekim slučajevima usporedivim sa standardnim antibioticima i antimikoticima. Pri koncentraciji od 1 mg/mL, ekstrakti su također pokazali antitumorska svojstva. Ovi rezultati donose nove uvide u fitokemijska svojstva invazivnih biljnih vrsta i njihov potencijal za primjenu kao antioksidansa u farmaceutskoj industriji, nudeći inovativan pristup upravljanju ekosustavima.

Ključne riječi: biološka aktivnost, ekstrakti, fenolni profil, projekt, usluge ekosustava

NATURe as an ALLY: Alien Invasive Plants as Phytopharmaceuticals

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Abstract:
The phytochemical composition plays a crucial role in the invasive potential of alien plant species, making it a key factor in their negative environmental impact. However, this same phytochemical diversity offers a largely untapped potential for the extraction of bioactive compounds and their application in phytopharmacy. The research project "NATURe as an ALLY: Alien invasive plants as phytopharmaceuticals – NATURALLY" (IP-2020-02-6899), funded by the Croatian Science Foundation, explores the phytopharmaceutical potential of four invasive alien plant species found in Istria (Croatia) - *Ailanthus altissima* (Mill.) Swingle, *Solidago canadensis* L., *Helianthus tuberosus* L., and *Robinia pseudoacacia* L. This presentation highlights key findings, including environmental impact assessments, phytochemical screening of leaf and flower extracts, and biological activity evaluations. All tested species were rich in bioactive phenolic compounds, with 116 specialized metabolites identified. The extracts exhibited antioxidant activity *in vitro*, showed no cytotoxic or genotoxic effects on human liver cells at concentrations below 1 mg/mL, and demonstrated antibacterial and antifungal properties—some comparable to standard antibiotics and antifungals. At concentrations of 1 mg/mL, the extracts also exhibited antitumor activity. These findings provide new insights into the phytochemical properties of invasive plant species and their potential use as antioxidants in phytopharmacy, offering an innovative approach to ecosystem management.

Keywords: biological activity, ecosystem services, extracts, phenolic profile, project

Prezentacija HRZZ projekta „Inovativni vinifikacijski postupci u funkciji povećanja biološkog i nutritivnog potencijala vina i nusproizvoda vinifikacije autohtonih i introduciranih sorti vinove loze – VinNutriVit" (IP-2022-10-9128)

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Sažetak:
Inovativne tehnologije, poput ultrazvuka (sonikacija), usprkos visokoj učinkovitosti u ekstrakciji fenolnih, aromatskih i nutritivnih spojeva, relativno malo se koriste u vinarstvu. Stoga bi njihova primjena u vinarskoj proizvodnji mogla postati važna tehnološka inovacija za ubrzavanje relativno sporih procesa kao što je maceracija masulja. Također, proizvodnja vina neizbježno generira nusproizvode vinifikacije, koji se uobičajeno smatraju otpadom, iako se zbog visokog sadržaja polifenola, vlakana, antioksidativnog i antimikrobnog potencijala, mogu učinkovito koristiti u prehrambenom sektoru kao funkcionalna hrana. HRZZ projekt VinNutriVit (2023.-2027.) matične organizacije Instituta za poljoprivredu i turizam, ima za cilj istražiti kako inovativne vinifikacijske tehnologije u proizvodnji vina autohtonih hrvatskih sorti Malvazije istarske i Terana, te introduciranih sorti Graševine i Merlota, mogu utjecati na bioaktivni, antimikrobni i nutritivni potencijal dobivenih vina i nusproizvoda, te istražiti mogućnosti njihove primjene u protektivne i prehrambene svrhe. U proizvodnji vina navedenih sorti primijenjeni su tretmani sonikacije masulja različitih amplituda ultrazvučnih valova i duljina trajanja. Proizvedena vina i nusproizvodi vinifikacije (kožica, sjemenke, talog, hladno prešano ulje sjemenki grožđa, pogača) podvrgnuti su analizi aromatskih i fenolnih spojeva, antioksidacijskog i nutritivnog potencijala, te će biti senzorno ocjenjena. Obavit će se senzorna analiza 3-5 novih laboratorijskih prototipova/proizvoda "ready-to market" s dodatkom nusproizvoda vinifikacije (ili njihovih ekstrakata) s ciljem dobivanja novog proizvoda tj. višekomponentnog prehrambenog proizvoda (hrane) koji je organoleptički prihvatljiv, zdravstveno ispravan i industrijski proizvodljiv. Budući da se neadekvatno zbrinuta komina grožđa smatra ekološkim problemom, mogućnosti iskorištenja nusproizvoda vinifikacije u nutritivne i protektivne svrhe, omogućit će dobivanje proizvoda s dodanom vrijednošću u kontekstu kružnog, održivog gospodarstva.
Istraživanje se ne provodi samo na autohtonim već i na introduciranim sortama vinove loze zbog čega će dobiveni rezultati biti primjenjivi na globalnoj razini. Vrijednost dobivenih rezultata dodatno naglašava i činjenica kako se sva istraživanja provode u realnim uvjetima proizvodnje vina, u vinarskom podrumu, što će omogućiti veću vjerodostojnost dobivenih podataka i služiti proizvođačima pri odabiru odgovarajuće tehnologije proizvodnje ovisno o željenom stilu vina.

Ključne riječi: inovativni vinifikacijski postupci, ultrazvuk, autohtone sorte vinove loze, introducirane sorte vinove loze, nusproizvodi vinifikacije

Presentation of the HRZZ project: "Innovative vinification procedures for increasing the biological and nutritional potential of wine and vinification by-products of autochthonous and introduced grape varieties – VinNutriVit" (IP-2022-10-9128)

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Abstract:
Innovative technologies, such as ultrasound (sonication), despite their high efficiency in extracting phenolic, aromatic and nutritional compounds, are rarely used in winemaking. Therefore, their application in wine production could become an important technological innovation for speeding up relatively slow processes such as grape maceration. Wine production inevitably generates vinification by-products, which are usually considered waste, although due to the high content of polyphenols, fiber, antioxidant, and antimicrobial potential, they can be effectively used in the food sector as functional food. The HRZZ project VinNutriVit (2023–2027), led by the Institute of Agriculture and Tourism as the implementing institution, aims to investigate the effect of innovative vinification technologies when producing wines from autochthonous Croatian varieties Malvazija istarska and Teran, and introduced varieties Graševina and Merlot, on the bioactive, antimicrobial and nutritional potential of the resulting wines and by-products. Moreover, the aim is to explore the possibilities of their application in protective and nutritional purposes. Sonication treatments of different amplitudes and durations of ultrasonic waves were applied in the production of wines of the mentioned varieties. Aromatic and phenolic compounds, antioxidant and nutritional potential of the produced wines and by-products (grape skin, seeds, wine lees, cold pressed grape seed oil) were analysed. Sensory analysis of wine and new laboratory prototypes/ready-to-market products with the addition of vinification by-products (or their extracts) will be performed. The aim would be to obtain a new product, i.e. a multi-component food product (food) that is organoleptically acceptable, healthy and industrially producible. Since inadequately managed grape pomace is considered an ecological problem, the possibility of using vinification by-products for nutritional and protective purposes will provide products with added value in the context of a circular, sustainable economy.
The research is conducted not only on autochthonous but also on introduced grape varieties, why the obtained results will be applicable on a global level. The value of the obtained results is further emphasized by the fact that all research will be carried out in the real conditions of wine production, in the wine cellar, which will enable greater credibility of the obtained data and serve the producers in choosing the appropriate production technology depending on the desired style of wine.

Key words: innovative vinification procedures, ultrasound, autochthonous grapevine varieties, introduced grapevine varieties, vinification by-products

Integrirane strategije i rješenja za smanjenje otpada u zaštićenim i Natura 2000 područjima (WASTEREDUCE)

Barbara Sladonja[1], Nataly Milovan[1]*, Ninoslav Luk[1], Martina Begić[1], Mirela Uzelac Božac[1], Klaudia Dragičević[1], Danijela Poljuha[1]

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Sažetak:
Italija i Hrvatska, uz to što dijele Jadransko more, dijele i izazove poput njegova onečišćenja i potrebe za očuvanjem. Iz godine u godinu, porast broja posjetitelja dovodi do nekontroliranog gomilanja otpada u zaštićenim i Natura 2000 područjima na kopnu, što negativno utječe na okoliš. Istovremeno, rijeke i obalni turizam doprinose unosu otpada u more, ugrožavajući morski ekosustav. Budući da problem otpada nadilazi državne granice, neophodno je zajedničko i koordinirano djelovanje kako bi se izbjegli jednostrani i neučinkoviti pristupi.
WASTEREDUCE je prvi Interreg projekt talijansko-hrvatske suradnje koji se bavi upravljanjem otpadom u zaštićenim i Natura 2000 područjima, uz potporu EU i lokalnih politika zaštite okoliša. Projekt ima za cilj razviti, testirati i primijeniti novi integrirani, participativni i holistički pristup koji u obzir uzima posebnosti tih područja, s naglaskom na riječne i obalne zone koje su najizloženije antropogenom otpadu. Pilot aktivnosti provodit će se u tri područja – jednom u Italiji i dva u Hrvatskoj. Projekt okuplja osam ključnih partnera iz javnog i privatnog sektora s obje strane Jadrana koji će zajednički raditi na rješavanju problema otpada i očuvanju ekosustava.
WASTEREDUCE će doprinijeti unaprjeđenju politika i praksi upravljanja otpadom, razvoju novih alata i strategija kontrole nepravilnog odlaganja otpada, podizanju svijesti, promjeni ponašanja posjetitelja i ostalih dionika, te smanjenju okolišnih i socioekonomskih troškova. Također će osnažiti prekograničnu, nacionalnu, regionalnu i lokalnu suradnju.

Ključne riječi: Jadransko more, Natura 2000, upravljanje otpadom

Integrated waste reduction strategies and solutions in protected and Natura 2000 areas (WASTEREDUCE)

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Abstract:
Italy and Croatia, in addition to sharing the Adriatic Sea, also share challenges such as its pollution and the need for conservation.
Year after year, the increasing number of visitors leads to uncontrolled waste accumulation in protected areas and Natura 2000 sites on land, which negatively impacts the environment. At the same time, rivers and coastal tourism contribute to the inflow of waste into the sea, threatening the marine ecosystem. Since the waste problem transcends national borders, joint and coordinated action is essential to avoid unilateral and ineffective approaches.
WASTEREDUCE is the first Interreg project of Italian-Croatian cooperation focused on waste management in protected areas and Natura 2000 sites, supported by the EU and local environmental policies.
The project aims to develop, test, and implement a new integrated, participatory, and holistic approach that considers the specific characteristics of these areas, with a focus on river and coastal zones most exposed to anthropogenic waste. Pilot activities will be carried out in three areas – one in Italy and two in Croatia. The project brings together eight key partners from the public and private sectors on both sides of the Adriatic who will work together to tackle waste issues and preserve ecosystems.
WASTEREDUCE will contribute to the improvement of waste management policies and practices, the development of new tools and strategies for controlling improper waste disposal, raising awareness, changing visitor and stakeholder behaviour, and reducing environmental and socio-economic costs. It will also strengthen cross-border, national, regional, and local cooperation.

Keywords: Adriatic sea, Natura 2000, waste managment

BioFarms Cluster: Znanošću do inovacija za održivi razvoj proizvodnje i prerade ljekovitog bilja

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Sažetak:
Biofarms Cluster (BFC) je 36-mjesečni projekt suradnje koji uključuje devet partnera iz četiri zemlje Europske unije (EU) (Italija, Slovenija, Hrvatska, Grčka), tri zemlje koje sudjeluju u programu Instrumenta za pretpristupnu pomoć (IPA) (Bosna i Hercegovina, Srbija, Albanija) i 12 pridruženih partnera. Glavni cilj BFC-a je uspostaviti transnacionalni klaster proizvođača ljekovitog i aromatskog bilja u zemljama članicama projektnog konzorcija, koji bi bio sposoban unaprijediti razvoj i implementaciju zajednički razvijenih pristupa temeljenih na transnacionalnim strategijama pametne specijalizacije u nutraceutskom i farmaceutskom sektoru, uz istovremeno olakšavanje prijenosa tehnologije i izgradnje kapaciteta na razini Adrion. BFC će implementirati učinkovite procese prijenosa tehnologije za učinkovitu i djelotvornu eksploataciju poljoprivredno-prehrambenih nusproizvoda i divljih biljnih vrsta za proizvodnju biljnih ekstrakata s inovativnom primjenom za nutraceutsko i biofarmaceutsko tržište. Stvaranjem zajedničkih rješenja proces transfera tehnologije obuhvatit će cijeli lanac vrijednosti. Ciljane skupine uključuju lokalne, regionalne i nacionalne javne vlasti, sektorske i regionalne razvojne agencije, sveučilišta, istraživačke ustanove, organizacije za potporu poslovanju (kao što su gospodarske komore, centri za poslovne inovacije i tehnološki informacijski centri), mala i srednja poduzeća te industrijska središta i parkovi. BFC klaster također će djelovati kao živi laboratorij, pružajući platforme 'stvarnog svijeta' za krajobrazne ekološke studije za informiranje o razvoju i testiranju metoda i alata, dizajn poticaja za poticanje upravljanja biološkom raznolikošću od strane poljoprivrednika i dijeljenje informacija i podataka za analizu sustava. Projekt financira Interreg IPA Adrion u okviru specifičnog cilja "SO1.1. Razvoj i jačanje istraživačkih i inovacijskih kapaciteta i usvajanje naprednih tehnologija", a glavni korisnik je Sveučilište Magna Graecia u Catanzaru, Italija.

Ključne riječi: Biofarms klaster, BFC, transnacionalni klaster, strategije pametne specijalizacije, IPA ADRION

BioFarms Cluster: From Science to Innovations for Sustainable Development of Aromatic and Medicinal Plants Production and Processing

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Abstract:
The Biofarms Cluster (BFC) is a 36-month collaborative project involving nine partners across four European Union (EU) countries (Italy, Slovenia, Croatia, Greece), three countries participating in the Instrument for Pre-Accession Assistance (IPA) program (Bosnia-Herzegovina, Serbia, Albania), and 12 associated partners. The main objective of BFC is to establish a transnational cluster of aromatic and medicinal plants producers in the member countries of project consortium, capable to enhance the development and implementation of jointly developed approaches based on transnational Smart Specialization Strategies in the nutraceutical and pharmaceutical sectors, while facilitating technology transfer and capacity building at the Adrion level. BFC will implement virtuous technology transfer processes for the efficient and effective exploitation of agri-food by-products and wild plant species to produce vegetable extracts with innovative applications for the nutraceutical and biopharmaceutical market. By creating joint solutions, the technology transfer process will cover the entire value chain. Target groups include local, regional, and national public authorities, sectoral and regional development agencies, universities, research facilities, business support organizations (such as chambers of commerce, business innovation centres, and technology information centres), SMEs, and industrial hubs and parks. The BFC Cluster will also operate as living labs, providing 'real-world' platforms for landscape ecological studies to inform the development and testing of methods and tools, the design of incentives to encourage biodiversity management by farmers, and the sharing of information and data for systems analysis. The project is financed by Interreg IPA Adrion within specific objective “SO1.1. Developing and enhancing research and innovation capacities and the uptake of advanced technologies” and the lead beneficiary is University Magna Graecia in Catanzaro, Italy.

Keywords: Biofarms Cluster, BFC, transnational cluster, Smart Specialization Strategies, IPA ADRION

Prezentacija projekta: Unapređenje obrazovanja o zelenom turizmu u visokoškolskom sustavu kroz razvoj alternativnih prilika za učenje (GreenTEA)

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Sažetak:
Projekt je osmišljen kako bi opremio učenike znanjem i vještinama potrebnim da budu informirani, odgovorni putnici koji podržavaju okoliš i globalnu borbu protiv klimatskih promjena. Kroz platformu, učenici će razumjeti utjecaje klimatskih promjena na okoliš i ulogu turizma u ublažavanju tih utjecaja. Nadalje, učenici će postati svjesni utjecaja klimatskih promjena na lokalne zajednice i gospodarstva te steći vještine potrebne za zagovaranje održivog turizma. Ovaj projekt je usmjeren na prioritet izgradnje inkluzivnih i raznolikih sustava visokog obrazovanja pružanjem obrazovnih resursa vezanih uz zeleni turizam. E-platforma će pružiti razne obrazovne materijale, od osnovnih pregleda do naprednijih tema, namijenjene učenicima bez obzira na njihovu obrazovnu pozadinu. Omogućavajući lakši pristup edukativnim resursima na temu zelenog turizma učenicima svih razina, ovaj projekt će doprinijeti izgradnji inkluzivnih sustava visokog obrazovanja. Osim toga, projekt će uključivati digitalne komponente koje će pomoći angažirati učenike, potaknuti njihovo bolje razumijevanje i pružiti povratne informacije. One će omogućiti prezentaciju obrazovnog materijala učinkovitijom, kroz digitalnu transformaciju, digitalnu spremnost i otpornost, čineći obrazovanje o zelenom turizmu dostupnijim širokom spektru učenika. Projekt je usmjerene na inkluziju i raznolikost u svim poljima obrazovanja i osposobljavanja mladih osiguravajući da je e-učenje platforma dostupna svim učenicima bez obzira na njihovu pozadinu ili okolnosti. Također će uključivati niz sadržaja koji se odnose na zeleni turizam, poput održivih praksi i odgovornog turizma, kako bi osigurali da korisnici budu dobro informirani i razumiju važnost očuvanja okoliša. Dodatno, platforma će sadržavati sadržaj relevantan za različite kulture i pozadine kako bi svi mogli imati koristi od učenja o zelenom turizmu.

Ključne riječi: zeleni turizam, održive prakse, klimatske promjene, odgovorno putovanje, E-platforma

Project presentation: Improving the educational background of green tourism in higher education by developing alternative educational materials and learning opportunities (GreenTEA)

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Abstract:
The project is designed to equip learners with the knowledge and skills to be informed, responsible travellers and support the environment and the global fight against climate change. Through the platform, learners will understand the impacts of climate change on the environment and tourism's role in mitigating those impacts. Furthermore, learners will become aware of the impact of climate change on local communities and economies and gain the skills to become advocates for sustainable tourism. This project addresses the priority of building inclusive and diverse higher education systems by providing accessible educational resources related to green tourism. The e-learning platform will provide various educational materials, from basic overviews to more advanced topics, to various learners regardless of their educational backgrounds. By making green tourism education materials more accessible to learners of all levels, this project will contribute to building inclusive higher education systems. Additionally, the project will include digital components, which will help engage learners, challenge their understanding, and provide feedback. They will help to facilitate the efficient delivery and consumption of educational material through digital transformation, digital readiness and resilience, making green tourism education more accessible to a wide range of learners. The project addresses the priority of inclusion and diversity in all fields of education and training of youth by ensuring the e-learning platform is accessible to all learners regardless of their background or circumstances. It will also include a range of content related to green tourism, such as sustainable practices and responsible tourism, to ensure that the users are well-informed and understand the importance of conserving the environment. Additionally, the platform will feature content relevant to different cultures and backgrounds so everyone can benefit from learning about green tourism.

Keywords: green tourism, sustainable practices, climate change, responsible travel, E-learning platform

Prezentacija projekta: Održive turističke inovacije putem hibridnog projektnog menadžmenta (HyPro4ST)

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Sažetak:
Turistički sektor diljem Europe prolazi kroz duboke promjene, dok živimo u projektnoj, digitalnoj, kreativnoj, poduzetničkoj eri i eri zelene ekonomije, stoga je primjena holističkog pristupa održivom razvoju turizma ključna. HyPro4ST suradnja nastoji donijeti pozitivan društveni i održiv učinak na turistički sektor, a temelji se na ideji da kolaborativne i transnacionalne aktivnosti nude prilike za poticanje inovacija i napretka kombiniranjem resursa i znanja vezanog uz potrebe tržišta u brzo promjenjivom svijetu. Cilj projekta je razviti novi profil posla "Održivi i hibridni voditelj projekata" za sektor održivog turizma, osposobiti profesionalce u održivom, hibridnom, digitalnom, kreativnom i poduzetničkom upravljanju projektima, pomažući ublažavanju gubitka radnih mjesta, nejednakosti i drugih rizika, te izgraditi bazen talenata koji turistički sektor može iskoristiti za budući rast. Također projekt je umjeren i na unapređenje vještina trenera u strukovnom obrazovanju i višem obrazovanju, kako bi se mogli prilagoditi potrebama tržišta rada. HyPro4ST razvija zajednički program obuke, HyPro4ST VOOC, u skladu s ECTS/EQF/EQAVET i mikrokredencijalnim pristupom, HyPro4ST praktičnim vodičem za trenere, shemom certificiranja za novi profil i HyPro4ST virtualnom obrazovnom platformom. Kroz 6 seminara, 6 online tečajeva, 2 aktivnosti učenja temeljenog na radu i transnacionalnu mobilnost, poboljšat će kompetencije 700 profesionalaca, umanjiti nesrazmjer u vještinama i podržati formiranje učinkovitog sustava višeg i strukovnog obrazovanja za sektor održivog turizma. Ovo projektno partnerstvo se sastoji od 16 partnera iz 6 europskih zemalja, razvija sve rezultate na 7 jezika EU, osiguravajući pri tome njihovu prekograničnu prenosivost. Nadalje, osigurava dugotrajni učinak rezultata projekta razvojem preporuka za politike, koje se mogu ugraditi u politike na nacionalnoj i EU razini.

Ključne riječi: održivi razvoj turizma, hibridno upravljanje projektima, digitalna platforma, obrazovanje, inovacije

Project presentation: Sustainable Tourism Innovation Through Hybrid Project Management (HyPro4ST)

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Abstract:
The tourism sector is undergoing profound changes throughout Europe, as we are living in the Project, Digital, Creative, Entrepreneurial and Green Economy era, thus applying a holistic approach to sustainable tourism development is crucial. HyPro4ST alliance seeks to bring positive social and sustainable impact to tourism sector and is built around the idea that collaborative, transnational activities offer opportunities for boosting innovation and progress by pooling resources and the deep knowledge of markets required in a fast-changing world. It aims to develop a new job "Sustainable and Hybrid Project Manager" profile for the Sustainable Tourism Sector, upskill professionals in sustainable, hybrid, digital, creative and entrepreneurship project management, helping alleviate the job losses, inequalities, and other risks, and to build a talent pipeline that tourism sector can mine for future growth. It also proposes the upscaling of VET and higher education trainers' skills, to be able to adapt to the tourism labour market needs. HyPro4ST develops a joint training programme, HyPro4ST VOOC, in accordance with the ECTS/EQF/EQAVET and Micro-credential approach, the HyPro4ST Practical Guide for trainers, a certification scheme for the new profile and the HyPro4ST Virtual Learning Hub. Through 6 Seminars, 6 online courses, 2 work-based learning activities and the transnational mobility, will enhance the competences of 700 professionals, tackling skills mismatches and supporting the formation of an effective higher and vocational education system for the sustainable tourism sector. This multi-stakeholder partnership, comprising of 16 partners from 6 European countries, develops all the outputs in 7 EU languages, ensuring their cross-border transferability. Furthermore, it assures the long-lasting effect of the project results by elaborating Policy Recommendations, able to inform the policy agendas at national and EU level.

Keywords: sustainable tourism development, hybrid project management, digital platform, education, innovation

Uspostava eksperimentalne površine za ekološko unaprjeđenje razvoja velikog bijelog tartufa (*Tuber magnatum* Pico) u Motovunskoj šumi

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Sažetak:
Tartufi su najcjenjenije prirodno dobro u šumama Hrvatske kao i u svijetu, koje s povećanjem standarda i razvojem turizma postaje sve važnije u svim dijelovima Hrvatske. Motovunska šuma je svjetski poznato nalazište i stanište velikog bijelog tartufa (*Tuber magnatum* Pico) te zbog toga zavrjeđuje posebnu pažnju. Tartufi su kao i svako drugo prirodno dobro izloženi različitim pritiscima i stresovima koji ograničavaju i onemogućavaju njihov razvoj. Prema podacima dobivenim anketiranjem tartufara 2024. godine, kao i prema stanju cijena velikog bijelog tartufa u zadnjih desetak godina u Istri, pronalaženje plodišta tartufa je sve teže i sve su manji primjerci pronađenih plodišta. Zbog važnosti velikog bijelog tartufa, kao i zbog velikog broja nepovoljnih čimbenika koji utječu na njegov razvoj, u Motovunskoj se šumi planira uspostaviti eksperimentalna površina za praćenje i ekološko unaprjeđenje razvoja velikog bijelog tartufa (*Tuber magnatum* Pico). Eksperimentalna površina bi bila podijeljena na nekoliko pokusnih ploha. Na jednoj pokusnoj plohi bi se pratilo postojeće stanje razvoja plodišta uz sadašnji način sakupljanja plodišta tartufa (kontrolna ploha), dok bi se na nekoliko drugih pokusnih ploha pratili utjecaji različitih načina unaprjeđenja razvoja tartufa temeljeni na ekološkim zakonitostima funkcioniranja šumskih ekosustava. Sakupljanje plodišta tartufa bi obavljali lokalni tartufari koji bi bili uključeni u projekt, ali pod nadzorom istraživačkog tima. U projektnom timu bi bili uključeni znanstvenici koji se bave klimatologijom, pedologijom, hidrologijom šuma, mikrobiologijom i drugim disciplinama. Projektom bi se utvrdilo početno stanje šumskih ekosustava na pokusnim plohama, posebno pedološka i hidrološka obilježja šumskih tala te bi se dugoročno pratila klimatska i mikroklimatska obilježja staništa. Napravila bi se komparativna analiza kontrolne plohe i različitih tretmana na ostalim pokusnim plohama. Rezultati projekta bi bili znanstvena podloga za unaprjeđenje razvoja velikog bijelog tartufa u Motovunskoj šumi, kao i smjernice za održivo gospodarenje tartufima u drugim dijelovima Hrvatske.

Ključne riječi: veliki bijeli tartuf, Motovunska šuma, unaprjeđenje razvoja tartufa, ekološke zakonitosti, funkcioniranje šumskih ekosustava

Establishment of an experimental area for the ecological improvement of the development of the large white truffle (*Tuber magnatum* Pico) in the Motovun forest

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Abstract:
Truffles are the most valued natural resource in the forests of Croatia and in the world, which is becoming increasingly important in all parts of Croatia with the increase in standards and the development of tourism. Motovun Forest is a world-famous site and habitat of the large white truffle (*Tuber magnatum* Pico) and therefore deserves special attention. Truffles, like any other natural resource, are exposed to various pressures and stresses that limit and prevent their development. According to data obtained from a survey of truffle hunters in 2024, as well as the price of the large white truffle in the last ten years in Istria, finding truffle fruiting bodies is becoming increasingly difficult and the number of fruiting bodies found is getting smaller. Due to the importance of the large white truffle, as well as the large number of unfavorable factors that affect its development, an experimental area is planned to be established in the Motovun Forest for monitoring and ecologically improving the development of the large white truffle (*Tuber magnatum* Pico). The experimental area would be divided into several experimental plots. On one experimental plot, the current state of fruiting body development would be monitored with the current method of collecting truffle fruiting bodies (control plot), while on several other experimental plots, the effects of different ways of improving truffle development based on the ecological laws of forest ecosystem functioning would be monitored. Truffle fruiting bodies would be collected by local truffle hunters who would be included in the project, but under the supervision of the research team. The project team would include scientists involved in climatology, pedology, forest hydrology, microbiology and other disciplines. The project would determine the initial state of forest ecosystems on the experimental plots, especially the pedological and hydrological characteristics of forest soils, and would monitor the climatic and microclimatic characteristics of the habitat in the long term. A comparative analysis of the control plot and different treatments on the other experimental plots would be made. The results of the project would provide a scientific basis for improving the development of the large white truffle in the Motovun Forest, as well as guidelines for sustainable truffle management in other parts of Croatia.

Keywords: large white truffle, Motovun Forest, improvement of truffle development, ecological principles, functioning of forest ecosystems

EIP projekt Usluge ekosustava

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Sažetak:
Usluge ekosustava definiraju se kao svi direktni i indirektni čimbenici ekosustava koji doprinose boljem životu kao društva ili kao pojedinaca. One se sve više koriste ne samo kao sredstvo predstavljanja vrijednosti prirode, već i s ciljem usmjeravanja društva prema održivom razvoju. Usluge ekosustava dijelimo na: opskrbne (hrana, gorivo, vlakna …), regulacijske (regulacija klime, pročišćavanje vode, kontrola bolesti, nametnika, oprašivanje) …, kulturne (npr. estetski, duhovni i rekreacijski doživljaji) te potporne (npr. formiranje tla, kruženje nutrijenata …).
Glavni cilj EIP projekta „Usluge ekosustava“ (trajanje: 18. 5. 2022. do 18. 5. 2025.) bio je unaprijediti kompetencije poljoprivrednih gospodarstava u području prilagodbe klimatskim promjenama te razvojem namjenske aplikacije pokušati riješiti problem s kojim se susreću mnoga manja gospodarstva – gdje na jednom mjestu dobiti sve informacije bitne za gospodarstvo, kako bi mogli planirati svoj razvoj i povećati otpornost na klimatske promjene. Uz pomoć aplikacije, koja je glavni rezultat projekta, pet poljoprivrednih gospodarstava i BC Naklo pristupa informacijama koje podržavaju tri usluge ekosustava kojima smo se bavili u projektu - bioraznolikost, turizam i ponor ugljika u šumama. Gospodarstva će tako postati "gospodarstva dobre prakse" te će moći dalje širiti stečeno znanje, a uz pomoć aplikacije pratiti svoj napredak i učinak provedenih mjera.

Ključne riječi: EIP projekt, usluge ekosustava, klimatske promjene, aplikacija

EIP Project Ecosystem Services

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Abstract:
Ecosystem services refer to all the direct and indirect contributions of ecosystems to the well-being of human society or individuals. They are increasingly used not only as a means of representing the value of nature, but also with the aim of guiding society towards sustainable development. Ecosystem services are divided into: supply (food, fuel, fibers...), regulatory (climate regulation, water purification, disease control, pests, pollination…), cultural (e.g. aesthetic, spiritual and recreational experiences) and support (e.g. soil formation, nutrient cycling...).
The main goal of the EIP project "Ecosystem Services" (duration: 18/05/2022 to 18/05/2025) was to improve the competences of agricultural farms in the field of adaptation to climate change and to try to solve the problem faced by many smaller farms by developing a dedicated application - where to get all the information important for the economy in one place, so that they can plan their development and increase resistance to climate change. With the help of the application, which is the main result of the project, five agricultural farms and BC Naklo access information that supports the three ecosystem services that we dealt with in the project - biodiversity, tourism and the carbon sequestration in forests. Farms will thus become "farms of good agriculture practice" and will be able to further spread the acquired knowledge, and with the help of the application, monitor their progress and the effect of the implemented measures.

Keywords: EIP project, ecosystem services, climate change, application

EIP projekt Inovativni model zaštite od požara integrirane revitalizacije farmi

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Sažetak:
EIP projektom pokušali smo poboljšati požarnu sigurnost poljoprivrednog i šumskog zemljišta jačanjem prirodnih i izgrađenih ekosustava te ukazati na mogućnost revitalizacije nakon požara. Kreirali smo inovativni protupožarni model za integriranu revitalizaciju poljoprivrednih gospodarstva, što je ujedno i glavni rezultat projekta. Geomantijska analiza, koja novim sadržajima objašnjava odnos ljudi i prirode, dala je osnovne podatke o prirodnim i nematerijalnim datostima pojedinih gospodarstava sa stajališta njihove sposobnosti samoobnavljanja, što također ovisi o geološkoj podlozi, nagibu i orijentaciji terena, te debljini i vrsti uzgojne podloge (zemljišta). Prirodna bogatstva podržana su uključivanjem vodno-zelene infrastrukture, koja obuhvaća mrežu vodenih i zelenih površina kako bi se stvorio ekosustav koji iskorištava potencijal prirode za pružanje niza ekoloških, društvenih i ekonomskih koristi. U projektu su ovi elementi uključivali načine zadržavanja vode u tlu, ponovno korištenje kišnice, povećanje humifikacije tla, korištenje biomase kao izvora obnovljivih sirovina, zadržavanje vode na padinama malčom od trave, korištenje tradicionalnih pristupa zadržavanju tla s kamenim ogradama te jačanje autohtonih vrsta grmlja i drveća i odabir biljaka otpornih na nedostatak vode. Glavni cilj projekta bio je razvoj i pokusno testiranje inovativnog modela integrirane obnove gospodarstava nakon požara i njihove zaštite od požara.

Ključne riječi: EIP projekt, vatrootporni model, revitalizacija, obiteljska poljoprivredna gospodarstva

EIP Project Innovative Fire Protection Model of Integrated Revitalization of Farms

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Abstract:
With the EIP project, we aimed to improve the fire safety of agricultural and forest land and indicate the possibility of revitalization after fires by strengthening natural and built ecosystems. We developed an innovative fire prevention model for the comprehensive revitalization of farms, which is the main result of the project. Geomantic analysis provided basic information about the natural and intangible features of individual farms in terms of their ability to self-renew, depending on the geological substrate, slope and orientation of the terrain, and the thickness and type of soil. Natural features were supported by blue-green infrastructure, which includes a network of water and green areas to create an ecosystem with ecological, social, and economic benefits. In the project, these elements included retaining water in the soil, reusing rainwater, increasing soil humification, utilizing biomass, retaining water on slopes with grass swales, using traditional soil retention approaches with stones, and strengthening indigenous shrub and tree species and selecting agricultural plants resistant to water scarcity. The main goal of the project was the development and pilot testing of an innovative model for the comprehensive restoration of farms after a fire and their fire safety.

Keywords: EIP project, fire protection model, revitalisation, family farm

Geographical Indications and Producer Cooperation in Slovenia: Challenges and Opportunities

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Abstract:
The globalization of food production has weakened the link between agricultural products and their geographical origins, leading to food homogenization and consumer distrust. In Slovenia, where agriculture is central to cultural identity and food security, these trends exacerbate challenges such as the decline of traditional practices and rural economic shifts. To counteract these effects, the EU introduced quality schemes like Protected Designation of Origin (PDO) and Protected Geographical Indication (PGI) to safeguard product authenticity and promote producer cooperation.

This presentation examines how PDO and PGI schemes influence collaboration among Slovenian food producers. Using semi-structured interviews and qualitative data analysis, we assessed the impact of these schemes on collective organization, resource sharing, and market performance. Findings suggest that while PDO and PGI schemes foster cooperation in regions with strong traditions of collective action, historical distrust of cooperatives—particularly from the socialist era—remains a barrier in other areas, limiting their full potential.

From a market perspective, the inclusion of products in PDO and PGI schemes has generally resulted in increased product reputation, higher prices, and greater sales volumes. Specific Slovenian examples, such as Kraški pršut, have demonstrated moderate improvements in visibility and consumer trust. However, in most cases, these gains have been marginal and have not led to a significant breakthrough in market success. The benefits remain modest and uneven across different regions and product types.

A key challenge is fragmented governance, as Slovenia lacks a centralized support system to help producers navigate PDO and PGI management. This results in inefficiencies and missed opportunities for collective organization. Establishing a national coordinating body and educational initiatives to build trust among producers could enhance cooperation and optimize the benefits of these schemes.

Additionally, economic pressures also limit the adoption and inclusion of producers in these schemes. Many producers perceive geographical indication standards as a "golden cage"—strict limitations on pesticide use, mechanical methods, and modern technological processes are viewed as overly conservative. These restrictions, although intended to preserve traditional methods, often constrain entrepreneurial initiative and innovation, discouraging broader participation, especially among younger or more commercially oriented producers.

The research also highlights the economic and sustainability dimensions of PDO and PGI. While these schemes strengthen market competitiveness and support sustainable agriculture, their adoption remains uneven due to the tensions between tradition and innovation. The study concludes with recommendations for improving implementation, strengthening governance structures, and promoting long-term producer cooperation.

These insights contribute to ongoing EU and national policy discussions on geographical indications, ensuring they better address producers' needs and support rural development in Slovenia and beyond.

Key Words: Geographical Indication, Protected Designation of Origin (PDO), Protected Geographical Indication (PGI), Rural Development, Slovenia

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