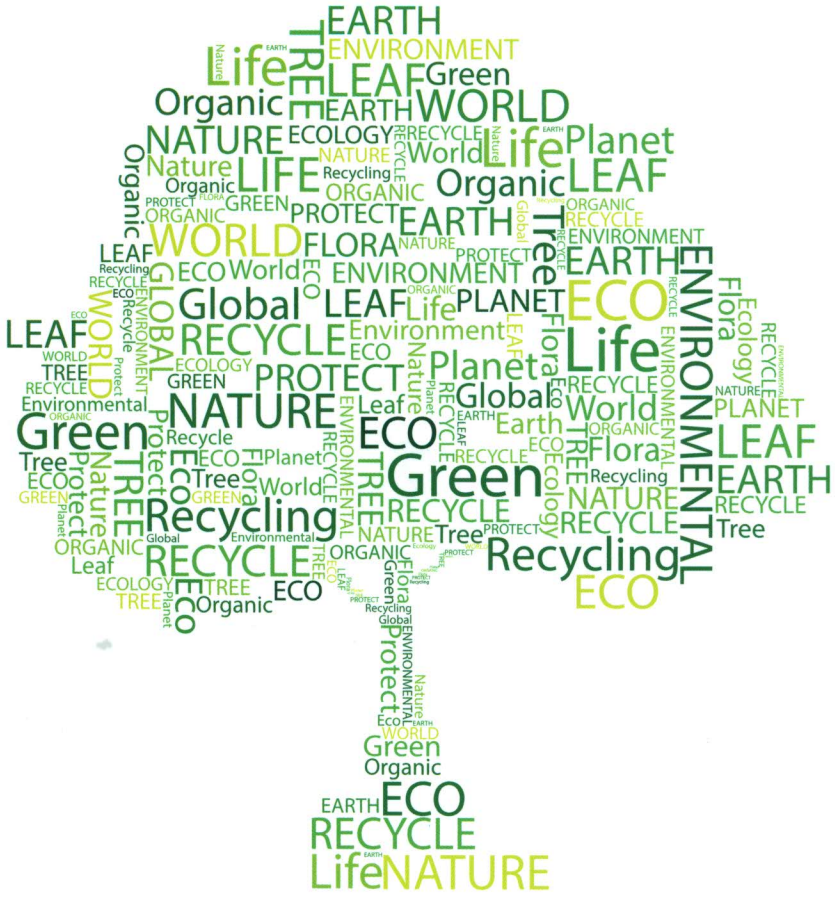

BOOK OF ABSTRACTS

Natural resources green technology & sustainable development

26 – 28 November 2014, Zagreb, Croatia

BOOK OF
ABSTRACTS

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Croatian Society of Biotechnology
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Dear coll
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Welcome to the International scientific and expert conference "Natural resources, green technology and sustainable development" organized by Croatian Forest Research Institute and Faculty of Food Technology and Biotechnology, University of Zagreb and supported by Faculty of Forestry, University of Zagreb, Institute for Adriatic Crops and Karst Reclamation and Croatian Society of Biotechnology. We are pleased that the Conference is taking place in Zagreb, the capital city of the Republic of Croatia.

Leagues friends,

We feel very proud to organize this Conference with the support of International organizations International Union of Forest Research Organizations, European Forest Institute and European Biotechnology Thematic Network Association.

The conference dedicated to challenges and opportunities in natural resource management, emphasizing potential of rural area, functional food and useful products coming from nature implementation of green technology, biomass and sustainability, and biodiversity and ecosystem services.

Beyond any expectations, more than 120 abstracts written by experts from 16 countries have been sent for presentation at GREEN2014. Researchers from eminent institutions will present their recent achievements. The multidisciplinary approach will bring together scientists and experts together to discuss and highlight the latest achievements in science, illustrate new policies, demonstrate innovative techniques and outline sustainability of natural resources.

We use this opportunity to express gratitude to our patrons and Auspices, International Scientific and Organizing Committee as well as to all of you for your scientific involvement which will certainly contribute to the success of the Conference. Special thanks are addressed to sponsors who enabled the preparation of this event.

Thank you for joining us!

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Ivana Radojčić Redovniković

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PLENARY PRESENTATIONS
CHAIRS: D. Vuletić, D. Pettenella

09.30-10.00 **Davide Pettenella:** NWFP marketing as a tool for the development of rural areas, Department of land, environment, agriculture and forestry, University of Padova, Italy

10.00-10.30 **Bernhard Wolfslehner:** Natural Resource Management – the European dimension, European Forest Institute, EFICEEC-EFISEE Head of Office

10.30-10.45 **Dijana Vuletić:** Attitudes towards forests, use of non-wood forest products and recreational opportunities- results from two case studies in Croatia, Croatian Forest Research Institute, Croatia

10.45-11.00 **Makedonka Stojanovska:** Challenges and opportunities for improving of NWFP-based small and medium enterprises businesses in SEE region, Faculty of Forestry, Ss. Cyril and Methodius University in Skopje, Republic of Macedonia

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SESSION A: NATURAL RESOURCE MANAGEMENT AND POTENTIAL OF RURAL AREA - *continues*

CHAIRS: D. Vuletić, D. Pettenella

11.15-11.30 **Adriano Ciani:** The valorisation of the local natural resources as example as of bottom-up action for the Sustainable Management and Promotion of Territory (A study case of the Stone Art School of Macereto-Italy), Faculty of Agriculture, University of Perugia, Italy

11.30-11.45 **Nenad Lukić:** Exploring the issue of urban forests in Serbia: human and institutional dimension, Faculty of University of Novi Sad, Novi Sad, Serbia

11.45-12.00 **Fabio Pastorella:** Does mountain landscape characteristics influence visual appeal? A study case in an Alpine valley in Italy, European Forest Institute (EFI) - Project Centre "MOUNTFOR", Italy

12.00-12.15 **Petra Isabella Schwarz:** Green Care FOREST – diversification as an opportunity for forestry, Austrian Research and Training Centre for Forests, Natural Hazards and Landscape, Austria

12.15-12.30 **Hikmet Batuhan Günşen:** Participation of stakeholders on protected area management in Turkey: case of Küre Mountains National Park, Faculty of Forestry, Bartın University, Turkey

12.30-12.45 **Wiene Andriyana:** Towards sustainable management of Java's teak forest: how have decentralization policy and movement affected the practices of collaborative forest management programme? University of Natural Resources and Applied Life Sciences, Institute of Forest Environmental and Natural Resource Policy, Austria

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CHAIRS: M. Avdibegović, H. Marjanović

13.45-14.15 **Margaret Shannon:** IUFRO -Divison 9 Forest policy and economics, Baldy Center for Law and Social Policy, SUNY Buffalo Law School, Buffalo, USA

14.15-14.30 **Mersudin Avdibegović:** Forest certification in Bosnia-Herzegovina and Slovenia: obstacles and effects, Faculty of Forestry, University of Sarajevo, Bosnia and Herzegovina

14.30-14.45 **Karlo Beljan:** Economic valuation of urban trees: park Ribnjak case study, Zagreb, Faculty of Forestry, University of Zagreb, Croatia

14.45-15.00 **Hrvoje Marjanović:** Distribution and dynamic of carbon stocks by pools in managed forest of Pedunculate oak, Croatian Forest Research Institute, Croatia

15.00-15.15 **Jura Čavlović:** Stand growth characteristics of common beech (*Fagus sylvatica L.*) - projection of even-aged to multi-aged stand structure, Faculty of Forestry, University of Zagreb, Croatia

15.15-15.30 **Krunoslav Teslak:** Impact of the actual structure and management on the future development and sustainable management of the pedunculate oak forests in eastern Croatia, Faculty of Forestry, University of Zagreb, Croatia

15.30-15.45 **Krešimir Krapinec:** Growth dynamic of some body parameters of European mouflon (*Ovis gmelini musimon*) in the EU-Mediterranean zone of the northern Adriatic Sea, Faculty of Forestry, University of Zagreb, Croatia

CONFERENCE HALL ZAGREB II

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SESSION B: FUNCTIONAL FOOD AND USEFUL PRODUCTS FROM NATURAL SOURCES

PLENARY PRESENTATION
CHAIRS: M. Serafini, V. Dragović-Uzelac

13.45-14.30 **Mauro Serafini:** Linking sustainable diets and functional food from natural sources for human and planet health, Functional Food and Metabolic Stress Prevention, Italy

14.30-14.45 **Verica Dragović-Uzelac:** Wild fruits as ingredients for functional food, Faculty of Food Technology and Biotechnology, University of Zagreb, Croatia

14.45-15.00 **Slađana Šobajić:** Fortified foods as an additional source of nutrients in Serbia, Faculty of Pharmacy, University of Belgrade, Serbia

15.00-15.15 **Vesna Zechner-Krpan:** Spent brewer's yeast, a raw material for isolation of β-glucan, Faculty of Food Technology and Biotechnology, University of Zagreb, Croatia

15.15-15.30 **Ömer Faruk Çelik:** The effects of starter culture on chemical composition, textural and sensory characteristics of turkish tulum cheese with half fat during ripening, Faculty of Agriculture, Ordu University, Turkey

15.30-15.45 **Ivana Tlak Gajger:** Impact of honeybee casting comb foundations production on lead concentrations, Faculty of Veterinary Medicine, University of Zagreb, Croatia

15.45-16.15 **COFFEE BREAK**

CONFERENCE HALL GRIČ

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20.00 **GALA DINNER**
Restaurante STARI FIJAKER, Zagreb

CONFERENCE HALL ZAGREB I

Hotel Panorama

8.00-9.00 Registration

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IMPLEMENTATION OF GREEN TECHNOLOGY

SESSION D:
BIOMASS AND SUSTAINABILITY

CHAIRS: **A. Sander, M. Brnčić**
PLENARY PRESENTATIONS

9.00-9.45 **James Clark:** Green chemistry and the bio-refinery, Green Chemistry Centre of Excellence, University of York, UK

9.45-10.30 **Roland Ludwig:** Oxidative cellulose degradation BOKU – University of Natural resources and Life Sciences, Vienna,

10.30-10.45 **Mladen Brnčić:** Novel processing technologies for food and agro waste and by products remediation, Faculty of Food Technology and Biotechnology, University of Zagreb, Croatia

10.45-11.00 **Matej Ravber:** Semi-continuous hydrothermal processing of larch bark for production of phenolic compounds and other natural antioxidans, Faculty of Chemistry and Chemical Engineering, University of Maribor, Slovenia

11.00-11.15 **Aleksandra Sander:** Green solvent in separation processes, Faculty of Chemical Engineering and Technology, University of Zagreb, Croatia

11.15-11.30 **Stela Jokić:** Supercritical fluid extraction – new green technology in production of edible oils, Faculty of Food Technology, University of Osijek, Croatia

11.30 -11.45 **COFFEE BREAK**

Lectures & Parallel sessions

CONFERENCE HALL ZAGREB I

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IMPLEMENTATION OF GREEN TECHNOLOGY - *continues*

CHAIRS: **A. Sander, M. Brnčić**

11.45-12.00 **Tina Perko:** Properties of starches in mixtures with supercritical CO_2 and theiruse as carriers in pgss micronization process, Faculty of Chemistry and Chemical Engineering, University of Maribor, Slovenia

12.00-12.15 **Ivana Radojčić Redovniković:** Green solvents for green technologies, Faculty of Food Technology and Biotechnology, University of Zagreb, Croatia

12.15-12.30 **Aleksandra Cvetanović:** Subcritical water extraction of biologically active compounds from natural sources, Faculty of Technology, University of Novi Sad, Serbia

12.30-12.45 **Ana Jurinjak Tušek:** Aqueous two-phase extraction of polyphenols from red and white wine in microextractor, Faculty of Food Technology and Biotechnology, University of Zagreb, Croatia

12.45-13.00 **Jasna Halambek:** Green approach in preventing corrosion of metals and alloys, Faculty of Food Technology and Biotechnology, University of Zagreb, Croatia

13.00-13.15 **Zvjezdana Stančić:** Application of phytoremediation for heavy-metal removal using common wild plant species in green city areas of Varaždin, Croatia, Faculty of Geotechnical Engineering, University of Zagreb, Croatia

13.15-13.30 **Instrumentalia Adria:** A New Category of Separations Science: Convergence Chromatography & Applications, Croatia

CONFERENCE HALL ZAGREB II

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SESSION D1:
FOREST BIOMASS AND SUSTAINABILITY

CHAIRS: **M. Šušnjar, P. Čurić**
PLENARY PRESENTATION

11.30-12.15 **Petar Čurić: Opportunities and potential of biomass utilization in Croatia,** Croatian Chamber of Economy, Croatia

12.15-12.30 **Marijan Šušnjar:** Energy balance of wood chip production, Faculty of Forestry, University of Zagreb, Croatia

12.30-12.45 **Dinko Vusić:** Optimization of energy wood chips quality by proper raw material manipulation, Faculty of Forestry, University of Zagreb, Croatia

12.45-13.00 **Vasko Plevnik:** Biomass fired cogeneration with wastewater sludge coincineration and 1 MW steam turbine, Enerkon Ltd, Croatia

13.00-13.15 **Željka Fištrek:** Optimising the environmental sustainability of short rotation coppice biomass production for energy, Energy Institute Hrvoje Požar, Croatia

13.15-13.30 **Zagrebačka banka:** Renewable energy and opportunities

13.30-14.30 **LUNCH**

Lectures & Parallel sessions

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CHAIRS: R. Ludwig, T. Rezić

14.30-14.45 **Anita Slavica:** Advances in production of optically pure lactic acid - platform C3 compound in manufacturing commodity and high-value chemicals, Faculty of Food Technology and Biotechnology, University of Zagreb, Croatia

14.45-15.00 **Suzana Rimac Brnčić:** Food by products as sources of functional ingredients, Faculty of Food Technology and Biotechnology, University of Zagreb, Croatia

15.00-15.15 **Senka Vidović:** By products of food industry and possibilities of utilization, Faculty of Technology, University of Novi Sad, Serbia

15.15-15.30 **Vlatka Petravić Tominac:** Forest residues and wood waste as renewable raw materials in biotechnology, Faculty of Food Technology and Biotechnology, University of Zagreb, Croatia

15.30-15.45 **Tonči Rezić:** Integrated Hydrolysation and Fermentation of lignocellulose to bioethanol, Faculty of Food Technology and Biotechnology, University of Zagreb, Croatia

15.45-16.00 **Bruno Bogdan:** Biomass gasification cogeneration plant with 1 MW gas engines, Enerkon Ltd, Croatia

16.00-16.15 **Jadranka Barešić:** A new technique for determination of biogenic fraction in liquid fuel by the 14C method, Ruđer Bošković Institute, Croatia

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SESSION D1:
FOREST BIOMASS AND SUSTAINABILITY - *continues*

CHAIRS: I. Balenović, D. Vusić

14.30-14.45 **Akira Kato:** Increasing biomass energy production from fast-growing tropical plantation forest, Graduate School of Horticulture, Chiba University, Japan

14.45-15.00 **Natasha Nikodinoska:** Environmental costs and benefits of wood-based bioenergy production: A case study in Sarentino Valley (Northern Italy), Department of Science and Technology, Parthenope University of Naples,Italy

15.00 -15.00 **Dušan Stojnić:** Production of wood biomass in coniferous forests of the Republic of Serbia, Faculty of Forestry, University of Belgrade, Serbia

15.15-15.30 **Elvis Paladinić:** Locally developed alometric models of forest woody biomass assessment in young Pendunculate oak forest stands of a part of Spačva basin, Croatian Forest Research Institute, Croatia

15.30-15.45 **Alessandro Paletto:** Environmental experts' perceptions of the impacts of forest biomass harvesting on ecosystem services, Agricultural Research Council (CRA), Italy

15.45-16.00 **Milorad Danilović:** Use of forest residues in the final cut of reproductive felling, Faculty of Forestry, University of Belgrade, Serbia

16.00-16.15 **Labeko:** Instrumental methods of determining carbon, hydrogen, nitrogen and sulfur in biomass, Croatia

16.15-16.45 **COFFEE BREAK**

CONFERENCE HALL GRIČ

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16.15-16.45 **Poster presentations (SESSIONS C&D)**

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CONFERENCE HALL ZAGREB I

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8.00-9.00 Registration

SESSION E:
BIODIVERSITY AND ECOSYSTEM SERVICES

CHAIRS: N. Potočić, A. De Marco
PLENARY PRESENTATIONS

9.00-9.45 **Alessandra De Marco:** Can modelled and measured data interact to evaluate forest health condition?, Italian National Agency for New Technologies, Energy and Sustainable Economic Development, Rome, Italy

9.45-10.00 **Nenad Potočić:** Monitoring of forest ecosystems as a part of UNECE – ICP Forests programme, Croatian Forest Research Institute, Croatia

10.00-10.15 **Ivan Pilaš:** Response strategies of the main forest types to climatic anomalies in Croatia inferred from JRC FAPAR sensing data, Croatian Forest Research Institute, Croatia

10.15-10.30 **Jasnica Medak:** Ground vegetation composition as an important biodiversity factor and possible bioindicator in lowland forest ecosystems of Spačva, Croatia, Croatian Forest Research Institute, Croatia

10.30-10.45 **Halil Özel:** The evaluation ground vegetation structure by the time series analyses in Turkish red pine (Pinus brutia Ten.) plantations in the western Black sea region in Turkey, Faculty of Forestry, University of Bartın, Bartın, Turkey

10.45-11.00 **Željko Zgrablić:** First results on mycocoenological and phytocoenological characteristics of Austrian pine (Pinus nigra) stands in Istria, Croatian Forest Research Institute, Croatia

11.00-11.30 **COFFEE BREAK**

CONFERENCE HALL GRIČ

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11.30 **POSTER PRESENTATIONS (SESSION E)**

CONFERENCE HALL ZAGREB I

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SESSION E:
BIODIVERSITY AND ECOSYSTEM SERVICES - *continues*

CHAIRS: S. Perić, D. Matošević

11.30-11.45 **Vojislav Dukić:** The structure and dynamics of mixed-species stand of Scots pine, Norway spruce and silver fir on mountain Klekovača (B&H), Faculty of Forestry, University of Banja Luka, Bosnia and Herzegovina

11.45-12.00 **Cengiz Yücedağ:** Studies on morphogenetic characteristics of juvenile and one year old seedlings of some registered Brutian pine (*Pinus b rutia Ten.*) seed stands in lakes district, Engineering Faculty, Bartın University, Turkey

12.00-12.15 **Vasilije Isajev:** Gene pool conservation and tree improvement in Serbia, Institute of Forestry, Belgrade, Serbia

12.15-12.30 **Sanja Perić:** Management of forest cultures on karst areas in Lika, Croatian Forest Research Institute, Croatia

12.30-12.45 **Dinka Matošević:** Box tree moth (*Cydalima perspectalis*), new invasive insect pest in Croatia, Croatian Forest Research Institute, Croatia

12.45-13.45 **LUNCH**

13.45-14.00 **Božena Barić:** Distribution and flight dynamic of Rhagoletis completa (Diptera;Tepritidae) and walnut quality evaluation in Croatia, Faculty of Agriculture, University of Zagreb, Croatia

14.15-14.30 **Boris Liović:** Alternative formulations for protection against oak powdery mildew, Croatian Forest Research Institute, Croatia

14.30-14.45 **Milan Pernek:** Comparison of Thaumatopea processionea populations in Brandenburg/Germany and Croatia - Why does the population in Croatia not increase? Croatian Forest Research Institute, Croatia

14.45-15.00 **Sanja Novak Agbaba:** Research activities in chestnut stands for their better future, Croatian Forest Research Institute, Croatia

15:00-15:30 **CLOSING REMARKS**


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Poster Presenta

tions

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AP2 **Alen Berta, Vladimir Kušan, Roman Danko, Dalibor Hatić, Oleg Antonić:** Correlation of forest ecosystem management and carbon sequestration

AP3 **Alen Berta, Vladimir Kušan, Roman Danko, Dalibor Hatić, Oleg Antonić:** Methods for forest carbon pool measurement

AP4 **Bum-Jin Park, YoonHo Choi, DaWou Joung, ChiWon Kwon:** The evidence of health promotion on walking in forest environments for ecotourism

AP5 **Adriano Ciani:** The Territorial Contract Management: a sharing proactive challenge for the rural areas actors for the Sustainable Development Strategy

AP6 **Elisa Gobbi, Francesca Odella, Alessandro Paletto, Natasha Nikodinoska:** Social capital and common forests management in Trentino (Italy)

AP7 **Ana Fornažar:** Model forest „River Mirna basin"

AP8 **Vezirka Jankuloska, Blagica Bliznakovska:** Evaluation of the quality of the drinking water within the water supply system „Studencica", Kichevo

AP9 **Igor Kolar:** Circular economy as an opportunity to increase forest sector competitiveness

AP10 **Hrvoje Marjanović, Maša Zorana Ostrogović Sever, Jura Čavlović:** Stocks and structure of standing dead wood in managed forests of Croatia

AP11 **Fran Poštenjak, Karmelo Poštenjak:** Croatia urban area - land cover analisys (preliminary report)

AP12 **Jadranka Roša:** Control and certification of organic productions in agriculture and forestry

AP13 **Zvjezdana Stančić, Dinko Vujević, Ines Dobrotić, Zoran Bajsić:** Heavy metals in the soil of the Varaždin region (Croatia)

AP14 **Kristijan Tomljanović, Marijan Grubešić, Helga Medić, Nives Marušić:** Wild boar meat production and market on the territory of Republic of Croatia

AP15 **Mirsad Veladžić, Fatima Muhamedagić, Dragan Šulović, Amarildo Mulić:** Resources and land use in the region of the National Park Una in the function of sustainable management and development

AP16 **Ana Žmire, Dora Tomić, Sonja Butula, Vesna Koščak Miočić-Stošić:** The application of landscape ecology principles within the landscape planning

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BP3 **Tamara Jakovljević, Jasna Halambek, Kristina Radošević, Višnja Gaurina Srček, Karla Hanousek, Ivana Radojčić Redovniković:** The potential use of *Amorpha fruticosa* L. as natural resource of biologically active compounds

BP4 **Maja Jukić Špika, Rajko Vidrih, Gvozden Dumičić, Lovro Sinkovič, Branimir Urlić, Katja Žanić:** Functional properties of some garlic ecotypes

BP5 **Dario Kremer, Iztok Jože Košir, Valerija Dunkić, Marko Randić, Ivan Kosalec, Siniša Srečec:** Phytochemical traits of some traditional medicinal plants

BP6 **Marija Radojković, Slađana Čestić, Aleksandra Cvetanović, Pavle Mašković, Zoran Zeković:** Antioxidative properties of various herbal mulberry teas

BP7 **Zekai Tarakçı, Yusuf Durmuş, Beşir Dağ:** Effects of adding cherry laurel (*Laurocerasus officinalis*) on macro and micro mineral concentrations of tarhana

BP8 **Zekai Tarakçı:** Turkish cacik and labneh production methods and properties

BP9 **Vanja Todorović, Slađana Šobajić, Ivan Stanković, Bojana Vidović, Ivana Đuričić:** Impact of alkalization on total polyphenols content, total flavonoids content and antioxidant capacity in commercial cocoa powders

BP10 **Mirella Žanetić, Eva Marija Čurin:** Virgin olive oil as functional food

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CP3 **Ines Dobrotić, Zvjezdana Stančić, Dinko Vujević, Zoran Bajsić:** Removal of heavy metals from soil by phytoremediation using dandelion (*Taraxacum officinale* Agg.) in the area of the city of Varaždin

CP4 **Filip Hajek, Marko Rogošić, Tina Perko, Željko Knez, Mojca Škerget:** Isolation of flavonoids from propolis by supercritical CO_2 extraction

CP5 **Tamara Jakovljević, Marina Cvjetko Bubalo, Karla Hanousek, Marija Sedak, Nina Bilandžić, Darija Papst, Ivana Radojčić Redovniković:** The potential of poplar (*Populus nigra* var. *italica*) in the phytoremediation of lead

CP6 **Tamara Jakovljević , Ivana Radojčić Redovniković, Chiara Proietti, Alessandra De Marco, Marina Cvjetko Bubalo, Valentino Blasina, Karla Hanousek, Marija Sedak,Nina Bilandžić:** Phytoremediation - Green solution for pollution

CP7 **Domingo Martínez-Fernández, Martina Vítková, Michael Komárek:** Effects of nano oxides on *Helianthus annuus* in a contaminated soil

CP8 **Aleksandra Sander, Maja Žužić, Marina Cvjetko Bubalo:** Deep eutectic solvent choline chloride:glycerol as selective solvent for extraction of pyridine from *n*-hexane

CP9 **Aleksandra Sander, Marko Rogošić, Borna Ferčec:** Liquid-liquid equilibrium for the systems hydrocarbon–thiophene–1-hexyl-3,5-dimethy -lpyridinium bis (trifluoromethylsulfonyl)imide

CP10 **Aleksandra Sander, Mladena Dujmenović, Marina Cvjetko Bubalo:** Separation of tiophene from *n*-hexane by the mixture of ionic liquids

CP11 **Anamarija Slivar, Valentino Sambolek, Barbara Žuteg, Martina Hrkovac:** Liquid-liquid extraction as a successfull tool for regeneration of ionic liquids

CP12 **Lukas Trakal, Michael Komarek:** Application of amorphous manganese oxide and biochar as stabilizing amendments for Pb and Zn in a contaminated soil

Session D

DP1 **Katerina Lappa, Panagiotis Kandylis, Argyro Bekatorou, Maria Kanellaki, Athanasios Koutinas:** Effect of pH and temperature on acidogenesis of sucrose using free and immobilized mixed anaerobic bacteria on mineral kissiris

DP2 **Davorin Kajba, Ivan Andrić:** Selection of willows (*Salix* sp.) for biomass production

DP3 **Marija Srbinoska, Vesna Krsteska, Jana Simonovska, Zoran Kavrakovski, Vesna Rafajlovska:** Evaluation of tobacco stems as lignocellulosic material

DP4 ~~**Vasilije Isajev, Aleksandar Lučić, Ljubinko Rakonjac:** Gene pool conservation and tree improvement in Serbia~~

Session E

EP1 **Ivan Balenović, Hrvoje Marjanović, Anamarija Jazbec, Elvis Paladinić, Krunoslav Indir, Danijela Ivanković, Dijana Vuletić:** Modelling tree characteristics of individual Black pine trees for use in remote sensing based inventory

EP2 **Lukrecija Butorac, Vlado Topić, Nikola Pernar, Goran Jelić:** The role of forest vegetation in karst on soil protection from erosion

EP3 **Nevenka Ćelepirović, Monika Karija Vlahović, Tibor Littvay, Milovan Kubat, Mladen Ivanković:** Genetic diversity of common walnut in Croatia

EP4 **Vladislava Galović, Saša Orlović, Miroslav Zorić, Branislav Kovačević, Sreten Vasić:** Different phenology induced genotype diversity of *Q. robur* L. in the seed orchard in Srem provenance, Republic of Serbia

EP5 **Kever Bruno P. Gomes, Rosana C. C. Martins, Ildeu S. Martins:** Evaluation of the internal morphology of *Terminalia argenta* Mart. et Zucc. (Combretaceae) seeds by the x-ray test

EP6 **Marija Gradečki-Poštenjak, Boris Liović, Sanja Novak Agbaba:** Investigation of conditions for processing and storage of pedunculate oak acorns (*Quercus robur* L.)and acorn quality during storage

EP7 **Krunoslav Indir:** On the possibility of using standard increment series in evenaged forests of NW Croatia

EP8 **Tamara Jakovljević, Daniel Žlindra, Mitja Skudnik, Karla Hanousek:** Nitrogen deposition measurement in Croatia and Slovenia

EP9 **Goran Jelić, Vlado Topić, Lukrecija Butorac, Anamarija Jazbec:** Influence of container size on quantitative morphological indicators of Aleppo pine (*Pinus halepensis* Mill.) one year old seedlings

EP10 **Vladimir Novotny, Stjepan Dekanić, Tomislav Dubravac:** Relationship of stand structure in Croatian pecundulate oak and common hornbeam forests with growth and yield tables as guidelines for forest management: current state and challenges

EP11 **Nenad Potočić, Davorin Kajba, Igor Anić, Stjepan Mikac, Ivan Andrić:** Nutritional status and stress tolerance index in effective selection of poplar clones

EP12 **Dejan Stojanović, Tom Levanič, Bratislav Matović, Saša Orlović:** An impact of temperature on a growth of Pedunculate oak in Strict Nature Reserve "Stara Vratična"

EP13 **Rasa Vaitkevičiūtė:** Status and protection of NATURA 2000 sites: case study of common juniper (*Juniperus communis* L.) formations in Lithuania

EP14 **Oguzhan Sarikaya, Huseyin Sayin:** Bark and ambrosia beetles of decidous trees in the Kasnak oak (*Quercus vulcanica*) nature protection area of Turkey

EP15 **Michelle S. Oliveira, Kever Bruno P. Gomes:** Evaluation of the internal morphology of Platypodium elegans Vog. (Fabaceae) seeds by the x-ray test

EP16 **Tomislav Dubravac, Sanja Perić, Martina Tijardović:** Growth and development dynamic of young holm oak high forest (Quercus ilex L.) – results of multiannual monitoring of natural regeneration by shelterwood cuttings

Plenary Talks

FOREST POLICY AND ECONOMICS

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KEYWORDS:
environmental services, economics, forest, management, policy, social dimension

The role of forests and forestry has changed in the last decades. Forests are no longer seen simply as a source for timber supply, but rather as ecosystems that sustain livelihoods and provide a range of products and environmental services. Additionally challenges like market globalization and global environmental problems encounter forests and demand new requirements for sustainable forest management. Moreover the economic dimension of forestry providing societies with the renewable raw material timber has proven to become more and more important during the past years. The resulting tensions at the different political levels need to be regulated by forest policy processes. The research of Division 9 Forest Policy and Economics investigates in elements and the function of this social dimension of forests. Different research areas are equally important to considerably improve the knowledge on drivers and consequences of change of the social dimension of forests, such as the historical perspective, the economic and political analysis or the regulative dimension. Areas like management, information and communication support the strong relation to the needs and opportunities of the forest sector in regards to the social dimension.

NATURAL RESOURCE MANAGEMENT – THE EUROPEAN DIMENSION

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KEYWORDS:
natural resource management, forest sector, European policy, research collaboration, innovation

The topic of the talk is to give an overview on the European dimension of natural resource management. It addressess the policy landscape for natural resources and forest management, and gives an overview on the plethora of instruments that directly or indirectly influence natural resource management addressing issues such as Agricultural and Rural Development Policy, EU cohesion policy, Environmental Policy and Biodiversity, Energy and Climate, Industry and Trade Policy, Research and Innovation Policy, Plant Health and Protection Policy, Development and Cooperation Policy, Water Policy. The presentation concludes with an overview on European research collaboration in the context of natural resource management and innovation needs for the future.

NWFP MARKETING AS A TOOL FOR THE DEVELOPMENT OF RURAL AREAS

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In Europe a substantial decreasing level of profitability in timber production has been observed over the past decades. On the contrary, in many European countries, in particular in Southern part of the continent, expanding markets for Non Wood Forest Products (NWFP) can be observed. These markets are associated to tourist and recreational activities or to sales, normally based on local and "short" value chains, of fresh and processed products offered as specialty products, with strong links with the local traditions and the cultural and environmental characteristics of the rural territories. Despite the growing interest in NWFP marketing, in most cases the social, economic and environmental implications of their use in European countries are largely unknown because of a substantial lack of data. If we do not consider some products with consolidated and specialized markets (e.g.: cork, Christmas trees, chestnut and few others), statistical information on volumes collected and values is patchy and often unreliable and there are only a few published accounts of how the NWFP industry operates. The paper, based on field surveys carried out within the EC 7th FP STAR-Tree project, analyzes the factors influencing the successful marketing of NWFP, illustrating the significant increment of forest products added value that can be connected with a modern organizational model of NWFP value chain management.

LINKING SUSTAINABLE DIETS AND FUNCTIONAL FOODS FROM NATURAL SOURCES FOR HUMAN AND PLANET HEALTH

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KEYWORDS:
biodiversity, flavonoids, functional food, endangered species, sustainable diets

Plants are essential constituents of ecosystems and play a key role in the Earth's system. Foods of vegetable origin contain a wide array of bioactive compounds (flavonoids, vitamins, mineral etc.) endowed with different biological activity (antioxidants, antimicrobial, antiinflammatory) and suggested to play a key role in reducing risk of degenerative diseases. The increasing deterioration of the environment, the progressive reduction in biodiversity, agricultural production with an excessive impact on the ecosystem has lead to a novel attention on the key-role of food sustainability. Sustainable diets have a low impact on the environment, preserve biodiversity, contribute to food and nutritional security and provide "functional" foods. This definition recognizes the interdependence between food production and consumption, dietary requirements and nutritional recommendations, while at the same time strength the concept that human health cannot be detached from Planet health. Typical example of this concept is the plague of obesity with about 1.5 billion overweight and 500 million obese. Obesity is characterized by an increase in metabolic risk factors such as insulin resistance, oxidative and inflammatory stress, hypertension etc. translating in a high risk of developing CVD. At the same time, the unnecessary intake of food in obesity translates also in ecological costs in addition to its health cost. There is the need of improving the research on functional food development from alternative and natural plant sources, such as endangered species, flowers and roots, characterizing their functional properties through a well-defined experimental path where human research is central and sustainability is a mandatory requirement. The big challenge for the next future relies on the Increase of life quality with sustainable and scientifically proven functional foods for human and Planet health.

OXIDATIVE CELLULOSE DEGRADATION

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KEYWORDS:
cellobiose dehydrogenase, lytic polysaccharide monooxygenase, oxidative cellulose degradation

The interaction of two enzymes – lytic polysaccharide monooxygenase (LPMO) and cellobiose dehydrogenase (CDH) – was recently shown to boost the effectiveness of lignocellulose hydrolysis. The oxidative nature of this mechnism changes the old paradigma that only hydrolases perform cellulose hydrolysis. Evidence is increasing that oxidative cellulose degradation is important for the effectiveness of the fungal attack on lignocellulose. The proposed oxidative degradation mechanism comprises two enzyme families widely distributed in fungi: LPMO (CAZy nomenclature AA9) and the flavocytochrome CDH (AA3). LPMO enzymes depend on oxygen and a reducing agent as cosubstrates to cleave cellulose into soluble oxidized oligosaccharides. The monooxygenase activity is supposed to degrade crystalline cellulose surfaces opening up new sites for hydrolase action. CDH has been suggested to be the second partner in this bi-enzymatic system. It's ability to transfer electrons via its cytochrome domain to the LPMO type-2 copper center greatly reduces the dependence on reducing compunds found in wood, e.g. gallic acid. To investigate the interaction, four LPMO enzymes and two CDH enzymes from Neurospora crassa were recombinantly epressed in Pichia pastoris. The purified enzymes were characterised and their reaction mechanism and electron transfer kinetics investigated by steady-state-, transient-state kinetic methods and electrochemical techniques. The results unambigously show that the natural role of CDH is to act as a reductase for the investigated LPMO. The interaction of LPMO and CDH was compared with several other electron donors present in wood and shows that this bi-enzymatic system is highly efficient in performing oxidative cellulose degradation to initiate the attack of hydrolases.

GREEN CHEMISTRY AND THE BIO-REFINERY

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KEYWORDS:
Green Chemistry, Biomass, Bio-refinery, Microwaves

The increasing demand for consumer goods from an increasing world population is placing enormous strain on the resources needed by the worlds manufacturing industries. Traditional resources have often been from non-renewable sources located in relatively accessible regions but these are finite, their exploitation non-sustainable and they are becoming scarce. Increasingly, the mining of new resources is in difficult places where the environmental impact is very high and the economic costs prohibitive; at the same time mineral resources are being seen as a political lever used to support the wider ambitions of governments. To compound the problems, the wastes generated in manufacturing and in use of the articles of todays society have been allowed to accumulate in landfill sites which are now filling up in many developed countries leading to the questionable export of large quantities of hazardous substances across the planet. This "out-of-sight, out-of-mind" reaction to the problem can create serious health and safety problems in regions where wastes are allowed to accumulate or are being processed without adequate protection for the local population. Industrial symbiosis seeks a closed loop approach to the twin problems of resource and waste by making the latter the solution to the former – waste is the future resource. To fully exploit the concept and make it widely useful to both inter- and intra-sector industry transfer while maintaining environmental advantage, we need to use Green Chemistry to extend the value of waste streams. The future exploitation of carbon is at the forefront of our societal challenges – we have to develop a system for using carbon, to make the very many articles that depend on carbon (including food, feed, plastics and countless chemicals) that is affordable, practical and sustainable. This needs to be based on feedstocks that re renewable within a reasonable timescale (ca. 100 years) and not as we have been doing, on feedstocks that took millions of years to accumulate. Food supply chain wastes are especially useful as sources of organic chemicals for a variety of processes and products; examples include the physical modification of polysaccharide wastes as novel Starbon materials for applications including the separation of natural products and water purification and as switchable and flame resistant adhesives; the use of the ashes from burning biomass as a source of silicate binders; and the use of citrus peel as a source of compounds that can be used as green solvents and food additives among other applications. These renewable resources must be exploited using low environmental impact processes. New, energy efficient conversion technologies that can convert a wide variety of waste streams into valuable chemicals include low-temperature microwave processing. Examples based on different renewable feedstocks and using different technologies will be described, as will the types of bio-refineries that can be developed to provide integrated solutions to the fundamental challenge of satisfying the increasing needs over a growing population with a limited quantity of resources.

BIOMASS IN CROATIA AND EU

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KEYWORDS:
biomass, bioenergy, recommendations, forest, wood, guidelines, legislation, sustainable

About 97% of all forests in Croatia are of natural origin, they have been developing for ages in their habitats, which makes them one of the most natural, the most stable and the most productive ones in Europe. Wood has always been significant energy source throughout the development of human society. Around 1850s wood ensured about 90% od energy needs, only to fall under 5% in the last decade of 20th century. But since the energy crisis has emerged, the contribution of wood for energy balance is rising on daily basis. Exploitation of forest and wood biomass for energy has a long tradition in Croatia especially when we are talking about fire wood and wood residue. The use of biomass has diminished, people use natural gas and fuel oil rather, because they are easier and more comfortable to use. Also, the problem is low ecological awareness that prevalents among Croatian population that gives advantage to to fossil fuels regardles to obvious ecological advantages of the biomass. The substitution of biomass for fossil fuels in energy consumption is a measure to mitigate global warming, as well as having other advantages. Political action plans for increased use exist at both European and national levels. The exploitation of biomass energy will be one of the most important parameters in the sustainable development of rural areas, waste management and agriculture and forestry. It is therefore necessary to devote adequate attention to the inclusion of energy production from biomass and integrate it into planning of other sectors. This presentaton briefly reviews the contents of recommendations, guidelines, and other publications on sustainable use of forest and wood biomass for energy. Topics are listed and an overview of advantages, disadvantages, and trade-offs between them is given, from the viewpoint of society in general and the forestry and energy sectors in particular.

CAN MODELLED AND MEASURED DATA INTERACT TO EVALUATE FOREST HEALTH CONDITION?

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KEYWORDS:
air pollution,
climate
change,
forest health,
modelling
approach

Modelling approaches are globally emerging to develop coupled biogeochemical-ecological models, to predict the combined effect of climate change, air pollution and atmospheric deposition of pollutants on forest functioning and biodiversity. Significant alterations in future global land use patterns are anticipated, both as a result of anthropogenic changes in land use and management and climate-driven changes in ecosystem distribution. These changes in land use and land cover patterns may have considerable impacts on the climate, both through modifying the physical properties of the land surface (biophysical effects) and by altering the absorption or emission of greenhouse gases and air pollutants (biogeochemical forcing). Air pollution and climate change effects on forest ecosystems constitute significant scientific research fields today. The modelling approach can help bridging the knowledge gaps in different scientific domains (air pollution, atmospheric deposition, climate change, forest impacts in terms of growth, health, yield, distribution and biodiversity loss) in order to: (1) translate environmental observations and predictions into future scenarios, including socio-economic implications; (2) improve understanding of interaction between climate change, air pollutants and impacts on land ecosystems; (3) quantify the ecological responses under changing climate conditions on forest ecosystems (4) reduce uncertainties of current climate predictions (5) identify hot spot regions where action is needed (6) provide risk maps for forests at regional and local scale (7) identify suitable actions to mitigate, adapt, manage and (8) propose adaptations and recommendations to forest ecosystem policy and management practices. Among common air pollutants, ozone (O_3) and nitrogen are likely the most damaging stressor for forests, frequently reaching high concentrations over large regions of the world. Several studies suggested that ozone might reduce the Gross Primary Production (GPP) of about 15-20% and the crop yield up to 30%, leading to relevant consequences for both surface climate and food supply. Impacts of nitrogen pollution on forest health are still unclear, because of the two component of nitrogen (oxidized and reduced) that may have antagonistic or synergistic effects depending on geographical and climate conditions. Here, we study the potential effects of air pollution and climate change on canopy defoliation over Europe, using both modelling data and measured ones from ICP Forests network.

Session A:

NATURAL RESOURCE MANAGEMENT AND POTENTIAL OF RURAL AREA

ATTITUDES TOWARDS FORESTS, USE OF NON-WOOD FOREST PRODUCTS AND RECREATIONAL OPORTUNITIES-RESULTS FROM TWO CASE STUDIES IN CROATIA

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KEYWORDS:
attitudes,
NWFP,
recreation,
survey

How people perceive and use forests may differ based on various factors, such as their socioeconomic status (e.g. age, education, income) or features of the forest area in question (landscape characteristics). The aim of the work is to present a study condacted in two forest areas - mountain Petrova Gora near Karlovac and town of Gospić. The purpose of the study was to describe and compare attitudes people hold towards forests, how they use forest and what is the overal level of satisfaction with recreational services provided in the forest area. The same face-to-face survey was conduced in both areas enabling the comparation of results. The number of collected questionnaires in both cases was 200. Secondary data included information on two forest areas, demographic data. Based on demographic data collected from national statistics assumption was made that there would be a difference in results in two case studies. Conclusions from this and similar studies are useful not only for researchers but also to forest practicioners and public in general since it provides valuable information on how to better meet public interests and improve provision of recreational services.

CHALLENGES AND OPPORTUNITIES FOR IMPROVING OF NWFPBASED SMALL AND MEDIUM ENTERPRISES BUSINESSES IN SEE REGION

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KEYWORDS:
non-wood forest products, small and medium enterprises, promotion, SEE region

SEE region is facing a new market economy period where establishing new businesses is more than needed in all sectors. Forestry is also challenging these new trends and the number of forest related companies is increasing all the time. The paper describes the challenges and opportunities related to promotion activities for improving business of the SMEs dealing with NWFPs in SEE region. Research in this area in SEE region is scarce. The region has a huge biodiversity potential, which can be a solid base for establishing SMEs (eco-business). That was the main reason for determining the challenges and opportunities of existing SMEs dealing with NWFPs related to promotion activities in order to improve their current business and to provoke others to start a new business with this potential. SMEs play a key role in the national, regional and global economy, stabilize function in society, provide outsourcing products and services. Thus, a significant attention they should pay on all their business activities like production, market and promotion. Involving promotion in their business activities is a very significant tool for future development of every business which is closely connected to increasing employment (poverty elevation) and income of the company. The method used in this paper is quantitative based on survey data collection and SPSS analyses. The questionnaires were conducted during 2011 and 2012 in four SEE countries: Croatia, Bosnia and Hercegovina, Serbia and Macedonia. The results have shown that developed channels of distribution, branding and advertising of NWFPs are recognized in all countries as important and very important, but these marketing tools the most of interviewee use them few times per year. Anyway, advertising was pointed out by the majority of respondents in SEE region as the most used and the most successful tool. Their future investments should be focused on improving their equipment for drying, packing, refrigerators, transport means and some of the entrepreneurs from Macedonia pointed out that they will invest in more buying points and herb plantations while almost all Croatian entrepreneurs will invest in advertising, branding and promotion. Majority of respondents in Serbia also believe that financial resources should be invested in new equipment. The reason for these investments can be summarized in reducing costs and increasing profit or faster turnover of money.

THE VALORIZATION OF THE LOCAL NATURAL RESOURCES AS EXAMPLE AS OF BOTTOM –UP ACTION FOR THE SUSTAINABLE MANAGEMENT AND PROMOTION OF TERRITORY (A STUDY CASE OF THE STONE ART SCHOOL OF MACERETO-ITALY)

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KEYWORDS:
Sustainable Development, Rural Development, Natural Resources, Sustainable Management of Territory, Territory Promotion, Tradi-Ovation, Rural Tourism , Agritourism

The strategy of the Sustainable Management and Promotion of Territory was the subject, from the author, of many theoretical and practical contributions. The concreteness of the same, for the possibility of eradication of poverty and to give rural populations and possible options for the future of happiness and prosperity, led him to found in 2011 an International Summer School on Sustainable Management and Promotion of Territory The author continues his work is in adapting and refining the theoretical part but especially in the research and analysis on the implementation of case practical. Recently called to visit a farm in Umbria that has within it some deposits of Grey Stone (much sought after in civil construction and urban furniture and interiors).
The scheme of the research it's the following:

1 -Examination of the locations affected
2 -The business context
3 -The territorial context
4 -The framework of policies and programs at local and European framework.
5 -The current legislation on the use of natural resources investigated
6 -Tradio-Ovation and design of a sustainable project management and promotion of resources investigated.
7 -The S.A.S. (Stone Art School) Macereto
-The vision
-The evaluation of the technical requirements, organizational and human resources
-The process of self-fertilization
-The first initiative: "A St. Martin: Stones, Plates, Oil and Wine."
8 -Evaluation of the I ^ initiative and SAS Management Plan.
8 -Analysis and consideration
-Conclusions

The author, through an agreement with the owner, has initiated a study that now managing a to establish an International School of Stone Arts. The first activity is confirmed for the day of 6th -8th June 2014. The title of the first activity is: *"Stones, Flavors, Colors, Sounds, Passion, Design ..... Love"*. The author in this paper, trough the study case, try to show the first concrete results in terms of sustainability for the economic, environmental, social , cultural and managerial aspects of an applied in the land of the Tradi-Ovation approach and Sustainable Management and Promotion of Territory.

EXPLORING THE ISSUE OF URBAN FORESTS IN SERBIA: HUMAN AND INSTITUTIONAL DIMENSION

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KEYWORDS:
forestry,
organisations,
Serbia,
survey,
urban forests

Population growth poses considerable challenges on the natural resource management. Growing pressures on forests are becoming ever more observable also in urban areas as more than a half of the world's population lives in the cities. Urban green areas are meant to provide citizens with the multiple benefits essential for their wellbeing. This is strongly related to the adequate resource management embedded into the supportive legal and organizational structures. In order to explore the issue of urban forests in Serbia we focused on the human and institutional dimension. Human dimension is reflected through the attitudes of citizens from Novi Sad towards city's green areas, whereas institutional dimension reflects organizational aspects related to urban forests and forestry in Serbia. Statistical analysis of primary data obtained from the representative survey (structured faceto-face interviews, conducted in 2012 on the controlled random sample of citizens of Novi Sad) shows (among others) that people perceive urban forests as being gradually reduced and they relate numerous problems to the issue of their management. In order to determine who is in charge of urban forests and greenery in Serbia the primary and secondary data were collected (semi-structured face-to-face interviews with organisation's representatives + document analysis; reference period 2012), analysis of which allowed for mapping of interrelated organisational structures at the national, provincial and local level. Surprisingly many different organisations are concerned with the issue of urban forests, whereas exact responsibilities remain mostly unclear.

DOES MOUNTAIN LANDSCAPE CHARACTERISTICS INFLUENCE VISUAL APPEAL? A STUDY CASE IN AN ALPINE VALLEY IN ITALY

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KEYWORDS: visitors' perception, Travel Cost Method (TCM), visual appeal, landscape, Val Genova (Italy)

Mountain forests are of great importance for human life because they provide a wide range of ecological and socio-economic services. In high density populated areas the social functions are very appreciated from visitors looking for aesthetical values during recreation activities. Tourist and recreational activities, in high value natural areas (i.e. protected areas, Nature2000 sites), may cause negative effects starting from soil compaction by walking to land use change for infrastructure building. Information on the reasons that lead people to visit a mountain area may be a tool for fit its management and its conservation. The main goals of the research are to analyse the visitor flows and the characteristics of the visitors, to investigate the landscape's and forest's visual appeal, and to quantify the expenses incurred to visit a high value natural areas. The research is carried out in a case study located in North-East of Italian Alps: Val Genova (Province of Trento). The valley is part of the Adamello Brenta Nature Park and is wide about 15,000 ha (about 60% covered by forest). Val Genova cover a high range of altitudes starting from about 800 m a.s.l. to more than 3000 m a.s.l. Due to its characteristics the wilderness of the area is very high with a few scattered settlements. The landscape results from the combination of different elements such as water bodies (river, waterfalls), glaciers, rocks, forests (both evergreen and deciduous forests), mountain shrubs, grasslands, settlements or other anthropic elements. The research is carried out by a field questionnaire submitted to a random selected visitor (about 10% of visitors encountered). The semi-structured questionnaire is divided in three thematic sections in order to facilitate the gathering of information: (1) the first section focused on the collection of personal information of the respondent (i.e. gender, age, level of education); (2) the second section investigated the preferences and perception of the landscape from visitors; (3) the third section has estimated the daily expenses incurred by respondents to visit the site using the Travel Cost Method (TCM). Expected results regard differences in naturalness, visual appeal and crowding perceptions among groups of visitors (e.g. provenance, preferred activity in mountain) and the intensity of their relationships. Finally, in order to evaluate from ecological and economic point of views the valley, a synthetic index that considers the characteristics of the site, the characteristics of the visitors and their preferences was developed and tested.

GREEN CARE FOREST – DIVERSIFICATION AS AN OPPORTUNITY FOR FORESTRY

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KEYWORDS:
Forest, Green Care, healing landscapes, public health, social inclusion

Since 2014 Green Care Forest represents a new research project of the Austrian Research Centre for Forests. In close collaboration with the existing Green Care project in the agricultural sector we want to analyse the potential of Green Care for the forest sector. To prove the effects of Forests the Study "Green Public Health – Benefits of Woodlands on Human Health and Well-being" was commissioned. The study was aimed at collecting international scientific literature on the benefits of woodlands on health, well- being, and quality of life of the population. The duration of stay, activities and exercise, as well as the social context may impact well-being in woodlands. There are manifold opportunities for farmers to participate actively in Green Care projects which are analysed in the project. Examples of Green Care Forest products are Forestkindergarten, Forest-youth project weeks and educational programs for seniors. However Green Care cannot serve as a panacea for every farm or forest holding. The Green Care product must be suited to the farming family's business and to their living conditions. Additionally, investments are often necessary before a Green Care product can be offered, for example to ensure disabled access.

For further information please visit http://bfw.ac.at/rz/bfwcms.web?dok=4745

PARTICIPATION OF STAKEHOLDERS ON PROTECTED AREA MANAGEMENT IN TURKEY: CASE OF KÜRE MOUNTAINS NATIONAL PARK

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KEYWORDS: Ecotourism, expectations from national parks, natural resources, perception of stakeholders

In the recent years, participation of stakeholders on planning and management processes of natural resources is a widely accepted practice. Stakeholders have different expectations from natural resources. When these expectations are not taken into account, natural resources may become irreversibly damaged. Participation of stakeholders on natural resource planning and management depends on their interest and their level of knowledge on these resources. This study is conducted in Bartın-Turkey, one of two provinces over which Küre Mountains National Park spread. In order to understand their thoughts on the park and its management, the survey included different questionnaires for four different stakeholders. These stakeholders are local government officials, private enterprises, non-governmental organizations, and village headmen. The survey was conducted with a total of 120 people -30 from each stakeholder. It gathered opinions on national park management, expectations from the park, legal restrictions and rights on utilization of natural resources, and alternative sources of income. The study then questioned the similarities and the differences of stakeholders' approaches on the subject, and the findings were used to develop recommendations for Küre Mountain National Park management.

IMPACT OF THE ACTUAL STRUCTURE AND MANAGEMENT ON THE FUTURE DEVELOPMENT AND SUSTAINABLE MANAGEMENT OF THE PEDUNCULATE OAK FORESTS IN EASTERN CROATIA

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KEYWORDS:
pedunculate oak, forest age structure, stocking, rent, stand regeneration planning

Spatial distribution and status of forest resources are based on national forest inventory data and their stratifications on eastern Croatia's five counties and according to forest types and age classes within the pedunculate oak forests. The projection of the spatiotemporal oak forest development was conducted using the computer program SIMPLAG. The initial data was taken from Croatian Forests Ltd. and the development projection included structure of 6.538 stands covering. Starting from the actual status, the development of pedunculate oak forest was based on the intensity and spatiotemporal dynamics of stand regeneration. According to various quantity of forest regeneration associated with the development of the age structure of forests (forest area, area of last age class, area of last two age classes, area of stands older than rotation half), but also with different models of stand regeneration success (optimal, realistic), scenarios of the future management and development of forests are defined. Selection of stands for the regeneration within a 10- year felling cut area is based on the stands ranking according to regeneration priority regarding to the potential rent's difference. The potential rent is a consequence of a decision on the implementation or regeneration delay of potentially mature pedunculate oak stand. In eastern Croatia pedunculate oak forest cover an area of about 129.000 ha (33.6% of the total forest area) with a growing stock of 44.158.000 m3 (37.3%). Area of floodplain forests of pedunculate oak is about 56.200 ha, while the mixed oak and hornbeam forests are more prevalent (72.700 ha). The age-class distribution in both forest types is characterized by large area of stands in fifth age class. Extremely low density of pedunculate oak trees in young stands as well in those older than 100 years are indicators of past management and guidelines for future management requirements. Actual state, but also the importance of pedunculate oak forests makes a particular challenge for future management planning expressed by determination of amount and felling cut area distribution. According to the results of this research, 10-year gross revenues of about 4.4 billion Kuna may be supported by management approach according to which the spatiotemporal dynamics and intensity of forest regeneration are based on the area dynamics of stands older than 100 years and also, with respecting several objective criteria (economic, structural and habitat features stands). This approach stands out as the most acceptable in the sense of sustainable forest management.

TOWARDS SUSTAINABLE MANAGEMENT OF JAVA'S TEAK FOREST: HOW HAVE DECENTRALIZATION POLICY AND MOVEMENT AFFECTED THE PRACTICES OF COLLABORATIVE FOREST MANAGEMENT PROGRAMME?

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KEYWORDS:
Collaborative forest management, forest community, institution, Java, policy arrangement approach

Decentralization policy has been adopted in many countries since 1990-s in different format, mostly as part of their reformation agenda. The enactment of decentralization policy aims at enabling local people to get more effectively involved in local decision making with regards to forest resources management.. By using a regional case study in Java Island of Indonesia, this research aims at providing insights into the 12 years implementation process of forestrelated decentralization policies and movement, and how have this affected the practices of Collaborative Forest Management Programme (CFMP). The end goal of CFMP is to establish a prosperous forest community and a sustainable forest at the same time – that is the sustainable development. In Indonesia, for more than 30 years the authority over state owned teak forests on Java Island has been granted to State Forest Corporation amid the fact that the state forests are surrounded by communities highly dependent on forestland for their livelihood. The research design builds on extensive review of policy and written documents and two major phases of fieldwork in two selected districts in Central Java. The expert interview was used to explore four dimensions of Policy Arrangement Approach (actors, rules, power and discourses) in the Collaborative Forest Management Programme (CFMP). This study reveals that although actors hold different perceptions concerning the programme, there have been changes in the power-relation structure between the State Forest Corporation and communities through the new mode of CFMP. The decentralization policy and movement in this study has enabled new actors and institution to come into play in CFMP arena and later to induce new ideas and changes in practising CFMP. Interestingly, many of the actual changes are taking places through more informal mechanisms rather than formal ones. This study re-emphasized the notion of the importance in having a policy that would works for both forest and the people to progress with sustainable development

ECONOMIC VALUATION OF URBAN TREES: PARK RIBNJAK CASE STUDY, ZAGREB

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KEYWORDS:
urban tree, urban forest, evaluation, compensation price

Population growth, urbanisation and technology development are creating a growing need for urban forests and parks, which are becoming green oasis for recreation and relaxation. Beside sociological and economic component, economic space valuation is presented through touristic, market value of main and secondary forest products, and with growing value of real estate in vicinity of green areas. Environmental economics explore optimal ratio between costs and benefits received from investment in environment. Calculation of urban forest values is a complex process because of the impossibility to do a market evaluation of all of the benefits that could be considered as public wealth. Danish model for tree value determination (2003) was applied in Park Ribnjak as a case study.
Dimension, expected age, aesthetic value, location and other values were measured. Model is based on tree growing costs and present value. It is limited with subjective aesthetic tree value estimation, but it is used in Europe because of its practicality. Individual tree value estimation is used because of tree damage from vehicles or new residential buildings. Method is valuable for individual trees or groups of trees, but it is not appropriate for the forest stands. Ecological, social and health tree values are taken separately into account with calculation of points. 20 trees from 9 different tree species have been analysed in park sample. Tree values vary depending on age, dimension or aesthetic values. The method's disadvantage is in the estimation of very old trees value and high involvement of subjective estimation, which provides opportunity for model development and modification in the future.

FOREST CERTIFICATION IN BOSNIA-HERZEGOVINA AND SLOVENIA: OBSTACLES AND EFFECTS

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KEYWORDS:
forest certification, forest policy, sustainable forest management, Bosnia-Herzegovina, Slovenia

Designed as a market-based and voluntary instrument of forest policy, forest certification has been primarily launched to prevent further degradation of forest ecosystems. Praised and reprehended within the last few decades, forest certification gradually solidified its position in day-to-day forest practice and became a worldwide recognized instrument for promotion of sustainable and social responsible forest management. As the countries with economy in transition, Bosnia-Herzegovina and Slovenia follow globally increasing trends in forest certification. While in Bosnia-Herzegovina more than a half of all public forests are certified, in Slovenia all state owned forests are certified according to FSC scheme. Based on analysis of available public reports, that are prepared by accredited certification bodies, this paper focus on the mix of obstacles that forest companies had to face with during the assessment process. The requested corrective measures, classified by FSC principles, will be discussed as well as several activities conducted by forest companies in order to satisfy FSC standards of forest management. The results of this paper, dealing with economical, social and ecological effects of forest certification in Bosnia-Herzegovina and Slovenia, may contribute to better understanding of forest certification as an innovative instrument of forest policy and its potentials towards achieving sustainable forest management.

DISTRIBUTION AND DYNAMIC OF CARBON STOCKS BY POOLS IN MANAGED FOREST OF PEDUNCULATE OAK

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KEYWORDS:
atmospheric carbon sequestration, forest ecosystem services, oak chronosequence, sustainable forest management

Forest ecosystems act as significant sinks of atmospheric carbon, as they sequester carbon through the process of growth. Forest management in Croatia is considered to be sustainable regarding the stability and biodiversity of forest ecosystems, but in recent years, in the context of climate change problem, there is a raising question of sustainability of forest ecosystems with respect to carbon accumulation and storage. Therefore, atmospheric carbon sequestration became highly important forest ecosystem service with direct influence on human wellbeing. Aim of this research was to explore whether current forest management practice in Croatia can be considered sustainable in terms of carbon storage throughout the life-time of Pedunculate oak forest. Temporal evolution of carbon stock distribution by pools was estimated using a chronosequence approach. Carbon stocks in pools: live biomass, dead wood (snags, stumps and woody debris), forest floor, and mineral soil, were estimated from field observations in eight stands of different age, ranging from 5 to 168 years. Carbon in coarse roots was estimated using existing age-dependent root-to-shoot ratios. Average distribution of carbon stocks is 53% in live biomass, 40% in forest soil and 7% in dead wood. Distribution by carbon pools changes during stand development. In youngest stands more carbon is stored in soil organic matter then in live biomass, while in old stands more carbon is stored in live biomass then in soil. Carbon stocks in live biomass and litter layer increase with stand age, while carbon stocks in dead wood peek in young and old stands, with minimum values in middle-aged stands. For carbon stocks in mineral soil layer no statistically significant age-dependent trend was observed. Obtained results indicate that current thinning and harvesting practices have no significant influence on carbon stocks in mineral soil layer. It can be concluded that current management practice in similar type of Pedunculate oak forests can be considered sustainable in terms of carbon storage, while the variation in the size of total carbon stock results from the variation in the tree biomass and litter pools.

GROWTH DYNAMIC OF SOME BODY PARAMETERS OF EUROPEAN MOUFLON *(OVIS GMELINI MUSIMON)* IN THE EU-MEDITERRANEAN ZONE OF THE NORTHERN ADRIATIC SEA

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KEYWORDS:
body length,
body mass,
kidney fat
index,
meet

European mouflon is native Mediterranean game species. Unfortunately, there are very few data about mouflon body parameters in Mediterranean habitats. That's why we collected some body parameters from 35 ewes and 27 rams (lambs were excluded from measurements), shooted on the island of Rab from 2002 to 2005. The parameters were masses (body weight of dressed and undressed animals, head, skin, foots, meet, hart, lung, liver, milt, kidney, kidney fat, rumen-gross weight, net weight, rumen content) and trophy value of rams. Data were sorted according to gender and age. Regard on age we found positive absolute values of the parameters and age. Gross body weight, body weight and meet didn't show liner but parabolic trend. Rams were significantly heavier at all parameters in relation to ewes, but according to amounts of parameters we didn't find significant difference between genders. Our rams didn't differ from Hungarian rams regard on body weight, but regard on gross body weight our rams were heavier. Reason for this difference is high rumen content of our rams. It can reach 11,3 % of gross body weight.

STAND GROWTH CHARACTERISTICS OF COMMON BEECH (*Fagus sylvatica L.*) – PROJECTION OF EVEN-AGED TO MULTI-AGED STAND STRUCTURE

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KEYWORDS:
multi-aged forest management,
Common beech,
stand growth,
stand structure

The Common beech (*Fagus sylvatica* L.) is a dominant tree species in Croatian forests. Applying of the uneven-aged and/or multi-aged stand management system to the forest has recently emphasized, especially in small-scale private forests and forest under nature protection. The study focuses on characteristics of pure beech stand growth and conversion of an actual even-aged beech stands into continuous multi-aged stand structure. Within the pure and well stocked beech stands, in total, 25 plots were sampled (young, middle-aged, pre-mature and mature pure beech stands) and, on average, 16 trees (between 11 and 26 trees) were measured (diameter at breast height, total height, two crown diameters, current annual increment (CA_{ldbh})) on each plot. Stand growth simulation model (SGSM) was based on: a fitted curve for the relationship of diameter at breast height (dbh) and total height with age, and indicators of competition (relationship between CA_{ldbh} and stand basal area, basal area and crown area). Using the SGSM and an actual mature beech stand (115 years, 10.5 ha, 28.1 m^2 ha^{-1} of BA, 480 m^3 ha^{-1} of standing volume, 9.6 m^3 ha^{-1} of volume increment), transition of even-aged to multi-aged stand structure was obtained. During 100-year period, balanced composition of stand developmental stages, diameter structure, stand density (5,420 trees per ha), basal area (19.2 m^2 ha^{-1}), standing volume (280 m3 ha-1), and balance between 10-year volume increment and felling (110 m^3 ha^{-1}), would be achieved. The obtained results of an even-aged to multi-aged stand structure conversion and the model of balanced multi-aged beech stand would have large implementation in research and management of beech forest in Croatia. Influence of different management approaches and target structures, as well as projection of spatial distribution of a multi-aged beech stands, would be further research tasks.

COMPARING DIFFERENT TYPES OF THE USE OF WILDLIFE RESOURCES

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KEYWORDS:
game species, local population, pairhoofed animals

I aimed to compare the status of local populations of pairhoofed wildlife species on the area of commercial hunting and the corresponding species on the area of usual hunting. As the professional hunting ground for commercial hunting I selected the area of Punia Pinewood. The next study area are hunting grounds rented by hunting clubs situated in the southern part of Prienai Forest. There are five pairhoofed game species as Moose (Alces alces), Red deer (*Cervus elaphus*), Fallow deer (*Dama dama*), Roe deer (*Capreolus capreolus*) and Wild boar (*Sus scrofa*). The data of the hunted animals and hunting intensity since 2009 were obtained from the Ministry of Environment and census data from certain hunting grounds. The census data of mentioned species were analysed calculating game density and hunting density per 1,000 ha. For comparison of the data, the statistical analysis was used. It was found that on the area of public hunter clubs, the main game species are roe deer and wild boar. Their local populations are used intensively because of the high densities. Meanwhile, the population abundance remains fairly stable at the permissible density level On the professional hunting grounds, the main game species are red deer and wild boar. Considering the commercial mission of these grounds, the largest numbers of game are keeping. The most eligible are trophy adults. The conclusion is that on the professional hunting grounds, the local populations of wild boar and red deer are used unreasonable and their density exceeds permissible level.

CORRELATION OF FOREST ECOSYSTEM MANAGEMENT AND CARBON SEQUESTRATION

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KEYWORDS:
carbon, forest, management, sequestration, sustainable

Observing forest management through history, it is quite obvious that purpose of wood as the main forest product has transformed together with the evolution of society. At first, wood was used for personal needs, then as building material, and with the arrival of the Industrial Revolution it became a source of energy. Development of science led to discoveries of other valuable purposes of forests. Parallelly, human awareness about the need to preserve and responsibly manage forests also grew as people began to comprehend that trees and forests have their own growth and yield dynamics and dynamics with the environment that must be respected in order to preserve and maintain them. At the moment, forests represent immeasurable and indispensible tool in the struggle to combat climate change, because as part of their breathing process, tress take in carbon dioxide from the atmosphere and build it in their wood mass through photosynthesis. It is also worth noting that trees are the only carbon neutral source of energy, which means their combustion releases the same amount of carbon trees have bound in their wood mass during their existence. Thinking of the forest through the sphere of sustainable management i.e. sustainable satisfaction of the need for wood material and its role as the carbon depot, it might seem one is talking about two completely contrasting notions. This paper will elaborate on the current researches and findings how to balance these two extremes, and get the maximum from both of them with equal amount of respect for each. Bearing in mind the conclusions for even age management, we see that shorter rotation are preferred in some cases as regards the quantities of bound carbon through a longer period of time, although wood products made in longer rotation have longer shelf life which means that carbon is bounded for a longer period of time in them. Taking pure evergreen forests into consideration, the conversion to mixed stands has slight effects in terms of bound carbon in the trees, however, some studies claim that such stands increase thickness of soil organic layer and consequently increase bound carbon in the soil. Exclusion of areas from management leads to the best results in binding carbon, yet, it does not qualify as sustainable management. The best results in reaching the balance between the need to manage and use wood and the need to bind carbon and not to manage are achieved by mixed age or selection management.

METHODS FOR FOREST CARBON POOL MEASUREMENT

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KEYWORDS:
carbon pool, forest, methods, procedure, sequestration

The greenhouse effect is undoubtedly one of the most difficult modern day environmental problems, and the biggest culprit for it, in terms of emitted quantities, is CO_2 – carbon dioxide. Its current concentration is higher than ever in the history of Earth. Forests, as one of the carbon sinks (along with seas and soil) may play a decisive role in mitigation or reduction of emitted CO_2. All living creatures on Earth are made up of a certain amount of carbon, and trees are the only ones who absorb it from the atmosphere, and build it in their biomass through the products of photosynthesis. Therefore, the first problem is how to determine the volume i.e. the biomass weight of a tree, a stand or an area, and then determine the percentage of carbon in wood mass. In this paper, the author provides an overview of available methods and procedures for assessments i.e. calculations of sequestered carbon and possibilities of carbon sequestration. However, assessments of greenhouse gases' dynamics inevitably result in uncertainties due to various interpretations of carbon sources and outflow, assumptions, units or usage of simplified results with average values. In addition to that, ambiguities also arise from different or inadequately scientifically researched core processes leading to emission or removal of carbon. In order to encompass entire carbon cycle in a forest ecosystem it is necessary to include: bound carbon in the soil and circulation of carbon in soil; carbon depot in main forest semiproducts and products as well as emissions originating from these products by decomposition or burning; emissions originating from forest utilisation operations and transport of wood mass. An attempt of harmonization of data from various parts of the world with the aim of creating a report that can be used to monitor carbon emission and drain on a global scale is presented in the handbook Good Practice Guidance on Land Use, Land Use Changes and Forestry (GPG LULUCF). This handbook was issued by the Intergovernmental Panel on Climate Change founded in 1988 by the United Nations, World Meteorological Organisation and United Nations Environment Progamme (UNEP).

THE EVIDENCE OF HEALTH PROMOTION ON WALKING IN FOREST ENVIRONMENTS FOR ECOTOURISM

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KEYWORDS:
forest and human health, forest road, physiological effect, psychological effects

The purpose of this study is to produce data to enhance value of forest business as tertiary industry primarily based on walking in forest environments. Although forest business in tertiary industry has been focused on forest recreation or ecotourism in forest so far, utilization of forest environment for health promotion has been recently more popularized. This study measured physiological and psychological effects on elderly people from walking in forest areas and walking in forest environment in order to clarify effects in health promotion. In addition, it measured difference of thermal comfort between forest environment and urban environment. As compared to walking in urban environment, the result showed that walking in forest areas lead to more active parasympathetic nerve activity, lower sympathetic nerve activity, and lower blood pressure. And the results of the experiments show that walking in forest areas lead to more higher V(Vigor) feeling, lower TA(Tension and Anxiety), A-H(Anger and Hostility), F(Fatigue,), and the TMD(Total Mood Disturbance) feeling. Furthermore, it showed that thermal comfort is more enhanced at forest environment than urban. This result is believed to contribute to increasing demand for walking in forest.

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THE TERRITORIAL CONTRACT MANAGEMENT: A SHARING PROACTIVE CHALLENGE FOR THE RURAL AREAS ACTORS FOR THE SUSTAINABLE DEVELOPMENT STRATEGY

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KEYWORDS:
Sustainable Development, Rural Development, Sustainable Territory Management, Territory Policies, Green Box, Bottom -Up

The strategy of the Sustainable Management and Promotion of Territory was the subject, from the author, of many theoretical and practical contributions. The concreteness of the same, for the possibility of eradication of poverty and to give rural populations and possible options for the future of happiness and prosperity, led him to found in 2011 an International Summer School on Sustainable Management and Promotion of Territory The author continues his work is in adapting and refining the theoretical part but especially in the research and analysis on the implementation of case practical. Recently called to visit a farm in Umbria that has within it some deposits of Grey Stone (much sought after in civil construction and urban furniture and interiors).

The scheme of the research it's the following:

1 - Examination of the locations affected
2 - The business context
3 - The territorial context
4 - The framework of policies and programs at local and European framework.
5 - The current legislation on the use of natural resources investigated
6 - Tradio-Ovation and design of a sustainable project management and promotion of resources investigated.
7 - The S.A.S. (Stone Art School) Macereto
- *The vision*
- *The evaluation of the technical requirements, organizational and human resources*
- *The process of self-fertilization*
- *The first initiative: "A St. Martin: Stones, Plates, Oil and Wine."*

8 - Evaluation of the I ^ initiative and SAS Management Plan.
8 - Analysis and consideration
- Conclusions

The author, through an agreement with the owner , has initiated a study that now managing a to establish an International School of Stone Arts. The first activity is confirmed for the day of 6th -8th June 2014. The title of the first activity is: *"Stones, Flavors, Colors, Sounds, Passion, Design ..... Love".*

The author in this paper, trough the study case, try to show the first concrete results in terms of sustainability for the economic, environmental, social , cultural and managerial aspects of an applied in the land of the Tradi-Ovation approach and Sustainable Management and Promotion of Territory.

SOCIAL CAPITAL AND COMMON FORESTS MANAGEMENT IN TRENTINO (ITALY)

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KEYWORDS:
natural resources management,
common property
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institutional social capital,
social network analysis,
Trentino (Italy)

The common management of natural resources (collective property) in the Italian Alps has a long tradition that has its roots in the Middle Ages. The Italian Alpine community village - know as regole, comunità, consortele and vicinie - have historically managed their pastures and forests based on a common set of rules designed to regulate the socio-economic life of village community. In the Italian Alps, many of these traditional institutions are still active and represent a model of natural resource management characterized by a greater management efficiency and respect for the environment when compared with the public and private property. Starting from these considerations, the research has focused on the quantification of social capital of community village in a case study (Trentino province in North-East of Italy) in order to analyse the relationships between social capital and natural resources management. The social capital was quantified by administering a semi-structured questionnaire - formed by 23 open- and closed-form questions subdivided in 5 thematic sections - to representatives of the institution responsible for the management of the commons in Trentino province (i.e. regole, comunità, consortele and amministrazioni separate per i beni di uso civico). During the first stage of the research, the questionnaire was submitted by email to 127 representatives of the commons in Trentino. After two telephone reminders the response rate was 42% (51 questionnaires were processed). Analysis of both the relational social capital and institutional social capital was performed using the collected data. Relational social capital was quantified considering the professional and friendly relationship between institutions responsible for the management of the commons using the social network analysis (SNA). Institutional social capital was analyzed taking into account the relationships and trust between institutions responsible for the management of the commons and other local actors (i.e. environmental associations, public administrations). The results show that social capital is a key variable in analyzing the sustainability of natural resources management: in fact, this element could produce some advantages in terms of accessibility to resources, information and ideas, it could spread trust and collective action between the actors or create important networks for the common's management. These elements underline that the common management is a good compromise in terms of performance and social sustainability.

MODEL FOREST "RIVER MIRNA BASIN"

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KEYWORDS:
Development of rural areas, Ecosystem services, Non- wood forest products, Sustainability, Value added products

"A Model Forest is a voluntary association of people that live in a particular territory, and are interested in discovering, defining, enhancing and guarantying its sustainability; and in sharing their experiences and their knowledge to contribute to global environmental goals". The purpose of the Model forest " River Mirna basin " is promotion and integration of a sustainable development in the rural areas of north and cental Istria. Vision allready defined by the MF members is a sustainable management of the forest and the Mirna River flow in order to encourage economic activities related to valorisation of forests' and rural resources. Activities of the Model forest are focused on improving policies and regulations about management of natural resources and are linked with promotion of cultural and natural values of this area. Concept is based on a horizontal decision making of partnership that involve various stakeholders ranging from forestry, tourism, agriculture, non-wood forest products , breeding, mushroom pickers, mountaineers, nature protection, education etc. Representatives from private, public and civil sector are joint in an association whose mission is an open and responsible cooperation between partners whose needs are different but are united with a wish to contribute to well-being of the area where they live and work. Aim of this work is to present a model forest concept as an innovative approach in forest governance that can deal with social, economical and environmental problems of the forested landscapes and of people who live there. Knowing that International model forest network have more than 60 model forest members whose number is increasing every year especially in the Mediterranean and around Adriatic region this subject deserves a space in forestry and scientific debates. "Traceability of non wood forest products in the Model forest River Mirna basin" will be presented like a particular project for giving an added value to good quality products. Traceability is a tool to promote and to follow production and origin of local products. Organizational steps for establishing a model forest will be described and explained as a tested methodology from Mediterranean and International model forest network. Poster will give an insight in what a model forest is and how to create a model forest. Objectives and results of the model forest will be presented in a specified case of Model forest "River Mirna basin "in Istria where Croatian forest research institute is involved from the beginnings.

EVALUATION OF THE QUALITY OF THE DRINKING WATER WITHIN THE WATER SUPPLY SYSTEM "STUDENCICA", KICHEVO

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AAS,
XRD,
ICPS

The river Studencica (north - western part of the Republic of Macedonia) is the only one water source for the population (140. 000 inhabitants) in the town of Kichevo. Namely, he regional water supply system (WSS) is in operation since 1981 and designed to serve for 30 years. Although the river water is clean and clear, possessing all parameters for drinking water prescribed by National Regulations for Drinking Waters Safety, in order to obtain a real picture about the possible changes in water quality during its transport, we performed detailed analysis on them at the entrance and exit of the WSS as well as on 7 selected measuring points within. On the base of as performed conventional procedure for water analysis, the main consideration could be completed i.e. that the water retains almost constant properties in regard to the physical-chemical and microbiological parameters. On the base of indirect method of analysis of solid scale formed in domestic water heater, the elevated content of zinc (Zn) was considered (AAS). This investigations were further extended by XRD (to obtain data about the scale morphologic structure) and ICPS (as semiquantitative method for the presence of all constituents of the solid scale). By both methods the presence of zinc was approved. Since the zinc concentration at the raw (untreated water) was far lower than maximal allowed value, the appearance of zinc in the solid scale from domestic water heater can only be a product of leaching of zinc from galvanizing metal layer of the transport tubes in the drinking water distribution system.

CIRCULAR ECONOMY AS AN OPPORTUNITY TO INCREASE FOREST SECTOR COMPETITIVENESS

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KEYWORDS:
circular economy, competitiveness, innovation, forest-based sector

Emergence of the circular economy concept, based on the idea of zero emission where the output of one production process provides input for the another one, gains momentum in recent nvironmental agenda of the European Union. Offering resource savings, increased productivity and new green-jobs opportunities in a transition towards a resource-efficient and resilient economy and society[1] this concept provides solutions for overcoming energydependence, resource scarcity and environmental degradation, tackling climate changes and increasing productivity of the struggling industry sector. The application of the circular economy model in forestry has long been known yet not sufficiently explored[2]. On the other hand the European forestry sector at this moment goes through significant structural changes[3]. In the circular economy model of the forestry-based sector the products (regarded as outputs in the production process) are part of the value-chain which ensures their constant re-use in a loop. It depends of the variety of products generated by the process and their durability, the ability to recycle these materials along the value chain, and the capacity of forests to capture and store carbon from the atmosphere, at the same time renewing and (therefore) providing sustainable resource of material for the bio-based economy. However, the loop i.e. opportunity for carbon sequestration does not end with trees but includes also forest products, which if appropriately managed and made , contribute to the circular economy by increasing their use-life and recycling opportunities. The work will show in which way the circular economy concept can act to maximise the carbon sequestration and material usage by minimising time that carbon is present in the atmosphere, and in which ways innovative environmental and forestry management can be combined with prospective approach and sound policies and strategies in order to increase the competitively of the forest-based sector.

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FIRST RESULTS OF THE STUDY ON THE STRUCTURE OF STANDING DEAD WOOD IN MANAGED FORESTS OF CROATIA

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KEYWORDS:
carbon stocks, dead wood, forest inventory, snags, coarse woody debris

Standing dead wood (DWs) is important part of forest ecosystems, providing habitat for great number of species. It serves as a feeding and/or nesting place for birds, and in recent years, dead wood is recognized as an important carbon pool. Information on the stocks of dead wood in forests at a country level has gained significant importance. It is necessary for meeting needs of the reporting within some international treaties, like UNFCCC and Kyoto protocol, or EU Directives like Birds, and Habitats Directive, or requirements of sustainable forest management certification. In our work we present results of the structure of standing dead wood obtained from 37 510 plots measured within 32 forest management inventory surveys. The surveys were conducted in continental part of Croatia from 2003 to 2008 by Croatian Forests Ltd., at first as a pilot (2003-2006), and later in accordance with new forest mensuration system that was in place from 2007 to 2008. Average share DWs by the number of trees (N) and by basal area (BA) is 2.14% and 1.34%, respectively. The highest share of DWs was recorded for tree species that characterize degraded forests in Croatia, i.e. scrubs, namely O. carpinifolia (15.8% and 14.2%) and Q. pubescens (15.4% and 8.9%). Follows C. sativa (12.4%, 9.0%), species with known problems in Croatia (e.g. chestnut blight) and species characteristic for the mountain region A. alba (5.0%, 5.1%) and P. abies (3.7%, 3.5%). With respect to tree size, the highest share in DWs (up to 5.5%) was observed for thin trees (dbh<25 cm), stable 1.1% for trees in the dbh range from 25 to 65 cm followed by gradual increase for thicker trees. Our study indicates that current management practice reflects on stocks of DWs with relatively low share of DWs in mid-aged and older even-age stands, but at the same time relatively high share for A. alba a species typically under uneven-age management. Further research of stocks and patterns of DW, in particularly lying DW, are necessary in order to determine optimal stocks that would secure the protection of biodiversity, but also took into account economic aspects.

CROATIA URBAN AREA- LAND COVER ANALISYS
(preliminary report)

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KEYWORDS:
pollution management, sustainable development, urban area pollution and depositions, urban greenery benefits, urban greenery cover

Geographical location and orography have influenced emergence of three significantly diverse ecological areas in Croatia what can be seen, amongst all, in canopy spread. We have researched several towns that spread through Croatian regions: Pannonian (Varaždin, Samobor, Zaprešić, Đakovo, Vukovar), Dinaric (Delnice, Gospić) and Mediterranean (Rovinj, Opatija, Kostrena, Solin, Omiš and Vrgorac). The main goal of this research was to show urban greenery benefits which influence life in urban areas. Also to point-out the differences between periurban and urban areas and among various ecological regions. Test analysis using historical satellite imagery was made to show and project how urban planning (2008. - 2013.) effects sustainable urban ecosystem development. Peri-urban areas-cover percentage, results show biggest difference in: tree canopy cover between Delnice -Vukovar (865%); shrub cover Vrgorac - Delnice (1167%); grass cover Solin - Đakovo (436%); agricultural land cover Đakovo - Solin (7475%). Regarding monetary benefits ($/m^2) biggest difference is visible in annual NO_2 removal Delnice (37507,44 $) - Opatija (660,96 $), while annual CO2 sequestration is in Delnice (48,32 kt) - Opatija (420,47 t). Urban areas- cover percentage, results show biggest difference in: tree canopy cover between Delnice - Đakovo (285,71 %); shrub cover Vrgorac - Đakovo (377,86%); built objects cover Opatija - Vrgorac (436%); ONG (other non green) cover Opatija - Delnice (170%). Monetary benefits ($/m2) biggest difference are visible in annual CO removal Samobor(16,37 $) - Opatija (1,88 $), while annual CO2 sequestration is in Samobor (1,93 kt) - Opatija (221,86 t). Differences (maximal-minimal) between peri-urban and urban plots: in tree cover Delnice (399,02 %)- Opatija (87,22 %); shrub cover Vrgorac (165,66 %)- Delnice (20,97 %); built objects Opatija (70,76 %)- Vrgorac (5,71 %). Historical imagery analysis in Samobor showed us following category cover changes-tree (5,76 %); grass (- 3,54 %); field (-15,00 %); road (4,00 %); building (4,00 %) while all other cover categories remain unchanged. Estimated monetary benefits changed (+4,45 %) due to tree canopy cover increase, and annual CO_2 sequestration is in 2008. (9,97 kt) - 2013. (10,44 kt). Bearing in mind the results of the research we can conclude that there is significant difference in area cover percentage between Croatian regions, as well as, in peri-urban and urban areas. While looking at the urban land development, we can conclude that there is increase in tree canopy cover percentage and also in built objects areas at expense of agricultural land.

CONTROL AND CERTIFACION OF ORGANIC PRODUCTIONS IN AGRICULTURE AND FORESTRY

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KEYWORDS:
organic agriculture, control and certification, organic label

In the last decade, an ever increasing interest of both foreign and domestic public for organic agriculture can be observed. Organic agriculture, as a new agricultural production system, enables full utilization of farming potentials while satisfying social and economic needs and preserving natural esosystem and environment. Act on Organic Production of Agricultural Products and Foodstuffs provides an elementary strategic frame for agricultural production development in Republic of Croatia. This article gives an overview of organic agriculture in EU and Republic of Croatia. The paper gives proceeding control and cerificatin for geeting oganic label.

HEAVY METALS IN THE SOIL OF THE VARAŽDIN REGION (CROATIA)

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KEYWORDS:
green city areas, heavy metals, pollution, soil, Varaždin

Heavy metals are naturally present in soil up to certain levels as a consequence of the soil's mineral content. However, above certain levels, the presence of heavy metals is a consequence of pollution. The most common sources of pollution are: traffic, fossil fuel consumption, mineral fertilizers, pesticides, floods, landfills etc. Heavy metals cannot be degraded; they accumulate in the soil or sediment of water ecosystems. So they get into the food chain, and in elevated concentrations have a toxic influence on humans and other living organisms. The aim of this work was to determine the concentration of heavy metals in the soil of regularly-mown green city areas in the Varaždin region, in order to find possible heavy-metal pollution, and to detect the types of metal which exceed prescribed levels. Samples were collected from the upper layer of the soil, up to 15 cm in depth, at 16 locations during June and July of 2013. The concentration of heavy metals was determined by using atomic absorption spectroscopy. The levels of the following metals were determined: cadmium (Cd), copper (Cu), iron (Fe), manganese (Mn), nickel (Ni), lead (Pb) and zinc (Zn). Pollution was estimated on the basis of the Ordinance on the Protection of Agricultural Land Against Pollution (OG 09/14), since at the moment it is the only legislative document in the Republic of Croatia that prescribes the maximum allowed concentrations of heavy metals in soil. The results obtained have shown that eight locations were contaminated with heavy metals. Excess amounts of Pb were observed at seven locations, of Cd and Zn at three locations, of Ni at two locations and of Cu at one location. The three most contaminated locations were: the railway station in Varaždin (maximum allowed concentrations of Cd, Cu, Ni, Pb and Zn exceeded), Dravski otok (maximum allowed concentrations of Cd, Pb and Zn exceeded) and Svilarska ulica (maximum allowed concentrations of Cd, Pb and Zn exceeded). The most likely cause of pollution at the railway station was railway traffic; at Dravski otok, flooding of the River Drava; and in Svilarska ulica, the vicinity of the VIS factory plant. Contrary to expectations, at locations by crossroads and roads with heavy traffic, either there was no observation of increased concentrations of heavy metals or, in some cases, a slight excess of Pb was detected, which can be attributed to pollution by road traffic.

WILD BOAR MEAT PRODUCTION AND MARKET ON THE TERRITORY OF REPUBLIC OF CROATIA

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KEYWORDS:
wild boar, venison usage, hunting management, game meat

Research covered the analysis of body masses, body growth and cull of wild boars on the territory of Republic of Croatia. Wild boar represents one of eight species of big game that are being managed on the territory of Republic of Croatia and makes the framework in cull with a yearly excreta of around 30 000 individuals. Meat that is yearly produced from wild boar comes mainly from open hunting grounds, in smaller part from breeding farms. Since wild boar has extremely high reproduction ratio, almost 50% of cull is realized by cull of younglings and meat production as such is highest in that age category. Research found that average cull masses of wild boar are 39, 87 kg in younglings, 55,84 kg for yearlings and 94,03 kg in adults. Quantity of meat with bones that is gained in relation to animal's body mass after cull is different at each age category within the same species. Meat yield is proportional to mass and in younger animals it is smaller and increases with the increase of mass. Conducted research determined that meat yield for younglings is 48,43% and average body mass 19,30 kg, yearlings records yield of 49,15 % and average body mass of 27,45 kg, while in adult animals yield is 51,96% and average body mass 48,84 kg. When you put average yearly cull in relation to cull in theory you get a yearly production of od 1 570 939 kg and with average sell price of 19,5 kn/kg the value of wild boar meat production is 30 633 310 kn. Wild boar meat market is pretty underdeveloped, there is no buyout strategy and therefore produced meat is mainly consumed within the families of hunters. If you put meat production in relation to number of inhabitants (4, 29 mil.), it turns out that average production and consumption of wild boar meat is 0, 36 kg/per capital yearly.

RESOURCES AND LAND USE IN THE REGION OF THE NATIONAL PARK UNA IN THE FUNCTION OF SUSTAINABLE MANAGEMENT AND DEVELOPMENT

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KEYWORDS:
national parks,
soil,
biodiversity,
functional
foods

National Park Una is a covered karst area with very rich and varied biodiversity. As such, there is a good predisposition towards promotion and development autochthonous plant and animal organisms, grown organically, thus offering a variety of functional foods. This paper presents the results of years of research into the whole area that are presented in two parts. In first part the method used by distance management with geoinformation system (GIS) where separate bonity categories represented soils in the park, which are then classified according to the value of the two groups: soils suitable for cultivation (I-IV bonity class) covering a total of 2,721.84 ha and soils less suitable for cultivation (V-VIII bonity class) covering a total of 4,368.30 ha. The second part was related to the field of research within the divided groups of soils, and examples of cultivated crops and animal organisms from which the various functional products.

THE APPLICATION OF LANDSCAPE ECOLOGY PRINCIPLES WITHIN THE LANDSCAPE PLANNING

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KEYWORDS:
Landscape ecology, landscape planning, optimization

The landscape is a dynamic structure made of interactive systems; a complex entity consisting of natural as well as anthropogenic processes that take place in it and that can only be studied using methods of different disciplines. The ecological problems, such as habitat fragmentation, natural reserves preservation, resources management and human habitat degradation caused by increasing needs of urbanization and more prominent climate change, must be solved in order to achieve the sustainable development goals. It is possible through the application of the landscape ecology principles within landscape planning procedure. However, landscape ecology and landscape planning are still developing as separate scientific disciplines. Therefore, despite the fact that the applicable concepts for implementation of landscape ecology principles into the planning process in the world are developed by landscape planning, currently they are not applied in Croatian spatial planning system. The aim of the paper is to indicate that the landscape ecology and the landscape planning are closely linked interdisciplinary landscape research approaches dealing with interrelations between natural and anthropogenic processes in spatial and temporal context. Landscape planning is a procedure that, by overlapping the development planning and the existing spatial values, determines conflicts and provides optimized solutions based on harmonized developmental and conservational interests. It also generates specific foresights of landscape function changes that have considered interactions between human activities and natural processes. Landscape ecology in turn provides the scientific basis for these foresights. The purpose of identifying and understanding the function of the landscape is a basis for protection of landscape qualities within a planning process. So this paper points to application possibilities of landscape ecology analysis and principles within landscape planning procedure as a part of spatial planning process. Such approach is aimed to resolve the conflicts that can cause ecological problems. The representative examples are presented in adequate map scale for specific spatial heterogeneity using the software programs QGIS, ArcMap, ProVal and AutoCAD.

Session B:

FUNCTIONAL FOOD AND USEFUL PRODUCTS FROM NATURAL SOURCES

WILD FRUITS AS AN INGREDIENTS FOR FUNCTIONAL FOOD

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KEYWORDS:
antioxidant capacity, bioactive compounds, functional food, polyphenols, wild fruits

Croatia as a central Mediterranean country has favourable climatic environment for growth of various herbal kinds, and Croatian diverse flora has 5536 species and subspecies many of which are medicinal and aromatic herbs and wild fruits (cornelian cherry, blackthorn, elderberry, bilberry, pomegranate etc.). The wild fruits are particularly valuable because of composition and content of biologically active compounds (BACs) (flavonoids, phenolic acids, anthocyanins, ellagitannins, stilbenes, etc.). Additionally, they may provide numerous positive effects to the human health (risk reduction for: cardiovascular disease, diabetes, obesity, hypertension etc.). Different analytical methods were developed for determination of BACs including total and individual polyphenols, as well antioxidant capacity (AOC), in plant material. The BACs present in fruit extracts require high resolution technique for its separation and identification. Besides spectroscopic/colorimetric methods, various fruit matrices containing mixtures of BACs have been analysed with the High Pressure Liquid Chromatography/Ultra Performance Liquid Chromatography coupled with UV/Vis PDA detector, and/or with electrospray ionisation (ESI) tandem mass spectrometry (MS/MS). Antioxidant assays in the fruit extracts can be performed by various in vitro methods: (i) hydrogen atom transfer reaction based methods [oxygen radical absorbance capacity method (ORAC), lipid peroxidation inhibition capacity assay, ABTS (2,2'–azinobis-(3-ethylbenzothiazoline- 6-sulphonic acid) radical scavenging method]; (ii) single electron transfer reaction based assays methods [2,2-diphenylpicrylhydrazyl (DPPH) free radical scavenging capacity assay, Ferric reducing ability of plasma (FRAP), Trolox equivalent antioxidant capacity (TEAC)]. This study summarized the content of various polyphenols (flavonols, anthocyanins, ellagitanins, phenolic acids) and AOC of selected wild fruit varieties (strawberry, cornelian cherry, blackthorn, elderberry, pomegranate, and bilberry) harvested on different location in Croatia during three years. All researched fruits contain remarkable quantities of anthocyanins, and each variety contained specific fingerprint of these compounds. The most abundant anthocyanin in strawberry was pelargonidin-3-rutinoside, in cornelian cherry pelargonidin-3-galactoside, in blackthorn cyanidin-3-rutinoside, in elderberry cyanidin-3-sambubioside, in pomegranate delphinidin-3-glucoside and in bilberry delphinidin glycosides. Flavonols, quercetin and kaempferol were presented in all analysed fruits, ellagitanins and their derivatives were found only in pomegranate, whereas in blackthorn the most abundant were neochlorogenic acid and flavan-3-ols. The composition of polyphenols depend on variety, while the quantities depend on variety, growing season and stage of maturity. The high AOC was observed in all fruits, and linear correlation was observed between the AOC and polyphenol concentrations. The development of functional foods is currently one of the fastest growing segments of the food industry and wild fruits as valuable source of BACs in the production of functional foods represent significant challenge.

FORTIFIED FOODS AS ADDITIONAL SOURCES OF NUTRIENTS IN SERBIA

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KEYWORDS:
fortified foods, regulation, Serbian market

Introduction: It is generally accepted that a balanced diet is able to provide nutritive requirements of an individual. Nevertheless, statistics and numerous studies indicate that many people are deficient in some nutrients, in spite of wide availability of different nutrient-dense foods. The information about the possible role of some biologically active food ingredients in disease prevention makes them also very popular with general consumers. Fortified foods can be useful tool for increasing the intake of certain ingredients through regular diet.
Aim of the study: Since in Serbia there is no specific national regulative on food fortification, except on adding iodide to the salt, the aim of this study was to investigate the presence of fortified foods on Serbian market and to list bioactive compounds and their quantities in fortified foods, as well as to collect data on their labeling.
Method: The method used in the study was questionnaire that was completed in retail objects in three towns in Serbia.
Results: Fortified foods are significantly less present on Serbian market than in other European countries and the variety of added ingredients is limited. We identified one hundred different fortified products on the market with milk products, cereals and juices as the main food categories that were most frequently fortified. Vitamins and probiotic&fiber were the most frequently used as bioactive compounds added to the food. The amounts of added ingredients were notified in the labels, and in some cases the recommended daily usage of products was notified. The lack of labeled forms of nutrients, vitamins and minerals mostly, was also noticed.
Conclusion: This investigation identified several problems concerning additional nutrient sources on Serbian market, including inadequate labeling and lack of legislative. No monitoring of these products, including their eventual impact on nutritive status, has been organized by the authorities.

SPENT BREWER'S YEAST, A RAW MATERIAL FOR ISOLATION OF β-GLUCAN

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KEYWORDS:
β-glucan, biotechnology, immuno-modulation, spent brewer's yeast

Brewer's yeast after beer production is waste material, but many of yeast components can achieve a greater commercial value and finally maximize the total profitability of the whole process. One such compound is β-glucan, a cell wall polysaccharide that can be used as a high-value product. Therefore, spent brewer's yeast can be a good raw material for its isolation and further application in food production, pharmaceutics, chemical industry, and cosmetics. β-glucan possesses many interesting properties which can improve human and animal health and immune system.

THE EFFECTS OF STARTER CULTURE ON CHEMICAL COMPOSITION, TEXTURAL AND SENSORY CHARACTERISTICS OF TURKISH TULUM CHEESE WITH HALF FAT DURING RIPENING

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KEYWORDS:
low fat cheese, physico-chemical properties, ripening, starter culture, Tulum cheese.

In recent years, along with increasing health awareness the demand for low-calorie foods has increased. Therefore the manufacturers have been using different ingredients and production methods for producing low fat cheeses giving similar mouth feel and taste with the full-fat cheese. However, given the lack of structure, taste and aroma low fat cheeses are not preferred by healthy people. Tulum cheese is one of the traditional cheeses of Turkey produced and consumed all over the country especially in northern region. This study is to to investigate the effects of different starter cultures on the ripening of Tulum cheeses and to produce half-fat cheese offering the taste of full-fat cheese using starter cultures to increase the market share and enlarge the consumer profile. In this study, selected starter cultures; Cheese culture 1; Lactococcus lactis subsp. lactis: Lactococcus lactis subsp. cremoris, Cheese culture 2; Lactococcus lactis subsp. lactis: Lactococcus lactis subsp. cremoris: Lactococcus lactis subsp. lactis biovar. diacetylactis, Cheese culture 3; Lactococcus lactis subsp. lactis: Lactococcus lactis subsp. cremoris: Streptococcus thermophilus: Lactobacillus delbrueckii subsp. bulgaricus: Lactobacillus helveticus, were added to pasteurized 1,7% fat milk to obtain Tulum cheeses and a noncultured cheese was used as a control. After dry salting cheeses were packed in glass jars and ripened at refrigerator temperature. Chemical, texture profile analysis, and sensory analysis of the cheeses will be conducted at certain time periods (2, 15, 60, 90 and 120 days) during ripening. Furthermore, the changes in protein fractions which are significantly effective in ripening will be analyzed.

IMPACT OF HONEYBEE CASTING COMB FOUNDATIONS PRODUCTION ON LEAD CONCENTRATIONS

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KEYWORDS:
beeswax, comb foundations, lead concentrations

Beeswax is natural product of honeybees. It is an extremely complex mixture consisted mainly of esters of higher fatty acids, alcohols, hydrocarbons, acids and other minor substances, like proteins. Lead is one of principle toxic heavy metal and contained at environment can contaminate honeybee products, primary nectar and honeydew, but as consequence of order and way performing social activity of foragers and house bees, also combs and inside hives. Lead may cause a large variety of toxic effects, including gastrointestinal, muscular, reproductive, neurological or behavioral effects. Wax, as well as, other apian products can be useful tool for collecting information about the environment contamination with toxic metals. In hives nectar and honey were stored in cells of wax comb. According European legislation beeswax specifications were set to 5 mg/kg (EC 1996) and 2 mg/kg by the FAO/WHO Expert Committee on food additives. The EFSA (European Food Safety Authority) 2007 committee recommended specification for lead should be set as low as possible. There is very few studies on lead contamination of beeswax and lack of data about its influence of comb foundation quality and correlations with rearing and biological characteristic of brood of honeybee colonies situated on contaminated combs. Also, the effectiveness of performing casting comb foundations production technology with long term of cooling on reducing heavy metal concentrations is total unknown. At processing beeswax or production of comb foundations during cooling period of 24 hours the few layers of wax are sedimented inside container. To compare the concentrations of lead in different layers of wax a 15 samples were collected. Beeswax samples were digested using microwave closed system. Concentrations of lead were measured by graphite furnace-atomic absorption spectrometer AAnalyst 800 (Perkin Elmer, USA). Concentrations of lead were in the range (µg/kg): 28.118 – 71.971 after resolving wax combs; 17.336 – 66.251 after sterilisation upon 125 ^{0}C; and 1338.277 – 10801.479 after sedimentation, respectively. The obtained results indicate a tendency to reduce the lead content in the wax and comb foundations as final product contain lowest concentrations and material was used just from highest layer. This may be an indication that the wax foundation producers better hold recommendation to use described technology and for beekeepers to accommodation hives away from highways and industrial areas that contribute to the accumulation of metals in apian products.

COMPARASION OF MINERAL CONCENTRATIONS OF GRAPE JUICES AND MOLASSES

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KEYWORDS:
Grape, molasses, macro and micro mineral properties

Grape juices and molasses were obtained from 7 different factories and The aim of this research was the determination of mineral concentrations' (calcium, phosphorus, sodium, magnesium, aluminum, zinc, iron, copper, manganese, boron, molybdenum, cadmium, cobalt, chromium, nickel and lead) of grape juice and molasses from the grapes grown in the region of Batman. There were significant differences ($P<0.05$) in macro and micro mineral concentrations between the samples of grape juices and the samples of molasses. All of tree types of mulberry contained the highest content of Strontium in the grape juice and the molasses. The level of iron in grape juices was ranged between 144.37 – 469.69 ppm while in the molasses was 454.60 - 1283.01 ppm. The concentration range of zinc for the tested grape juices was found to be from 10.83 to 33.71 ppm and for the molasses as 26.40 to 61.5 ppm. The content of metals in the grape juices decreases in the following order: Sr > Fe > Mn > Cu > Zn > Cd > Co > Cr > Sn > Ni > Pb > Mo and in the molasses decreases in the following order: Sr > Mn > Fe > Cu > Zn > Cr > Ni > Cd > Co > Pb > Sn > Mo.

PROBIOTIC FERMENTED MILK WITH FREEZE DRIED IMMOBILIZED LACTOBACILLUS CASEI ATCC 393 CELLS ON APPLE PIECES

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KEYWORDS:
apple, dairy, immobilization, probiotic

The regular consumption of lactic acid bacteria through fermented milks has long been associated with improved health and longevity. Nowadays several probiotic microorganisms, such as bifidobacteria and lactic acid bacteria, have received attention for the development of novel foods. Such functional foods demonstrate a great potential in promoting human health. However to deliver the health benefits, probiotics need to contain an adequate amount of live bacteria (at least 10^6 cfu/g), able to survive the acidic conditions of the upper gastrointestinal tract and proliferate in the intestine, a requirement that is not always fulfilled. In the present study probiotic fermented milks were produced using pasteurized cow's milk. Three different microorganisms were used in their production namely Streptococcus thermophilus, Lactobacillus delbrueckii ssp. bulgaricus and *Lactobacillus casei* ATCC 393. *Lactobacillus casei* was also used in freeze dried immobilized on apple pieces form. The viability of all three microorganisms, pH and acidity were monitored during storage at 4°C for 4 weeks. All microorganisms were present at the same numbers at the first day (≈8 logcfu/g), however in the case of apple pieces the numbers of L. casei were even higher. During storage and especially after the first week, their numbers were declined. This decline was higher in the case of L. *bulgaricus* and in the counts of L. *casei* and S. thermophilus a slow and constant decrease was observed. The use of immobilized cells retained L. *casei* viability in higher numbers compared to free cells and control sample. It should be noted that all microorganisms retained viable numbers higher that 6 logcfu/g even at the end of the storage, something that is important to confirm the probiotic character of the product. The sensory evaluation ascertained the overall quality of the probiotic fermented milks and especially that with immobilized on apple pieces cells that scored similar values with the commercial sample. The results of present study are very promising for dairy industry as the freeze dried new biocatalyst proved capable for production of high quality probiotic fermented milks. This biocatalyst has high potential for application in other dairy products in order to retain high numbers of viable probiotic cells.

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THE POTENTIAL USE OF *Amorpha fruticosa* L. AS NATURAL RESOURCE OF BIOLOGICALLY ACTIVE COMPOUNDS

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KEYWORDS:
Indigobush, biologically active compounds, in vitro cell growth, green corrosion inhibitors

Indigobush *(Amorpha fruticosa* L.) belongs to the genus of deciduous shrubs and semi-shrubs *(Amorpha* L.) from the Fabaceae family. The range of its natural habitat is from southern Canada to Mexico. In Croatia it is present since the beginning of the 20th century in the valleys of the rivers Sava, Drava and Kupa in the lowland oak forests. Due to its ability to adapt to environmental conditions and fouling the soil it is grouped in the invasive weed plant species and it represents a problem in the natural regeneration of floodplain forests. On the other hand, recent research indicates that Indigobush should not be considered only as a low used and harmful plant, since lately it has been recognized as a plant with high biological potential with possible use in the forestry and biotechnology field. Published studies indicate the presence of various phenolic compounds in the Indigobush extracts with possible antimicrobial, antioxidant and antitumor activity. Therefore, in this study we wanted to explore some of potential application of *Amorpha fruticosa* L. extract, as a source of biologically active compounds, for animal cell culturing as well as green corrosion inhibitors. The effect of ethanol extract of Indigobush was conducted on human tumour cell lines (HeLa and MCF-7) indicating not cytotoxic effect in tested concentrations (0.5-10 mg/ml), but even showed stimulatory effect on cell growth at the highest tested concentration. Furthermore, since serum supplementation of cultivation media has many disadvantages, scientists try to reduce or completely omit its use nowadays. Therefore, we explored the growth of cells in a medium with a reduced serum content and the stimulatory effect of the Indigobush extract was even more pronounced in medium with 5% vs. 10% of serum, indicating the potential use of this extract as an alternative for replacement of serum in culture medium. Furthermore, the inhibition effect of *Amorpha fruticosa* L. extract on the corrosion of aluminium in 0.5 M hydrochloric acid solution was investigated by potentiodynamic polarization and electrochemical impedance spectroscopy (EIS) methods. Electrochemical studies showed that with increasing extract concentrations (2.5-15 mg/ml) the values of corrosion current densities decrease, while the polarization resistance values increase. The maximum inhibition efficiency of *Amorpha fruticosa* L. extract is reached with addition of 15 mg/ml (82.9 %), which indicates that *Amorpha fruticosa* L. extract has potential as green alternative to existing synthetic corrosion inhibitors. Obtained data indicate that *Amorpha fruticosa* L. extract could have potential application in various green technologies.

FUNCTIONAL PROPERTIES OF SOME GARLIC ECOTYPES

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KEYWORDS:
Allium sativum L., antioxidant activity, f atty acid composition, phenols

Garlic (*Allium sativum* L.) is an important ingredient of the diet of many populations and there is long-held belief in health enhancing properties. The chemical composition of garlic bulbs can be influenced by ecotype, growing location and cultivation factors. The aim of this study was to determine the quality components in six garlic ecotypes, collected in northeast Adriatic region. Samples were collected from six different locations: Brgud, Konavle, Kričke, Ljubitovica, Opuzen and Trnbusi. Total polyphenols and antioxidant activity of garlic ecotypes were evaluated using Folin-Ciocalteau and 2,2–diphenyl-1-pirydrazyl method. Besides, ecotypes influence on fatty acid composition was also investigated by gas chromatography. Ecotypes Brgud, Konavle and Ljubitovica had garlic bulbs contained more than 40% of dry weight (DW) while significantly lower bulb DW was recorded in samples from Kričke, Trnbusi 2 and Opuzen Ozimi (37.4; 36.0 and 35.8% DW). The amount of total phenols varied widely and ranged from 86.65 to 227.29mgGAE/g DW. Garlic bulbs contained 42.1 to 69.4 mg/kg DW total fatty acids. In all ecotypes, linoleic acid, essential fatty acid, was predominant in amount of average 58%. Ecotype Ljubitovački (56.37) had the lowest and Opuzen Ozimi had the highest (60.70%) content of linoleic acid. Ecotype significantly affected content of palmitic, oleic and linolenic acid while no statistically differences were found between investigated ecotypes in the stearic acid content. All samples exhibited some radical scavenging activity and positive correlations between total polyphenol content and antioxidant activity was found. The study showed that all evaluated components are strongly influenced by genotype and growing location, and all galic samples had high levels of nutritionally important components and thus might be a rich source of antioxidants beneficial to human health.

PHYTOCHEMICAL TRAITS OF SOME TRADITIONAL MEDICINAL PLANTS

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KEYWORDS:
endemic plants, essential oils, medicinal plant species, natural resources, sustainable development

The aim of this work is to define the importance of Illyric–Balcanic plant species of spontaneous vegetation, which are distributed along the Adriatic Coast and Dinaric Alps of Croatia, Bosnia and Herzegovina, Montenegro, Albania, and Greece. Most of them are overspread in Mediterranean and sub-Mediterranean regions. They are mostly endemic lithophytic and xerothermic medicinal plant species. Some of the plant species are natural source of polyphenolic and other antioxidants with radical-scavenging and even chelating properties. The extracts of their essential oils showed broad spectrum of antimicrobial activity with on *Staphylococcus aureus, Pseudomonas aeruginosa, Escherichia coli, Candida albicans* and *Aspergillus niger*. Most of the wild plant species such as: *Micromeria croatica, Satureja subspicata, Satureja montana, Teucrium arduini and even Moltika petraea* are not important only because of their medical effects but they are also decorative plants, collected very often by the tourists and visitors. So, they are definitely natural resources which might have important role in sustainable development of economically underdeveloped areas of the Adriatic coast, islands and hinterland. In spite of their decorative characteristics, there is no interest for their production (i.e. using the tissue culture and other propagation techniques) in controlled conditions and protected areas. This is possible to achieve only by interdisciplinary approach, which implies engagement of experts from different branches such as: botanists, touristic workers, experts for marketing, landscape architects, and entrepreneurs.

ANTIOXIDATIVE PROPERTIES OF VARIOUS HERBAL MULBERRY TEAS

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KEYWORDS:
Morus nigra, mulberry, herbal tea, antioxidant properties

Herbal teas, i.e. extracts of herbs, are popular because of their fragrance and antioxidative activity. Mulberry is the most medicinally important plant of the genus *Morus*. Mulberry (*Morus*) fruits, leaves, bark and branch have been used in traditional medicine such as diuretic, hypoglycemic and hypotensive activities. The mechanism of their effects is correlated with the content of active components. Objective of this work was to evaluate and compare antioxidant properties of deferent mulberry leaves teas of *Morus* species growing in Serbia (*Morus nigra* L., black mulberry). The study examines the impact of time preparing tea on antioxidant properties of mulberry teas. The contents of phenolics (17.77– 28.44 mg CAE/g of dry weight) and flavonoid (17.26–25.13 mg mg CE/g of dry weight) in the extracts were determined spectrophotometrically. Some individual phenolic compounds, including rutin, chlorogenic, ferulic, galic and sinapic acids were identified and quantified by HPLC. The antiradical activities of mulberry teas were tested by measuring their ability to scavenge DPPH (EC50: 0.0679 - 0.1026 mg/ml). Experimental investigation has shown that the best time of preparation of tea is 10 minutes. Our study suggested the use of mulberry as a potential health food, or important antioxidant carrier in the food and pharmaceutical industries. The authors would like to thank the Ministry of Education, Science and Technological Development, Republic of Serbia, for financial support (Project No. TR31013).

EFFECTS OF ADDING CHERRY LAUREL *(Laurocerasus officinalis)* ON MACRO AND MICRO MINERAL CONCENTRATIONS OF TARHANA

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KEYWORDS:
Tarhana, cherry laurel fruit, macro and micro mineral properties

Tarhana, a traditional fermented soup produced from a mixture of wheat flour and yoghurt, is widely consumed in Turkey. It is prepared by mixing cereal flours and a variety of cooked vegetables, red and green peppers, onions, tomatoes, salt, mint, paprika and various herbs. In addition to these ingredients one or more of the following ingredients can be used in the formulation of the tarhana: milk, soybean, corn, barley and rye flour, chick bean, lentils, cornelian cherry and baker's yeast. Cornelian cherry has been used for the medical treatment of gastrointestinal disorder and diarrhea among people in Turkey. The aim of this study was to investigate the effect of cherry laurel pulp on the macro and micro mineral characteristics of Tarhana. Tarhana samples with 0%, 5%, 10%, 15%, and 20% cherry laurel pulp were manufactured. Different heavy metals were found out in tarhana by Inductively Coupled Plasma Optical Emission Spectrometer (ICP–OES). Concentrations of calcium (Ca), phosphorus (P), sodium (Na), magnesium (Mg), aluminum (Al), zinc (Zn), iron (Fe), copper (Cu), manganese (Mn), boron (B), molybdenum (Mo), cadmium (Cd), cobalt (Co), chromium (Cr), nickel (Ni) and lead (Pb) were measured. There were significant differences ($P<0.05$) in macro and micro mineral concentrations between the control tarhana and the samples made with cherry pulp. Highest Fe and Mn contents were detected in the samples manufactured that contain %20 cherry laurel pulp on average as 706,35 ppm and 2316,87 ppm respectively but the highest Zn and Cu contents were detected in the samples manufactured that contain %0 cherry laurel pulp.

TURKISH CACIK AND LABNEH PRODUCTION METHODS AND PROPERTIES

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KEYWORDS:
cacik, labneh, properties

Herby cacik is a traditional food specially produced from mixer of yoghurt, ayran and sometime small amount of whey. Milk should be clarified prior to heat treatment to remove unwanted materials. After clarification, the milk is boiled for 20–30min to increase its solid content. It is then cooled to 35–40°C and inoculated with yoghurt culture (1–4%). The inoculated yoghurt mixtures are filled into big containers and incubated at 43°C. Incubation is terminated at pH 4.5. The yoghurt is then churned and butter and ayran produced. Yoghurt or ayran is heated at 90–100°C for about 10min until a white coagulum floats on the surface: the çökelek is formed by placing this in a clot bag and putting weights on it to drain water off until the desired solids level is reached. Then prepared herbs are added at a level of 1–2% and mixed well. The cacik can be eaten fresh or it can be used with herby cheese to fill the cheese container. Labneh, concentrated yoghurt, popularly known as labneh in the Middle East and as strained yoghurt in Greece and the rest of Europe, is consumed as a main dish at breakfast in many Middle Eastern countries, such as Iraq, Iran and Lebanon. Labneh can also be served as a dip with garlic, dried herbs (usually mint and parsley) and red peppers, or with cucumber and olive oil. The effects of adding herbs, purslane, dill, parsley, cress, coriander, rocket, diplotaxis and mint, on physicochemical and sensorial properties of labneh were investigated. It was found that labneh made with the adding of herbs differed from each other depending on the herb strain and storage time.

IMPACT OF ALKALIZATION ON TOTAL POLYPHENOLS CONTENT, TOTAL FLAVONOIDS CONTENT AND ANTIOXDANT CAPACITY IN COMMERCIAL COCOA POWDERS

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KEYWORDS:
ACI, cocoa powder, total flavonoids content, total polyphenols content

Introduction: Cocoa is the source of more than 300 known chemical constituents of different physiological effects. The most common are polyphenol compounds and purine alkaloids. The most important dietary sources of polyphenols are: fruit, vegetables, cocoa, tea, red wine, coffee, beer, juices etc. Polyphenols, specially flavonoids, have strong antioxidative and antiradical potential and are important bioactive compounds. Aim: The polyphenolic content of cocoa powder differs substantially by country of origin, method of production (alkylated and non alkylated cocoa powder), fat content (share in butter). Each stage in the processing of cocoa alters its chemistry. The aim of this study was evaluation of total polyphenols and flavonoids content, as well as the antioxidant capacity in extracts made from samples of cocoa powder of different origin and production method that are being used by two large chocolate manufacturers in Serbia. Method: Total polyphenols content was determined using Folin-Ciocalteu method. Gallic acid used as a standard and the amount of total polyphenols was expressed as gallic acid equivalents (GAE) in mg/1 g cocoa powder. Total flavonoids content was determined using method with aluminum-chloride, catechin was used as a standard, and the amount of total flavonoids was expressed as catechin equivalents (CE) in mg/1 g cocoa powder. For determination of antioxidant capacity DPPH, FRAP, ABTS and ORAC tests were used. Results were expressed as ACI value (antioxidant potency composite index). At the same time, the correlation between total polyphenols content, total flavonoids content and antioxidant capacity in analyzed extracts of cocoa powder was determined. Results: Total polyphenol content of non-alkalyzed cocoa powder is 31.76 $\pm$ 0:51 (mg GAE/1g cocoa), while the content of the same in alkalyzed samples is 16.01 $\pm$ 0.44. The content of flavonoids and ACI value of of non-alkalyzed cocoa powder amount 61.01 $\pm$ 0.93 (μmolCE/1g cocoa) and 87.86 $\pm$ 0.79 (%), respectively. In samples of alkalyzed cocoa powder, these values are 33.30 $\pm$ 0.73 and 44.17 $\pm$ 0.64, respectively. In addition, there are correlation between total polyphenols (TPC) and antioxidant potency composite index (ACI) (R2 = 0.9018) and higher correlation between total polyphenols (TFC) and antioxidant potency composite index (ACI) (R2 = 0.9291). Conclusion: Results obtained have shown that process of alkalinization had significant influence on total polyphenols and total flavonoids content since all the results for alkalyzed cocoa samples were two times lower than for non-alkalyzed ones. As was expected, the same was noticed for the antioxidant capacity in analyzed samples. The correlation analysis indicated that there was higher correlation between total flavonoids content and antioxidant potency composite index than between total polyphenols content and antioxidant potency composite index.

VIRGIN OLIVE OIL AS FUNCTIONAL FOOD

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KEYWORDS:
antioxidants, fatty acids, functional food, health, virgin olive oil

Functional food is fresh or processed foods, which in addition to the usual characteristics of food has more additional features, which have beneficial effects on health, because it improves or prevent certain diseases. The main purpose of functional foods is to providing essential nutrients that promote good health, which has preventive and therapeutic effects confirmed by various scientific research. Dietary supplements are consumed in its natural original form in the normal diet, while food supplements are intaked in tablet, capsule or liquid preparations. Recently, the functional foods are increasingly includes olive oil, thanks to a large number of scientific research and knowledge about the quality of olive oil and its positive health effects on the human organism. Olive oil is the oldest of known oils, as well as one of the healthiest oils. It is the basis of the Mediterranean diet, which many health experts recommend to maintain health. Virgin olive oil (VOO) is easily digested, stimulates the secretion of gastric juice and allows for better absorption of vitamins, especially vitamin E. It has been successfully used in the diet of diabetics. The use of VOO has a positive effect on HDL cholesterol, reduce the serum lipid levels and reduce oxidative stress. Moreover VOO's biophenols prevent the oxidation of LDL cholesterol. One of the reasons for the positive effect of VOO on the health is well-balanced fatty acid composition. VOO has low content of saturated fat, and it is rich in mono unsaturated oleic acid, and small but sufficient amounts of essential fatty acids. VOO is characterized by the presence of biophenols, which are effective natural antioxidants. Consumed fats in every day diet should represent mono unsaturated fats rich in oleic acid and low in saturated fatty acids and a sufficient amount of essential fatty acids. In this paper we described the chemical composition of VOO, the influence of its individual compounds on human health and the influence of specific chemical compounds or groups of compounds in VOO on sensorial experience.

Session C:

IMPLEMENTATION OF GREEN TECHNOLOGY

NOVEL PROCESSING TECHNOLOGIES FOR FOOD AND AGRO WASTE AND BY PRODUCTS REMEDIATION

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KEYWORDS:
Food waste, by-products, Non-thermal technologies, Ultrasound, High pressures, Pulsed electric fields

Food and agricultural waste and by-products are proven to be valuable source of various functional ingredients. Besides as possible raw material after the processing such material is on the spot of the processing and is competitive with the price. The main task and the goal of the engineers and scientists is to establish most applicable technology for processing. World today is looking for the technologies that will contribute to various demands including environmental protection but also to maintain procedures that would be capable to produce final products with the same or even better quality. Well-established processing of agro and food waste rely mostly on heat intake during thermal processing like evaporation, drying, sterilization, cooking, and pasteurization. Those technologies are still irreplaceable but improved technologies and techniques are yet finding their place in mentioned processing of food and agro waste with goal and trend towards cleaner, safer and more improved processing. Those technologies among the others are high hydrostatic pressures (HHP), hiintensity ultrasound (HUS), microwave heating (MH), Low temperature plasma treatment (LTPT), pulsed electric fields (PEF), Laser ablation (LA) and some others.

GREEN SOLVENTS IN SEPARATION PROCESSES

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KEYWORDS:
deep eutectic solvents, ionic liquids, separation processes

For the separation of a homogenious mixture a second immiscible phase must be created or added in order to enhance mass transfer between two phases. Phase is created by an energy separating agent, ESA, and this process involves heat transfer. Processe that involves the addition of mass separating agent, MSA, are more complex since MSA must be recovered. Furthermore, if the feed and MSA are not completely immiscible the product will be contaminated with the MSA. Liquid-liquid extraction using selective solvent is widely used when distillation is not feasible for separation of liquid mixture. As for any other process that involves MSA, special care must be taken when selecting a proper solvent. Solvents commonly used in industry are volatile organic compounds that exhibit high vapour pressure. Additionally, volatile organic solvents are flammable and are of varying toxicity, depending on their nature. During past decade, an increasing trend of investigations concerning the possibilities of replacing the existing commercial solvents with ecologically acceptable, so called green solvents. Ionic liquids and their greener analogues deep eutectic solvents have attracted great attention because of their unique adjustable physical and chemical properties. The key advantages of these green solvents in this separation process are their high selectivity, non-volatility and their capability to dissolve different types of organic, inorganic and polymeric compounds. In addition, ionic liquids and deep eutectic solvents can easily be regenerated and even reused several times. In this review the major contributions of ionic liquids and deep eutectic solvents will be reported.

SUPERCRITICAL FLUID EXTRACTION – NEW GREEN TECHNOLOGY IN PRODUCTION OF EDIBLE OILS

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KEYWORDS:
edible oils, equipment design, supercritical fluid extraction

Food industry is always looking for processes that can minimize the environmental impact, decrease toxic residues, use by-products more efficiently and also obtain high-quality products with good nutritional and organoleptic properties and preserved original ingredients. Supercritical fluid extraction has attracted considerable attention in recent years as a promising alternative to the conventional solvent extraction and mechanical pressing in food processing. As a new green solvent in recent years is considered supercritical carbon dioxide which proved to be a highly desirable solvent in the separation process since it is non-toxic, non-flammable, no taste or smell, inexpensive and readily available in large quantities, as well as because it is environmentally friendly and GRAS solvent. By using carbon dioxide as solvent the process of supercritical extraction becomes environmentally friendly process resulting in extracts free of toxic solvents. This technology is still relatively new and is not widely used on the commercial scale for the extraction of edible oils. This is mainly due to very high investment costs of equipment. This paper will review the application of supercritical fluid technology in the extraction of edible oil from different seeds.

SEMI-CONTINUOUS HYDROTHERMAL PROCESSING OF LARCH BARK FOR PRODUCTION OF PHENOLIC COMPOUNDS AND OTHER NATURAL ANTIOXIDANTS

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KEYWORDS:
Larch bark, Hydrothermal processing, Subcritical water, Phenolic compounds, Antioxidants.

In many European countries bark is still considered a biomass waste, usually with little to no value. Due to its weak mechanical properties and low content of fibers, not many applications can be found in the wood processing industry and in paper mills, therefore the best option for its disposal is usually still the simple burning of material. On the other hand, bark is known to consist of many compounds with properties such as antioxidant and antimicrobial activities, which could if correctly isolated be beneficial to humans, for instance as food additives. Also, other naturally derived products from bark could be obtained from this hemicellulose and lignin rich material, which could be interesting for production of new bio-based products, such as polymer precursors and plasticizers. One possibility to obtain the above mentioned products is by hydrothermal processing of bark, which is a relatively new method of biomass treatment using high-temperature highpressure water, also commonly referred to as subcritical water. At these conditions water becomes a medium with a strong affinity to rupture the molecular bonds typically present in natural biopolymers (cellulose, lignin etc.) forming many water soluble products. The formation of these products is dependent on the process conditions, which should be investigated more in detail before any further large-scale processing. In this study, bark of European larch was hydrothermally processed in a semi-continuous high-pressure high-temperature tubular reactor in a temperature range from 200 °C to 400 °C. Kinetics of extraction was evaluated, by collecting samples every 10 min for 2 hours. Collected samples were analyzed for their total phenolics content using the Folin-Ciocalteu spectrophotometric method. Furthermore, the antioxidant activities of samples was determined using the radical scavenging method. The sample solutions were evaporated until dryness and the phenolic compounds were analyzed using high performance liquid chromatography.

PROPERTIES OF STARCHES IN MIXTURES WITH SUPERCRITICAL CO_2 AND THEIR USE AS CARRIERS IN PGSS MICRONIZATION PROCESS

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KEYWORDS:
starches, supercritical CO_2, solubility, diffusivity, magnetic suspension balance, PGSSTM

Starch is the most abundant storage reserve carbohydrate in plants. It is a polymer of glucose which is linked by glycosidic bonds. Starch is a versatile and useful polymer not only because it is a cheap, natural material but also because of the ease with which its physicochemical properties can be altered through chemical or physical treatment. Solubility and diffusivity data are important when designing technologies for processing natural or synthetic polymers. CO_2 has been proposed for sustainable processing of polysaccharides; however, the phase equilibrium data are highly scarce. Therefore, this study represents an original contribution to the understanding of the interactions between starch derivatives and CO_2 as a potential "green" solvent. The solubility of supercritical carbon dioxide (SC CO_2) in starches (pure, wheat and corn) at different temperatures (313, 333 and 353 K) and pressures (0-30 MPa) was measured using a magnetic suspension balance (MSB). The results show good solubility of CO_2 in polymers: up to 28.2 % in starches. The diffusion coefficients of CO_2 in the polymers were determined from the sorption curves obtained from MSB. In the next step raspberry juice concentrates were micronized by a high pressure PGSSTM (Particles from Gas Saturated Solutions) micronization process using supercritical CO_2 and various carriers (pure starch, tristearate). The efficiency of micronization was above 90 %. The obtained products were in the form of the free flowing red colored powders which are interesting for the use in the food industry as natural colorants.

SUBCRITICAL WATER EXTRACTION OF BIOLOGICALLY ACTIVE COMPOUNDS FROM NATURAL SOURCES

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KEYWORDS:
Subcritical water extraction, phenols, flavonoids, apigenin

The application of Green chemistry aims to develop and encourage the utilization of procedures that reduce or eliminate the use or production of hazardous substances. This implies reducing the use of organic solvents and encourage of using of novel extraction techniques that are known to be more environmentally friendly. Long extraction times, large quantities of samples, sorbents and organic solvents, are the primary drawbacks of the traditional extraction methods that often have negative impacts on human health and environment. Furthermore, obtained final extracts often require subsequent concentration and clean-up prior to analysis. Keeping in mind that bioactive compound, such as phenols and flavonoids, are sensitive, thermolabile and present in very small quantities, traditional extraction techniques are often not the most suitable option. To obtain these compounds from natural sources, green extraction approach is required. In this sense subcritical water extraction (SWE) is considered particularly promising method. The present study was designed to define the impact of process parameters on total phenols and flavonoids content, as well as on apigenin content in extracts prepared from chamomile ligulate flowers. Moreover, the differences in cytotoxic and antimicrobial activity of extracts, obtained at different operation conditions, were investigated. Cytotoxic activity of selected extracts was defined with three different cells lines derived from: human rhabdomyosarcoma (RD), human cervix carcinoma Hep2c (HeLa) and murine fibroblast (L2OB). Antimicrobial activity, expressed as minimum inhibitory concentrations (MIC) was determined for eight selected indicator strains. The obtained results showed that the content of total phenols, flavonoid, as well as apigenin content, changed depending on the applied operation conditions, because changes in process parameters caused a change in polarity, and thereby the selectivity of the subcritical water. The achieved results clearly demonstrate that by changing the operating parameters, the composition and biopotential of extracts could be manipulated. Certainly, in order to optimize SWE extraction it is necessary to empirically optimize operational parameters. The authors would like to thank the Ministry of Education, Science and Technological Development, Republic of Serbia, for financial support (Project No. TR31013).

AQUEOUS TWO-PHASE EXTRACION OF POLYPHENOLS FROM RED AND WHITE WINE IN MICROEXTRACTOR

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KEYWORDS:
starches, supercritical CO_2, solubility, diffusivity, magnetic suspension balance, PGSSTM

Extraction of polyphenols is traditionally performed using organic solvents e.g. methanol, ethanol, acetone, dimethylformamide etc. Application of these solvents results in efficient extraction but the extracts are not safe for human consumption due to the potential effect of toxic solvent. Additionally, organic solvents can disrupt the polyphenol structure and reduce their activity, used organic solvent require special care for disposal and represent possible source of pollution. To eliminate the described problems aqueous two-phase system containing PEG_{6000}-H_2O-$(NH_4)_2SO_4$ was used in this investigation for extraction of polyphenols. Under optimal operating conditions published elsewhere (Šalić et al. 2011) continuous extraction of polyphenols from red and white wine was performed in microextractor system. Microextractor system was composed of two microchips connected in series. The first one was equipped with micromixers for mixing at high Reynolds numbers, while the second one was the tubular microchip. The first microchip was used for homogenisation of two aqueous phases and the second one for the phase separation. Total working volume of described microextraction system was V = 8 mm^3. The obtained results indicate that aqueous two-phase system can be successfully used of extraction of polyphenols from red and white wine in microextractor. The obtained mass transfer rate for the microextraction system was two orders of magnitude higher that those achieved in conventional batch and continuous macroextraction system.

Šalić, A., Tušek, A., Fabek, D., Rukavina, I., Zelić, B. (2011) Food Technol. Biotechnol. 49, 495-501.

GREEN APPROACH TO PREVENTING CORROSION OF METALS AND ALLOYS

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KEYWORDS:
corrosion, essential oils, green corrosion inhibitors, natural products

Corrosion of metals and alloys is an important and unavoidable problem in almost all industrial processes, and results in a large economic losses caused by shortening the duration of the industrial equipment, and quality deterioration of the final product. The use of corrosion inhibitors in the industry has a long tradition, because it provides good protection of metals and thus minimizes economic wasting. Despite the fact that the large number of synthetic compounds is used for this purpose, most of them are highly toxic. In the 21st century, the research in the field of green or eco-friendly corrosion inhibitors has been addressed to natural products of plant origin. From the economic and environmental points of view, these natural sources are an excellent alternative as corrosion inhibitors because of their availability, biodegradability and nontoxicity. Natural products of plant origin, such as essentials oils and extracts, are incredibly rich sources of naturally synthesized chemical compounds such as glucosinolates, alkaloids, polyphenols, tannins, terpenes etc. In general, these compounds present conjugated aromatic structures, long aliphatic chains, and heteroatoms that are available to form bonds with the metal surface; in most cases, they act synergistically to exhibit good efficiency regarding the corrosion protection. This work focuses on studying essential oils of lavender, bay laurel, dill and basil as inhibitors for corrosion protection of aluminium and its alloy in acidic and neutral solutions. The investigation of corrosion inhibition parameters was performed by weight loss, potentiodynamic polarization, electrochemical impedance spectroscopy and scanning electron microscopy methods.

APPLICATION OF PHYTOREMEDIATION FOR HEAVY-METAL REMOVAL USING COMMON WILD PLANT SPECIES IN GREEN CITY AREAS OF VARAŽDIN, CROATIA

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KEYWORDS:
Croatia, heavy metals, phytoremediation, Varaždin, wild plant species.

Phytoremediation is a method for removing various types of contaminants from the environment using plants. This method has proved highly efficient for the removal of heavy metals. As is known, heavy metals in high concentrations are very toxic for living organisms. They are usually present in the soil, below certain concentrations as a result of the soil's mineral content, and above certain concentrations as a result of pollution from various sources: fossil-fuel consumption (traffic, industry, households), landfills, waste water, agriculture (mineral fertilizers and pesticides) etc. The aim of this study was to examine how common wild plants can successfully remove heavy metals from green city areas. During June and July 2013, in 16 locations in Varaždin, soil and plant samples were collected from precisely defined areas. Three plant species were examined: dandelion (Taraxacum officinale agg.), ribwort plantain (Plantago lanceolata L.) and white clover (Trifolium repens L.). The following heavy metals were detected: cadmium (Cd), copper (Cu), iron (Fe), lead (Pb), manganese (Mn), nickel (Ni) and zinc (Zn). For the detection of the amounts of heavy metals, the method of atomic absorption spectrometry was used. In the soil samples for eight locations, maximum allowed amounts of heavy metals were exceeded. In plant samples, the highest accumulation of cadmium was recorded in Taraxacum officinale, with 0.945 mg/kg; of copper, in Plantago lanceolata, with 239.03 mg/kg; of iron, in Plantago lanceolata, with 246.25 mg/kg; of manganese, in Taraxacum officinale, with 49.60 mg/kg; of nickel, in Taraxacum officinale, with 5.498 mg/kg; of lead, in Plantago lanceolata, with 3.88 mg/kg; and of zinc, in Trifolium repens, with 216.50 mg/kg. The levels obtained could have practical value in the process of removal of heavy metals from contaminated soils by phytoremediation. The advantage of the use of common wild plant species is that they do not need to be sown. Furthermore, green city areas are mown, on average, 10 times during the growing season, and in this way a considerable amount of swath biomass, and hence heavy metal, can be removed. Accordingly, it can be concluded that common wild plants can be used for phytoremediation of heavy metals in an environmentally-friendly and inexpensive way, but over a lengthy period. Besides contaminated green city areas, this method can be applied to other contaminated surfaces with similar climatic conditions.

A NEW CATEGORY OF SEPARATIONS SCIENCE: ULTRAPERFORMANCE CONVERGENCE CHROMATOGRAPHY

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KEYWORDS:
SFC,
UltraPerformance
Convergence
Chromatography,
natural products

UltraPerformance Convergence Chromatography™ (UPC2®) is a broad-based, complementary analytical platform that is taking its place alongside of LC and GC as one of the three essential separation technologies for modern laboratory analysis. There are three main forms of chromatography: GC, LC, and now convergence chromatography (CC). While all three use a stationary phase to interact with compounds of interest and a mobile phase to move compounds through the stationary phase and achieve separation, the techniques differ mainly by the mobile phases used. GC is defined by using a gas as its mobile phase, LC is defined by using liquids as its mobile phase, and CC is defined by using both gas and liquids. It is this convergence of mobile phases in combination with a far greater choice of stationary phases that makes CC a powerful additional choice for laboratory scientists. A major concern of scientists in regulated industries is that impurity, degradation peaks, or structurally similar compounds may be overlooked. Orthogonal methods that provide different elution orders of peaks are needed to ensure full characterization and that nothing is overlooked. Having a second technology platform that can routinely provide reliable orthogonal data is proving to be a strong driver for UPC^2 adoption. Among the advantages that reversed-phase chromatography offers are ruggedness and reliability, as well as the power of gradient elution for rapid method development, these capabilities significantly improve workflow and were not possible with normal-phase LC. Reversed-phase LC, however requires sample injection in water-compatible solvent which can mean hours (sometimes days) worth of repeated extractions and dry-down processes. As the diversity of samples increased so too did the time to do sample prep. All the workflow benefits of reversed-phase chromatography were being eroded. Because UPC^2 can receive samples in organic solvents, it significantly simplifies the requirements for sample preparation, while maintaining all the advantages of RPLC. SFC excels at separating and purifying chiral compounds and natural products because it's faster, uses much less solvent, and overall is a less expensive and greener method that exceeds high pressure liquid chromatography (HPLC) in performance for chiral separations.

GREEN SOLVENTS FOR GREEN TECHNOLOGIES

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biocatalysts,
deep eutectic
solvents,
extraction,
green solvents,
phenolic
compounds

Within 'green economy' approach, growing area of research in the development of green technologies is devoted to designing new, more environmentally friendly solvents. As a promising alternative to traditional organic solvents deep eutectic solvents (DESs) have been dramatically expanding in popularity last few years as a new generation of designer solvents with possible applications in various industrial fields. Herein, we will present recent progress of our multidisciplinary studies on DESs application in biotechnology. Within this study a number of DESs based on renewable sources (e.g. choline chloride, sugar, amino acids and carboxylic acid) were prepared, and screened for their applicability as green solvents in extraction of phenolic compounds from grape skin and lipasecatalyzed synthesis of short chain ester. In order to fully define DESs as environmentally benign, and thus the processes involving them, toxicity profiles of these solvents were also studied. The data obtained would serve to fill the existing gaps in the knowledge regarding DESs application in the extraction of various natural products from plant material as well as in biocatalytic processes. Data present here are our proof-of-concept for possible implementation of DESs into truly green industrial processes.

INTEGRATED REACTOR AND/OR MEMBRANE SYSTEM AS A GREEN PROCESS IN FOOD TECHNOLOGY AND BIOTECHNOLOGY

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KEYWORDS:
green process technology, membrane engineering, reactor engineering

The successful implementation of greener chemical processes relies on the development of reactor and separation technologies which can deliver enhanced processing performance through decreasing raw materials utilization, energy consumption, production cost, equipment size and waste generation. Membrane engineering as a separation technology and reactor engineering are alreadygiving interesting solution to some of the major problem of our modern industrialized society. For approaching the ambitious objective of reaching „zero liquid discharge" and „low energy consumption", different membrane operations and reactor technology can be coupled in integrated systems (membrane reactors, reactive distillation, reactive extraction, reactive absorption). For intensification of processes, as well as decreasing energy consumption, different intensified reactor technologies can be used as a green process technology (monolith reactors, microreactors, oscillatory flow reactors, cavitational reactors). Integrated membrane and reactor system allows to develop more cost effective and environmentally acceptable processes, and to use their synergic effect in terms of better performance of the overall system. In this paper, overview of application of integrated membrane and reactor technology as a green technology in food- and biotechnology was presented.

POSSIBILITIES OF WATER RECYCLING IN THE PRODUCTION OF BITUMEN BASED PRODUCTS

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KEYWORDS:
water recycling, water savings, bitumen, bitumen based products

Water is the essence of life, as well as an important raw material in many industrial processes. Due to rapid economic development and often irresponsible behaviour of mankind towards nature, in many cases the resources of clean water have been endangered. Therefore, water management is a significant part of human prospect and welfare. From the environmental point of view, the possibility of water savings in every field of human activity is very desirable. Since the industrial sector demands huge amounts of water, it is extremely important that industry adopts a concept of various water savings possibilities. This primarily applies to those industries, where health properties of water are not the most important issue, such as the case in manufacturing of bitumen based products, construction works, concrete preparation, the use of water as cooling fluid in power-plants... In this work the study of wastewater reuse in manufacturing of bitumen based products have been studied in one production plant in the North West region of Croatia. A special focus has been put on water reuse and findings of possible solutions regarding minimisation of the amount of fresh water usage, as well as the costs of water drainage in the production cycle.

REMOVAL OF HEAVY METALS FROM SOIL BY PHYTOREMEDIATION USING DANDELION *(TARAXACUM OFFICINALE AGG.)* IN THE AREA OF THE CITY OF VARAŽDIN

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KEYWORDS:
dandelion, heavy metals, phytoaccumulation, phytoremediation, Varaždin.

Phytoremediation is a relatively new method for the removal of different types of contaminants from the environment using plants. It is especially suitable for the removal of heavy metals from soil. Therefore, the purpose of this study was to investigate the possibility of removal heavy metals from the soil by wild plant species (Taraxacum officinale agg.) on green urban areas that are exposed to various anthropogenic impacts. During June and July of 2013, the samples of soil and plants were collected on 16 sites of Varaždin region in order to determine concentration of the following heavy metals: cadmium (Cd), copper (Cu), iron (Fe), lead (Pb), manganese (Mn), nickel (Ni) and zinc (Zn). Determination of heavy metals content was performed by using atomic absorption spectroscopy. The results of research have shown that dandelion has a great ability to accumulate heavy metals; accumulation for cadmium 0.945 mg/kg, for copper 23.45 mg/kg, for iron 218.33 mg/kg, for manganese 49.60 mg/kg, for nickel 5.498 mg/kg, for lead 0.910 mg/kg and for zinc 142.20 mg/kg. Obtained values could have practical purpose in the process of removal of heavy metals from contaminated soil by phytoremediation. The highest values of phytoaccumulation factors have obtained for cadmium (1.0), zinc (0.83) and copper (0.39), and lower values for manganese (0.064), iron (0.0047), nickel (0.0041) and lead (0.0034). The advantage of using dandelion is that it is a common wild plant species, it is not necessary to sow it, and it can be mow down several times a year from urban green surfaces. Based on the results, it can be concluded that the dandelion can be used in phytoremediation of contaminated soil with heavy metals, such method is relatively inexpensive and environmentally friendly, but its application needs a longer period of time.

ISOLATION OF FLAVONOIDS FROM PROPOLIS BY SUPERCRITICAL CO_2 EXTRACTION

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phenolics,
supercritical
CO_2
extraction

This work describes the isolation of flavonoids from propolis using supercritical CO_2. The conditions which offer the best extraction yields were determined as well as flavonoids and phenolics content in the extracts. The study was conducted on a raw bee propolis sample from Croatia. At first, the material was processed to obtain wax-free propolis. Propolis was dissolved in ethanol and filtered several times to remove the fraction insoluble in ethanol. The solution was then dried in a rotary evaporator to obtain dry ethanolic extract of propolis (EEP). Extractions with supercritical CO_2 were performed by a semi-continuous apparatus. Nine extractions were performed at pressures of 200, 250 and 300 bar and temperatures of 40, 50, 60 °C. In addition, the Soxhlet extraction of raw propolis was performed with ethanol, for the sake of comparison with supercritical extraction. Extraction yields were calculated. The results did not show regular pattern. However, it was noticed that the extraction yield enerally increases with increasing temperature. The best extraction yield of supercritical extract of propolis (SCEP), (X_0 = 13.58 %) was obtained at the pressure of 250 bar and temperature of 60 °C. The yield of Soxhlet extraction of propolis (SEP) was X_0 = 35.06 %. The total flavonoids as well as total phenolic content were determined by standard spectrophotometric methods. The highest flavonoids content in the extract was obtained at the pressure of 300 bar and at 50 °C and reached the value of 8.595 mg / g of SCEP (as expressed by quercetin equivalent). The highest phenolics content was obtained at the pressure of 200 bar and at 50 °C, and reached the value of 112.4 mg / g of SCEP (as expressed by gallic acid equivalent). However, both the flavonoids and phenolics content did not vary much with extraction conditions, except for the lowest temperature/pressure combination. The analysis of SEP showed much higher level of flavonoids (11.39 mg / g of SEP) and slightly higher level of phenolics (114.7 mg/ g). The analysis for EEP gave 12.94 mg / g of EEP for flavonoids and 113.3 mg/g. The study showed that two-step extraction using first ethanol and then neat supercritical CO_2 did not show any advantage in comparison with Soxhlet extraction, regarding the desired increase of flavonoids and phenolics content. However, Soxhlet extraction was performed at a higher temperature – i.e. atmospheric boiling point of ethanol.

THE POTENTIAL OF POPLAR *(Populus nigra var. italica)* IN THE PHYTOREMEDIATION OF LEAD

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KEYWORDS:
phytoremediation, poplar, lead, oxidative stress, antioxidant enzymes

One of the biggest problems today is pollution. Contamination with heavy metals which includes the lead (Pb), is a distinct problem because metals are not biodegradable and have negative impact on the living world. Ecologically and enivronmentally acceptable solution provides a new biotehnological process called phytoremediation, which is based on the ability of plants to clean and restore contaminated area. This study was used to assay the effect of lead on the growth of poplar (Populus nigra var. italica), phytoremediation potential of poplar for lead, his redistribution in certain parts of the plant. Some biochemical markers of oxidative stress, the amount of malondialdehyde as an indicator of lipid peroxidation and the amount of H_2O_2 were determined. Frutehremore the effects of lead in the soil on the activity of antioxidant enzymes like superoxide dismutase (SOD), peroxidase (POD), catalase (CAT), ascorbate peroxidase (APOX), glutathione-S-transferase (GST) and glutathione reductase (GR) as an indicator of the potential protection against oxidative stress were studied. All of the results together indicate that the studied poplar (Populus nigra var. italica) can be considered as a species with the potential use in phytostabilization of the soil contaminated with lead.

PHYTOREMEDIATION – GREEN SOLUTION FOR POLLUTION

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KEYWORDS:
antioxidant enzymes, cadmium, lead, oxidative stress, phytoremediation, poplar

Industrial, domestic, agricultural, medical and technological applications of heavy metals have led to their wide distribution in the environment, raising concerns over their potential effects on human health and environment. Among all heavy metals, the most common of them are cadmium and lead, which can occure as byproducts of petrochemical industries and traffic. Phytoremediation, as a new biotech method, is considered as an ecological, inexpensive and aesthetically acceptable, in situ technology to remediate heavy metals from contaminated soils. The potential use of fast-growing trees with high biomass production in the phytoremediation of soil has been recognized recently. The response to the presence of heavy metals in the plant leads to increased oxidative stress in the form of creation of reactive oxygen species or ROS. The first line of defence against harmful ROS consists of antioxidant enzymes. Plants ability to accumulate heavy metals present in the soil and its resistant to their effects lead to the possible potential of poplar (*Populus nigra* var. *italica*) in the phytoremediation of cadmium and lead. Therefore, as there is a small number of scientific papers which examine the synergistic effect of two or more heavy metals, an outdoor pot experiment was designed in order to evaluate changes of poplar growth parameters during prolonged exposure with 4 harvest points (GP1-GP4), allowing the consideration of prolonged adaptions to heavy metal stress. During 77 days long growing period (from July to September) in soil, poplar (*Populus nigra* var. *italica*) was treated withcombination of different concentrations of Cd (w = 10, 25, 50 mg kg^{-1} soil) and Pb (400, 800, 1200 mg kg^{-1} soil). The aims were to explore the accumulation and distribution of Cd and Pb in different plant parts (leaf, stem, root), the malondialdehyde content (an indicator of membrane lipid peroxidation) in order to estimate the extent of oxidative stress as well as the potential role of antioxidant enzyme activity (superoxide dismutase, guaiacol peroxidase, catalase and ascorbate peroxidase) in response to oxidative stress caused by the accumulation of different amounts of heavy metals. A statistical analysis based on the Random Forests Analysis (RFA), a new and powerful statistical classifier, was performed. The importance of antioxidant enzyme activity, different amounts of Cd and Pb, soil and meteorological parameters change in different plant parts. However, the preliminary results highlighted a key role of the catalase activity in response to the oxidative stress in all plant parts.

EFFECTS OF NANO OXIDES ON HELIANTHUS ANNUUS IN A CONTAMINATED SOIL

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stress

Due to their reactivity and relatively-large specific surface area (tens to hundreds of m^2 g^{-1}) and their oxidative properties, iron nano oxides (particle size of 1-100 nm) are important scavengers of potential contaminants, being a good choice for the assisted phytostabilization of trace elements (TEs) in contaminated soils. The purpose of this research was to study the effects of nanomaghemite (NM) (<50 nm nanopowder of iron oxide Fe_2O_3) on plant responses to TEs. For this task, a pot experiment was carried out with plants of *Helianthus annuus* in a TEs-contaminated soil treated with NM. The soil was collected from the former mine area of La Unión (Murcia, Spain: pH=7.5; EC=2.3 dS m^{-1}; OM=1.06%; total metal concentrations (CaCl2-extractable in brackets): Cd 31 (0.6), Cu 142 (0.05), Pb 6130 (3.3), Zn 12506 (138) all mg kg^{-1}; Fe 153 g kg-1 (0.7 mg kg^{-1}) and Mn 4.07 g kg^{-1} (1.26 mg kg^{-1})). For the optimization of plant growth, OM was supplied to the soil (73.1% OM). After the stabilization of the compost in the soil during 3 weeks, NM was mixed with the soil in a dose of 1%. Control pots without compost and NM were used for comparison, so the resultant three treatments were: (i) control soil, (ii) compost, and (iii) compost+NM. All the treatments were prepared in quintuplicate. After a subsequent stabilization period (15 days), seeds of H. *annuus* were sown in the pots. The plants grew in the pots for 8 weeks in a greenhouse, under conditions of constant temperature (22 °C) and humidity (65%). The water content of the soil was maintained at 30% of the water-holding capacity, but water deprivation was imposed for all the treatments by withdrawing irrigation for the last 7 days. The TEs concentrations in pore water were analyzed by ICP-OES. The highest biomass was obtained in the compost+NM soil (a significant increase of 37 and 40% relative to the control and compost treatments, respectively), perhaps related to the significant reduction of available Zn in the pore water (from 470 to 366 µg l^{-1}; $p<0.05$). The relative water content (RWC) and specific leaf area (SLA) of plants did not manifest any disruption of their water balance by NM. Furthermore, the amino acid proline will be measured in the freeze-dried plant material, as an indicator of stress in the plants during the drought-NM interaction, and the concentrations of TEs in plants will be analyzed (results will be shown). The addition of OM+NM seems to be beneficial in terms of phytoremediation.

DEEP EUTECTIC SOLVENT CHOLINE CHLORIDE:GLYCEROL AS SELECTIVE SOLVENT FOR EXTRACTION OF PYRIDINE FROM *n*- HEXANE

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KEYWORDS:
denitrification, deep eutectic solvents, liquid-liquid extraction

Demands concerning liquid fuel purity as well as green chemistry principles consequently influence trends in the field of research and development of new technologies. Besides production of fuels with ultra low sulfur content, demands for low nitrogen content must also be fulfilled. Alternative desulfurization processes were widely investigated and numerous solutions have been published. On the other hand, only few articles about denitrification can be found. Liquid-liquid extraction with environmentally friendly solvents, as one of the possible solution for denitrification, became interesting since different types of ionic liquids dissolve nitrogen compounds together with sulfur compounds. Use of deep eutectic solvents for denitrification of model fuels have not been published jet. Since deep eutectic solvents possess similar properties as ionic liquids, in this investigation separation of pyridine from its mixture with n-hexane by means of liquid-liquid extraction with choliniumbased deep eutectic solvent (choline chloride:glycerol (1:2,n)) was analyzed. Experiments have been performed in a laboratory scale extractor equipped with magnetic stirrer. The influence of solvent ratio and concentration of pyridine was investigated. Solvent ratio significantly influences extraction efficiency.

LIQUID-LIQUID EQUILIBRIUM FOR THE SYSTEMS

HYDROCARBON –THIOPHENE – 1-HEXYL-3,5 DIMETHYLPYRIDINIUM BIS(TRIFLUOROMETHYLSULFONYL)IMIDE

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KEYWORDS:
desulfurization, liquid-liquid equilibria, [C$_6$mmPy] [Tf$_2$N]

Liquid-liquid equilibrium for four ternary systems involving one hydrocarbon (*n*-hexane, *n*-heptane, *i*-ocatne or toluene), thiophene and an ionic liquid (1-hexyl-3,5-dimethylpyridinium bis(trifluoromethylsulfonyl)imide) was experimentally determined at atmospheric pressure and 25 °C. Equilibrium data are presented with binodal curves as well as with tie lines. Physical properties (density, viscosity and surface tension) of ionic liquid were measured at room conditions. The suitability of ionic liquid for extractive desulfurization was evaluated in terms of solute distribution ratio and selectivity. Extraction experiments with threecomponent and seven-component (*n*-hexane, *n*-heptane, *i*-octane, toluene, thiophene, pyridine and IL) systems have been performed. Based on the obtained results it can be concluded that 1-hexyl-3,5-dimethylpyridinium bis (trifluoromethylsulfonyl)imide is a good selective solvent for desulfurization of model fuels. The solute distribution ratio and selectivity decreases with increasing solute mass fraction in the hydrocarbon-rich phase. The equilibrium data in three-component systems were well described with NRTL and UNIQUAC models. Extraction efficiency is higher in the three-component systems because in the seven-component system a larger number of components participates in the mass transfer between the model solution and ionic liquid.

SEPARATION OF TIOPHENE FROM *n*-HEXANE BY THE MIXTURE OF IONIC LIQUIDS

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KEYWORDS:
desulfurization, ionic liquids, liquid-liquid extraction

Separation of sulfur compounds from its mixture with hydrocarbons, model fuels or real refinery samples, by means of liquid-liquid extraction with ionic liquids, has been widely investigated. Most commonly used ionic liquids for that purpose are based on variously substituted imidazolium or pyridinium cation. Non volatility of ionic liquids as well as its capability to dissolve various types of compounds makes them a good candidate as the selective solvent in liquid-liquid extraction. Mixture of two different ionic liquids was used as the selective solvent for desulfurization of n-hexane by means of liquid-liquid extraction. Combinations of four ionic liquids (1-ethyl-3-methylimidazolium ethylsulfate, 1-pentyl-3-methylimidazolium bis(trifluoromethylsulfonyl)imide, 1-benzyl-3-methylimidazolium bis (trifluoromethylsulfonyl)imide and 1-hexyl-3,5-dimethylpyridinium bis(trifluoromethylsulfonyl) imide) at different mass fractions were prepared. Experiments have been performed at mass ratio (ionic liquid / mixture of thiophene and n-hexane) 0.25 in the laboratory scale batch extractor agitated by magnetic stirrer. Ionic liquids as well as their mixtures were characterized by means of ^{1}H NMR spectrometry. Concentration of thiophene in the feed solution and rafinate were calculated from the refractive indices measured at 25 °C. Composition of extract phase was determined from the mass balance. Based on the obtained results it can be concluded that addition of higher efficiency ionic liquid improves extraction efficiency of less efficient one. The best improvement of the extraction efficiency of 1-ethyl-3-methylimidazolium ethylsulfate was obtained with the addition of 1-hexyl-3,5-dimethylpyridinium bis(trifluoromethylsulfonyl)imide.

LIQUID - LIQUID EXTRACTION AS A SUCCESSFULL TOOL FOR REGENERATION OF IONIC LIQUIDS

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KEYWORDS:
liquid-liquid extraction, green solvents, ionic liquids

Ionic liquids (ILs) are regarded as a promising substance group, not only as substitutes to replace more hazardous solvents in industrial processes, but to be used as solvents and new materials in a wide field of applications as synthesis and catalysis, biocatalysis, electrochemistry, liquid and gas separations, and polymer science. ILs are being considered as green replacements for industrial volatile organic compounds (VOCs) owing to their low melting point (below 100°C). The reputation of these solvents as ''environmental friendly'' chemicals is based primarily on their negligible vapor pressure, their stability, nonflameability and easy recovering. Due to the high design costs of ILs, any extension of their lifetime by reuse and recyling potentially reduces total costs. A regeneration process is necessary as soon as the used IL can not be directly re-used due to the presence of other components. For these reasons, the possibility of regeneration of different ILs (based pyridine and imidazole) used in separation of sulfur and nitrogen compounds from model solution representatives diesel fractions was explored. Liquid-liquid extraction, as the separation method, in which selective solvent was n-dodecane, have been used for the regeneration. Nuclear magnetic resonance (NMR) confirmed liquid-liquid extraction as a suitable operation for regeneration of ILs since dibenzotiophene, as the only pollutant, have been completely removed.

APPLICATION OF AMORPHOUS MANGANESE OXIDE AND BIOCHAR AS STABILIZING AMENDMENTS FOR Pb AND Zn IN A CONTAMINATED SOIL

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KEYWORDS:
biochar; amorphous manganese oxide (AMO); metal sorption; soil moistening

Biochar and amorphous manganese oxide (AMO) were used as perspective amendments for the remediation of a metal-contaminated soil (alluvium of the Litavka River in the Příbram ore region, Czech Republic). Biochar was produced using pyrolysis of grape stalks at 600 °C in a muffle furnace under 16.7 mL min-1 nitrogen flow rate at atmospheric pressure and retention time of 30 minutes. AMO was prepared using the sol-gel procedure by mixing of 1.4 M glucose with a 0.4 M $KMnO_4$ solution without heating. Soil was air-dried, sieved through a 2-mm sieve and homogenized. Sorbents were added to soil at 2 wt.%. Additionally, the treated soil was then moistened to 80 % of WHC for one week. Aqueous solutions of metals were prepared from $Zn(NO_3)_2.4H_20$ and $Pb(NO_3)_2$ (p.a.), (Lach-Ner, Czech Republic) in background electrolyte (0.01 M $NaNO_3$). Reaction kinetics and batch sorption experiments were implemented for this case. According to kinetic experiments, the equilibrium was established after 24 hours. Results of equilibrium batch experiments showed that both studied sorbents affected the sorption capacity of the studied soil significantly. In more detail, metal sorption efficiency of the tested sorbents decreased in the following order: (i) AMO (121/67 mmol kg^{-1} for Pb/Zn); (ii) AMO+BC (111/39 mmol kg^{-1} for Pb/Zn); and (iii) BC (98.8/35.0 mmol kg^{-1} for Pb/Zn). Furthermore, in the case of multi-metal (Pb+Zn) sorption the effect of sorbents application was more significant than in the case of single-sorption. More precisely, Zn was desorbed in the soil without treating, whereas after sorbents application, Zn was fixed in the soil. It is also obvious from the results, that mixture of AMO+BC have no additional effect on the removal efficiency in comparison with the AMO, which should be explained by a relatively high amount of organic compounds in the studied soil. Finally, soil moistening showed negligible effect on metal sorption efficiency, only in the case of multi-metal sorption the efficiency of Zn was increased by 35% in comparison with the soil without moistening.

Session D:

BIOMASS AND SUSTAINABILITY

ENERGY BALANCE OF WOOD CHIP PRODUCTION

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KEYWORDS:
energy balance, EROI, wood chips, oak, transport distance

Wood chips are used to produce thermal energy, but the amount of energy obtained by burning depends on the moisture content and the features of the energy plant. Energy balance of production shows the relationship between obtained and invested energy in the production process. This relationship is a key factor in sustainable global energy supply. Energy can not be produced without consumption of some part of the energy, and the proportions in which this occurs is a key indicator of the efficiency of the production process. This paper deals with the issue of the amount of energy required to produce in the process of wood chips production and wood chips transport to the heating plant. When calculating the energy balance is important to include as many input parameters (parameters of energy consumption) which represents almost impossible task because the one parameter directly binds several others. According to several authors, the relationship obtained and invested energy or EROI (Energy Return on Investment) for energy wood is 30: 1 which is a better ratio than the production of oil, whose relationship obtained and invested energy is about 20: 1. The results of this study show that during the production and supply of wood chips from final felling of oak stands most of the energy used to fuel for machinery and vehicles used in production process. Ultimately relationship obtained and invested energy is approximately 25: 1 in the case of moisture content in the wood chips in the limit (market) value of 35% and the mean distance truck transportation of wood chips of 50 km. This is a satisfactory relationship, but it decreases with a greater transport distance. Such is the case when chips manufactured in Croatia, where due to the lack of heat plants, are transported over long distances to neighbour countries.

OPTIMIZATION OF ENERGY WOOD CHIPS QUALITY BY PROPER RAW MATERIAL MANIPULATION

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KEYWORDS:
particle size distribution, ash content, bulk density, moisture content

Forest fuel is by nature a very diverse source of energy. Most of its properties are given and limit the possibility of upgrading the fuel in the forest production process. Because of that, the ones that can be manipulated during the transformation from raw material source (tree biomass) to useful and easy to handle forest fuel form (wood chips) are of great importance. This research was conducted in order to determine the impact of raw material preparation by different harvesting systems on the quality of produced wood chips. The research material was procured in a spruce plantation thinning operation. It consisted of pulp wood and whole trees harvested with partially mechanized harvesting systems (chain-saw and skider) and of pulp wood, stem wood and tops harvested with mechanized harvesting systems (harvester and forwarder). The roadside chipping of the unseasoned raw material was done by a drum chipper. Sampling of produced wood chips was done on a total of 21 chipping cycles (truck loads) and laboratory analyses were performed in accordance with the EN standards for Solid biofuels. Results of laboratory analyses were statisticaly processed in order to test corelation between the raw material features and quality parameters as weel as in between the quality parameters themselves. A positive correlation was found between the raw material group and the ammount of fine (< 3.15 mm) wood chip particles, and a negative correlation was found between the raw material group and a median value of partice size distribution of individual wood chip samples. The ash content positively correlated with the raw material group and the amount of fine particles. Detail plot analysis of wood chips quality parameters by raw material types reveals a possibility to manipulate the natural ash content of the forest fuel (a given value that varies mainly with the tree part used as raw material) and the polluting ash content (a consequence of (mis)handling in the procurement chain) to minimase the fuel quality deterioration. Results obtained in this research can be regarded as a indicator of necessity to expand the research-based knowledge to various stand and operational conditions, as a crucial tool of the forest fuels quality control in order to produce the forest fuel of the best possible quality even from the lower quality raw material and more important to avoid that from the highquality raw materials a forest fuel of poor quality is produced.

PRODUCTION OF WOOD BIOMASS IN CONIFEROUS FORESTS OF THE REPUBLIC OF SERBIA

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KEYWORDS:
wood biomass, chipping, transportation costs, landing, optimization

Wood biomass for energy production originating from natural and man-made conifer stands in Serbia accounts for a significant share of raw materials used for energy production. The material used for this study was taken from forest management plans and a direct field survey. The aim of this study is to review the results of previous research related to the assessment of the potentials of raw materials intended for power plants. The assessment is based on quantitative and qualitative analyses in order to assess the real biomass that can be offered to the market. In terms of wood material the structure of wood biomass that is the subject of use involves cordwood, stump wood, forest residues and residues from wood industry. The share and prospects of use of these categories of wood vary depending on stand and site characteristics. Poor quality wood biomass originating from these stands is primarily intended for heating plants or cogeneration plants, which are still poorly represented in Serbia, unlike plants for the production of pellets and briquettes. The installed capacities of the plants for the production of pellets and briquettes in Serbia are characterized by an ever growing demand for raw material. The main input raw material in these plants is residues from wood industry, i.e. broadleaf cordwood mainly originating from state and private forests. The use of forest residues from hardwood and conifer stands is negligible, and the reason for that is the lack of heating plants and cogeneration plants that would use this raw material for energy production. Another problem is the high cost of production of technological wood chips from wood materials with the technology of work that has been applied so far. Given this problem, in addition to the quantitative indicators related to the real possibilities of forest biomass utilization in coniferous forests, this study will present the results of previous research related to the selection of an optimal technology for the utilization of forest biomass for energy production in lowland and mountainous areas of Serbia.

ENVIRONMENTAL EXPERTS' PERCEPTIONS OF THE IMPACTS OF FOREST BIOMASS HARVESTING ON ECOSYSTEM SERVICES

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KEYWORDS:
forest biomass, ecosystem services, environmental experts' perception, ecological impacts, Alpine Space

In the EU political agenda, the use of forest biomass for energy production has grown rapidly and significantly, in order to mitigate carbon dioxide emissions and reduce the energy dependence on oil of European member countries. The targets of the EU climate and energy package are to raise the share of renewable energy consumption produced from renewable resources to 20% in 2020 and to reduce the greenhouse gas (GHG) emissions by 20% compared to 1990 levels (Directive 2009/28/EC). With regards to biomass energy, the supply of forest wood biomass is expected to increase by 45% (reference period: 2006-2020), in response to increasing demand. The increase of forest biomass supply could have positive or negative impacts on several forest ecosystem services (ESS), such as the provision of forest products, fresh- or potable water, carbon sequestration and storage in vegetation and soil, protection against natural hazards, habitat provision for ecological conservation, aesthetical and recreational values. These impacts should be assessed in a proper manner and taken into account when formulating management strategies. The Project Recharge.green "Balancing Alpine Energy and Nature", funded by the Alpine Space Programme (2007-2013), is focused on the analysis of how to reconcile biodiversity conservation of ecosystems and renewable energy production. As part of this Project, the present paper analyses experts' perceptions of the positive and negative impacts of forest biomass harvesting on ESs. The research was developed through 5 case studies located in the Alpine Region (Leiblachtal in Austria, Triglav National Park in Slovenia, Natural Park of the Maritime Alps in Italy, Mis and Maè valleys in Italy). A semi-structured questionnaire - containing 20 closed-ended questions and subdivided in 7 thematic sections - was administered face-to-face to 40 selected environmental experts. In each case study, the experts were identified taking into account the following criteria: balancing of expertise between two main fields (renewable energies and ESS), local knowledge and expertise, no direct stake in the Recharge.green project. The positive and negative impacts of forest biomass harvesting for energy use on seven ESS were evaluated using a 5-point Likert scale (from "quite negative impact" to "quite positive impact"). Findings show some interesting differences between case studies. These differences could be partly explained by differences in past use of wood biomass and the management objectives of each case study. Finally, statistical differences between case studies and groups of experts were tested using the non-parametric tests of Kruskal-Wallis and Mann-Whitney.

INCREASING BIOMASS ENERGY PRODUCTION FROM FAST-GROWING TROPICAL PLANTATION FOREST

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biomass,
breeding,
gene,
laser,
remote
sensing

Tree biomass is one of the most expected future renewable energy resource. To catch up dramatic increase of energy demand in the world, biomass should be produced efficiently and sustainably in a suitable site. In this study, Eucalyptus trees planted in tropical plantation site are focused for the biomass production. Our research site has the total 40,000 ha Eucalyptus plantation and is located in Macapa, the northern part of Brazil. Harvested and chipping trees are exported to Europe and Japan from the site in Brazil mainly for materials of paper production. Paper consumption is decreasing globally, because the usage of electric document is expanding. And Eucalyptus trees are fast-growing and grow at the rate of 3 meters per year in the tropical site and the harvesting cycle of the tree is 6 years, therefore the wood chip can be used for biomass energy besides paper production. The main purpose of our research is to increase tree biomass production in the tropical plantation. To achieve our goal, we identify the fast-growing characteristics of Eucalyptus trees for tree breeding. In order to identify the advantageous structure of the fast-growing trees, we introduced terrestrial laser sensor (Leica ScanStation P20 laser scanner) to capture the detail tree shape by three dimensional dense point data. We established research plots in different gene types of Eucalyptus trees. From the three dimensional laser data, we measured shapes of stem, branch, and crown structure. The laser tree measurement is validated by destructive tree measurement in the field. The error of laser measurement was within 2 cm of diameter at breadth height (dbh) and within 0.5 m of tree height. This accuracy of laser tree measurement is equivalent to conventional field measurement. Therefore, the laser data can estimate tree biomass accurately and efficiently without manual, labor-intensive work. Furthermore, the tree shape characterized by laser data is compared and reflected to gene level characteristics to identify which type of gene is prioritized for tree breeding. Through this process, unknown characteristics of gene type is explained enough to improve tree biomass production. The laser technology can bridge between gene to tree level information to improve biomass production, which has been difficult to find the relationship between them. These new technologies for tree breeding are applicable to another tree species to increase biomass energy production in the world.

ENVIRONMENTAL COSTS AND BENEFITS OF WOOD-BASED BIOENERGY PRODUCTION: A CASE STUDY IN SARENTINO VALLEY (NORTHERN ITALY)

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KEYWORDS: Bioenergy; wood biomass, environmental accounting; cost-benefit analysis; Val Sarentino

The use of wood biomass for energy production plays a crucial role in ensuring energy security while reducing greenhouse gas emissions, also supporting sustainable forestry practices and rural development. Forest ecosystems are important biomass source that need to be exploited through sustainable management schemes to cope with climate change targets. While sequestering emitted carbon dioxide, forests also reduce carbon emissions at source when replacing fossil fuels currently in use to generate heat, electricity, and transportation fuels. The rising energy prices and political initiatives to reduce fossil fuel consumption and to promote renewable energy options have led to an increasing demand for wood biomass as a renewable energy source. Wood residues from forestry operations are a significant biomass feedstock that can be exploited to generate heat or electricity solely or in combination through a combined heat and power plant. Significant investments are being made to improve energy efficiency and environmental sustainability of woodbased bioenergy options in European countries. In this study, we investigate upstream environmental costs and downstream environmental impacts of a district heating plant located in Sarentino Valley, (South Tyrol Province, Northern Italy). The Sartnthein Biomass district heating plant uses as feedstock low quality timber from local and PEFC – certified forestry, generating about 9 million kWh of heat supplying 53% of the buildings in the three most populated hamlets of the valley. A total amount of about 7,200 solid cubic meters of wood biomass per year is provided by hundred private forest owners situated within a range of 20 km from the district heating plant. Finally, direct economic costs and benefits of the bioenergy production system were also evaluated to provide an overall picture of its environmental and economic performance.

A NEW TECHNIQUE FOR DETERMINATION OF BIOGENIC FRACTION IN LIQUID FUEL BY THE ^{14}C METHOD

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KEYWORDS:
biogenic component, liquid fuels, radiocarbon

An increased level of CO_2 concentration in the atmosphere is a direct consequence of intense fossil-fuel combustion over a last century. Search for alternative energy sources and reduction of emission of CO_2 from fossil fuels by production of energy from biogenic material are topics of intense current studies. European Union stimulates the production and use of biofuels by lower excise and income tax relief. In this context there is a need for control of producers and dealers of various types of fuels and independent determination of the biogenic fraction in fuel. Here, the term "biogenic" refers to a compound produced in natural processes by living organisms but not fossilized or derived from fossil resources. The fraction of the biogenic component can be determined by measuring the ^{14}C content (EN 15440:2011) since bio-fuels reflect the ^{14}C activity of atmospheric CO_2 during the plants' growth period, while fossil fuels do not contain ^{14}C. Therefore, a simple linear mixing curve with welldefined end members is obtained. Any measuring technique for ^{14}C content, widely used in the radiocarbon dating laboratories, may be used for determining the bio-based content. All these techniques are accurate and precise, but are also time-consuming and expensive, so there is a need for simple, fast, reliable, sensitive, accurate, and not expensive technique. When liquid fuel is concerned, a direct measurement of fuel mixed with an appropriate scintillator by LSC is possible. However, various types of fuel matrices and various blends show different quenching properties (due to different colours) resulting in rather complicated data evaluation procedure which depends on the type of the matrix/blend mixture.To avoid this problem we have developed a novel technique for direct measurement of any liquid fuel by liquid scintillation counting. The idea is to use various purely biogenic compounds of different colours and quenching properties to construct the "modern calibration curve", as well as various purely fossil liquids to construct the "background calibration curve". The fraction of the biogenic component in an unknown sample is then determined as the ratio of net count rates of the sample and the biogenic sample having the same quenching properties. The proposed technique has been validated by preparing various mixtures of modern and fossil samples, and the satisfactory agreement between the expected and measured biogenic fractions has been achieved.

LOCALLY DEVELOPED ALOMETRIC MODELS FOR ABOVEGROUND WOODY BIOMASS ASSESSMENT IN YOUNG PEDUNCULATE OAK FOREST STANDS OF A PART OF SPAČVA BASIN

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KEYWORDS:
bark, branches, largewood, pedunculate oak, woody biomass

Woody biomass is one significant component of biofuels which are used in electric energy production. The biofuels together with waste participated with 10.2% in total primary energy supply in 2009, excluding electricity trade (OECD/IEA 2011). According to current scientific and professional estimations (IEA 2008), in order to decrease global GHGs emissions for 50% to 2050, it will be needed 15 billion metric tonnes (Mg) of biomass annually, assuming 60% conversion efficiency. Regarding this, the research of woody biomass potential of forest stands, especially pedunculate oak forests which are ecologically and economically important for Croatia, is essential to determine the potential amounts of aboveground woody biomass of those stands more precise. This research is in line with efforts of EU to meet the climate and energy objectives until year 2020, set in relevant documents as Climate and Energy Package (2009) and Renewable Energy Directive (2009). Our research has been carried out in a young oak forest stand representing flooded lowland peduncled oak forest of Spačva Basin. First phase of research included setting up sample plots into forest compartment and dendrometrical measurements of the trees to calculate main structural elements and distribution of diameter breast hight per main tree species. In the second phase, the volume of the large wood (stemwood, thick branches) was measured on the sample trees, which is up to 7 cm in diameter overbark. Per sample tree, the mass of branches and twigs thinner than 7 cm was measured in the thickness gradient. Double thickness of the bark was also measured to find out how the percentage of thickness and volume of the bark is changing along the roundwood. There were measured 108 sample trees of 4 prevailing tree species, of 4.9 to 46.5 centimeters in breast diameter and of 7.4 to 27.3 meters in height. Using volume of the largewood and branches and twigs, their relative shares in whole tree volume was calculated, and the mass of the components was obtained by wood density. The regression analysis was carried out to find out which alometric models best fit to the volume of stemwood, largewood and mass of thin branches. The most significant models are proposed to help foresters calculating tree biomass in young pedunculate oak mixed stands, together with site- and tree-species- specific parameters. Calculating bark thickness has confirmed the previos findings that percentage of thickness and volume of the bark drops with the increase of the thickness of roundwood.

USE OF FOREST RESIDUES IN THE FINAL CUT OF REPRODUCTIVE FELLING

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KEYWORDS:
adapted farm tractor, damage to remaining trees, final cut of reproductive felling, mountainous region, new method, skidding assortments.

This paper presents the research results of the implementation of an original method of felling and bucking of beech in the final cut of reproductive felling. The research was performed in MU "Zeljin", FA "Despotovac", FU "Stolovi-Kraljevo". The aim was to research the possibility of implementation of a new method that would solve the problem of using forest residue while doing the reproductive felling of beech (final cut) in mountainous regions of Serbia. The basis of this method is the use of wood volume with a diameter of up to 3 cm with bark and winching by a tractor to the temporary storage without using animal labor. The whole work focused on the preservation of outgrowth, and the aim was to research the occurrence and degree of damage to the outgrowth created by the implementation of the new method. Quantifying of the damage was done by counting the damaged plants. A previously bucked tree was felled and cut into logs of optimal length for skidding from the aspect of maximum qualitative utilization with the application of the national quality standards for roundwood. In the part of the stem with branches thicker braches were incised with an intention to reduce the width of the load, in order to reduce the damage on the outgrowth in the stand. The number of damaged plants was analyzed for each grip of the winch, as well as for the total volume of the load. In addition, the impact of felling tree direction and the slope of the terrain on the degree of damage were also analyzed. The results of this research indicate that the effects of applying the new method are much better than the results achieved by applying the assortment method. It can be added that the damages were minor.

LOPTIMISING THE ENVIRONMENTAL SUSTAINABILITY OF SHORT ROTATION COPPICE BIOMASS PRODUCTION FOR ENERGY

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KEYWORDS: biodiversity, biomass, bioenergy, short rotation crops, water quality, soil quality

Solid biomass from short rotation coppice (SRC) has the potential to significantly contribute to European renewable energy targets and the expected demand for wood for energy, driven mainly by market forces and supported by the targets of national and European energy policies. It is expected that in the near future the number of hectares under SRC will increase in Europe. Besides producing biomass for energy, SRC cultivation can result in various benefits for the environment if it is conducted in a sustainable way. This paper provides with an overview of these environmental benefits. The review of existing literature shows that SRC helps to improve water quality, enhance biodiversity, prevent erosion, reduce chemical inputs (fertilizers, pesticides) and mitigate climate change due to carbon storage. To promote and disseminate environmentally sustainable production of SRC, based on existing literature and own project experience, a set of sustainability recommendations for SRC production is developed. In addition to numerous environmental benefits, sustainable SRC supply chains can bring also economic and social benefits. However, these aspects of sustainability are not addressed in this paper since they are often country specific and often rely on local conditions and policies. The sustainable practices identified in this manuscript should be promoted among relevantstakeholder to stimulate sustainable local SRC production.

INSTRUMENTAL METHODS OF DETERMINING CARBON, HYDROGEN, NITROGEN AND SULFUR IN BIOMASS

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KEYWORDS: biodiversity, biomass, bioenergy, short rotation crops, water quality, soil quality

Leco company is manufacturer of laboratory equipment with years of experience and continuos innovations orientaded in field of elemental analysis and separation science. Using Leco instruments, two methods for simultaneus determination of carbon, hydrogen, nitrogen and sulfur can be used. For sample weight up to 3 g, proper instrument is TruMac with its unique horizontal ceramic furnace, designed to burn sample at temperatures up to 1450 °C in pure oxygen environment. For lower weight samples, proper instrument is CHNS 628 which burns sample in its unique vertical quartz dual stage furnace, capable to reach temperatures up to 1050 °C. Common for both methods is that carbon, hydrogen and sulfur are determined by apsorption of infrared radiation and nitrogen by determination of thermal conductivity of gases. Both instruments characterize high accuracy, precision, low cost-per-analysis and high speed analysis. Instruments are capable determine carbon, hydrogen, nitrogen and sulfur in various organic samples like biomass, soil, food and fuels.

ADVANCES IN PRODUCTION OF OPTICALLY PURE LACTIC ACID – PLATFORM C3 COMPOUND IN MANUFACTURING COMMODITY AND HIGH-VALUE CHEMICALS

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KEYWORDS:
biotechnological production of lactic acid, commodity and high-value chemicals, platform chemicals, renewables, sustainable technologies

Fossil fuels can be replaced by renewable raw materials and the raw materials can be used in production of several thousands of platform compounds and final products. Availability of particular renewable as well as climate, geo-political and economical environment defines boundaries of innovative technology to be implemented in such production. In addition, need for novel products and affiliated market dictate investments in plants for industrialscale production of defined range of the platform compounds and other biochemicals.Biotechnological production of optically pure lactic acid, very important C3 platform compound, opens up numerous routes for its catalytic transformation and manufacturing commodity and high-value chemicals. Nowadays, the production of lactates depends on two main renewables - corn and sugarcane. The bioprocess sustainability has to be improved and moved to second and third generation of the raw materials. The sustainable technologies includes employment of efficient biocatalyst, mild bioprocess conditions, near 100% yields and relatively simple down-stream processes, which bring the system to hybrid integrated bioprocesses and, further, to factories of future.

FOOD BY PRODUCTS AS SOURCES OF FUNCTIONAL INGREDIENTS

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KEYWORDS:
functional ingredients, byproducts, phenolic compounds, pectins

Food processing industry deals with high amounts of by-products such as peels, seeds, leaves and unused flesh generated in the different steps of the processing chains depending on the raw material. By-products of food processing are usually used for animal feed. The potentially valuable compounds (phenolic compounds, pectins) within by-products out of food industry could be used to make highly valuable food products. By-products from food industry poses high content of natural antioxidant compounds or other substances with positive health effects. Its physicochemical properties may improve the viscosity, texture, sensory characteristics and shelf-life of products. They may be incorporated into food products as inexpensive and non-caloric bulking agents, enhancers of water and oil retention or to improve emulsion and oxidative stabilities. A wide variety of intermediate products represent a meaningful source of valuable compounds for the preparation of functional ingredients for the shelf-life elongation of lipid-rich foods as well as avoiding browning. Food processing by-products could be used as antimicrobials, flavouring, colorants, sweeteners and texturizer additives.

BY-PRODUCTS OF FOOD INDUSTRY AND POSSIBILITIES OF UTILIZATION

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KEYWORDS:
By-products,
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protection,
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utilization,
waste

Since food, including beverage industry, represents the largest industry in the world, during the industrial food processing and final food products production, significant amounts of different by-products and wastes are generated. For example, solid waste from tomato juice production can be up to 15%, while solid waste obtained from the apple juice production can go up to 40% comparing to input raw material. Utilization of such by-products and wastes represents the great challenge, as such material is usually biologically unstable, with high water content, exposed to intensive free radical activity and autoxidation, microbiologically contaminated, with high enzymatic activity, etc. Adequate utilization of food industry by-products and wastes could lead to the sustainable use of natural resources, creation of new added-value products, and increase of profit for the food producers. Today, wastes and by-products of food industry are usually utilized in following manner: conversion to the low added-value products - animal feed (usually from material left after pressing or drying); conversion to the high added-value functional products such as liquid extracts, dry powders and isolated compounds; fermentation (using biomass to produce ethanol, sugar from corn-starch to produce biodegradable plastic etc.) and digestion by microorganisms; composting (decomposition of organic components under controlled aerobic conditions, e.g. dewatered sludge from brewery waste); edible fibre production etc. By-products and wastes of food industry usually generate environmental problems due to theirs volume and physical-chemical properties. Therefore, such materials should be observed, not only from the point of process efficiency and increase of producer profit, but also from the point of environmental protection. Efficient management of food industry wastes and by-products (with main aim increase of process efficiency and profit) is in line to the strategy of environmental protection. For both the following is needed: improvement of process of production meaning less waste generation, leading to improvement of yield and efficiency and at the same time leading to the reduction of potential waste and pollution issues; employment of environmentallyfriendly and cost-effective „green technologies" in the food processing; identification of byproducts, waste and their volume/amount; physical, biochemical and microbiological characterization of wastes and by-products; adequate utilization in a manner to provide production of quality „waste origin products" which will increase the company profit on the level that will cover the total cost of such quality waste management.

FOREST RESIDUES AND WOOD WASTE AS RENEWABLE RAW MATERIALS IN BIOTECHNOLOGY

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KEYWORDS:
lignocellulose, forest residues, wood waste, biotechnology

The subject of this presentation is possibility of using forest residues and wood waste as renewable lignocellulosic feedstock in biotechnology. Use of these materials is justified from the environmental but also from the economical standpoint. There is a large number of products that can be obtained from lignocellulosic raw materials, such as various chemicals, drugs, biofuels, enzymes and other high added value products. Forest residues and wood waste could therefore become the basis of the development of Croatian biotechnological production.

INTEGRATED HYDROLYSATION AND FERMENTATION OF LIGNOCELLULOSE TO BIOETHANOL

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KEYWORDS:
bioethanol, integrate bioprocesses, lignocellulose

A crisis of energy storing molecules (fuels), which are currently produced from crude mineral oil, is expected, in the future due to limited resources. One strategy to compensate a part of the oil deficiency is the production of biofuels from lignocelluloses waste materials from agriculture and wood waste biomass. This work investigates an efficient and economical approach for the integrated enzymatic hydrolysation and fermentation of lignocelluloses (sugar beet pulp-SBP, corn cob and beech bark) to bioethanol trough a new aspect of bioethanol production processes by investigating: Suitability of the Design of Experiment (DOE) to optimize the effectiveness of different enzymes (cellulase, pectinase, Ultrazym AFP-L and Viscozym L) Based on the obtained results we found that hydrolysation of lignocelluloses can be enhanced by using DOE methodology. The optimal enzyme amount expressed in mg g-1 of dry weight lignoceluloses were 11.3 (1.3% w/w), 14.0 (1.4% w/w), 20.3 (2.0% w/w), and 42.0 (4.2% w/w) for pectinase, Ultrazym AFP-L, Viscozym L, and cellulase, respectively. Selection end evaluation of three fungal hemi-/cellulolytic secretomes for sugar lignocelluloses hydrolysation. It was found that that the combination of pectinolytic, hemicellulolylic and cellulolytic activities works synergistically on the complex lignocelluloses composition and enable achieving a high degree of enzymatic lignocellulose hydrolysation with a low enzyme load (0.04% w/w protein from secretomes supernatant was sufficient to hydrolyze most of the pectine and hemicelluloses present in used materials). Selection of physical pretreatment methods in combination with enzyme treatment Physical (ultrasound and thermal) pretreatment methods were tested and combined withenzymatic hydrolyses by cellulases and pectinases to evaluate the most efficient strategy. IV. Selection of bioreactor and optimization of bioprocess performances for enhancement integrated bioethanol production. For the efficient bioethanol production two bioreactor types (stirred tank bioreactors-STR and horizontal rotating tubular bioreactor-HRTB) and two Saccharomyces cerevisiae species were investigated. Genetically modified S. cerevisiae Y9 in combination with HRTB significantly increased bioethanol production according S. cerevisiae Y9 ability to produce ethanol from SBP uronic acid and HRTB construction characteristics.

BIOMASS FIRED COGENERATION WITH WASTEWATER SLUDGE COINCINERATION AND 1 MW STEAM TURBINE

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KEYWORDS:
biomass, emissions, renewable energy, waste to energy - WtE, water treatment sludge

Wood biomass is renewable energy source with large potential in Croatia. Wood biomass can be utilized as fuel in several technologies but most common is grate firing and steam production for turbine. In each water treatment plant sludge is generated as byproduct in the proces. Average dry sludge composition is carbon – 30%, hydrogen – 4%, nitrogen – 4%, oxygen – 20%, sulphur + chlorine – 1,5%, ash – 40% and other elements 0,5%. Lower heating value between 8 and 10 MJ/kg. Sludge from water treatment process is first dewatered by press or centrifuge system to moisture content between 60 and 85%. By 2020. there will be more than 300 water treatment plants in Croatia generating arount 600.000 tones of sludge per year. None of planned water treatment plants have full solution for sludge disposal. From 2018. waste water sludge deposition will be prohibited due to high organic matter content, high TOC, high phosporus content and significant heavy metal content. According to BAT/BREF documentation sludge termal treatment is one of most preffered and widely applyed technology for sludge disposal. In order to achieve required parameters in boiler cofireing sludge in 1:1 ratio, sludge is dryed from 85% to around 15% moisture in low temperature dryer using the heat from cogeneration plant. Evaporated water from sludge is captured, condensed and returned to water treatment plant. Plant uses 1 ton per hour of biomass and 1 ton per hour of dry sludge to produce 3 MW of heat for dryer and 1 MW of electricity which is exported to the grid. Plant also has the possibility to run fully on biomass and in full condensation mode. Flue gas from the plant is treated with alkali substance (sodium bicarbonate or lime) and activated carbon to remove acidic particles and heavymetals which are together with dust efectivly removed by bag filter. All emissions are continuously measured and recorded. Emissions are below limits set by Directive 2010/75/EU on industrial emissions. Bottom ash from the process can be used as landfill or as concerte filling, fly ash will be taken over by acredited company for disposal.

BIOMASS GASIFICATION COGENERATION PLANT WITH 1 MW GAS ENGINES

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KEYWORDS:
biomass, gasification, gas engine, renewable energy, thermal energy

The main purpose of gasification of dry wood biomass is production of synthetic gas (Syngas). Syngas is fuel gas mixture consisting primarily of hydrogen, carbon monoxide and carbon dioxide. Gasification is carried out in the reactor, by pyrolysis process with a reduced presence of oxygen. After gasification Syngas has to be filtrated and cooled, so it can be used (combusted) in gas engine. Gas engine is connected to an electrical power generator. Thermal energy is produced by cooling the gas engine and flue gases produced by combustion of syngas. Thermal energy is used for drying the wet biomass in belt dryer. Wet biomass has to be shredded to size of around 50 mm. The belt, predominantly in horizontal position, carries biomass through the drying area where drying air flows through or over the wet biomass and dries it. Gasification is process of burning solid fuels like wood without enough oxygen to complete combustion, so the output gas still has combustion potential. The unburned gas is then piped away to burn elsewhere as needed. All organic carbonaceous material is made up of carbon (C), hydrogen (H), and an oxygen (O) atoms– though in a dizzying variety of molecular forms. The goal in gasification is to break down this wide variety of forms into the simple fuel gasses of H_2 and CO – hydrogen and carbon monoxide. Incomplete gasification can also produce undesirable products in the raw syngas in the form of tar and particulate char. A gas engine is an internal combustion engine which runs on a syngas. Main advantage of gasification plant is use of Syngas in gas engines; higher efficiency (production of electrical energy) and therefore less production of thermal energy then with conventional (wather/steam) or ORC plant. This advantage makes gasification plant optimal solution as decentralized source of energy for countries like Croatia.

EFFECT OF PH AND TEMPERATURE ON ACIDOGENESIS OF SUCROSE USING FREE AND IMMOBILIZED MIXED ANAEROBIC BACTERIA ON MINERAL KISSIRIS

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KEYWORDS:
acidogenesis, kissiris, lactic acid, pH, VFAs

The interest in alternative renewable energy sources is currently growing fast due to the increasing cost, lower availability and greenhouse emissions caused by fossil fuels. Among the proposed feedstocks and technologies, anaerobic digestion of several soluble organic materials for biofuel production has been proposed. The accumulation of volatile fatty acids (VFAs) (anaerobic acidogenesis) is an important step in such processes. However parameters like pH and fermentation temperature importantly affect productivity and VFAs composition. In the present study the use of mineral kissiris in the anaerobic fermentation of sucrose was reported. A mixed bacterial anaerobic culture from a UASB reactor was used and the effect of the initial pH (4-8) and fermentation temperature (18-52°C) in VFAs production was evaluated. In all cases the promoting effect of mineral kissiris was confirmed compared to free cells, resulting to two-fold increase in VFAs production and yield. The higher VFA concentrations were obtained at pH 7 and pH 8. In both free and immobilized cells the increase in initial pH resulted to increased VFAs concentrations and yields. In the case of fermentation temperature that of 37°C proved ideal for the anaerobic acidogenesis of sucrose both with free and immobilized cells, however the use of mineral kissiris led to two-fold higher VFAs concentrations. Lactic acid was the predominant acid, accounting for more than the half of total VFAs, followed by butyric and succinic acid. In the case of free cells also minor concentrations of acetic acid were produced. The results of the present study are useful for the optimization of acidogenic processes to control the composition of the produced VFAs, which is crucial for valorization in some applications and for the easy design of a continuous scale up system.

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SELECTION OF WILLOWS *(Salix sp.)* FOR BIOMASS PRODUCTION

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KEYWORDS:
biomass production, Croatia, Salix clones, Short Rotation Forestry

Fast growing willows can be bred and selected for use as dedicated energy crops to provide a long-term, sustainable replacement for fossil fuels in temperate regions. Most projections of global energy use predict that biomass will be a more important component and that woody crops will be the primary source of biomass. Willow has several characteristics that make it ideal for woody crop systems, very high biomass production potential, tolerance of high planting density, high yields can be obtained in a few years, easily are propagated from unrooted cuttings, vigorously resprout after each harvest, the amount of heat in a dry ton of willow is similar to other hardwoods and they can be grown and harvested as a sustainable, renewable biomass crop. In the improvement of the White Willow (*Salix alba* L.) and Chinese Willow (*Salix matsudana* Koidz.) methods of intraspecific and interspecific hybridization and back cross have been used by cloning plus variants from the hybrid families it was possible to make a selection of new genotypes that are suitable for biomass production. Clonal tests were established in two-year rotation and mean biomass production at the first breeding level of all studied clones (more than 60) was 9.3 t DM ha^{-1} a^{-1}. At the second breeding level mean biomass production vary from 10.7 to 28.8 t DM ha^{-1} a^{-1}. The highest biomass production as well as the best adaptedness and phenotypic stability on testing sites was shown by clones ('V 374', 'V 461', 'V 578' from 25,0 – 28,8 t DM ha^{-1} a^{-1}) originated from backcross hybrid S. matsudana × (S. *matsudana* × S. *alba*) and by one S. *alba* clone ('V 95', 28,8 t DM ha^{-1} a^{-1}). This clones are now at the stage of registration and these results indicate significant potential of Chinese Willow for further breeding aimed at biomass production in short rotations.

EVALUATION OF TOBACCO STEMS AS LIGNOCELLULOSIC MATERIAL

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KEYWORDS:
cellulose, hemicellulose, lignin, macro biomolecules, stems, tobacco

Lignin, along with cellulose and hemicelluloses, is considered as a leading component of the composite system consists of natural macro biomolecules that are responsible for the strength and rigidity of tobacco stems. The objective of this study was to determine the chemical composition of stems of different tobacco types Burley, Flue-cured and Oriental cultivated in the Republic of Macedonia, as well as, to evaluate the suitability of these agricultural residues for industrial utilization. The content of cellulose, hemicellulose, Klason lignin, acid soluble lignin, proteins and ash was determined. The protocols developed by the National Renewable Energy Laboratory (NREL) were applied at the determination of content of moisture, ash, lignin, xylose and glucose in the tobacco stems. TAPPI standard method T203 was used in the analysis of insoluble in 17.5% w/v NaOH a-cellulose. The hemicellulose isolation was carried out by acid hydrolysis pretreatment (4.9 % H2SO4, 133 °C and 27 min). The stems of tobacco types Burley (35.7%) and Flue-cured (32.9 %) were the richest in cellulose compared to the cellulose content in Oriental (30.4%). The highest content of total lignin was determined in Burley (22.8%). The content of total lignin in stems of Flue-cured and Oriental was 21.4% and 20.7 %, respectively. The content of hemicellulose determine in Flue-cured tobacco stems was the highest that in other two tobacco types. The obtained results point out that the stems of all three tobacco types are prospective raw materials of lignocellulose in the production of paper and chemicals like xylan.

CHEMICAL COMPOSITION OF WHEAT STRAW AS A POTENTIAL RAW MATERIAL IN PAPERMAKING INDUSTRY

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KEYWORDS:
alkaline treatment, wheat straw, chemical composition, ICP-MS analysis

In the paper industry as one of the fastest growing industries, cellulose fibres are the main raw material for paper production. According to its origin, cellulose fibres are divided into synthetic and natural fibres. Natural fibres are abundantly present in various plant species such as trees, grasses, reeds and straw. Wood as a raw material still holds a key position in pulp and paper production. As the demand for paper products is growing, different types of conifers and deciduous trees become insufficient raw material for paper production. This lack of raw material is the result of irrational exploitation of the natural resources for different purposes (lumber, heating material, pulpwood). Therefore, alternative sources of quality primary cellulose fibres are of great importance for papermaking industry. Non-wood fibres gained from the by-products of agricultural production of annual crops are an interesting alternative source of cellulose fibres. They are inexpensive and annually renewable source of fibre available in large quantities in many regions of countries across Europe. In Croatia the agricultural crop with highest production that give straw as the byproducts is wheat. In this research wheat straw as a potential raw material in papermaking was evaluated through chemical composition. Straw was subjected to alkaline treatments in order to obtain fibres with as large a share of cellulose. The first treatment type was straw cooking in caustic soda and the second type of treatment was consisted of straw soaking in caustic soda and then cooking in tap water. On wheat straw and dried isolated fibres determination of organic (cellulose, α-cellulose, lignin, accessory material, moisture) and inorganic compounds were made according TAPPI methods. ICP-MS analysis of straw and isolated fibres was done using digestion method (wet ashing method for organic matter destruction) and in those way 26 chemical elements was explicit. Content of cellulose, especially α-cellulose and lignin in the selected raw material are the most important indicators of its usage in paper production. On the other hand, low content of problematic elements as copper, iron, cobalt, manganese, zinc and silica are desirable. It is very important to use proper method for fibres isolation in order to avoid loss of cellulose content during separation of non-cellulose components from lignocellulose structure of straw. Based on results of provided analysis, wheat straw is a valuable raw material and its utilization is of great importance considering that they are currently burned or ploughed back into the ground.

Session E:

BIODIVERSITY AND ECOSYSTEM SERVICES

MONITORING OF FOREST ECOSYSTEMS IN CROATIA AS A PART OF UNECE-ICP FORESTS NETWORK

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KEYWORDS:
UNECE ICP Forests, transboundary air pollution, monitoring plot network, forest conditionts, cause-effect relationships

Given the common view on widespread forest dieback being caused primarily by atmospheric pollution, the International Cooperative Programme on Assessment and Monitoring of Air Pollution Effects on Forests (ICP Forests) was founded in 1985 under the umbrella of United Nations Convention on long-range transboundary air pollution (CLRTAP). With the gradual development of knowledge on functioning of forest ecosystems it hasbecome clear that a multitude of ecological factors play a role in the dieback of forests. Therefore the main task of the programme has become to collect and interpret the data on the vitality of forests ecosystems and their reaction to various stress factors on the national and international level. While in the past the degradation of forest ecosystems was attributed almost exclusively to atmospheric pollution, in recent years there has been a growing tendency to attribute the deterioration of crown condition of forest trees to the synergy of various factors responsible for health condition of forests. Today 39 European countries actively participate in ICP Forests. The collective monitoring of forest condition of UNECE and EU constitute one of the world's largest biomonitoring systems. The major aim of transnational Level I survey (currently around 6000 plots) is to provide a periodic overview on the spatial and temporal variation in forest condition in relation to anthropogenic and natural stress factors in a European and national large-scale systematic networks. The idea behind Level 2 monitoring is to gain a better understanding of the cause-effect relationships between the condition of forest ecosystems and anthropogenic as well as natural stress factors by means of intensive monitoring on a number of (currently around 800) selected plots. Croatia takes part in the ICP Forests programme since 1987, when first large-scale and permanent monitoring of forest ecosystems started on 16x16 km grid network of plots (Level 1 network, 105 plots) and intensive monitoring plots (7 plots in characteristic forest associations of Croatia – Level 2) according to common ICP Forests methods. Since 2007, the monitoring programme in Croatia is funded by the Ministry of Rural development, Forestry and Water Management, with Croatian Forest Research Institute as the ICP-Forests National Focal Center.

RESPONSE STRATEGIES OF THE MAIN FOREST TYPES TO CLIMATIC ANOMALIES IN CROATIA INFERRED FROM JRC FAPAR REMOTE SENSING DATA

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KEYWORDS:
climate change impacts; extreme climatic events; forest responses; forest resilience; land surface phenology, Fraction of Absorbed Photosynthetically Active Radiation (FAPAR)

Croatia distends across three main European biogeographical regions - Continental, Alpine and Mediterranean - and therefore has a very high level of forest diversity comprised of 11 out of 14 European forest types. This makes it very convenient to study the exposure of main European forest types to extreme climatic events in the southern limits of their species distribution range. This study provides an assessment of responses of forest vegetation under episodes of climatic anomalies consisting of the most severe historical dry and warm spells in 2000 and 2003, together with extremely the rainy season in 2005 across Croatian territory. The question of interest in this study was to reveal how the existing forest types across the territorial gradient respond to highly expressed extreme climatic variations and to infer some clues about related adaptive strategies. The regional scale approach was applied which previously performed structural delineation of forest cover into eleven main forest groups or bioclimates and were examined considering functional differences. Responses of eleven bioclimatic types were analysed by time series (1998-2005) of monthly FAPAR (The Fraction of Absorbed Photosynthetic Active Radiation) coverage with a spatial resolution of 1.2 km, freely available from JRC FAPAR project. To quantify and differentiate the vegetation response in the considered years we adopted indices of resilience (resistance, recovery, resilience and relative resilience). We also provided a modified approach by applying these indices on a seasonal scale to examine the relationship between variations of phenology and ecosystem responses. The results of this study confirmed the modification of seasonality of photosynthetic activity of the main forest types in relation to changes in the altitudinal and spatial gradient. At the intraseasonal scale, we distinguished specific opportunistic behaviour of the common beech and oak forest types to alternating climatic conditions. Beech forest types show a very high ability to shift their phenology to earlier spring warming as a consequence of global warming. However, continental and Mediterranean oak forest types and in particular Aleppo pine and holm oak forests showed a higher increase of FAPAR during rainy events. The revealed capability of some tree species to better exploit rainfall in very wet periodic episodes has to be further evaluated in drawing conclusions about the overall resilience of forests under future climate change scenarios.

GROUND VEGETATION COMPOSITION AS AN IMPORTANT BIODIVERSITY FACTOR AND POSSIBLE BIOINDICATOR IN LOWLAND FOREST ECOSYSTEMS OF SPAČVA, CROATIA

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KEYWORDS: ground vegetation, bioindicator, ground water regime, lowland forest ecosystem

In the area of FA Vinkovci, in the forest complex Spacva, phytocoenological survey has been performed in the lowland forest ecosystems (narrow-leaf ash, oak forests) at 30 sites along the piezometers, during 2012th and 2013th year. The cluster and ordination analysis of vegetation releves and also analysis of various diversity indexes (Shannon index, Simpson index, Renyi-profile diversity) to existing recordings was performed using the software package BiodiversityR. Results of performed analysis showed the grouping of releves on the first level to the wetter type (narrow-leaf ash) and drier type (oak forests). Plots representing oak forests are also grouped into two main groups related to two plant communities: the forest of common oak with hornbeam and the forest of common oak and large broom. In the layer of ground vegetation, narrow-leaf ash, highlight the bioindicator species humid habitats (Leucojum aestivum, Lythrum salicaria, Lychnis flos-cuculi, Lycopus europaea, Stachys palustre, Peucedanum palustre...) compared to the drier. Alpha diversity (overall biodiversity of an ecosystem), which actually represents the total number of different individuals of an ecosystem is expressed in number of species, and changes in the structure of a community is analyzed by indices. Indices of biodiversity (Shanonov, Simpson) for all plots show a distinct grouping by communities although generally ash forests are more diverse.

THE EVALUATION GROUND VEGETATION STRUCTURE BY THE TIME SERIES ANALYSES IN TURKISH RED PINE (*Pinus brutia* Ten.) PLANTATIONS IN THE WESTERN BLACK SEA REGION IN TURKEY

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KEYWORDS:
Turkish Red Pine,
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Plantation, Time
Series Analysis.

The Turkish Red Pine (*Pinus brutia* Ten.), which is kind of Mediterranean pine, because of fast growing forest tree species widely used in the industrial plantation works in Turkey. Furthermore, there are various vegetation types along the climatic and topographic gradient in Turkey. Especially in the western Blacksea region of Turkey, they contain a number of differing biotopes such as grassland above the timber line, evergreen coniferous and deciduous broad-leaved forests, scrubland, river beds, lagoons, coastal saltmarshes, coastal woodland, and sand dunes. And, the cold climate in the north and arid/semi-arid zones in the south, help to enhance the ecological diversity of the Anatolian Peninsula and there is a considerable diversity of flora in the mountainous region. If global warming occurred, it will most likely affect the vertical distribution of the vegetation of this region through changing complexly the distribution of each species. The field surveys of vegetation distribution and land use were done on the basin of the Filyos and Bartın rivers from 2011 to 2014, and 30 experimental plots were set to investigate the stand structure of main forests in the research area. Coniferous forest dominated *Pinus brutia* is to be found up to an altitude of 700- 1000m. and is replaced by *Abies nordmanniana* subsp. *bornmülleriana*. *Platanus orientalis* and *Carpinus betulus* dominates in the galery forests (near the Bartın and Filyos rivers). Furthermore, up to an altitude of 550m, a dense, scrubland, dominates and ground vegetation of *Pinus brutia* plantation forest becomes rich. The ground vegetation mainlyconsists of several species of evergreen shrub. The most common species in the research area *Quercus petreae, Quercus robur, Fagus orientalis* and mixes up *Phillyrea latifolia, Myrtus communis, Arbutus andrachne, Pistacia terebinthus, Pistacia lentiscus*. If *Pinus brutia* plantation forest and degraded, they are replaced by garrigue formation consisting of several dwarf species such as *Cistus sp., Lithodora hispidula, Rubus sanctus,* tree flor such as *Calicotome villosa, Capparis spinosa* and *Paliurus spina-christi*. Around the river estuaries, salt marshes cover large areas on the hydromorphic alluvial soils. This type of biotope has an almost uniform vegetation aspect, consisting of hallophytes such as *Salicornia europaea* and *Atriplex portulacoides* in variable dominance. A patch of coastal woodland, remaining from a former evergreen forest, is located at Gözpınarı village. This woodland community, which is surrounded by the saltmarsh, is dominated by *Pinus brutia*. However, due to intensive grazing, the undergrowth has largely been degraded to garrigue-type vegetation with *Myrtus communis, Cistus sp., Pistacia terebinthus, Pistacia lentiscus, Tamarix smyrnensis, Vitex agnus-castus, Imperata cylindrica*.

FIRST RESULTS ON MYCOCOENOLOGICAL AND PHYTOCOENOLOGICAL CHARACTERISTICS OF AUSTRIAN PINE (*Pinus nigra*) STANDS IN ISTRIA, CROATIA

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KEYWORDS:
Austrian pine, Diversity, Mycocoenosis, Phytocoenosis

Mycological and plant characteristics of Austrian pine (*Pinus nigra* Arnold) stands in Istria, Croatia were surveyed. Mycocoenological description was based on fruit body and species number. Fungi samples were collected on three different permanent research plots of 400 m^2 each, for three consecutive years (2011/2012/2013) from week 36 to week 50 every fortnight. Plots showed distinct differences in fungal species and fruit body number. High variation of fruit bodies for the single year was observed. Stands characteristics were also observed in order to define potential natural vegetation status of pine cultures. Phytocoenological survey was performed during April and June of 2014. at all plots. Three soil types recorder were Eutric Cambisol on flysch bedrock, Terra Rossa and Black soil on limestone (Calcomelanosol). Floristic composition of pine stands differed among the plots showing mixtures between eumediterranean/submediterranean and submediterranean/ mountain vegetation regions. Together with plants, different fungi species were found as good indicators of Austrian pine habitat characteristics. Long term survey is needed to better understand the ecology.

THE STRUCTURE AND DYNAMICS OF MIXED-SPECIES STAND OF SCOTS PINE, NORWAY SPRUCE AND SILVER FIR ON MOUNTAIN KLEKOVAČA (B&H)

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KEYWORDS:
age structure, mixed-species stand, succession, stand homogeneity index

Mixed stand of Scots pine (*Pinus sylvestris* L.), Norway spruce (Picea abies Karst.) and silver fir (*Abies alba* Mill.) i.e. sub-associations Abieti-Piceetum *illyricum* (Fuk.) Stef. 1962 subass. pinetosum sylvestris, is the successive stage of pine forests with spruce Piceo-Pinetum *illyricum* Stef. 1959 towards the permanent stage Abieti-Piceetum *illyricum* (Fuk.) Stef. 1962. Significant complexes of these forests are located in the western part of Bosnia and Herzegovina. The stand is exempted from regular management (seed stand). Besides the analysis of the main stand structural elements, the focus of the research is on the analysis of the age structure and the analysis of the diameter increment. The stand is characterized by a very high stand density and a specific diameter structure. The number of trees per ha is 370 for silver fir, 154 for Norway spruce and 271 for Scots pine, in total 798. A very large stand volume of 745.7 m^3/ha was determined (out of which 16% of silver fir, 14% of Norway spruce and 69% of Scots pine). The youngest silver fir tree is 19 years old, Norway spruce is 34 and Scots pine is 83, which means that since 1930 there have been no ingrowth trees of Scots pine. Contrary to that, the differences between these three species are much smaller when it comes to the oldest trees. The analysis of the age structure and diameter increment provides a clear insight into the dynamics of the stand in which the ratio among the species has changed over time. All three species also differ in terms of the variation of the stand's spatial structure. The determined stand homogeneity index and the Lorenz's curve show a significantly higher degree of homogeneity of the Scots pine component in the stand, in relation to silver fir and Norway spruce.

STUDIES ON MORPHOGENETIC CHARACTERISTICS OF JUVENILE AND ONE YEAR OLD SEEDLINGS OF SOME REGISTERED BRUTIAN PINE (*Pinus brutia* Ten.) SEED STANDS IN LAKES DISTRICT

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KEYWORDS:
Brutian Pine, Lakes District, Morphogenetic, Seedling, Variation

In this study, the variation and the relations between of some metric morphological characteristics of juvenile and one year old seedlings of some registered Brutian Pine (*Pinus brutia* Ten.) seed stands (populations) of the lakes district in Turkey were investigated. Cotyledon number, initial growth (epycotyl length) and rootlet lenght, two months old seedling weight, one year old seedling lenght, collar diameter of the seedling, the longest root lenght, oven dry stem/root ratio, moisture percentage of seedling of the studied Brutian Pine populations were determined. The obtained data were analysed by using SPSS program. It was found that there were significant relations at 0,05-0,001 level between the number of cotyledon-the weight of juvenile seedling, fresh and oven dry weight moisture content of the one year old seedling in Pamucak and Gölhisar populations, respectively. Besides, it was also found that there were significant relations at 0,05-0,001 level only between the number of cotyledon-epycotyl length, the longest root length-one year old seedling height, collar diameter-one year old seedling height, collar diameter and the longest root length-stem/root oven dry weigth ratio, rootlet weight-juvenile seedling weight in Gölhisar population. According to calculated coefficient of variation, it was found out that there were important differences among the populations from stand point of their metric characteristics of the juvenile and one year old seedlings of the investigated populations. However, Karadağ population was similar to Gölhisar, Pamucak and Merkez populations from point view of their cotyledon numbers. The same, it was found that Merkez population was the transition population among the populations of Karadağ, Gölhisar and pamucak populations from viewpoint of rootlet length. Finally, by means of this study, although it was reached up to some main biosystematic information, it could be indicated here to be necessary to carried out more extensive and study with much more material for the species.

MANAGEMENT OF FOREST CULTURES ON KARST AREAS IN LIKA REGION

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KEYWORDS:
afforestation, natural renewable sources, wood production, species selection

Planned and organised efforts on increase of conifer species share in forest fund of Republic of Croatia started around 1960. At the same time more significant scientific research on establishment and silviculture measures of forest cultures were initiated. Forest cultures of different conifer species such as Norway spruce, Scots pine, Austrian black pine, European larch and Douglas fir were established on 3.850 ha on the area of Forest Administration Office Gospić. According to data of «Croatian forests» Ltd. on the area of this Administration office there is still 37.000 ha of uncovered areas suitable for forest culture establishment. Since there is increased demand for renewable energy sources in Republic of Croatia which are predicted to be even higher in the future and highlighted need for related research activities as a result, the objective reasons for analysis of biological, ecological and economical indicators of 40-year old forest cultures are evident. The investigation area encompassed complexes of forest cultures Medak and Žitnik (Gospić Administration office). Scope of the research aims on determination of condition and management activities of forest cultures regarding their age, site conditions, implemented silvicultural measures and effects of negative biotic and abiotic influences on which forest cultures survival depends (forest fires, damages induced by snow and wind, pests, climate changes, etc.). Basic structural parameters have been measured (stem number, DBH, height, wood volume) on the basic of which the share of individual tree species was calculated. Distribution of diameters at breast height and tree heights together with production of wood volume in pure and mixed forest cultures are presented according to tree species. Comparison of success and management methods on two already mentioned localities is provided based on the analysis of the multiple biotic factors and anthropogenic influences. Standard silvicultural measures were applied on research plots and measurement and laboratory analyses have been carried out with the purpose of analysis of individual parameters. Results of this research provide scientific and expert basis for guidelines related to selection of localities and species for conifer forest culture establishment and afforestation activities together with application of adequate establishment techniques and related silvicultural measures. Harmonization of ecological requirements of different tree species with site conditions will be specially taken into consideration together with prerequirements for better success of forest cultures which result with enhancement of wood volume quality and higher economical gain at the end of the rotation period. Thus, enhancement and modernisation of management of existing forest cultures will the provided both in biological, ecological and economical sense. Present forest cultures and planned establishment of new forest cultures presents significant national renewable source.

BOX TREE MOTH (*CYDALIMA PERSPECTALIS*), NEW INVASIVE INSECT PEST IN CROATIA

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KEYWORDS: alien invasive species, damage, defoliation, biology of Box tree moth

Box tree moth (*Cydalima perspectalis*, Lepidoptera; Crambidae) is an alien invasive pest recently introduced to Europe causing serious damage to ornamental box (*Buxus* spp.) shrubs and trees. Alien invasive species have been described as an outstanding global problem and hundreds of species are intentionally and unintentionally moved worldwide. Numbers of introductions to new habitats have been accelerated all over the world due to the increasing mobility of people and goods over the past decades. The box tree moth was recorded for the first time in North Croatia in August 2013. According to damages it can be assumed that the pest has been introduced to the region earlier (in 2011 or 2012) and that the primary infection has not been detected. In 2014 the pest spread rapidly in Continental Croatia with several new infection foci. The damage done to box tree plants is serious. The plants are completely defoliated and their amenity value is reduced. It can be expected that the pest will rapidly spread in all directions seriously damaging box plants, becoming threat to gardens and parks in Croatia. The invasion biology and ecology of this highly invasive insect pest are discussed and compared to other ongoing invasion processes in Croatia.

DISTRIBUTION AND FLIGHT DYNAMIC OF *RHAGOLETIS COMPLETA* (DIPTERA; TEPRITIDAE) AND WALNUT QUALITY EVALUATION IN CROATIA

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KEYWORDS: invasive species, mycotoxin contamination, nutritional value, walnut husk fly

Walnut husk fly, Rhagoletis completa is an invasive species spreading quickly and damaging walnuts in Croatia and neighbouring countries. We researched distribution, flight dynamics of this pest in Croatia and its influence on quality of walnut kernels. For monitoring the spread and flight dynamics of R. completa CSALOMON® PALz traps were used. Weight and the nutritional value of kernels (proteins) and the presence of mycotoxin contamination were measured. Walnut husk fly was found in six out of total of seven counties in Croatia and some of them are first records for the locations. The presence of the fly was not confirmed in eastern Croatia. The flight dynamics showed rapid increase in number of adults only a year after the introduction into new area. The weight of infested kernels was 5.81% lower compared to not infested. Protein content was 14.04% in infested kernels and 17.31% in not infested kernels. There was no difference in levels of mycotoxins. Additional research on mycotoxin levels in stored nuts, ovipositional preferences of walnut husk fly and protection measures against this pest are suggested.

ALTERNATIVE FORMULATIONS FOR PROTECTION AGAINST OAK POWDERY MILDEW

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KEYWORDS:
Environmentally friendly, Oak powdery mildew, Pesticides

Company "Croatian Forests" accepted the FSC principles and criteria to ensure forest management in a way that will, among other things, promote environmentally responsible system for the protection of forests. The basic criteria regarding the use of pesticides are the use of environmentally friendly non-chemical methods of protection of forests from pests. Proven effective preparations will enable the forests to retain the necessary level of protection with environmentally friendly posticides, the impact on biodiversity and the stability of the forest would be reduced to a minimum and the safety of Croatian forests to FSC certification will not be canceled. To protect against oak powdery mildew five environmentally acceptable pesticides were tested: Sakalia - 2.5 l / ha, Equisetum plus -1%, Milsana - 0.25%, Vitisan -1.5%, Neem oil -3%. For the control treatment Artea plus - 400 ml / ha fungicide was used. Each treatment was repeated four times. Due to the rainy weather fungicides are applied only 27th June for the first time. After application of fungicides at intervals of four days the intensity of powdery mildew infection were assessed in five degrees. Fungicides are applied for the second time on July 13 and the intensity of infection was assessed three times every four days. Last score intensity of powdery mildew (24 July) showed that all the preparations provide very good protection against powdery mildew and preparation Vitisan even showed better performance than fungicides Artea plus. At the same time powdery mildew infection in the control plots was very strong.

COMPARISON OF THAUMATOPEA PROCESSIONEA POPULATIONS IN BRANDENBURG/ GERMANY AND CROATIA - WHY DOES THE POPULATION IN CROATIA NOT INCREASE?

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KEYWORDS:
oak,
pest insect,
defoliation,
natural enemies

The Oak Processionary Moth (*Thaumetopoea processionea* L., Lepidoptera, Notodontidae) is a thermophilic butterfly which tends to regional outbreaks. Repeated massive feeding damage right up to complete defoliation of the host trees (*Quercus spp*.) by the gregarious caterpillars constitutes an important threat to oak stands. *Thaumetopoea processionea* poses also a serious public health problem. A contact with the allergenic urticating hairs of the caterpillars can cause inflammatory skin rashes, eye irritations, breathing difficulties or allergic shock. Within a bilateral project (DAAD and Ministry of Education, Science and Sports of Republic Croatia) the natural enemies found in Germany and Croatia have been compared. In Brandenburg, Berlin, and other parts of Germany T. *processionea* is extending it´s range since 2004. The intensity of infestation is increasing in Germany, especially in the land Brandenburg, in a until then unknown scale. In addition to forest areas, trees along forest edges and avenues, individual trees or oaks in parks are attacked such as in cities like Potsdam, a potential threat for urban citizens. Up to date, this has never been reported in Croatia, as outbreaks in Croatia are rare and usually restricted to very small areas (e.g. Jastrebarsko: 5ha in 2001). Control measures of T. *processionea* in Germany range from physical removal of the usually very large nests such as suction to more effective control measures like biological or chemical insecticides. The preferred insecticide is the selective and effective Dipel ES with it´s active ingredient *Bacillus thuringiensis.* Dipel ES is applied from the air by helicopter into the treetops. Treatment with Dipel ES was successful in many places, but success depends on weather conditions on the day of application and time of application in respect to the susceptible larval stage. Therefore, a survey of naturally occurring enemies is needed. In Brandenburg/Germany, tachinids and parasitic wasps were observed at nests of T. *processionea*, but egg parasitoids are missed until know and caterpillar predators are insignificant, in contrast to many other countries. In comparison, a high number of tachinids was observed at nests in Slunj in Croatia in June 2014. This high number of natural enemies and the small size of the nests (approx. hand-size) indicate that the population of T. *processionea* in Croatia is rather low and probably regulated by the natural enemies. We suggest that the antagonist complex of the oak processionary moth in Croatia should be investigated in more detail and that the introduction of natural enemies in Germany should be considered as a part of an integrated management of this pest insect.

RESEARCH ACTIVITIES IN CHESTNUT STANDS FOR THEIR BETTER FUTURE

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KEYWORDS:
Chestnut forest, health condition, chestnut blight disease, integral forest protection methods

Chestnut forests are important resource and have significant economic, ecological and touristic role and are of biodiversity importance. Chestnut blight disease present in all chestnut stands is the most important problem for years. The research object of this work is to investigate integral methods for preservation the chestnut forest and to improve their health condition. To find out the best method for chestnut protection the investigation the health condition of chestnut forest and different research methods were performed in the field and laboratory. Experimental and control plots were established in two localities: in Petrinja and Hrvatska Kostajnica in Forest Administration Sisak in region with largest area of chestnut forest stands. On experimental plots the different methods of breeding and protection measures were carried out. In laboratory experiments the investigation of biological control of chestnut blight with antagonist fungi *Trichoderma viride* and *Trichothecium roseum* that are isolated from chestnut nuts were carried out. In experimental plot where mild thinning and cleaning were carried out the largest number of trees with superficial necroses and healing cancer were present. In control plot the trees with active cancer and dry trees were present the most. On chestnut leaves the fungi Microsphaera alphitoides and *Mycospherella maculiformis* were present from weak to strong infection degree. The health status of chestnut nuts showed that two-thirds were healthy and one-third was damaged with insects and fungi. The most present fungi on nut were *Aspergillus* spp., *Ciboria batschiana, Fusarium* sp., *Penicillium* spp., *Phomopsis* sp., *Trichotechium roseum* and *Trichoderma viride*. Detected insects on nut were *Curculio* sp. and *Cydia* sp. *Schizophyllum commune*, *Stereum* spp. and Trametes spp. decaying fungi were detected on chestnut trees. Biological control with antagonist fungi in laboratory experiment showed that fungus *Trichoderma viride* has grown over the Cryphonectria parasitica culture on 6th days and *Trichtecium roseum* on 29th day. The conclusion is that the most efficient and economical method of chestnut protection were mild thinning and cleaning with implementation of forest order. Laboratory experiment suggests the possibility of biological control with antagonist fungi which should be testing in natural condition in following research.

GENE POOL CONSERVATION AND TREE IMPROVEMENT IN SERBIA

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KEYWORDS:
gene pool, conifers conservation, tree improvement

Paper presents the concepts applied in the gene pool conservation and tree improvement in Serbia. Gene pool conservation of conifers tree species in Serbia includes a series of activities aiming at the sustainability and protection of genetic and species variability. This implies the investigation of genetic resources and their identification through the research of the genetic structure and the breeding system of individual species. Paper also includes the study of intra- and inter-population variability in experiments - provenance tests, progeny tests, half- and full-sib lines, etc. The increased use of the genetic potential in tree improvement in Serbia should be intensified by the following activities: improvement of production of normal forest seed, application of the concept of new selections directed primarily to the improvement of only one character, because in that case the result would be certain, establishment and management of seed orchards as specialised plantations for long-term production of genetically good-quality forest seeds, and the shortening of the improvement process by introducing new techniques and methods (molecular markers, somaclonal variation, genetic engineering, protoplast fusion, micropropagation, etc.).

MODELLING TREE CHARACTERISTICS OF INDIVIDUAL BLACK PINE TREES FOR USE IN REMOTE SENSING BASED INVENTORY

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KEYWORDS:
aboveground biomass, Austrian black pine (Pinus nigra var. austriaca Arn.), diameter at breast height, volume

Due to lower timber stocks, costs of classical forest inventory present a problem in management of Mediterranean forests. Using data from remote sensing could help in reducing the forest inventory costs. The main aim of this research was to build models for predicting dbh, volume, and aboveground biomass of individual black pine trees which will be suitable for inventories based on remote sensing, in our case aerial photogrammetry. Black pine (*Pinus nigra* Arn.) is important tree species in the Mediterranean and Submediterranean parts of Croatia where it comes mostly in pure even-aged stands or in forest cultures. The research was conducted in a pure even-aged stands of Austrian black pine (Pinus nigra var. austriaca Arn.) in the management unit 'Borovača', which is located in the Submediterranean part of Croatia. In Croatia is no research on the allometric equations that could be used for estimation of dbh, volume and aboveground biomass of black pine trees using remote sensing data. Therefore, field measurement of tree variables (dbh, crown diameter, tree height) was conducted on the sample of 500 black pine trees. Reference volume and biomass were calculated from field measurements for each individual tree using existing volume and biomass equations. Distance to the closest tree (DCT) and number of the trees in the circle of 5 m (stand density) radius were recorded for each tree in the sample. Additional site variables (elevation, slope, exposure) were derived for each tree based on GPS recorded tree's coordinates overlaid upon generated digital terrain model. Models predicting tree dbh, volume and aboveground biomass were built by multiple linear regressions using tree height, crown diameter, DCT, stand density, and site variables as independent variables on a subsample of 300 randomly selected trees, while remaining 200 trees were used for models validation. Variability of dbh, volume, and biomass is explained best by crown area and tree height. Others variables (distance to the closest tree, stand density, elevation, used for models building predicted the variability with lower values, but however increased the reliability of models. According to obtained results it may be concluded that build models can be used for estimation of tree characteristics of Austrian black pine in Submediterranean part of Croatia. However, this conclusion should be further validated by conducting remote sensing inventory and comparing the obtained results with the results of field measurement on another area.

THE ROLE OF FOREST VEGETATION IN KARST ON SOIL PROTECTION FROM EROSION

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KEYWORDS:
afforestation, Black pine, grass cover, Oriental hornbeam, runoff, soil erosion

Land degradation has been recognized as a major environmental issue whose processes have been varying in places and time, within the Mediterranean basin. Forest management policies in this area have traditionally encouraged land cover changes, with the establishment of tree cover in natural or degraded ecosystems for soil conservation purposes: to reduce soil erosion and to increase the vegetation structure. In order to evaluate the role of forest vegetation on soil protection from erosion in Mediterranean landscapes we compared 4 vegetation cover types (Black pine-old and young culture, Oriental hornbeam shrublands and grass cover) monitored in 6 hydrological plots (2,5 x 20 m) in the Suvava catchment (Dalmatia, S Croatia) during 7 years (from 2003 to 2009). Each cover type represented a different dominant patch of the vegetation mosaic of the catchment. The values obtained for the seven-year study period were compared with the values from the period since 1972 to 1975 year. The results showed that in mentioned period (2003-2009) the soil losses under young Black pine plots averaged 2.234 g m^{-2}, old culture of Black pine 1.774 g m^{-2}, grass cover 2.234 g m^{-2} and Oriental hornbeam shrublands 0.0516 g m^{-2}. According to the literature data, runoff and erosion measured in 6 plots may be considered low. Flow off in the Suvava catchment slightly increased, while the soil loss was 3.7 times lower than in the previous period (1972- 1975), when more than 50% of the catchment area was without forest vegetation. Annual coefficients of runoff on the investigated types of vegetation cover are small and do not exceed 10% of total annual rainfall. In line with this annual soil loss are also low, and erosion is completely excluded. Forest vegetation in the Suvava catchment has a significant and very positive role in protecting soil from erosion. Natural vegetation and/or afforestation is adequate method to prevent soil from erosion.

GENETIC DIVERSITY OF COMMON WALNUT IN CROATIA

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KEYWORDS:
genetic diversity, Juglans regia, microsatellite loci, heterozygosity

Common walnut (*Juglas regia* L.) belongs to the genus *Juglans* of the family *Juglandaceae*. Common walnut tree has ecologically as well as economically significance and so it is cultivated as forest, agricultural and horticultural tree. Common walnut is prevalent in South Asia, North, South and Central America and South-East Europe. It is believed that common walnut has origins from the Iran-Afghan region, from where it was transferred into China, Russia and Europe. Throughout the Mediterranean region, it was cultivated since the time of the ancient Greeks and Romans. In Croatia, the common walnut is widespread throughout the country. Different cultivars and varieties were entered from neighboring and other European countries throughout history in Croatia. It was planted as individual tree or in a group on a private property. Consequently, it could be supposed that the common walnut has a mixed origin and hence great genetic diversity. The aim of this study was to determine the genetic diversity and structure of common walnut in Croatia. Field sampling included the Northwest Croatia, Slavonia, Istria, Kvarner and Dalmatia. From a total of 232 collected samples, the DNA was isolated and analyzed on eight nuclear microsatellite loci (WGA089, 009 WGA, WGA 004, 332 WGA, WGA 118, WGA148, WGA204, and WGA349). Forty four different alleles were found in the range of 145-297 base pairs. The largest number of ten different alleles was determined at WGA009 locus, and only three different alleles were found on the loci WGA204 and WGA332. The mean value of expected heterozygosity was 0.790, the mean value of observed heterozygosity was 0.535 and the mean value of the fixation index was 0.303. Statistical data indicates a very high genetic differentiation of the genotypes of walnut.

DIFFERENT PHENOLOGY INDUCED GENOTYPE DIVERSITY OF *Q.ROBUR* L. IN THE SEED ORCHARD IN SREM PROVENANCE, REPUBLIC OF SERBIA

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KEYWORDS:
English oak, Srem provenance, molecular taxonomy

Oak is a woody species of high biological and economic importance in forestry. In Serbia, a native species, *Quercus robur* L. (Q. *pedunculata* Ehrh.), Fam. Fagaceae, grows in the valleys of major rivers-the Danube, Sava and Drina. Develope pure forest or mixed communities with elm and ash. Forest of Q. *pedunculata* in Slavonia and Srem are valuable, well known and famous for their wood quality all over the world. First seed stands of oak in Srem were selected on the basis of phenotype and phenology of trees. The largest seed stands is in GJ "Vinična-Žeravinac-Puk" - ŠU Morović, seed orchard established in 1979-1983 in Morović. Seed stands of oak in Srem are resource of European importance that allows natural populations of oak in Serbia and beyond to become a viable and vital through the climate changes that are inevitable and continuously present. There are a number of biotic and abiotic environmental factors that affect the state and development of this woody plant species. Given that the pedunculate oak is the endangered species the efforts are being made to preserve it through various forms of ex situ and in situ conservation. The seed stands of oak are the best form of conservation of genetic diversity of the species and it is important to constantly do new efforts to ensure that they maintain. In order to give the first insights into the genetic structure and diversity in the oak seed stand of Srem provenance, the aim of this work was to characterise the genetic structure related to different phenology of sampled oak genotypes using a system of established microsatellite molecular markers. Leaves from fifteen individuals were sampled from four different varieties of English oak (*Q. robur* var.*praecox*, *Q. robur* var.*typica*, *Q. robur* var.*tardiflora*, *Q. robur* var. *tardissima*). Seven microsatellite primer sets were used designed to be specific to the sequences flanking the (GA/CT)n and $(AG/TC)_n$ dinucleotide repeat motives in oak genome. Quercus species have revealed high levels of polymorphism suggested that these markers are well suited for studies of genetic diversity within oak population and between different varieties. Successful amplification of all observed microsatellite loci revealed allelic polymorphism between and within all varieties established the variety specific genetic structure.

EVALUATION OF THE INTERNAL MORPHOLOGY OF *TERMINALIA ARGENTA* MART. ET ZUCC. (COMBRETACEAE) SEEDS BY THE X-RAY TEST

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KEYWORDS:
Image analysis.
Three species of Cerrado.
Germination.
Vigor.

ABSTRACT – Forest species, especially those from brazilian Cerrado, are characterized by the occurrence of predation, empty fruits and germ formation deficiency. The objective of this work was to evaluate the internal morphology of *Terminalia argenta* Mart. et Zucc seeds. By the xray test and to verify its relation with germination. It was taken 200 radiographs of each lot and the tests were taken with the seeds set at 28,0 cm from the source of x-rays, using the digital equipment Faxitron X-ray model MX-20 DC 12. Next, the seeds were classified according to its internal morphology as seen in the radiographs. It was established three categories of seeds: full, empty and malformed. For each seeds category germination tests were performed. Statistical design in factorial, with three lots and three categories. From the results obtained in this work, the use of x-ray test with *Terminalia argenta* seeds is promising in quality of seeds lots detection, assisting in empty and malformed seeds separation, invalidating its use immediately or for storage. For the 3 analyzed lots, the germination percentage of the Full categories diverged statistically from the others. The Lot 2 obtained a higher percentage of normal seedlings (61.74%), followed by Lots 1 and 3. The X ray test, in 26kV by 1,2 seconds intensity was efficiency in *Terminalia argenta* internal morpholy evaluation. The *Terminalia argenta* seeds germinal percentage can be compromised by fruits formed without embryonic tissue or malformed embryos.

INVESTIGATION OF CONDITIONS FOR PROCCESSING AND STORAGE OF PEDUNCULATE OAK ACORNS (*Quercus robur* L.) AND ACORN QUALITY DURING STORAGE

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KEYWORDS:
Pedunculate oak,
acorn quality,
thermotherapy
treatment,
acorn storage

The largest forest complex of pedunculate oak Spačva is situated in eastern part of Croatia in the river basin of Spačva and Studva. It occupies approximately 40.000 ha that makes one fifth of all pedunculate oak forests in Croatia. The consequences of negative pressure on the forest ecosystem are visible in forest decline as the irregular and loe yield of acorns. The most important factor for conservation of genetic resources and biodiversity and ensuring the sustainability of oak forest ecosystems, is good acorn quality. Seed storage without major deterioration of germination capacity is a great problem for the larger seeded broadleaved tree species. Acorns belong to recalcitrant seed storage type and are sensitive to the loss of moisture content and the storage temperature. In this work the most favourable temperature for processing of acorns by thermotherapy treatment, moisture content in the acorn before storage and the storage temperature of different pedunculate oak provenances were investigated. The most important seed quality parameters for determination of seed processing and storage, viability and moisture content were determinate according to ISTA methodology. In the thermotherapy treatment temperature of 41°C and 43°C were used for 2.5 hours. After this process acorn were dried to 42% i 35% moisture content, and packed in PE-bags before storage at 2°C for 4 months. Moisture content was controlled once per month and the viability once in two months. During storage the moisture content in the acorn varied between 1 – 3%, depending on initial moisture content. After 2 and 4 month storage, the acorn viability for all investigated provenances was higher for acorn with 42 % of moisture content and both temperatures.

ON THE POSSIBILITY OF USING STANDARD INCREMENT SERIES IN EVENAGED FORESTS OF NW CROATIA

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Forest management plans have information about increment on tree species level for every subcompartment. Forest management rules act regulates a method of getting data on volume increment in evenaged forests on the basis of current radial increment. Samples for radial increment measuring are separated into groups by forest type, site quality and age. Increment series consists of volume increment percentages for every diameter class. It is allowed not to produce new local increment series, when they exist from older forest management plans. Analysis of local increment series which are in use in NW Croatia (Regional Forest Office Koprivnica) showed that many of them have almost same values. Nevertheless, they are used for the same groups of subcompartments. On the other hand, many anomalies and discontinuities are noticed, due to typing errors and sometimes as a result of small sample size. In such conditions, it seems reasonable to use standard increment series, created with no anomalies, and that will be suitable for particular group of subcompartments. In line with it, evenaged forests managed by Regional Forest Office Koprivnica are divided in 3 regions, according to ecological-geographical conditions: 1 – Bilogora and Prigorje region with area of 19000 ha, 2 – Kalnik with area of 14800 ha and 3 – Drava river lowland with area of 21500 ha. Currently used local increment series are grouped according to: region – forest type – site quality – age, and mean values for each diameter class is calculated. So, for main tree species, standard increment series are composed. Its number significantly decreased in relation to local increment series. This practice oriented research offers one of possible ways to equalize existing local increment series in given area. Use of new standard increment series can be helpful in rationalization of forest management works.

NITROGEN DEPOSITION MEASUREMENT IN CROATIA AND SLOVENIA

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KEYWORDS:
critical load, Croatia, ICP Forests, nitrogen deposition, Slovenia

Forest condition is influenced by a multitude of stress factors, including air pollution and climatic factors. In Europe, forest condition is assessed by the International Cooperative Programme on Assessment and Monitoring of Air Pollution Effects on Forests (ICP Forests) and EU regulation. In order to detect the influence of various stress factors the continuous monitoring on the plots throughout Europe is carried out. Croatia is participating with 7 Level II plots and Slovenia with 11 Level II plots. Climate change could influence the levels of acidity and nitrogen in forests. Exceedance of their critical loads describes the vulnerability of forests to environmental stress caused by anthropogenic impact. A critical load for nitrogen is exceeded on many plots in Europe. Following the ICP Forests methodology, annual bulk and throughfall deposition of nitrogen was calculated as the means of the yearly sums (kg ha^{-1} y^{-1}) from 2008 to 2010 for two Level II plots. One plot is located in Croatia (Jastrebarski lugovi, 110) and the other in Slovenia (Murska šuma, 11), both at similar latitude and longitude, with similar age both dominated by *Quercus robur* L. (Pendeculate oak).

The aims of this study are the following:
(1) to identify differences in nitrogen deposition and precipitation between the sites and across time;
(2) to evaluate the nitrogen loads in Croatia and Slovenia
(3) to compare actual and critical loads of the plot

Preliminary results of this study showed that nitrogen loads for bulk and throughfall deposition is not exceeded the critical level on both plots. Therefore, it`s still not influencing the stress on in the *Quercus robur* L. forest ecosystem. The average nitrogen deposition is higher on plot 11 than on plot 110. The nitrogen deposition was the highest in 2008 on plot 110 and in 2009 on plot 11.

INFLUENCE OF CONTAINER SIZE ON QUANTITATIVE MORPHOLOGICAL INDICATORS OF ALEPPO PINE (*Pinus halepensis* Mill.) ONE YEAR OLD SEEDLINGS

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KEYWORDS:
Aleppo pine, container type (size), morphological features of seedlings

For successful afforestation in Mediterranean karst areas several important criteria must be met, especially adequate tree species and high-quality seedlings. With that in mind, morphological features of one-year old Aleppo pine (*Pinus halepensis* Mill.) seedlings were analyzed. Seedlings were grown in different types of containers to establish the effect of container type on development (quality) of above- and belowground parts of the seedlings. Four types of containers were used: $MP_{53/12}$, $MP_{33/18}$, $T_{7/24}$ and $T_{8/24}$. Studied seedling variables (morphological features) include: seedling height, root collar diameter, biomass of the aboveground part of the seedlings and total seedling biomass. Two morphological indexes were calculated from measured variables: S/R ratio and DQI. Morphological dimensions of root systems were scanned and measured with software WinRhizo, namely: total root length, number of root tips, surface area and root volume. Morphological features with regard to container type were evaluated with analysis of variance (ANOVA) and multiple Turkey's post hoc test.
Morphological features of seedlings derived from the samples of 20 seedlings per container type, almost all show significantly higher values in larger containers ($T_{7/24}$ and $T_{8/24}$) compared to smaller containers ($MP_{53/12}$ and $MP_{33/18}$). Root analyses also show that roots of seedlings from smallest containers ($MP_{53/12}$) are deformed to a high degree. In larger containers ($MP_{33/18}$) root deformation is largely reduced. On the other hand, bind of roots into growing medium in seedlings grown in large containers is insufficient, although the roots are not deformed. Seedlings of Aleppo (*Pinus halepensis* Mill.) grown in container $MP_{53/12}$ have developed highly deformed root systems because of inadequate dimensions of this container and its technological absoluteness. Therefore is recommended to gradually abandon the use of $MP_{53/12}$ and $MP_{33/18}$ containers from nursery production. Further research is needed to eventually define new, modern solutions adapted to production of high-quality seedlings for afforestation of Mediterranean karst area.

RELATIONSHIP OF STAND STRUCTURE IN CROATIAN PECUNDULATE OAK AND COMMON HORNBEAM FORESTS WITH GROWTH AND YIELD TABLES AS GUIDELINES FOR FOREST MANAGEMENT: CURRENT STATE AND CHALLENGES

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KEYWORDS:
mixed pedunculate oak and common hornbeam forests, modeling, relative growing stock, growth and yield tables,stand structure

Climate and other anthropogenic changes significantly alter the growing conditions of forest tree species in Croatia, especially so in the case of pedunculate oak. Dynamic changes in the site conditions demand a new approach for the management of forest stands. In Croatia, similar to many countries in the region and Central Europe, growth and yield tables are still used as major guidelines for forest planning and management. Foundations of these tables are usually made up of mathematical models which are static in nature and are developed on the data collected long before the onset of the climate change. Intention of our contribution is to relate the actual state of the structural elements of mixed pedunculate oak and hornbeam forests in Croatia with the values presented in the growth and yield tables of domestic authors currently in everyday use. Our goal was to expose the grade of (diss)agreement between the actual condition of these stands and the theoretical models used as the guidelines for their management. Comparison is based on stand basal area.For our research we have utilized database of "Croatian forests" Ltd., HS Fond, from which we extracted data on 5,060 subcompartments with total area of 76,000 ha through seven filtering steps. Methodology we applied allowed us to consider in our analyzes 77% of the total area of pedunculate oak and common hornbeam stands in Croatia. Results of our analyzes indicate significant variability of stand structural elements in investigated oak stands in all of their development stages. It is evident that the major part of the stands has the values of the relative growing stock between 0.8 and 1.0. However, there is still a significant part of stands outside of this, commonly accepted, range. Our results further indicate the apparent disproportion between the variability of the basic structural features of pedunculate oak stands and the static nature of the growth and yield tables. Reason for this lies in the simple mathematical construction of currently used growth and yield tables which aim to describe their development with stand age as the only independent variable. In reality, the development of these stands is a highly complex and dynamic process in which a significant role falls to the dimension and vitality of trees, interand intraspecies competition, productive capacity of the site and an array of anthropogenic induced site and climate changes. Our research results raise the question of the justifiability of further application of current growth and yield tables, based on their limited ability of integration of climatic an anthropogenic changes into predictions of future stand development. Therefore, within the scope of our contribution and based on the results of our research, we propose the construction of local mathematical models with integrated shift from stand based to tree based modeling efforts based on higher number of independent variables.

NUTRITIONAL STATUS AND STRESS TOLERANCE INDEX IN EFFECTIVE SELECTION OF POPULAR CLONES

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KEYWORDS: groundwater table, mineral nutrient concentration, poplar radial increment, soil fertility

The assessment of poplar clone productivity, with the goal of selection of elite genotypes for diverse ecological conditions, is the main pillar of tree breeding. The interaction of a certain genotype and various environments in which this genotype may survive results in various phenotypes, which are in fact the level of reaction of the genotype to outside factor intensity. A genotype will possess a certain norm of reaction enabling it to change its phenotype as a reaction to the pressure of environmental factors (genotype x environment interaction, GEI). Biotope-related stress is caused by a low level of elementary plant needs such as water and nutrient availability. Due to recent changes in the groundwater table along the Drava river, we assumed that the changes in the water table are the primary cause of lowered production of poplar clones `M1' (P. x canadensis) and `S1-8' (*Populus deltoides*) in Osijek area, eastern Croatia. These two clones are widely planted in the area, and regarded as clones of a high potential in regular stand conditions. Stress tolerance index (STI) enables identification of high yield genotypes and a high stress tolerance, taking into account the potential production in non-stress and stress conditions. We used the stress tolerance index (STI) as the selection criteria for the stress response of the clones on two differing biotopes – low stress area (open to river flooding) and moderate to severe stress area (separated from the flooding by river banks). The STI was calculated on the basis of increment. Given the inconsistencies revealed in the analysis of STI, additional research focused on the poplar clone nutrition to better pinpoint the source of stress. Based on the results of DBH measurements, climate properties, water table depth, soil and foliar analyses, the source of stress for poplar in the Osijek area is discussed.

AN IMPACT OF TEMP. ON A GROWTH OF PEDUNCULATE OAK IN STRICT NATURE RESERVE "STARA VRATIČNA"

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KEYWORDS:
Pedunculate oak, dendroecology, growth decline, Serbia

Pedunculate oak (*Quercus robur*) forests that are widely distributed across Europe are experiencing extensive mortality. Numerous researches reported oak dieback in Sava River basin. Up to now there were no strong evidences about the cause of these diebacks. Change of temperature has never been considered in deep as a possible oak growth decrease and dieback factor. Cores from totally 15 trees were sampled from the Strict Nature Reseve "Stara Vratična" during 2013 and analyzed with the state-of-the-art dendroecological analysis. Site was in the narrow flooded zone near the Sava River. Tree-ring widths (TRW) were compared with monthly average temperatures for past 62 years. Critical months in which increased temperatures showed negative impact on growth were January, February, March, April, May, Jun, July and August. Significant 30-years running correlation between growth (TRW) and temperature were noticed for the whole observed period. Around 1980 temperatures start to rising. At the same time, water level of Sava River drops, so that can also be the factor of decreased growth, mortality and loss of multiple ecosystem services.

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STATUS AND PROTECTION OF NATURA 2000 SITES: CASE STUDY OF COMMON JUNIPER (*Juniperus Communis* L.) FORMATIONS IN LITHUANIA

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KEYWORDS: common juniper formations, habitat protection, NATURA 2000

Juniper communities are included in the list of the EU network of protected areas NATURA 2000. In Lithuania, two types of habitats are found, in which common juniper is a protected species – juniper groves and steppic grasslands. The habitats are often found having serious stability problems, endangered or of poor condition. The aim of the study was to identify the key environmental factors that determine the stability and condition of juniper communities. 11 Lithuanian juniper groves were selected, where one of the protected natural habitat types are juniper groves (habitat type 5130), and those found but remaining outside the existing NATURA 2000 list of sites, corresponding to the habitat type 5130. The health status of the junipers was evaluated. The problems of decline and recovery of juniper groves were determined as a complex of biotic, abiotic and anthropogenic factors. Future actions for protection of juniper formations are discussed in the context of NATURA 2000 protection strategy to enable successful conservation the formations.

BARK AND AMBROSIA BEETLES OF DECIDOUS TREES IN THE KASNAK OAK (*Quercus Vulcanica*) NATURE PROTECTION AREA OF TURKEY

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KEYWORDS:
Kasnak Oak Natural Protected Area, deciduous trees, bark beetle, Turkey

Kasnak Oak (*Quercus vulcanica*) Nature Protection Areas is situated in Yukarıgökdere province of Isparta city in the South-western of Turkey. This area contains Quercus vulcanica [BOISS. ET HELDR. EX] KOTSCHY which is endemic for Turkey. This species form nature forest only in this area on the word. Kasnak oak constitute pure stands and also mixed forests with many species like *Cedrus libani, Quercus cerris, Quercus libani, Juniperus excelsa, J. oxicedrus, J. foetidissima, Acer hyrcanum, Sorbus terminalis, Pistasia terebinthus, Cornus mas, Fraxinus ornus, Populus tremula, Pinus nigra* and *Abies cilicica.* In this study bark and ambrosia beetle species (Col.: Curculionidae, Scolytinae) which distribute on deciduous trees of the Kasnak Oak Nature Protection Area were determined. For this aim, Red color Rebell Rosso attractive traps (by mixed of ethyl alcohol 96% and toulen 1%) and window type traps (40x70 cm size and including glycol) were set in stand and they were checked periodically. Also, specimens were collected from weaken trees and also broken and fallen trees by snow. As result, 12 Scolytinae species were determined. These species are; *Hylesinus crenatus; Hylesinus varius; Dryocoetes villosus; Taphrorychus ramicola; Taphrorychus villifrons; Scolytus intricatus; Scolytus koenigi; Scolytus mali (; Scolytus rugulosus; Anisandrus dispar; Trypodendron signatum; Xyleborinus saxesenii.* Among these species, X. *saxesenii* is the most abundant species.

EVALUATION OF THE INTERNAL MORPHOLOGY OF *PLATYPODIUM ELEGANS* VOG. (*FABACEAE*) SEEDS BY THE X-RAY TEST

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KEYWORDS:
Forest seeds, Vigor, Physiological quality

The estimation of the physiological quality of seeds groups is a procedure of great importance for the various links in the chain of the production of forest seeds sector. The objective of this work is to evaluate the internal morphology of *Platypodium elegans* Vog. through the x-ray test and to verify its relation to germination. 200 radiographs were taken of each group and the tests were performed with the seeds set at 28,0 cm from the source of x-rays, using the digital equipment Faxitron X-ray ,model MX-20 DC 12. Aferwards, the seeds were classified according to their internal morphology as seen in the radiographs. Three categories of seeds were established: full, empty and malformed. Germination tests were performed on each seed category. The Statistics in group of seeds classified as full differed from the other two groups. This group contained the highest number of seedlings comparing to the other groups. According to the results obtained in this work, the use of x-ray test with *Platypodium elegans* Vog. seeds is promising in quality of seed group detection, assisting in empty and malformed seeds separation and invalidating their use immediately or for storage. For the 3 analyzed groups, the germination percentage of the Full category diverged statistically from the others. The 3 group obtained higher percentage of normal seedlings (72%), than groups 2 and 1. The percentage of 28% to 35% of seeds classified as Empty is an indication that the process of classification of seeds can be improved by avoiding unnecessary costs of seedling production and laboratory tests. It can be observed that the phenotypic and genetic conditions can influence the quality of the seeds. The X ray test, in 26kV during 1,2 seconds intensity was efficient in *Platypodium elegans* Vog. internal morpholy evaluation.

GROWTH AND DEVELOPMENT DYNAMIC OF YOUNG HOLM OAK HIGH FOREST (*QUERCUS ILEX* L.) – RESULTS OF MULTIANNUAL MONITORING OF NATURAL REGENERATION BY SHELTERWOOD CUTTINGS

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KEYWORDS:
coppices, natural regeneration, shelterwood cuttings, young generation, Holm oak.

Holm oak (*Quercus ilex* L.) presents basic climax tree species in the warmer part of Croatian Mediterranean region. Early human settlement and its exploitation habits turned most of the ancient quality Holm oak high forests to coppice stands and degradation forms such as maquise, garrigue and even bare karst.Respecting the principle of sustainable management as the basic postulate of Croatian forestry, the management aim for the most of coppices should be conversion to higher silvicultural forms. Regarding the fact that Holm oak bears seeds more or less intensively every year, the proven fact that all coppices are degraded stands on quality sites and in the harmony with the forest inventory and management regulations, commercial coppices should be regenerated naturally on the principles of shelterwood cuttings. Literature analysis points out that only few authors are dealing with these issues. Scientific research brings successful and concrete results of monitoring of natural regeneration under the principles of shelterwood cuttings on the permanent trial plot. Basic stand structural elements have been monitored throughout multiannual measurements: DBH, tree heights, horizontal crown projections, forest floor coverage, occurrence and the number of young generation. Occurrence and survival of Holm oak young seed generation, because of high growth strength of Holm oak and Laurel tree (*Laurus nobilis* L.) from the stump and too dense shrub occurrence, demands efficient, timely and repeated tending measures (already under the shelterwood) with the protection of the regeneration area from game. These kinds of activities encompass all actions which are aimed at enhancement of forests and forest land management in the Mediterranean forest area. Silvicultural measures should be guided by management aims and therefore respect the number of ecological and management influences (soil and stand condition, location, fire protection measures) together with available economic assets gained from the biological reproduction of forests and payments for environmental services.Throughout the ten years long regeneration period and by monitoring of mast years, application of two seed cuttings and regular and adequate tending operations in young generation, quality young Holm oak high stand was gained. Autochthonous stands of Holm oak, as a basic climax tree species of Mediterranean forests, due to their multifunctionality in the sense of aesthetic, protective, ameliorative, touristic and altogether all environmental forest functions deserve intensive and permanent research activities aimed at preservation of genetic and biological diversity together with potential and sustainability of forest ecosystems in Croatian part of Mediterranean region.

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