Virtual International Conference

„Plant productivity and food safety: Soil science, Microbiology, Agricultural Genetics and Food quality”

15-17th September 2021

Scientific Committee

Prof. David B. Collinge (University of Copenhagen, Denmark)

Prof. Mahendra Rai (Amravati University, India)

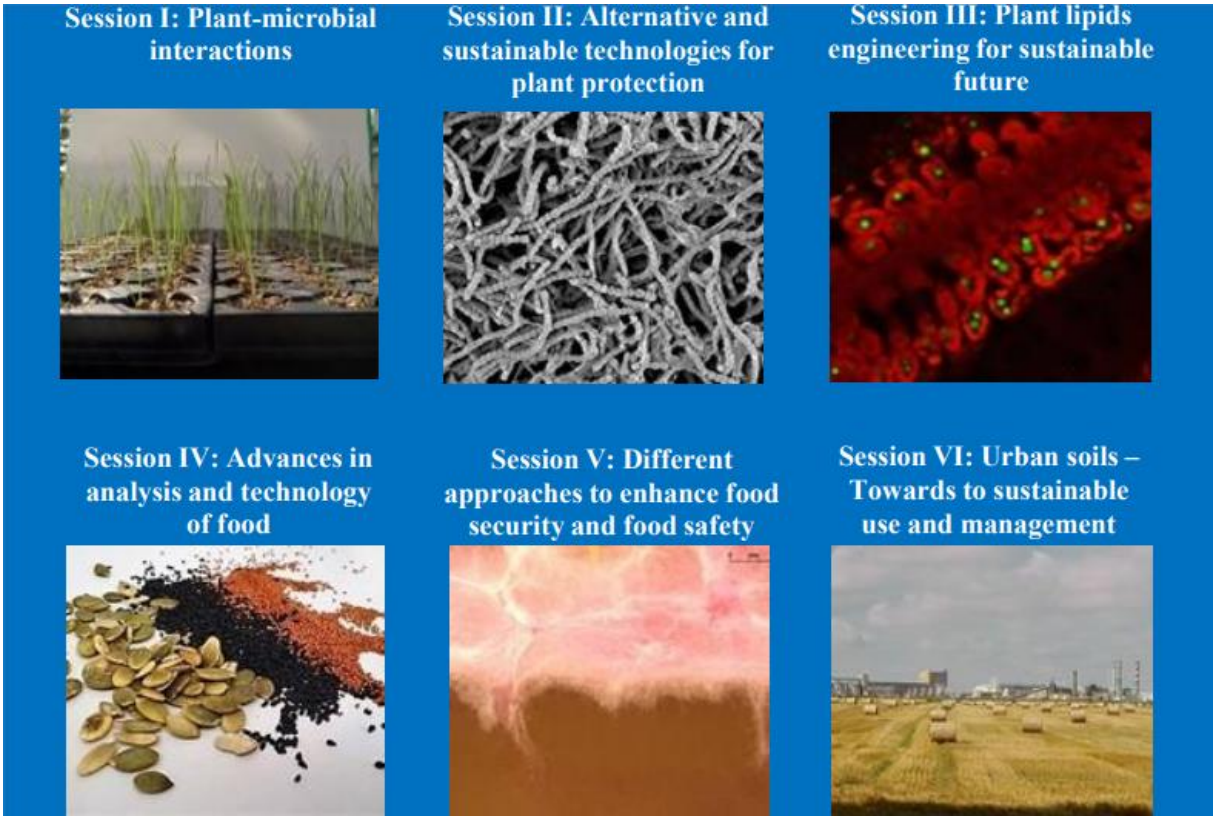
Prof. Patrick Horn (East Carolina University, USA)

Prof. Mohamed Bouaziz (Sfax Tunisia - University of Sfax, Tunisia)

Prof. Claudia A. Blindauer (Warwick University, UK)

Prof. Tatiana V. Prokofieva (Lomonosov Moscow State University, Russia)

Conference Sessions



Conference Schedule

1st day, 15.09.2021			
	Presenter	**Title of presentation**	**Time***
Time for connecting with participants			8:00 – 8:25
Open Talk			8:25 – 08:30
Keynote Speaker	**David B. Collinge**	„Biological control of *Fusarium* head blight with fungal endophytes"	08:30 – 09:00
Session I Session Chair: Katarzyna Hrynkiewicz Session Organizers: Agnieszka Kalwasińska, Sonia Szymańska, Bliss Furtado	Eric C. Pereira, Beatriz R. Vázquez de Aldana, Rufin Toghueo, **Iñigo Zabalgogeazcoa**	„Structure, function and applications of the fungal microbiome of wild grasses"	09:00 – 09:30
	Christel Baum, Nora Vitow, Julia Kaminiski, Anika Zacher, P eter Leinweber and Katarzyna Hrynkiewicz	„Promotion of mycorrhiza formation and use in arable crops by adaptation of agricultural management"	09:30 – 10:00
	Silke Ruppel, Sascha Patz	„*Kosakonia radicincitans*: a new emerging bacterial species with plant growth-promoting effects - From isolation to a commercial product"	10:00 – 10:30
	Krzysztof Treder, Mateusz Mielczarek, Milena Sagan[1], Anna Pawłowska, Agata Kaczmarek, Dorota Michałowska	„The impact of the potato cultivars resistance level on the rate of movement and replication of three strains of potato virus Y"	10:30 – 11:00

	Makoto Kanasugi, Edyta Deja-Sikora, Dominika Thiem, Katarzyna Hrynkiewicz	„Microbiome of perennial crop Kernza: *Thinopyrum intermedium* for sustainable agricultural production”	11:00 – 11:10
	Chinenyenwa Fortune Chukwuneme, Ayansina Segun Ayangbenro, Olubukola Oluranti Babalola	„Deciphering the abundance of genes involved in disease suppression and quorum-sensing in the rhizosphere microbiome of two distinct maize fields through shotgun metagenomics”	11:10 – 11:20
	Discussion to short presentations		11:20 – 11:30
	Poster Session I with discussion (+ short presentation of 2 selected posters)		11:30 – 11:40
	Aleksandra Trzewik, Katarzyna Mynett, Teresa Orlikowska	„*Serendipita indica* as growth stimulator of rhododendron plants”	
	Piotr Koczorski, Bliss Ursula Furtado, Marcin Gołębiewski, Piotr Hulisz, Christel Baum, Martin Weih, Katarzyna Hrynkiewicz	„Fungal microbiomes and phosphorus solubilization in willow Short Rotation Coppice”	
Break			11:40 – 12:00
Session II Session Chair: Patrycja Golińska Session Organizers: Magdalena Wypij,	**Mahendra Rai**	„Can we combat plant pathogens using nanotechnology as a potential tool?"	12:00 – 12:30
	Gabor Tarcali, Laszlo Radocz Jr., Gabriella Kovacs, Laszlo Radocz	„Biological control of **Cryphonectria parasitica** fungus - a good example of the effective use of hypovirulent fungal strains against plant pathogenic fungi”	12:30 – 13:00
	W. Keith Moser, Ireneusz Olejarski, Tomasz Oszako, Tadeusz Malewski, Daria	„Application of wood wastes in the revitalization of post-agricultural soils"	13:00 – 13:30

Magdalena Świecimska	Berezovska, Eva Leonovic, Justyna A. Nowakowska		
	Ammara Nawaz, Marianna Molnárová	„Algal Species as Biocontrol Agents Against Plant Pathogens”	13:30 – 13:40
	Avinash Ingle, Mahendra Rai	„Mycosynthesis and antifungal efficacy of copper nanoparticles against plant pathogenic fungi”	13:40 – 13:50
	Luiza Helena da Silva Martins, Julia Helena da Silva Martins, Mahendra Rai	„Nanoencapsulation of plant extracts, essential oils and bioactive compounds for the control of plant diseases”	13:50 – 14:00
	Gisela M. Seimandi, Laura N. Fernández, María A. Favaro, Verónica E. Ruiz, **Marcos G. Derita**	„Phytochemicallycharacterized extracts from *Polygonum* species for the control of fruit phytopathogenic fungi”	14:00 – 14:10
	Ireneusz Olejarski, Wiesław Szulc, Beata Rutkowska, Justyna Nowakowska, Tomasz Oszako, **Keith Moser**	„Organic biomass and phosphogypsum for restoring nutrient cycling in forest soils”	14:10 – 14:20
	Discussion to short presentations		14:20 – 14:30
	Poster Session II with discussion (+ short presentation of 2 selected posters)		14:30 – 14:40
	Romina Giacometti	„Enabling sustainable and smart agriculture with green nanoparticles”	
	Imen Haddoudi, Moncef Mrabet, Jordi Cabrefiga, Isabel Mora, Haythem Mhadhbi, Emilio Montesinos	„*Bacillus amyloliquefaciens* VFS2 bored spectrum of metabolites under salt and drought stress with key role in *Vicia faba* root-rot suppression caused by *Fusarium equiseti* “	
Break			14:40 – 15:00

Session III Session Chair: Agnieszka Zienkiewicz Session Organizer: Edyta Deja-Sikora	**Patrick Horn**	„Big Data Overload: Deriving Structure-Function Insights within Plant Lipid Metabolism through Analyses of Diverse Plant Genomes"	15:00 – 15:30
	Magdalena Miklaszewska	„The key enzymes in metabolic engineering for production of wax esters in plants"	15:30 – 16:00
	M. Luisa Hernández, M. Dolores Sicardo, **José M. Martínez-Rivas**	„Differential contribution of **DGAT** and **PDAT** genes to triacylglycerol biosynthesis in olive fruit"	16:00 – 16:30
	Krzysztof Zienkiewicz	„Oleaginous Microalgae – the green gold for the sustainable development"	16:30 – 17:00
	Zied Zarai	„Microbial lipases and phospholipases and their use as biocatalysts in modifying plant lipids"	17:00 – 17:10
	Discussion to short presentations		17:10 – 17:20
	Poster Session II with discussion (+ short presentation of 2 selected posters)		17:20 – 17:30
	Marta Saldat, Krzysztof Zienkiewicz	„Biotechnological potential of diacylglycerol acyltransferases from the green microalgae *Nannochloropsis oceanica*"	
	Vipul Swarup Bhatnagar, Krzysztof Zienkiewicz	„The response of genes encoding diacylglycerol acyltransferases of type 2 from N annochloropsis oceanica to diverse stress conditions"	
2nd day, 16.09.2021			
Time for connecting with participants			8:00 – 8:30

Session V Session Chair: Grażyna Dąbrowska Session Organizer: Agnieszka Mierek-Adamska	**Claudia A. Blindauer**, Agnieszka Mierek-Adamska, H. Tanvir Imam, Oksana I. Leszczyszyn	„Zinc in plants: Homeostatic proteins and their potential for biofortification”	08:30 – 09:00
	Dragana Jakovljević, Milan Stanković, Marzena Warchoł, Edyta Skrzypek	„Basil improvement through tissue culture- cultivar specific response”	09:00 – 09:25
	Asfaw Degu, Uri Hochberg, Noga Sikron, Luca Venturini, Genny Buson, Ryan Ghan, Inbar Plaschkes, Albert Batushansky, Vered Chalifa-Caspi, Fulvio Mattivi, Massimo Delledonne, Mario Pezzotti, Shimon Rachmilevitch, Grant R Cramer, Aaron Fait	„ Physiological and biochemical response of grapevines towards water stress"	09:25 – 09:50
	Agnieszka Richert, Urszula Jankiewicz, Justine Gaurenne, Guillaume Cogne, Grażyna B. Dąbrowska	“Innovative biodegradable films with birch tar for plant protection”	09:50 – 10:00
	Karolina Okoń, Artur Nosalewicz	“Photosynthetic productivity under fluctuating light”	10:00 – 10:10
	Sena Turkan, Wiktoria Konieczna, Agnieszka Mierek-Adamska, Edyta Skrzypek, Marzena Warchoł, Grażyna B. Dąbrowska	“Seed germination, antioxidant enzymes activity, proteins, and sugars content during *Brassica napus* L. development“	10:10 – 10:20
	Hasan Tanvir Imam, Agnieszka Mierek-Adamska, Claudia A. Blindauer	“Biophysical studies of small molecule interactions with zinc binding metallothioneins from plant *Arabidopsis thaliana”*	10:20 – 10:30
	Kinga Dziurka, Michał Dziurka, Ewa Muszyńska-Sadłowska, Ilona Czyczyło-Mysza, Marzena Warchoł, Katarzyna Juzoń, Kamila Laskoś, Edyta Skrzypek	“Phytohormonal balance disturbances during oat (*Avena sativa* L.) doubled haploids development”	10:30 – 10:40

	Wiktoria Konieczna, Agnieszka Mierek-Adamska, Marzena Warchoł, Edyta Skrzypek, Grażyna B. Dąbrowska	"The expression of oat metallothioneins increases under osmotic stress"	10:40 – 10:50
	Discussion to short presentations		10:50 – 11:00
	Poster Session V with discussion (+ short presentation of 2 selected posters)		11:00 – 11:10
	Agata Zaremba, Katarzyna Bartkowiak, Kamila Doman, Krystyna Szymandera-Buszka	„Consumer preferences regarding the type of fortified vegetables"	
	Naciri Kaoutar, Belahyan Abdel Mounaim, Belahsen Rekia	"Contribution to the valorization of some varieties of local cereals from Khénifra and Tétouan regions in Marocco"	
Break			11:10 – 11:30
Session VI Session Chair: Piotr Hulisz, Przemysław Charzyński Session Organizer: Sylwia Pindral	**Hadi Pirasteh-Anosheh**	„Biosaline Agriculture: A system for Rereading Environmental Resources"	11:30 – 12:00
	Tatiana V. Prokofieva, Aminat Umarova, Anastasia Gasina, Marina Butylkina, Zakhar Ezhelev, Maria Suslenkova, Anna Kokoreva, Irina Martynenko	„Importance of soil physical properties for urban soil management strategy"	12:00 – 12:30
	Remigio Paradelo Núñez	„Knowledge of urban soils morphology and properties for sustainable land use in the city"	12:30 – 13:00
	Andrzej Greinert, Jakub Kostecki	„Anthropogenic soils in the context of elements circulation in urban environment"	13:00 – 13:10

	Sylwia Pindral, Rafał Kot, Piotr Hulisz	„Assessment of agricultural land losses related to the city's territorial expansion using the pedodiversity index”	13:10 – 13:20
	Jamal Harchi, Przemysław Charzyński	„The impact of metallic trace elements on the soil physicochemical and microbial properties in the vicinity of abandoned mines”	13:20 – 13:30
	Szymon Łucjan Różański, Jose Matias Peñas Castejón	„Child risk assessment of selected metal(loid)s from urban soils using in vitro UBM procedure”	13:30 – 13:40
	Agnieszka Kalwasińska, Patrycja, Tarnawska, Monika Latos, Krystyna Pałubicka, Aleksandra Janik,Maria Świontek-Brzezińska	„Effect of natural and synthetic antifungal substances on soil fungal assemblages“	13:40 – 13:50
	Discussion to short presentations		13:50 – 14:00
	Poster Session VI with discussion (+ short presentation of 2 selected posters)		14:00 – 14:10
	Agnieszka Ludwiczak, Anna Ciarkowska, Agnieszka Piernik	„The time-dependent effect of salinity on biochemical parameters of *Tripolium pannonicum”*	
	Agnieszka Kalwasińska, **Patrycja Tarnawska**, Monika Latos, Krystyna Pałubicka, Aleksandra Janik, Maria Swiontek Brzezinska	„Effect of natural and synthetic antifungal substances on soil bacterial assemblages”	
Break			14:10 – 14:20
Session IV	**Mohamed Bouaziz**	„Olive by-products: valuable nutrients, drugs and functional bioactive compounds"	14:20 – 14:50

Session Chair: Aleksandra Szydłowska-Czerniak Session Organizer: Dobrochna Rabiej-Kozioł	**Jan Kyselka**	„Industrial innovation in the production and processing of vegetable oils”	14:50 – 15:20
	Magdalena Rudzińska, Aleksandra Grudniewska, Anna Olejnik, Anna Grygier, Anna Chojnacka, Katarzyna Kowalska, Dominik Kmiecik, Witold Gładkowski, Gabriela Maciejewska	„The thermo-oxidative stability and cytotoxicity of distigmasterol-modified acylglycerols as the new structured lipids”	15:20 – 15:50
	Sylwia Mildner-Szkudlarz, Aleksander Siger, Krzysztof Przygoński	„Effects of polyphenols on N^{ε} -(carboxymethyl)lysine and pyrazines formation in a model wheat bread system”	15:50 – 16:00
	Małgorzata Wroniak, **Marianna Raczyk**, Bartosz Kruszewski, Katarzyna Ratusz	„Effect of deep-frying of potatoes and tofu on thermo-oxidative changes of cold pressed rapeseed oils ”	16:00 – 16:10
	Katarzyna Włodarczyk, Alicja Tymczewska, Dobrochna Rabiej-Kozioł Aleksandra Szydłowska-Czerniak	„Effect of antioxidants on physicochemical properties of emulsions”	16:10 – 16:20
	Dobrochna Rabiej-Kozioł, Aleksandra Szydłowska-Czerniak	„Fluorescence spectroscopy – tool to evaluate the quality of rapeseed oils fortified with phenolipid during storage”	16:20 – 16:30
	Alicja Tymczewska, Jacek Nowaczyk, Aleksandra Szydłowska-Czerniak	„Bioactive gelatin/PVA films containing black cumin cake extract and zinc oxide nanoparticles”	16:30 – 16:40
	Discussion to short presentations		16:40 – 16:50
	Poster Session IV with discussion (+ short presentation of 2 selected posters)		16:50 – 17:00
	Fadwa Jendoubi, Mahdi Fendri, Ajmi Larbi	„Study of total phenolic content variability in Extra Virgin olive oil produced from three cultivars ‘*Chétoui*’, ‘*Chemlali*’ and ‘*Arbequina*’ according to Maturation index”	
	Małgorzata Wroniak, Marta Lefek, **Nour Ksibi**	„Oxidative stability analysis of selected oils from seeds of herbs and vegetables”	

Awarding and Closing Talk	17:00 – 17:15
3rd day, 17.09.2021	
Workshop 1 „Introduction to GIS techniques with QGIS”	09:00 – 12:00
Workshop 2 „Basics of satellite image analysis in QGIS”	13:00 – 16:00
Workshop 3 „Mapping the species distribution and diversity”	17:00 – 20:00

List of posters

Session I		
Edyta Deja-Sikora, Laura Kalinowska, Katarzyna Hrynkiewicz	„Arbuscular mycorrhiza improves the growth of PVY-infected potato (*Solanum tuberosum* L.) while PVY decreases the mycorrhization level in plant roots”	
Bliss U. Furtado, Torben Asp, Istvan Nagy, Jarosław Tyburski, Niels Roulund, Katarzyna Hrynkiewicz	„Plant growth-promoting fungal endophytes in salt-stressed grasses: a transcriptome view”	
Onalenna Galeemelwe, Ayomide Emmanuel Fadiji, Olubukola Oluranti Babalola	„Unraveling the endophytic virome inhabiting maize plant in North West Province of South Africa”	
Piotr Koczorski, Bliss Ursula Furtado, Marcin Gołębiewski, Piotr Hulisz, Christel Baum, Martin Weih, Katarzyna Hrynkiewicz	„Fungal microbiomes and phosphorus solubilization in willow Short Rotation Coppice”	3 min flash presentation + poster
Joanna Mucha	„Reaction of *Pinus sylvestris* root under structurally different siderophores”	
Sonia Szymańska, Marcin Sikora, Justyna Mazur, Katarzyna Hrynkiewicz	Colonisation of vegetables by human pathogenic microorgansisms (HPMOs)	
Aleksandra Trzewik, Katarzyna Mynett, Teresa Orlikowska	„*Serendipita indica* as growth stimulator of rhododendron plants”	3 min flash presentation + poster
Dominika Thiem, **Olivia Wiergowska**, Marcin Gołębiewski, Katarzyna Hrynkiewicz	„Root microbiome of *Alnus glutinosa* (L.) Gaertn. growing in saline conditions”	
Session II		
Norma Hortensia Alvarez, María Inés Stegmayer, José Francisco Pensiero, Juan Marcelo Zabala, María Alejandra Favaro, Marcos Gabriel Derita	,,Fungicidal activity of extracts obtained from *Solanum* species against the postharvest citrus pathogens *Geotrichum citri-aurantii* and *Penicillium digitatum*”	poster
Kalisa Bogati, Maciej Walczak	,,A study on the impact of soil moisture on microbiological diversity and their enzyme activity in agricultural soil”	poster
Barbara Breza-Boruta, Piotr Kanarek	,,Study on effectivieness of biological and chemical preparations in inhibiting the growth of *Lecanicillium fungicola* – the causative agent of dry bubble of white button mushrooms”	poster

Romina Giacometti	„Enabling sustainable and smart agriculture with green nanoparticles”	3 min flash presentation + poster
Imen Haddoudi, Moncef Mrabet, Jordi Cabrefiga, Isabel Mora, Haythem Mhadhbi, Emilio Montesinos	„*Bacillus amyloliquefaciens* VFS2 bored spectrum of metabolites under salt and drought stress with key role in *Vicia faba* root-rot suppression caused by *Fusarium equiseti* “	3 min flash presentation + poster
Beata Kowalska, Magdalena Szczech	,,Inhibition of *Botrytis cinerea* by lactic acid bacteria on lettuce and spinach”	poster
Denisse Yatzely Mercado-Meza, Juan Luis Jacobo-Cuellar, Rafael Parra-Quezada , Nuvia Orduño-Cruz, Mahendra Rai, Graciela Ávila-Quezada	,,Efficacy of Silver nanoparticles on *Erwinia amylovora* causing apple fire blight”	poster
Ana Luisa Olivas-Tarango, Graciela Dolores Ávila-Quezada, Socorro Héctor Tarango-Rivero, Damaris Ojeda-Barrios, Rafael Parra-Quezada, José Molina-Ruiz, Juan Luis Jacobo-Cuellar	,,Improving pecan production by zinc in drip irrigation in calcareous soils”	poster
Oluwadara Pelumi Omotayo, Olubukola Oluranti Babalola	,,*Fusarium verticillioides* and fumonisin of maize plants: optimizing propitious rhizosphere-associated microorganisms as biocontrol agents”	poster
Dnyaneshwar Rathod, Mahendra Rai	,,Synergistic Growth promotion Activity of Silver Nanoparticles with Endophytic *Nigrospora oryzae* on *Cajanus cajan”*	poster
Hilda Karina Sáenz-Hidalgo, Esteban Sánchez-Chávez, Juan Luis Jacobo-Cuellar, Damaris Ojeda-Barrios, Cesar Berzoza-Gaytan, Víctor Olalde-Portugal, Mahendra Rai, Graciela Ávila-Quezada	,,Ectomycorrization in pecan trees in northern Mexico”	poster
Surbhi Shinde, Mahendra Rai	,,Biogenic synthesis of zinc based nanoparticles using *Aspergillus niger* and their efficacy in plant growth promotion”	poster
Federico Spagnoletti, Romina Giacometti	,,Green silver nanoparticles for soybean seed treatment against bacterial pathogens”	poster
María Inés Stegmayer, Norma Hortensia Álvarez, Ignacio Miguel Dellaferrera, Andrea Guadalupe Reutemann, Marcos Gabriel Derita	,,*In vitro* phytopathogenic fungal inhibition assays and composition of the essential oils obtained from *Conyza* species belonging to the Argentine flora*”*	poster

Magdalena Świecimska, Patrycja Golińska, Michael Goodfellow	,,Novel species of *Actinobacteria* as a potential biocontrol agents against fungal phytopathogens"	poster
Joanna Trzcińska-Wencel, Patrycja Golińska, Magdalena Wypij, Mahendra Rai	,,Biogenic silver nanoparticles as a tool to combat bacterial and fungal plant pathogens"	poster
Session III		
Vipul Swarup Bhatnagar, Krzysztof Zienkiewicz	„The response of genes encoding diacylglycerol acyltransferases of type 2 from Nannochloropsis oceanica to diverse stress conditions"	3 min flash presentation + poster
Marta Saldat, Krzysztof Zienkiewicz	„Biotechnological potential of diacylglycerol acyltransferases from the green microalgae *Nannochloropsis oceanica*"	3 min flash presentation + poster
Session IV		
Niloofar Akhavan, Katarzyna Hrynkiewicz, Dominika Thiem, Katarzyna Stadincka	„OVOBIOM: Elucidating mode of probiotic and prebiotic action in chicken gut through early microbiome modulation *in ovo*"	
Monika Beszterda, Rafał Frański	„*Prunus avium* L. and *Prunus cerasus* L. as sources of flavone C-glycosides"	
Patrycja Brudzyńska, Marzanna Kurzawa, Alina Sionkowska	„Photochemical stability of selected plant-derived food colorants"	
Adonis Hilal, Anna Florowska, Małgorzata Wroniak	„The potential application of plant-based protein-polysaccharide hydrogels in the food sector "	
Fadwa Jendoubi, Mahdi Fendri, Ajmi Larbi	„Study of total phenolic content variability in Extra Virgin olive oil produced from three cultivars '*Chétoui*', '*Chemlali*' and '*Arbequina*' according to Maturation index"	3 min flash presentation + poster
Anna Kmieciak, Sylwia Kowalska, Aneta Jastrzębska, Marek Krzemiński, Joanna Olenderska, Edward Szłyk	„Selection of protein amino acids derivatization procedure conditions for chromatographic determination in food samples"	
Sylwia Kowalska, Justyna Kiełpińska, Aneta Jastrzębska	„Effect of the heating method on selected quality parameters of fruit and vegetable mousses"	
Małgorzata Wroniak, Marta Lefek, **Nour Ksibi**	„Oxidative stability analysis of selected oils from seeds of herbs and vegetables"	3 min flash presentation + poster
Agnieszka Makowska, Katarzyna Kusz, Agnieszka Waśkiewicz, Sylwia Chudy	„The effect of technological factors on the content of lignans in triticale products"	

Monika Momot, Aleksandra Szydłowska-Czerniak	„Sensory Quality of cold pressed camelina oils”	
Sabina Pązik, Katarzyna Ratusz, Edyta Symoniuk	„Using a hemp oil cake as an addition to bakery products”	
Szymon Poliński, Sylwia Kowalska, Patrycja Topka, Aleksandra Szydłowska-Czerniak	„Physicochemical, antioxidant, microstructural properties of dark chocolate with plant extracts”	
Monika Przeor	„Antioxidant activity and the processing scale of white mulberry leaves”	
Katarzyna Ratusz, Edyta Symoniuk, **Justyna Susik**, Nour Ksibi	„Safety and quality of cold-pressed camelina oils”	
Edyta Symoniuk, Aneta Łapińska, Katarzyna Ratusz, Nour Ksibi	„Influence of the Rancimat apparatus operating parameters on oxidative stability determination of cold-pressed camelina and hemp seed oils”	
Aleksandra Telichowska, Joanna Kobus-Cisowska, Judyta Cielecka-Piontek, Szymon Sip, Kinga Stuper-Szablewska, Piotr Szulc	„Antidiabetic values of *Prunus padus* L. fruit and bark and their bioactive compounds - effect for alpha-glucosidase inhibitors”	
Session V		
Habtamu Chekol, Agnieszka Mierek-Adamska, Asfaw Degu, Grażyna B. Dąbrowska	„Aquaporins of *Coffea arabica* – putative functions identified by promoter *in silico* analysis”	
Agnieszka Richert, **Justine Gaurenne**, Guillaume Cogne, Grażyna B. Dąbrowska	„Biodegradable tar film to protect food”	
Anna Grygier, Urszula Sklepkowska, Magdalena Rudzińska	„Effects of rapeseed humidity on oil quality”	
Małgorzata Lemańska, Daria Bejgrowicz, Grażyna B. Dąbrowska	„*In silico* analysis of gene and promoter sequences of metallothioneins type 4 in mono- and dicotyledons plants”	
Naciri Kaoutar, Belahyan Abdel Mounaim, Belahsen Rekia	„Contribution to the valorization of some varieties of local cereals from Khénifra and Tétouan regions in Marocco”	3 min flash presentation + poster
Jakub Brózdowski, **Emmanuel Oloyede**, Oskar Szczepaniak, Magdalena Zborowska	„Tar: historical material - modern approach in innovative technologies”	

Oskar Szczepaniak, Jakub Brózdowski, Marcin Dziedziński, Monika Przeor, Joanna Kobus-Cisowska	„Phytochemical composition and antioxidant activity of children-dedicated low-volume beverages enriched in *Cornus mas* L., *Berberis vulgaris* L. and *Prunus spinosa* L. fruits”	
Marzena Warchoł, Ilona Czyczyło-Mysza, Kinga Dziurka, Katarzyna Juzoń, Kamila Laskoś, Edyta Skrzypek	„Comparison of grain composition of oat doubled haploids and oat × maize addition lines”	
Agnieszka Wesołek, Justyna Skórczak, Kinga Skoracka, Damian Skrypnik	„Is tap water healthy and safe? The view of Polish consumers”	
Agata Zaremba, Katarzyna Bartkowiak, Kamila Doman, Krystyna Szymandera-Buszka	„Consumer preferences regarding the type of fortified vegetables”	3 min flash presentation + poster
Session VI		
Edmund Hajduk, Stanisław Właśniewski, Marcin Pieniążek	„Selected properties of agricultural used soils in the city of Rzeszów”	
Hanna Jaworska, Joanna Klimek	„Impact of a motorway on content and spatial distribution of mercury in adjacent agricultural soils”	
Agnieszka Ludwiczak, Anna Ciarkowska, Agnieszka Piernik	„The time-dependent effect of salinity on biochemical parameters of *Tripolium pannonicum”*	3 min flash presentation + poster
Agnieszka Kalwasińska, **Patrycja Tarnawska**, Monika Latos, Krystyna Pałubicka, Aleksandra Janik, Maria Swiontek Brzezinska	,,Effect of natural and synthetic antifungal substances on soil bacterial assemblages”	3 min flash presentation + poster

Keynote lecture

Biological control of *Fusarium* head blight with fungal endophytes

Edward C. Rojas[1, 2], Birgit Jensen[1], Hans Jørgen L. Jørgensen[1], David B. Collinge[1]

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Head blight caused by *e.g.*, *Fusarium graminearum* and Septoria tritici blotch (STB) caused by *Zymoseptoria tritici* are arguably the most serious challenging diseases of wheat in temperate climates. Disease resistance is fairly ineffective against both diseases, and especially control of Septoria suffers from prevalent fungicide resistance in the fungal population. Biological control, either alone or perhaps integrated with other measures offers a promising strategy for control of these diseases. We have used an ecological approach to identify and isolate endophytic fungi from healthy wheat tissues which were subjected to disease pressure.

Using an amplicon sequencing, we showed that Fusarium had a major influence on the composition of wheat-associated fungi in the mycobiome (Rojas *et al.*, Microbial Ecol. 79: 397, 2020). Subsequently, we demonstrated that four of these could suppress Fusarium head blight in wheat in detached spikelets in a controlled environment and intact wheat spikes in the greenhouse (Rojas *et al.* Biological Control 144: 104222, 2020).

We have studied the three way interaction between one of the potential BCAs, *Penicilium olsonii*) in three way interactions involving wheat, and *Fusarium graminearum*. Transcriptomics using RNAseq suggests that induced resistance is a major mechanism.

Keywords: *Fusarium graminearum*, RNAseq, *Penicilium olsonii*

Session I

„Plant-microbial interactions”

Session Chair: Prof. Katarzyna Hrynkiewicz

Session Organizers: PhD Agnieszka Kalwasińska, PhD Sonia Szymańska, PhD Bliss Furtado

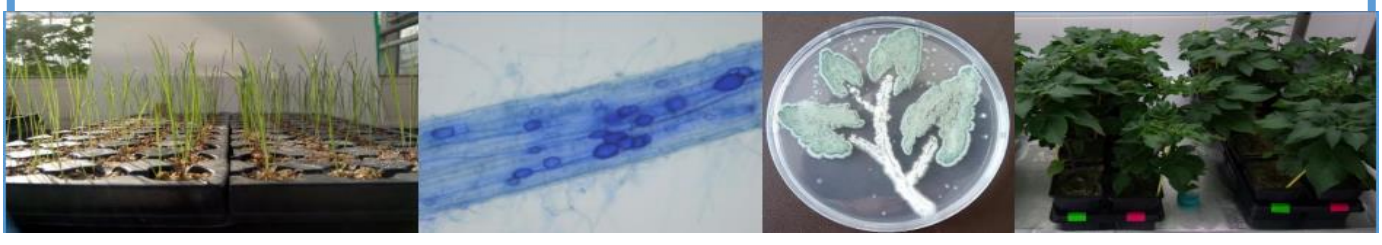
Guest Speakers

1. Prof. Iñigo Zabalgogeazcoa (Institute of Natural Resources and Agrobiology of Salamanca, IRNAS-CSIC, Spain)

„Structure, function and applications of the fungal microbiome of wild grasses”

2. Prof. Christel Baum (University of Rostock, Germany)
„Promotion of mycorrhiza formation and use in arable crops by adaptation of agricultural management”

3. Prof. Silke Ruppel (Leibniz Institute of Vegetable and Ornamental Crops e.V., Germany)
„**Kosakonia radicincitans**: a new emerging bacterial species with plant growth-promoting effects - From isolation to a commercial product”



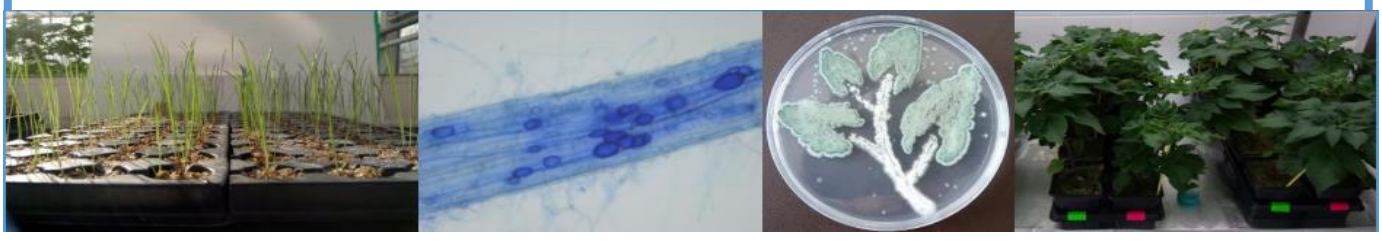
Session I

„Plant-microbial interactions”

Microorganisms can interact with plants through the rhizosphere, phyllosphere and endosphere which may positively or negatively affect plant growth and development. These microbes form non-symbiotic associations as free living soil microbes or as saprophytes, while some form symbiotic plant association’s such as the mutualistic interactions of mycorrhizae, nitrogen fixing bacteria and the hidden colonizers i.e. the endophytes, or the parasitic interactions of the plant pathogens. The type and structure of the plant-microbial community depends on several abiotic and biotic factors e.g. plant genotype, development stage, composition of exudates, climate, soil composition, nutrient availability, microbial species and function. Research on understanding the basis of plant-microbe interaction has gained interest today as it paves for a more sustainable and environment friendly future in agriculture. The positive effects of Plant growth promoting microorganisms (PGPMs) may be (i) direct - providing nutrients synthesized by microrganisms or released by them to the environment and thus making them available to the plant and / or (ii) indirect - reducing or eliminating the harmful effects of phytopathogens. Application of this available resource as bio-formulations will increase the productivity of plants and contribute to reduce the progressive degradation of agricultural land by the application of fertilizers. The protection of plants with the use of bioinoculants against the adverse effects of biotic and abiotic stresses is consistent with the assumptions of sustainable agriculture.

Research subjects includes:

- impact of environmental factors on plants microbial diversity,
- microbiome of plant rhizosphere, endosphere and phyllosphere,
- selection of beneficial microorganisms for increasing plant productivity,
- techniques in preparation of bioinoculants for commercial application,
- role of PGPMs in biotic and abiotic stress mitigation of crops,
- evaluation of compatibility between PGPMs and plant genotypes.



Session I - presentations

Promotion of mycorrhiza formation and use in arable crops by adaptation of agricultural management

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The majority of arable crops benefits from symbiosis with arbuscular mycorrhizal fungi. An improved soil structure, improved host plant nutrition, increased resistance against infections with pathogens and improved tolerance of abiotic stress are main advantages of mycorrhiza formation. However, arable management, especially fertilization, tillage and a temporary lack of host plants under black fallow, disturbs mycorrhiza formation. Since farmers worldwide face problems in crop production with increased soil erosion and abiotic stress caused by the consequences of global climate change, the interest in mycorrhiza promotion is significantly increased. Furthermore, the limited access to rock phosphates and their decreasing quality for fertilizer production leads to the need of an improved P recycling in agriculture. Decreased P fertilization, on the other, contributes to mycorrhiza promotion in agriculture with high relevance for mycorrhizal main crops like e.g. mays (*Zea mays* L.).

Therefore, we have investigated the impacts of different agricultural management treatments: fertilization, cropping of perennial crops with temporal no-till management, catch cropping and temporal weed tolerance, which lead to increased host plant diversity and abundance, on mycorrhiza formation. In the first place, the impact of tillage and host plant presence, but also the amount and quality of P fertilization were revealed as leading controls of mycorrhiza formation in arable soils. Management recommendations for promotion of mycorrhiza formation in arable crop production are derived and an outlook of further control of mycorrhiza formation is provided. The role of mycorrhiza helper bacteria and were potentials and limitations in the arable management are identified. Furthermore, potential risks of mycorrhiza promotion for non-host crop plants and for the relation of mutualistic to parasitic behaviour on host crop plants are presented.

The lasting challenge for plant breeding and seed production will be to optimize the cultivar-specific receptivity to mycorrhizal fungi considering also potential risks of excessive mycorrhiza promotion on plant health.

Keywords: mycorrhizal fungi, fertilization, tillage, weed regulation, crop rotation

Deciphering the abundance of genes involved in disease suppression and quorum-sensing in the rhizosphere microbiome of two distinct maize fields through shotgun metagenomics

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The plant rhizomicrobiome is occupied by microbes that enhance its protection against infection and diseases. These beneficial rhizosphere communities can improve their hosts' performance by suppressing disease infections through the production of antimicrobial compounds such as metabolites, antibiotics, and siderophores and by activating certain defense response genes. Evidence shows that land-use and management affect the diversity of microbial communities and functions in soils, with very few studies on the impact of land-use and management histories on the diversity of microbial genes involved in disease suppression in soils. In this study, microbial genes that facilitate microbial-plant interactions and disease suppression in two maize fields with different agricultural and management histories were analyzed using shotgun metagenomics. Analyses revealed the abundance of several genes associated with quorum-sensing and disease suppression in the soils. The highest abundance of the polyketide synthase genes, *Irp*1, *fen*E, *fen*C, and *fen*B, was found in the former grassland compared to the chalcone synthase (chs) yersiniabactin synthesis (*Irp*2) genes whose highest abundance were observed in the intensively cultivated soils. Beta analysis revealed a separation of the genes across the fields indicating that functional genes composition and abundance were affected by land-use and management histories. These results provide a better understanding of microbial functional genes in the maize rhizosphere under different management practices. Knowledge of the implications of soil management on functional genes potential in agricultural soils will help make decisions concerning better management approaches that will enhance crop protection for sustainable food production.

Keywords: crop protection, functional gene diversity, microbial functional genes, soil fertilization, tillage systems

Microbiome of perennial crop Kernza: *Thinopyrum intermedium* for sustainable agricultural production

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High agricultural production, such as an intensive annual grain cultivation is presumed to create negative impact on terrestrial ecosystems, emerging as land-use issue. Perennial grain crop Kernza (*Thinopyrum intermedium*) are promising alternative for sustainable agricultural production, which is capable of being harvested multiple times for a year. Endophytes are symbiotic microbial traits which inhabit plant tissues (e.g.crops) without disease symptom and show multi-benefits such as nutrients supply. Moreover, microbial traits including endophytes co-exist in multiple plant-associated niches and form plant microbiome, which is recognized as crucial factor for plant productivity. We hypothesize that endophytes play a key role in the productivity of Kernza. Objective of this study is to reveal the role of endophytes in microbiome of Kernza in the development of sustainable agriculture.

For the further understanding of endophytes in Kernza production, field scale experiment was conducted. Study sites were established in three countries: France, Belgium, and Sweden. From each field roots, rhizosphere soil, stems and leafs were sampled at harvesting period in June 2021. Before microbiome analysis and endophytes isolation plant material was surface-sterilized. Bacterial and fungal endophytes were isolated from Kernza root and categorized based on morphological characteristics. As next step, further taxonomic identification, and characterization will be carried out. Microbiome analysis is under progress.

Keywords: Kernza, perennial crop, plant microbiome, bacteria, fungi, endophytes, community analysis, land-use

Funding:
This work was financially supported by the National Science Centre (NSC, Poland), BIODIVCLIM UMO-2020/02/Y/NZ9/00007.

Kosakonia radicincitans: a new emerging bacterial species with plant growth-promoting effects - From isolation to a commercial product

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The type strain of the newly described bacterial species *Kosakonia* radicincitans (formerly *Enterobacter radicincitans*) was isolated from the phyllosphere of winter wheat in 1987. Originally, the strain *K. radicincitans* DSM 16656 was identified to biologically fix atmospheric nitrogen and, thus, eligible to be re-inoculated to wheat plants. Later on, it could be proved that the strain further produces various phytohormons, efficiently solubilizes rock phosphate and competitively colonizes plant tissues. In greenhouse and field experiments, as well as in agricultural practices, the bacteria enhanced the plant growth and yield up to 25%. Hence, our strain has to be considered as the first one alongside the recent worldwide discovery of plant growth-promoting (PGP) *Kosakonia radicincitans* in a large variety of crop plants, suggesting their significant influence on plants, both in terms of yield increase and product quality improvement. Here we show its development to become a commercial product and the application of the novel PGP trait annotation tool (PGPT-Pred), that genetically confirms the PGP potential of *Kosakonia* in a standardized manner.

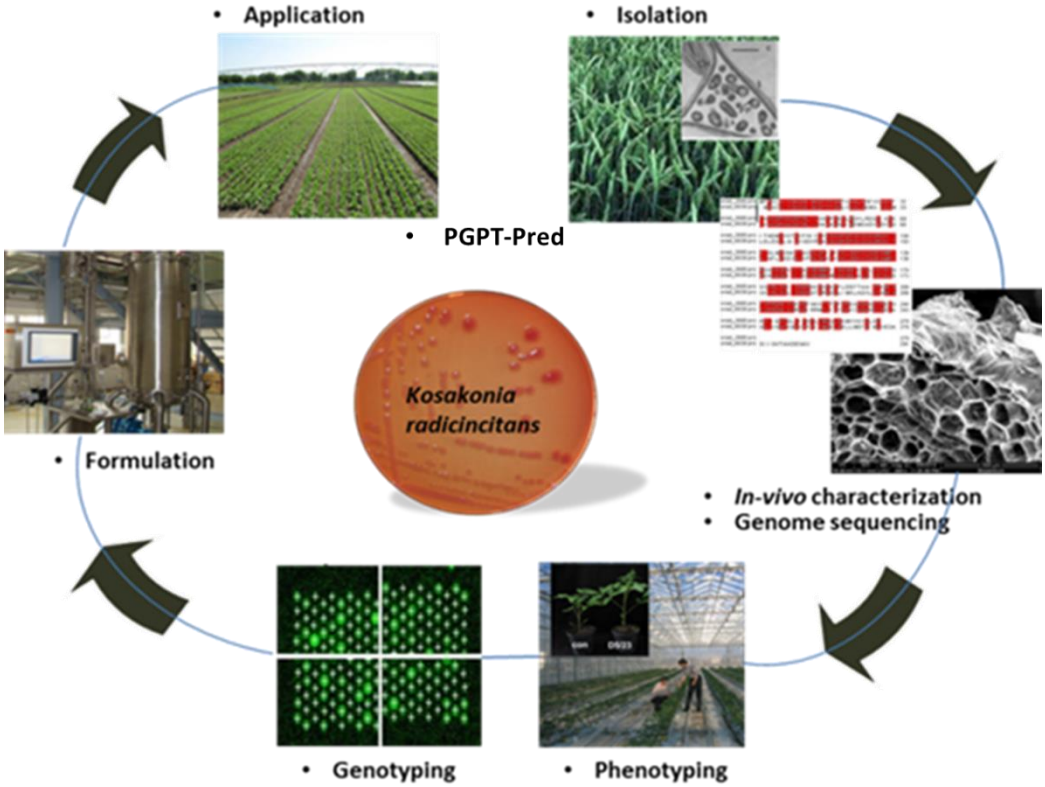

Figure 1: Process of prediction, isolation, characterization and application of plant growth-promoting bacteria associated with the species *Kosakonia radicincitans*.

Keywords: Plant growth-promotion, endophyte, biological product, sustainable agriculture

The impact of the potato cultivars resistance level on the rate of movement and replication of three strains of potato virus Y

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Potato virus Y (PVY) is a typical member of the genus *Potyvirus*, belonging to the *Potyviridae* family. PVY is currently the most crucial virus that infects potatoes and other important crops of the *Solanaceae* family. The virus population has changed dynamically during the last three decades. New recombinants appeared and in few years displaced old parental, nonrecombinant strains. This fast changes in the viral population indicate that new strains have an evolutionary advantage over old ones. We assumed that viruses that replicate efficiently in a plant and/or in a shorter period could establish systemic infection are more likely to displace the less effective strains. For both processes, a significant impact can have the level of plant resistance to viral infection and the virus's ability to break it. This hypothesis was investigated using as a model the three strains of potato virus Y (PVY^{NTN}, PVY^{N-Wi}, PVY^{O}) in plants of varying resistance to PVY infection.

Keywords: Potato virus Y, potato cultivars, viral movemnt, viral replication

Acknowledgements:
We would like to thank Maria Fedczak and Ala Przewłoka for excellent technical help.

Funding:
The study was supported financially by National Science Centre, Poland (grant No. 2016/21/B/NZ9/03573).

Structure, functions and applications of the fungal microbiome of wild grasses

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Plants are associated to a relatively large number of microbes, including fungi, bacteria, archaea, viruses and protozoans, which constitute their microbiome. These symbionts can have an important influence in the growth and adaptation of their host plants. For this reason, it is of interest to know how particular microbiome components can aid their host plants to tolerate environmental stress factors.

For a given plant species, the structure of its fungal microbiome can be defined in terms of species richness, taxonomic composition, and abundance of each species. These concepts can be illustrated with results from a survey of the fungal microbiome of roots of *Festuca rubra* subsp. *pruinosa*. This grass inhabits rocky sea cliffs where soil and nutrients are scarce and exposure to salinity is continuous. In terms of species richness, the microbiome of *Festuca* was composed of 135 different species. However, this number is an underestimation due to the limited number of plants (105) and locations (5) analyzed, and the fact that only culturable species were isolated. In terms of abundance, only two taxa were found in more than 50% of the plants and at all locations analyzed: *Fusarium oxysporum* and a *Diaporthe* species. These are likely components of the core microbiome of this grass, and therefore, prime targets to test their contribution to plant adaptation to environmental stress. In a greenhouse experiment *Festuca* plants artificially inoculated with an endophytic strain of *Fusarium oxysporum* grew better than uninoculated control plants in the presence and absence of salinity. Furthermore, the Na^+ concentration in the leaf tissue of inoculated plants was lower than that of uninoculated controls, suggesting that a Na^+ exclusion mechanism might be linked to *Fusarium* symbiosis, possibly increasing plant adaptation to a saline environment.

Festuca microbiome components seemed to be useful to improve the performance of agricultural crop species. The symbiosis with *Diaporthe* improved salinity tolerance in *Lolium perenne*, and the response to drought and disease caused by pathogenic *Fusarium oxysporum* f.sp. *lycopersici* in tomato plants. Several endophytic *Fusarium* strains increased the biomass of horticultural crop species like celery, lettuce, eggplant, pepper, melon, pea, and bean, but had no effect on basil, tomato, cucumber, watermelon or broad bean. *In vitro*, both *Diaporthe* and *Fusarium* strains exhibited several plant growth promotion activities.

Keywords: *Festuca rubra* subsp. *pruinosa,* microbiome, fungi, *Diaporthe*, *Fusarium*, growth promotion

Session I – posters

Arbuscular mycorrhiza improves the growth of PVY-infected potato (*Solanum tuberosum* L.) while PVY decreases the mycorrhization level in plant roots

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Arbuscular mycorrhiza is a symbiotic association created between arbuscular mycorrhizal fungi (AMF) and the roots of host plants. This underground interaction, that is common in the soil environment, ensures many benefits for plants, including, e.g. an efficient uptake of water and nutrients (especially phosphorus compounds) as well as increase in biotic and abiotic stress tolerance. AMF as an inherent component of each soil ecosystem are currently tested for their bioprotective function in agriculture as they can modulate plant response to under- and above-ground phytopathogenes.

World potato production is severely impacted by potato virus Y (PVY) causing huge economic losses in potato crop yield. In presented study we examined the potential of AMF to alleviate the symptoms of potato virus Y (PVY) infection in potato. For this purpose the *in vitro* and pot experiments were performed using healthy and $PVY^{N\text{-}Wilga}$-infected potato plants cultivar Pirol, and *Rhizophagus irregularis* inoculum (AMF). The measured variables included plant growth parameters, chlorophyll content, oxidative stress level and mycorrhiza level in plant tissues. The results indicated the beneficial effect of endomycorrhiza on the performance of both healthy and PVY-positive potato plants. Virus-infected plants after inoculation with AMF showed improved growth, reduced level of oxidative stress and increased photosynthetic activity. PVY was indicated to reduce the mycohhiza level in the plant roots, nevertheless, the positive effect of AMF on plant growth was still detectable.

Keywords: *Solanum tuberosum*, AMF, potato virus Y (PVY), mycorrhiza level, oxidative stress

Funding:
This work was financially supported by the National Science Centre (NSC, Poland) OPUS 2016/23/B/NZ9/03417.

Plant growth promoting fungal endophytes in salt stressed grasses: a transcriptome view

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Microbes such as the "endophytes" inhabit inner parts of the plant and are known to produce metabolites that assist in the host plants development, growth and diversification. But the question arises if they are able to confer these beneficial traits if inoculated in other non-host plant species?

In this study, we inoculated two salt-tolerant fungal endophytes (isolated from a halophyte *Salicornia europaea*) in a nonhost grass *Lolium perenne* (glycophyte). *L. perenne* is s a popular cool-season grass, one of the major turf and forage species in the world. Changes in climatic conditions and improper irrigation practices have led to soil salinization which drastically affects ryegrass yields since this species is moderately salt tolerant. This grass specie is also naturally colonized by a clavicipitaceous asexual endophyte *Epichloë* sps which produces alkaloids to deter herbivores and insects. Therefore we used two grass varieties: one Epichloë infected and the other Epichloë free for fungal inoculation and the plants were subjected to three salinity stress levels ranging from no salt to high salt stress.

Our results suport that the two fungal strains Stereum gausapatum (E1) and Parasarocladium gamsii (E2) showed incerease in plant growth and are able to regulate plant genes in mitigating plant soil stress.

Comparative transcriptome analysis (using cluster plots and WGCNA (*weighted gene co-expression network*)) revealed E1 inoculated plants showed higher number of differentially expressed genes compared to E2. For both the grass varieties the effect of endophyte inoculation was observed only in the roots but not in leaves. The gene ontology classification showed genes for transcription factors, secondary metabolism, oxidative stress scavenging, cell wall organization and synthesis, transporters and growth factors that were positively regulated after endophyte inoculation.

These results provide a promising basis for the study of *S. europaea* endophytes as a solution for saline entrenched areas and in improving future farming systems.

Keywords: fungi, endophyte, halophyte, salinity, ryegrass, salt tolerance, Epichloë

Funding:
This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No. 676480.

Unraveling the endophytic virome inhabiting maize plant in North West Province of South Africa

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Endophytes are well-known for their symbiotic interaction with plants and their ability to promote plant growth by producing various metabolites. The most well-studied endophytes are bacteria and fungi. For generations, viruses were misnamed, and their symbiotic relationship was ambiguous. Recent advances in omics techniques, particularly next-generation sequencing, have given rise to a new perspective on the mutualistic viral relationship. Endogenous viruses have received a lot of attention in the animal world, but they are less well understood in plants. In this study, endophytic viral populations inhabiting the root of a maize plant were assessed for the first time using shotgun metagenomics. Complete DNA was extracted and sequenced using shotgun metagenomics from the roots of maize plants cultivated with organic fertilizer (FZ), inorganic fertilizer (CZ), and maize planted without fertilizer (NZ) at different planting sites in an experimental field. Our result identified 2 order namely: *Caudovirales* (67.5%) and *Herpesvirales* (28.5%) which dominated the FZ site, although they do not differ significantly (P >0.05) across the sites. At the class level *Microviridae, Phycodnaviridae, Podoviridae, Phycodnaviridae* and *Poxviridae* dominated the FZ site. *Myoviridae* and *Podoviridae* dominated the CZ site while only *Siphoviridae* dominated the inorganic fertilizer site (NZ). Diversity analysis revealed that viral populations were more abundant in the organic fertilization (FZ). Taken together, this research adds to our understanding of the symbiotic integration of endophytic viruses with maize plants and that their abundance is affected by farming practices. Also, their potentials that can be exploited to solve a variety of agronomic issues.

Keywords: endophytes, plant health, shotgun metagenomics, symbiosis, virus

Fungal microbiomes and phosphorus solubilization in willow Short Rotation Coppice

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Phosphorus (P) is an essential plant nutrient. However, P compounds released during weathering are usually complex and are not immediately bio-available. Beneficial microbes, such as P solubilizing fungi can increase the available P in soil and improve plant growth and productivity.

In this study, we analyzed the effects of environmental conditions, plant genotype, and level of plant association (rhizosphere or endophytic root organism) on the abundance and diversity of phosphorus solubilizing fungi in a Salix production system. Two Salix genotypes grown in pure and mixed cultures were investigated for their fungal microbiome community and diversity in the rhizosphere and endosphere during two growing seasons.

We revealed that the classes Agaricomycetes and Pezizomycetes were more frequent in the endosphere, while Tremellomycetes and Mortierellomycetes were more abundant in the rhizosphere. Plot-specific soil properties (pH, total organic carbon, and nitrogen) significantly affected the fungal community structure. Among the culturable fungi Penicillium was the dominant genus of PSF isolated from both sites. The main factors controlling the fungal communities (endophytic vs. rhizosphere fungi) were the soil properties and level of plant association, while no significant influence of growing season was observed. Differences between Salix genotypes were observed for culturable fungal diversity, while in metagenomic data analysis, only the class Dothideomycetes showed a significant effect from the plant genotype.

Keywords: endophytes, fungi, phosphate solubilization, short rotation cropping

References:

Koczorski, P., Furtado, B.U., Gołębiewski, M., Hulisz, P., Baum, C., Weih, M. and Hrynkiewicz, K. (2021). The effects of host plant genotype and environmental conditions on fungal community composition and phosphorus solubilization in willow Short Rotation Coppice. Front. Plant Sci. 12:647709.

Reaction of *Pinus sylvestris* root under structurally different siderophores

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Changes in iron may be one of the mechanisms determining the nature of the mutual interaction. Production of structurally different compounds binding iron (siderophores) may determine the way that fungi establish the infection in root. However, do host cell compartments morphology and element concentration respond differently to the structurally different siderophores and histone acetylation is less understood. To determine the effect of siderophores, structurally different siderophores (desferrioxamine (DFO), desferricrocin (DES-FCR) and desferritriacetylfusarinine C (DES- TAFC)) were applied to *in vitro* growing Scots pine seedlings. Application of iron free DES-FCR and DES-TAFC resulted in an enrichment of Fe counts regardless of analyzed organelles in comparison to control except nucleus. Regardless of the used siderophores, counts of other elements in cell walls exhibited increase with increasing of iron level. In cytoplasm, however, the intensity of interactions between Fe and other elements was affected differently by siderophores compounds. This results indicated that fungi have high capacity to modulate and diverge the iron concentration through siderophores for achieved specific type of symbiosis. Additionally, histone and microtubule acetylation data suggest that the metabolites of pathogenic fungi mirror siderophore action, and that iron limitation can lead to enhanced alternations in cell structure and physiology.

Keywords: siderophores, histone, microtubule, fungi, Scots pine

Colonisation of vegetables by human pathogenic microorganisms (HPMOs)

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Foodborne illness can be caused by consumption of raw or minimally processed vegetables and fruits. *E.coli* 0157:H7, *Salmonella* spp., *Shigella* spp., *Listeria monocytogenes* and *Clostridium botulinum* are considered as the most frequently identified human pathogenic microorganisms (HPMOs). The occurrence of HPMOs in crops are primarily associated with polluted soils enriched with organic fertilisers, crops irrigated with contaminated waters or the faeces of free-living animals.

The aim of our investigation was to determine the interactions between selected species of HPMOs (e.g. *Salmonella enterica* subsp. *enterica* PCM 2565, Listeria monocytogenes PCM 2191) and vegetable crop radish (*Raphanus sativus* L.). We assume that colonization of HPMO can be specific to plant organs and the colonization of plant tissues by HPMO can affect growth parameters.

The results of our study revealed that the selected HPMOs negatively affected the growth parameters (e.g. number of leaves, length of roots, as well as fresh and dry weight) of *R. sativus*, especially in the early stage of plant growth. All tested HPMOs showed the ability to colonize *R. sativus*, however the degree of colonization was organ-specific (leaves, stems, roots).

Keywords: *Escherichia coli*, *Salmonella enterica*, *Listeria monocytogenes*, *Raphanus sativus*, growth parameters of plants

Funding:
This work was financially supported by the National Science Centre (NSC, Poland) OPUS UMO-2019/33/B/NZ9/02803; Miniatura-3 2019/03/X/NZ9/00751.

Serendipita indica as growth stimulator of rhododendron plants

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Serendipita indica is an endophytic fungus that colonizes roots (root cells and intercellular space) of many plant species, where it produces pear-shape chlamydospores.Several authors found its beneficial influence on colonized plants: increase in biomass and seed yield, and enhancement of tolerance for biotic and abiotic stresses, including the stress associated with acclimatization of microplants. The advantage of *S. indica* over other endophytes is possibility to culture it on solid and liquid media in sterile condition and to produce inoculum for commercial application.

The goal of our study was to determine whether a concentration of inoculate of *S. indica* influences the growth of two *Rhododendron* cultivars 'Alfred' and 'Nova Zembla'. The following concentration of the inoculate: 8.5×10^3, 8.5×10^4, 8.5×10^5 suspension of chlamydospores of *S. indica* were added, to *in vitro* culture of already rooted on auxin medium microshoots. The two weeks after inoculation, plants were transplanted to the substrate peat : perlite (3:1) and acclimatized in the greenhouse. Shoot length, number of lateral shoots, and root system size were evaluated after 2, 10, and 18 months of growth in the greenhouse.

S. indica had positive effect on the growth of microcuttings of both cultivars. The average length of shoots cv. 'Alfred' 2 months after inoculation with increased concentration of *S. indica* chlamydospores was higher by 20, 30, and 50%, respectively, compared to non-inoculated plants. After 10 months from inoculation, the average length of shoot for the three above doses was 50, 65, and 90% higher compared to non-inoculated plants. Similar results were obtained after 18 months.

The lowest dose of *S.indica* chlamydospore suspension did not stimulate plant growth of cultivar 'Nova Zembla', while the average lengths of shoot on 2nd, 10th and 18th month after inoculation with doses 8.5×10^4, 8.5×10^5 were higher by 10 and 15, 24 and 26, 33 and 35%, respectively, compared to non-inoculated plants. There was no effect of *S. indica* inoculation on the number of lateral shoots and the root system for the cultivars tested.

Keywords: endophyte, growth stimulation, micropropagation, *Rhododendron*

Root microbiome of *Alnus glutinosa* (L.) Gaertn. growing in saline conditions

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Black alder (*Alnus glutinosa* Gaertn.) is a representative of a unique tree species, forming tripartite symbiosis with mycorrhizal fungi (ectomycorrhiza, endomycorrhiza) and nitrogen-fixing bacteria *Frankia* sp. Our previous metagenomic studies of alder's roots revealed the important role of other endophytes in functioning of this tree under saline stress conditions. However, exposure to this unfavorable conditions may change significantly abundance and microbial community structure both inside and outside roots.

In our study bacterial and fungal microbiomes of rhizosphere soil and alder roots growing at three forest sites (one non-saline and two saline) in two different seasons (spring and fall) were analyzed using metagenomic approach. Analysis of variance showed that abindance of endophytic and rhizosphere microorganisms depends significantly on the source of isolation (roots, rhizosphere), level of salinity and analyzed season. *Actinobacteria* were more frequent in roots than in soil, especially during fall, and they were characteristic for saline sites. *Firmicutes*, *Gemmatimonadetes* and rare bacteria were observed more often in the soil. Root fungal endophytes were dominated by *Basidiomycota*, however at saline sites less sequences belonging to this phylum was noted. In contrast, in the soil dominated *Ascomycota* regardless of analyzed variants. Non-metric multidimensional scaling analysis (NMDS) demonstrated that salinity was significant environmental factor shaping bacterial and fungal communities of alder roots, but it was not relevant in soil samples.

Based on the received results we can conclude that tree can select endophytes from rhizosphere dependently on environmental conditions in the soil.

Keywords: black alder, endophytes, salinity, rhizosphere soil, microbiome

Funding:
The research was financed from the project "Universitas Copernicana Thoruniensis In Futuro - the modernisation of Nicolaus Copernicus University" as part of the Integrated University Programme (project No. POWR.03.05.00-00-Z302/17-00) being conducted as part of the Knowledge Education Development Operational Programme.

Session II

„Alternative and sustainable technologies for plant protection”

Session Chair: PhD Patrycja Golińska, Prof. Assoc. at NCU

Session Organizers: PhD Magdalena Wypij, MSc Magdalena Świecimska

Guest Speakers

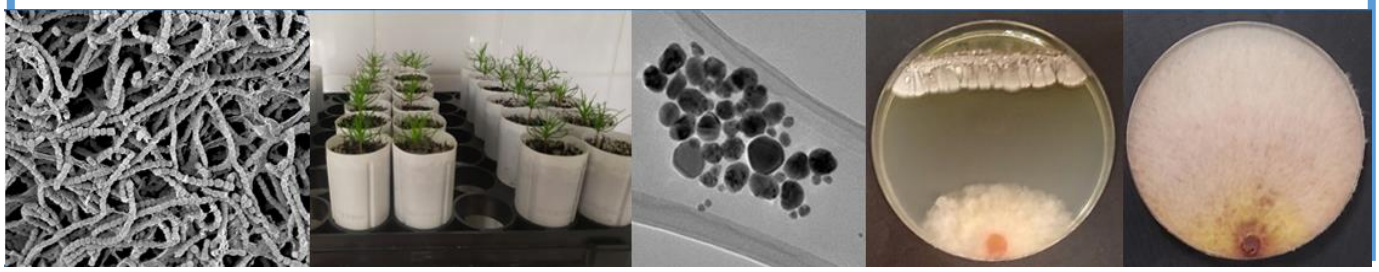
1. Prof. Mahendra Rai (Amravati University, India)

„Can we combat plant pathogens using nanotechnology as a potential tool?"

2. PhD Gabor Tarcali (University of Debrecen, Hungary)

„Biological control of *Cryphonectria parasitica* fungus - a good example of the effective use of hypovirulent fungal strains against plant pathogenic fungi”

3. Prof. W. Keith Moser (United States Department of Agriculture (USDA), USA)
„Application of wood wastes in the revitalization of post-agricultural soils"



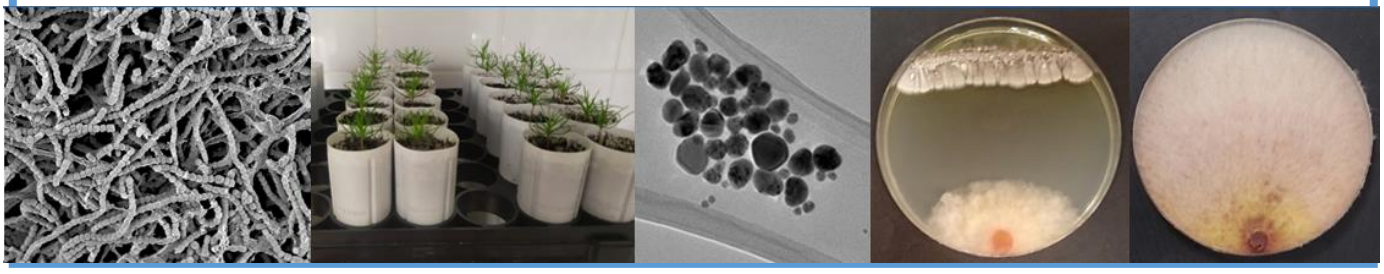
Session II

„Alternative and sustainable technologies for plant protection”

Agricultural production provides fundamental products for nutrition, and industry (food, feed, fiber and fuels). Apart from abiotic factors, pests and pathogens highly influence yield reduction. Plant diseases caused by different microorganisms (i.e. bacteria, fungi, insects, viruses) are responsible for agricultural crop and economic losses worldwide. These pathogens attack crops in the field, and during storage, transportation and commercialization phases. Traditional plant protection strategies are often insufficient. Consequently, huge financial resources are spent annually on pesticides to control plant pests and pathogens and secure quality and yield in plant production. However, an excessive and inappropriate application of chemical-based pesticides has negative effects on animals, humans, and other non-target organisms as well as the environment. The biological control is an eco-friendly and economically viable method that involves the use of living organisms for the management of plant pathogens and pest populations, has been considered among the most promising applications for sustainable agriculture. Novel eco-friendly strategies or technologies (e.g. nanotechnologies) for the management of plant diseases are developed. Nanotechnology can be an alternative to the current practices and provide new tools that allow to minimize production inputs and maximize agricultural production outputs. Both of these strategies meet the increasing need for global sustainability.

Research subjects includes:

- biocontrol of plant pathogens for sustainable plant production,
- microbial diversity and disease suppression,
- botanicals/ plant-based eco-friendly products as alternatives for plant disease control,
- integrated management of plant diseases,
- nanotechnology, including bionanotechnology for management of plant diseases,
- plant tissue culture as a tool for the sustainable production of disease-free plants.



Session II – presentations

Phytochemically characterized extracts from *Polygonum* species for the control of fruit phytopathogenic fungi

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Plant diseases caused by phytopathogenic fungi are responsible for economic losses arising mainly from crop yield reduction, but also resulting from diminished products quality and safety; sometimes they also represent a risk for human and animal health due to food contamination and the accumulation of toxic residues in the environment. Since regulations on the use of new and existing fungicides are becoming more and more stringent, it urges to identify and develop new chemical entities with fungicidal properties. Different naturally occurring compounds, semisynthetic derivatives, chitosan-based formulations and plant products including extracts or essential oils have been reported as part of this strategy. *Polygonum acuminatum* (Kunth) M.Gómez (Polygonaceae) is a perennial herb that grows in the central area of Argentina and it is commonly used by native populations to heal infected wounds and other ailments related to fungal infections. In this work, we explored the *in vitro* antifungal activity of its ethyl acetate extract, according to the CLSI guidelines, against a panel of five phytopathogenic fungi that greatly affect citrus, stone fruits and berries including: *Penicillium digitatum*, *P. italicum*, *Monilinia fructicola*, *Botrytis cinerea* and *Rhizopus stolonifer*. The sesquiterpenes isolated from the extract were also evaluated against these strains demonstrating that the dialdehyde polygodial was the responsible for this activity. In order to encourage the use of the extract rather than the pure compound, we displayed *ex vivo* assays using fresh oranges, peaches and strawberries inoculated with *P. digitatum*, *M. fructicola* and *B. cinerea* respectively, and subsequently treated by immersion with an extract solution of 250, 62.5 and 62.5 µg/mL concentration, respectively and according to the *in vitro* test results. For the *ex vivo* assay, 10 fruits each were superficially disinfected, inoculated with the appropriate pathogen, treated with the fungicides and incubated at the optimum conditions for each fungus. A set of 10 fruits each was used as positive control (treated with sterile water) and another set was used as negative control (treated with commercial fungicides). Then, the degree of sporulation (sporulation index) of *P. digitatum* (for oranges), *M. fructicola* (for peaches) and *B. cinerea* (for strawberries) on the surface of the decayed fruits was evaluated from a 0 to 4 scale, in which the value 0 was assigned to negligible sporulation and 4 referred to a dense fungal sporulation over the entire fruit. The index value for each fruit was treated as a biological replicate and the experimental data were analyzed statistically by a one-way ANOVA followed by Tukey's multiple comparison test ($\alpha = 0.05$) using the GraphPad Prism v.7.0 software. Results showed that both commercial fungicides and the plant extract significantly reduced the degree of fungal sporulation compared to the untreated control for the three fruit rots. The concentration of the active compound present in the extract used on fruit experiments was determined by GC-MS. Finally, cytotoxicity evaluation against Huh7 cells showed that *P. acuminata* extract was less cytotoxic than the commercial fungicides at the assayed concentrations.

Keywords: fruit pathogens, natural products, sesquiterpenes

Mycosynthesis and antifungal efficacy of copper nanoparticles against plant pathogenic fungi

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Plant pathogenic fungi cause a great loss of crop yield by setting various diseases in plants. Among the different biotic factors, fungi reported to contribute for about 40-60% in a variety of crop plants. Different agrochemicals are being used for the management of such fungi since a long time. Although the use of different agrochemicals helps to control plant diseases, its continuous and widespread applications mainly responsible for development of resistance in plant pathogens. Besides, such agrochemicals are harmful to the beneficial micro-flora of rhizosphere and other useful soil insects and are also able to cause risks to human beings by entering in food chain. Considering these major concerns, researchers have tried to develop novel and most effective antifungal molecules that do not stimulate resistance and are less expensive. In this context, copper nanoparticles (CuNPs) can be served as potential nano-based antifungal agents due to their broad-spectrum antifungal activity.

In the present study, CuNPs were synthesized using cell free extract of *Fusarium oxysporum* and copper nitrate as precursor salt. The fungus was found to have the ability for rapid synthesis of stable CuNPs. The UV-Visible spectrophotometer analysis showed the absorbance peak at 570 nm which is considered specific for CuNPs. The nanoparticles tracking and analysis (NTA) performed for the determination of size showed that the average size of CuNPs is 25 nm. Moreover, the transmission electron microscopy (TEM) analysis showed that thus synthesized CuNPs were polydispersed and spherical in shape having size in the range of 5-35 nm. Zeta potential analysis showed the synthesis of stable nanoparticles having a zeta potential of -23.2 mV. Further, the *in vitro* evaluation of antifungal activity of thus synthesized CuNPs showed that these nanoparticles were highly effective against different plant fungi such as *F. oxysporum* (ZOI= 16.33 mm) followed by *F. culmorum* (ZOI= 16 mm), *F. moniliforme* (ZOI= 13 mm), *Aspergillus niger* (ZOI= 13 mm) and showed less efficacy against *F. tricinctum* (ZOI= 12.66 mm).

The biological approach used in the present study was found to be very rapid, green and ecofriendly for the synthesis of novel CuNPs. Considering the significant antifungal efficacy, CuNPs can be used as next generation nano-based fungicides after extensive studies of toxicity to the environment and other beneficial organisms.

Keywords: copper nanoparticles, plant fungi, agriculture, antifungal activity, *Fusarium*, fungicide

Nanoencapsulation of plant extracts, essential oils and bioactive compounds for the control of plant diseases

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Products derived from the chemical industry have been widely used to control diseases and pests in agriculture in recent years, and their use has been questioned by society due to the adverse effects they can cause on plants, the environment and food contamination, soil, water as well as the poisoning of farmers. As an alternative, we have plant extracts and essential oils that could be used instead of chemical products, since such extracts/oils can present valuable antimicrobial properties for solving the problem, these properties of the plant extracts and essential oils are due to the groups of secondary metabolites, which are involved in plant survival and competition in the environment. The secondary metabolites of plants are chemical compounds that are not necessary for the immediate survival of the cell, serving as an evolutionary advantage for its survival and reproduction, and can also act as natural pesticides to defend against herbivores and act against pathogenic microorganisms. Some compounds are abundant in several plant species, such as phenolic compounds. However, such extracts are not very stable during their production, requiring technologies that can help in their non-degradation, therefore, nanotechnology emerges as a way of valuing these products. Nanoencapsulation consists of compartmentalizing substances in carriers, whose size is in the nanometer range, typically between 50 and 300 nm. In this context, nanotechnology can be used to stabilize different compounds, also increasing the stability of the products. Additionally, nanoencapsulation of antioxidant compounds can increase their antioxidant activity and prolong their release, thus increasing their effectiveness. This work aims to present nanoencapsulation techniques, nanoparticles coupled to plant extracts and their synergistic effects that have already been applied to extracts/oils and can be used in techniques for protecting and maintaining the health of these plants, minimizing negative environmental impacts caused by chemical products.

Keywords: nanotechnology, bioactive compounds, plant health, agriculture, nanoencapsuation

Application of wood wastes in the revitalization of post-agricultural soils

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The organic components applied in 2001 to the soil (in furrows in Bielsk Forest District or the whole area in Czarne Człuchowskie Forest District) accelerated the natural transformation processes of former agricultural soils into forest soils. We observed many positive changes in the physicochemical properties of soils and the content of nutrients in the assimilation apparatus of trees. Very significant changes occurred in microbiological properties, particularly the increase in diversity of bacterial and fungal species. The introduced organic matter provided spores (and mycelium) of many fungal species (*Trichoderma* spp., *Penicillium* spp.) antagonistic to needle- (e.g., *Lophodermium* spp.) and pine root (e.g., *Heterobasidion annosum*) pathogens. It also transferred essential mycorrhizal fungi (*Rusulla* spp, *Suillus* spp., *Rhizopogon*, *Amanita*, etc.), enhancing tree stand growth and stability. By releasing enzymes into the soil, they further restricted the development of potential pathogens. Assimilates (sugars) enabled treated trees to form symbiotic mycorrhizal associations. The treatments provided sites with better oxygen and moisture conditions for forest mycorrhizae (aerobes), particularly important for stable stand development. By improving conditions for mycorrhizal fungi, we observed significant quantitative and qualitative changes in the soil mycobiome. This outcome is important in drought conditions, as the area of formed mycorrhizal fungi increased several times. Mulching the soil with organic material accelerated the natural processes of organic layer formation, especially in poorer soils of the Bielsk Forest Inspectorate. Positive effects were similarly observed in the more fertile sites in the Czarne Człuchowskie Forest Inspectorate. Applying organic components on the soil surface restored the organic layer, improving carbon content and water retention. The observed positive changes in the soil's biological, physicochemical, and physical properties resulted in increasing height and diameter growth in the pines. The photosynthetic efficiency of the assimilation apparatus also improved, resulting in more photosynthetic products being delivered to the root systems of treated trees, resulting in an increase in the total length and area of fine roots (up to 2 mm) and mother roots (from 2 to 5 mm). The goal of accelerating the processes of conversion of former agricultural soils into forest soils was achieved.

Keywords: *Heterobasidion annosum*, microbiome, afforestation, *Pinus sylvestris*

Algal Species as Biocontrol Agents Against Plant Pathogens

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Plant pathogenic biocontrol agents include a variety of organisms used with different methods to control plant pests. Among all, algal strains and cyanobacteria have been most exploited showing promising results. Algal active agents as bioflavonoids, sulfated polysaccharides, carotenoids, polyphenols and proteins etc show antibacterial, antifungal, antiviral, nematocidal and insecticidal properties. Several studies have confirmed the use of algal extracts for plant pathogenic control as on tomatoes, soyabeans, carrots etc. As the idea of sustainable agriculture is gaining familiarity, the use of natural extracts from the diverse, rapidly growing and abundantly distributed algal group will result in environmentally friendly crop production. Researches are now focused to use algal potential to the full as biocontrol agents by probing best and economical techniques for algal growth, active compounds extraction and application. It is important to introduce this method to the local farmers and provide commercial legalization to algal extracts. Algae are suitable and sustainable candidates for biocontrol agents of plant pathogens as they can be mass cultured, are environmentally safe and show good results in the field.

Keywords: biocontrol agents, plant pathogens, Algae

Organic biomass ash and phosphogypsum for restoring nutrient cycling in forest soils

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The combustion of organic material produces ash, which contains, among others, many calcium and magnesium oxides and can be used to improve the acidity of soils, especially on excessively acid sites. Oak stands naturally acidify the soil in which they grow, which over time negatively affects the mycorrhizal components necessary for tree growth. Under acidic conditions, many macronutrients such as calcium (Ca), magnesium (Mg), and potassium (K) are not available in sufficient quantities and cannot be utilised until the soil pH reaches optimal conditions, which is about 5.5-6.5 for oaks. In addition, aluminium ions present in acidic soils (pH is currently around 3) become toxic to fine roots, leading to problems with uptake of sufficient water with mineral salts and exacerbating tree water management problems, especially during dry periods. In the most valuable oak stands in Poland, growing on the Krotoszyn plateau, a deficiency of phosphorus (P) has also been found, the lack of which favours damage to root systems by the pathogen Phytophthora. To prevent this, the waste produced in the manufacture of phosphoric acid, known as phosphogypsum, can be used. In suitable combination with ash, they can be a valuable substrate to stimulate the improvement of degraded forest soils, e.g. on post-compacted areas (industrial emissions, firewood) or in clearings (as compensation after the harvest of woody biomass).

Keywords: circular economy, biomass, wastes, microbiome, afforestation, *Pinus sylvestris*

Can we combat plant pathogens using nanotechnology as a potential tool?

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Plant pathogens are responsible for the huge loss of crops and vegetables. According to FAO every year, there is a loss of 40% crops due to the phytopathogens. Moreover, the world population is increasing with a fast rate and would be 9.6 billion by the end of 2050. The chemicals used as fungicides are causing harmful effects to the human and environment by mixing into the ecosystem as a result it may cause toxicity. In addition, the plant pathogens (fungi, bacteria, viruses, mycoplasma, phytoplasma, etc.) are developing the resistance to the chemical fungicides making them ineffective. Also, these chemical-based microbicides are sometimes beyond the reach of the marginal farmers. These hurdles have generated the pressing need of alternative technologies for the plant protection. Among these technologies, nanotechnology plays an important role in addressing the above-mentioned issues particularly the problem of resistance of pathogens to different fungicides. Nanotechnology includes the nanomaterials in the size range of 1-100 nm. The nanomaterials particularly nanoparticles of metals such as silver, gold, copper, zinc, silica, titanium, and biodegradable organic nanoparticles including ß-D glucan, chitosan, etc. can be used. There are ample of opportunities to use nanotechnology for early detection, fungicide delivery and protection/inhibition from the pathogen. However, there are some bottlenecks concerning the toxicity of the nanoparticles which depends on the shape, size, surface charge, concentration, agglomeration, etc. and can be optimized for eco-friendly and sustainable agriculture. My talk will address the aforementioned issues particularly the application of nanomaterials in coping with plant pathogens.

Keywords: nanotechnology, control, pathogens, alternative technology, biodegradable, sustainable technology

Biological control of *Cryphonectria parasitica* fungus - a good example of the effective use of hypovirulent fungal strains against plant pathogenic fungi

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Cryphonectria parasitica (Murrill) Barr (chestnut blight disease) is one of the most important pathogens for *Castanea* species. The pathogen originates from Eastern Asia. Probably, it was introduced into North-America from either China or Japan at the end of the XIX-th century, and it spread throughout the main chestnut areas of the world over the next five decades. C. parasitica was first identified in the USA in 1904, on American chestnut (*Castanea dentata*), and the infection of the fungus caused the almost complete destruction of the species. Later, the fungus was introduced to Europe. In 1938, the pathogen was first discovered on European chestnut (*Castanea sativa*) in Europe near Genoa, Italy. Then the fungus spread rapidly in the continent. By the end of the XX-th century, almost all chestnut growing areas of Europe were affected by the pathogen, including Central-Europe. Control of the disease is very difficult. There are some solutions: agrotechnical and mechanical controls, resistant hybrids (*Castanea sativa* x *C. crenata*), chemical control, but they are not capable of effective protection. Biological control is possible by antagonistic fungi (*Trichoderma* spp.) and hypovirulent strains. The basis of biological control is the use of hypovirulent fungal strains. It is a fungus with reduced virulence caused by a mycovirus encoded in the RNA of their cytoplasm. This RNA is transmitted by hyphanastomosis, but only if the virulent and hypovirulent fungi belong to the same Vegetative Compatibility Group (VCG). The presence of mycoviruses is very common in fungi and affects almost all major genera of fungi. The discovery of mycoviruses and their subsequent studies opened up a whole new field of experimental mycology. These mycoviruses have often been used in biological plant protection as an effective control against their host fungus. In 1959, a “transmissible disease” was discovered which was caused by the ds RNA in the cytoplasm of the mycelium of *Helminthosporium victoriae* fungus. This virus-like particle (VLP) causes significant changes in the virulence of the fungus, and *in vitro*, abnormal morphological fungal bodies were produced. Then, it was recognized in several other plant pathogenic fungi, so it is not a unique phenomenon. The recognition of the characteristics of these nonencapsidated mycoviruses containing dsRNA resulted in the creation of the *Hypoviridae* family, and Cryphonectria hypovirus (CHV) is one of this mycovirus group. In 1964, abnormal morphological fungi were isolated from the cankers caused by *C. parasitica* on European chestnut. It was a reduced sporulated, less pigmented white strain. Its infection capacity was significantly lower than the infection capacity of the other fungal strains. It was named hypovirulence. Hypovirulent strains of *C. parasitica* have spread all over the Southern-European region. Once the pathogen has appeared in an area, its hypovirulent strains will also appear naturally. However, that will happen only after a long time. A great example is Switzerland, where *C. parasitica* was noticed first in 1948, but its hypovirulent strains were found only 27 years later, in 1975. The artificial spreading of hypovirulent fungal strains of *Cryphonectria parasitica* can be used for biological control. This biology method is the only effective control method against the pathogen of chestnut blight disease. In Hungary, we have been researching the topic for several decades with the research group of the Plant Protection Institute, University of Debrecen. We assessed the prevalence of the disease in the country and identified its prevalent VCGs. We have developed and established the possibility of biological control using hypovirulent fungal strains of *C. parasitica*. This method was applied on many occasions on European chestnut (*Castanea sativa*) trees in Hungary and in Slovakia as a successful biological control against the pathogen.

Keywords: *Cryphonectria parasitica*, chestnut, mycovirus, hipovirulent strain, biological control

Session II - posters

Fungicidal activity of extracts obtained from *Solanum* species against the postharvest citrus pathogens *Geotrichum citri-aurantii* and *Penicillium digitatum*

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Citrus spp. are the most widely produced fruits for human consumption and they are cultivated in over one hundred countries. Postharvest handling practices in citrus packing houses try to obtain fruits with maximum quality, increasing their postharvest life and reducing losses, particularly those from phypathological origin. *Geotrichum citri-aurantii*, the cause of sour rot; and *Penicillium digitatum,* the cause of green mold, are two of the most economically important postharvest diseases of citrus in all production areas. Considering the concerns of consumers about the inadequate use of fungicides as well as its impact on the environment and public health, this study aims to provide information on alternatives such as the use of extracts obtained from *Solanum* species for the control of postharvest diseases of citrus. The genus *Solanum* comprises around 1500 species and 158 of them, are present in Argentina. For this study, four of them (*Solanum argentinum* Bitter & Lillo, *S. granulosum-leprosum* Dunal, *S. pilcomayense* Morong and *S. caavurana* Vell., all native species reported as antibacterial or antifungal in traditional medicine systems) were evaluated *in vitro* as fungicides against *G. citri-aurantii* and *P. digitatum*. Fresh material from each species was collected and a *specimen* was herborized and deposited in “Arturo E. Ragonese” (SF) Herbarium. The plant material was successively dried and extracted (24 h x 3 at RT and constant stirring) using dichloromethane (DCM) and methanol (MeOH). The extractive solutions were concentrated under reduced pressure, in order to obtain the corresponding extracts that were evaluated for their fungicidal capacity by PDA diffusion method, at a concentration of 500 ppm and using Petri dishes with four repetitions. After 7 days, the averages of the percentages of fungal growth inhibition were determined, using a commercial product based on imazalil as a negative control and DMSO as a positive one. The growth inhibition percentages for *G. citri-aurantii* were: 63,84±0,87% and 73,31±11,92%; 41,33±12,94% and 61,43±7,44%; 71,17±1,89% and 100±0% and 79,80±4,53% and 100±0% for DCM and MeOH extracts of *S. argentinum*, *S. granulosum-leprosum*, *S. pilcomayense* and *S. caavurana*, respectively. For *P. digitatum*, the percentages of growth inhibition were: 45,17±9,63% and 62,25±12,19%; 54,67±6,00% and 49,49±4,55%; 46,38±13,59% and 100±0,00% and 59,98±7,74% and 94,55±1,45% for DCM and MeOH extracts of *S. argentinum*, *S. granulosum-leprosum*, *S. pilcomayense* and *S. caavurana*, respectively. Most of the extracts exceeded 45% of fungal growth inhibition, but MeOH extracts of *S. pilcomayense* and *S. caavurana* showed the highest activity, displaying 100% of inhibition against both fungal strains. Results presented in this study show the potential of alternative methods for the control of post-harvest diseases of citrus.

Keywords: citrus; postharvest; phytopathogenic fungi; *Solanum*; extracts.

A study on the impact of soil moisture on microbiological diversity and their enzyme activity in agricultural soil

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Changes in the water content of the soil alters the microbiological and biochemical activities in the soil. In addition appropriate water content helps in regulating the catalytically active soil enzymes. Soil moisture being an unstable component in the ecosystem its relation between soil microbial community and biochemical activities is complex. However, changes in soil moisture caused due to climate change or human factors can have significant impact on soil microbiological diversity resulting in loss or decrease in soil fertility leading to reduction in crop or plant productivity or yield. Hence, posing an important effect on plant production/productivity.

In this study, the microbiological parameters and soil enzyme activities on agricultural soil were investigated.

Significant changes on number of microbial groups and impact of moisture on soil enzyme activity were observed. Changes in moisture content of the soil leads to alteration on structural diversity of main group soil microorganism's number as well as their enzyme activities and also physiological status of plants, thereby changing the biological activity of the soil. Perhaps, such changes may lead to lower plant productivity.

Keywords: moisture, microbial community, enzyme activity, plant productivity

Study on effectivieness of biological and chemical preparations in inhibiting the growth of *Lecanicillium fungicola* – the causative agent of dry bubble of white button mushrooms

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The dry bubble disease, caused by *Lecanicillium fungicola*, is the most common fungal disease of white button mushroom (Agaricus bisporus). The aim of this study was to estimate the effectiveness of two chemical agents based on periacetic acid and biopreparations Effective Microorganisms (EM) in inhibiting the growth of *L. fungicola* isolated from infected fruiting bodies of button mushrooms. Analyses were performed under in vitro conditions on the PDA medium (Potato Dextrose Agar) to which preparations at proper concentrations were added and then the fungi inoculum was inoculated. The pathogen sensitivity was determined based on the degree of inhibition of the mycelium growth on 5 and 10 day of incubation. A pot experiment was also established where the efficacy of Lerasept Spezial in eliminating *L. fugicola* in inoculated casing soil was tested. In a plate experiment Agrosteril disinfectant caused the complete inhibition of pathogen development at each tested concentration (1, 1.5, 2, 2.5, 3, 3.5%). In the case Lerasept the lack of mycelium growth was obtained only after the application of the highest dose of 1%. Biopreparation EM-5 and its combination with EM-NA in a dose of 100mg/cm3 of the medium turned out to be the most effective of EM preparations in inhibiting the development of *L. fungicola*. Those preparations also caused a significant decrease in sporulation of the pathogen. Chemical preparations applied in the form of sprinkling to the casing infected with the fungi turned out to be less effective. The highest decrease in the pathogen number was obtained on 7th day from inoculation of the casing. Based on the pot experiment it was found that chemical preparations used for disinfecting the casing, applied in doses recommended by the producer, caused only a partial inactivation of *L. fungicola*.

Keywords: *Lecanicillium fungicola*, chemical preparations, effective microorganisms (EM), dry bubble, white button mushroom

Enabling sustainable and smart agriculture with green nanoparticles

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The astounding advancement in the field of nanotechnology in the last decades has led to the synthesis of a wide range of nano-sized materials with unique features. In general, these nanomaterials are considered "synthetic" and regarded as potentially unsafe by consumers. Although in fact the technological sophistication behind many of these syntheses was developed by mimicking nature and its ability to create “nano” materials or materials with a hierarchical architecture in the nano scale. The development of environmentally friendly new procedures for the synthesis of metallic nanoparticles is one of the main goals of nanotechnology. Proteins and enzymes from plants, filamentous fungi, yeast, and bacteria to produce nanoparticles are both valuable and viable alternatives to conventional synthesis of nanomaterials due to their high efficiency and the low cost to scale up and generate large quantities. The aim of this talk is to offer a series of results comparing biogenic nanoparticles obtained using cell free filtrates from fungi and plants to conventional chemical nanoparticles in their potential use for crop protection against bacterial pathogens, as fertilizers and in seed pre-treatments. We observed that the effect of using nanoparticles not only contributes to improving plant nutrition *per se*, but also synergizes the efficiency of macronutrient absorption. Our results also suggest that biogenic nanoparticles display less toxicity than chemical nanoparticles in the model organism *Caenorhabditis elegans*. We employed biochemical and proteomic techniques to profile the unique surface chemistry of the capping in biogenic nanoparticles and results not only suggest that the proteins involved in the synthesis of the nanoparticles and corona formation are responsible for keeping the metallic core preserved making them more stable in time, but also masking and protecting eukaryotic cells from metal toxicity.

Keywords: crop science, nanotechnology, green nanoparticles, pathogen control, nutrition, seed treatment.

Bacillus amyloliquefaciens VFS2 bored spectrum of metabolites under salt and drought stress with key role in *Vicia faba* root-rot suppression caused by *Fusarium equiseti*

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Fungal infection combined with abiotic stress becomes a serious constraint limiting *Vicia faba* production and the use of a biological solution remains a challenge. The aim of this study is to investigate the stability of the antifungal activity and compounds involved in the inhibitory activity in *Bacillus amyloliquefaciens* strain VFS2 against *Fusarium equiseti* infecting *V. faba* under salt and drought stress. Strain VFS2 showed a high antifungal activity against different phytopathogenic fungi including the genera *Fusarium*, *Alternaria*, *Boeremia*, *Rhizopus* and *Rutstroemia* under different concentrations of NaCl (up to 200 mM) and PEG6000 (up to 20 %). The percentage of *F. equiseti* growth inhibition (IH%) by strain VFS2 was up to 98 % at high concentrations of NaCl and PEG6000. Furthermore, the HPLC profiles of cyclic lipopeptides (cLPs) produced by strain VFS2 grown in PM medium amended different concentrations of NaCl and PEG6000 showed high production of Iturins, Fengycins and Surfactins. Cluster analyses of the heatmaps for the produced cLPs showed that the isoforms were satisfactory segregated into groups according to their corresponding production profiles under different concentrations of NaCl and PEG6000. Moreover, the amount of the phytohormone IAA produced by strain VFS2 was significantly increased ($p < 0.05$) under stress conditions (0.1 µg / ml vs 0.7 µg / ml under drought stress and 0.9 µg / ml under salt stress). Also, it has shown an enhanced siderophores production in CAS medium under abiotic stresses by 50% in comparison to the control. Biocontrol assay showed that *B. amyloliquefaciens* VFS2 was able to reduce root-rot in *V. faba* plants caused by *F. equiseti* under three systems (unstressed soil, saline soil with 1.8 ≃1.9 ms /m and 50% water holding capacity in soil). Results highlighted the effectiveness of the *B. amyloliquefaciens* VFS2 as a potential agent which could be a great protector of plant against fungal diseases under stressful conditions of high salinity and drought.

Keywords: antifungal activity, cyclic lipopeptides, IAA, siderophores, abiotic stress, biocontrol.

Inhibition of *Botrytis cinerea* by lactic acid bacteria on lettuce and spinach

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Grey mould caused by *Botrytis cinerea* is one of the most important diseases of vegetables. To develop a microbial pesticide that is safe and acceptable by consumers, strains of lactic acid bacteria (LAB) for biocontrol potential of *B. cinerea* were screened. The bacteria were isolated from fermented cabbage and cucumber. Three of above 100 isolates were chosen as the most active to inhibit the growth of *B. cinerea* in antagonistic test on potato dextrose agar medium.

A method has been developed to coat cut off spinach and lettuce leaves with LAB isolates. The inoculum remained high for 8 days, and ranged about 10^5 and 10^6 cfu per 1g of leaves for spinach and lettuce, respectively. Then, the microbiological contamination of leaves sprayed with these lactic acid bacteria was studied. It occurred that treated leaves were less contaminated by mould fungi compared to untreated control.

To examine activity of LAB in reduction of *B. cinerea* on lettuce, the leaves were coated with these bacteria, placed in jars, and then inoculated with *B. cinerea*. Three isolates of *B. cinerea* obtained from carrot, cyclamen and tomato were used for inoculation. The jars were placed in a growth chamber at 10°C. Leaf infection was evaluated 6, 10 and 15 days after inoculation. The inhibitory effect of three LAB isolates against grey mould development on lettuce leaves was found for one isolate of *B. cinerea,* obtained from tomato. Isolates from carrot and cyclamen were not inhibited by LAB isolates. The results were confirmed in glasshouse experiments on lettuce plants. The infection of lettuce by *B. cinerea* isolate from tomato was significantly inhibited on plants coated by applied LAB isolates. This effect was particularly evident up to 5 days after plant infection. Similar experiments were conducted for spinach plants. The plants during growing were sprayed by LAB isolates and then inoculated by *B. cinerea*. In the experiment, no infection of plants with *B. cinerea* was obtained in any of the treatments. However, a significant effect of LAB on spinach growth was found. The fresh weight of plants treated with these bacteria was 20-40% higher compared to control. The increase depended on the bacteria isolate tested.

In conclusion, by conducting experiments on cut off leaves and whole plants of lettuce and spinach, it was found that the three tested LAB isolates showed an inhibitory effect on the development of grey mould caused by one of three *B. cinerea* strains and significantly increased the weight of spinach plants.

Keywords: LAB, leafy greens, grey mould, biocontrol

Funding:
This work was financed by Polish Ministry of Education and Science, task ZM/2/2018 (2018 -2021): “Development methods limiting the occurrence of microbiological contamination of ready-to-eat vegetables and fruit”.

Efficacy of Silver nanoparticles on *Erwinia amylovora* causing apple fire blight

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Erwinia amylovora is a causative agent of apple fire blight. This secretes amylovoran, an exopolysaccharide that obstructs the vascular system of the tree. The problem associated to antimicrobial resistance has generated the search for new methods to control pathogenic microorganisms. Metallic nanoparticles (NPs) are an option for the control of phytopathogenic fungi and bacteria. In this study, the cell viability of *E. amylovora (*5 x 10^7 CFU / ml) was evaluated by being subjected to an *in vitro* test to three antimicrobial agents, silver nanoparticles (AgNPs 200 ppm), $CuSO_4.5\ H_2O$ (COMET ® 200 ppm) and Gentamicin + oxydotetracillin (Agrygent plus 5000 ® 200 ppm). The experiment consisted of the confrontation in liquid medium (peptone water 1.8%) with the mentioned treatments, which were maintained at 100 rpm for 24 hours at 25 °C. The effectiveness of AgNPs to inhibit biofilm formation was evaluated by the crystal violet method and measured by spectrophotometry at 600 O.D. Cell viability was determined by the trypan blue exclusion method by spectrophotometry 600 O.D. AgNPs at 200 ppm show an inhibitory effect for *E. amylovora*, reducing cell viability by 64.8%. The smallest Area Under Curve accumulated was limited by the treatment with AgNPs. Biofilm formation of *E. amylovora* was inhibited in samples treated with AgNPs by 96.06%.

Keywords: metallic nanoparticles, cell viability, biofilm, quarantined phytopathogenic bacteria, apple fire blight

Improving pecan production by zinc in drip irrigation in calcareous soils

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The pecan tree [*Carya illinoinensis* (Wangenh.) K. Koch.] is the most important deciduous fruit tree in Mexico, with 144,567 ha planted; 88,834 ha are established in Chihuahua state. Foliar fertilization by sprying is a commonly used technology in pecan tres. This management pollutes the environment, it is laborious due to the use of supplies and equipment, and because it requires to be applied at night. Most of the pecan trees in northern Mexico and the southern United States are established in calcareous soils, where the alkaline pH strongly reduces the availability of zinc for the tree, besides the inefficiency of the root to uptake the nutrient. The aim of this study was to evaluate the production of pecan trees with edaphic fertilization of chelated zinc with carboxylic acids, besides the addition of the ectomycorrhizal fungus *Pisolithus tinctorius* and a microbial consortium through drip irrigation in a three-year study. Conventional foliar application was the control treatment. Fertigation was effective by providing nutrients in a very localized area of the root. Edaphic contribution of chelated Zn with carboxylic acids was effective in pecan trees in production. The new sustainable technology proposed here, allowed to obtain an additional kilogram of nut per tree. The ecological advantages of the application of this technology is the reduction of tillage, reduction of environmental pollution by avoiding night spraying and the non-compaction of the soil, and the promotion of ectomycorrhization. This management in pecan orchards offers producers an ecological and sustainable option that allows them to improve yield.

Keywords: *Carya illinoinensis,* chelated zinc, pecan nuts, *Pisolithus tinctorius*

Fusarium verticillioides and fumonisin of maize plants: optimizing propitious rhizosphere-associated microorganisms as biocontrol agents

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Diverse disease outbreaks have been recorded in the past due to exposure to *Fusarium verticillioides* and fumonisin, a mycotoxin produced by this fungus. *F. verticillioides* which is a fungal pathogen of maize causes infections such as wilting and rotting in this plant, while contact with its fumonisin derivative manifest in form of mild to severe illnesses in animals. Maize infection by *F. verticillioides* causes loss or reduction in expected crop yield, thereby influencing households and nations' economy. While several mechanical, physical and chemical approaches have been used to eliminate the pathogenic fungus, it remains a challenge in agriculture, particularly in maize. To prevent and control this toxicogenic fungus and its derivative, this study appraised the use of rhizospheric biocontrol agents, such as *Bacillus* spp.*, Pseudomonas, Enterobacter* and *Microbacterium oleivorans,* which are mainly reported to be found in maize rhizosphere. These are not only effective in controlling the occurrence of the aforementioned pathogen in maize but are environmentally safe and can promote crop yield for a sustainable ecosystem.

Keywords: biocontrol agents, environmental pollution, *Fusarium*, maize rhizosphere, mycotoxin

Synergistic Growth promotion Activity of Silver Nanoparticles with Endophytic *Nigrospora oryzae* on *Cajanus cajan*

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We report the extracellular biosynthesis of silver nanoparticles (AgNPs) by endophytic fungi *Nigrospora oryzae* isolated from leaf of *Syzygium cumini* collected from Melghat forest, India. The preliminary detection of AgNPs was made by colour change from colourless to dark-yellow to brown and confirmed by UV-vis spectrophotometer where specific peaks at 417. Silver nanoparticles were characterized by Fourier transform infrared spectroscopy and Transmission electron microscopy, which confirmed formation of spherical and polydispersed AgNPs within size range of 5-50 nm and capped with proteins. After inoculation of S. nanoparticles and endophytic *N. oryzae* to the host plant *Cajanus cajan*, the vitality of plant was determined using Handy pea analyser. Handy pea analysis (which measures the chlorophyll a fluorescence) indicated that seedlings inoculated with combination of S. nanoparticles and endophytic *N. oryzae* were the healthiest seedlings and also showed maximum vitality (Height, weight of stem) as compared to seedlings inoculated with S. nanoparticles alone. From the above result it can be concluded that nanoparticles in combination with endophytic *N. oryzae* serve as a bio-fertilizer and bio-protectant. It can also be summarized that the endophytic fungi acted as catalyst for S. nanoparticles in plant growth promotion.

Keywords: bio-protectant, endophyte, *Nigrospora oryzae*, handy PEA, silver nanoparticles

Ectomycorrization in pecan trees in northern Mexico

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Several studies indicate that ectomycorrhizal fungi provide multiple benefits to the host plant. Pecan tree [*Carya illinoinensis* (Wangenh.) *K. Koch*.] is a crop of global economic importance. However, colonization by these fungi can be influenced by various abiotic factors. The aim of this research was to determine the percentage of ectomycorrhization in orchards with different agronomic management and tree age. Western Schley pecan variety of different ages were selected and grouped according to their type of agronomic management. Feeding roots and rhizospheric soil samples were taken from each orchard, to determine the percentage of ectomycorrhization, phosphorus, organic matter content and pH. Ectomycorrhizal colonization was analyzed by the Mann-Whitney non-parametric test with correction for ties at 95% confidence. The percentage of ectomycorrhization ranged from 31.44 to 59.89%. No significant difference was detected in ectomycorrhizal colonization with the different types of agronomic management. However, it was observed that ectomycorrhization is negatively related in orchards where the rhizospheric soil has a phosphorus concentration greater than 30ppm and its organic matter content is greater than 1%. The future step of this research is the confrontation of pecan trees with ectomycorrhized roots, with the plant pathogenic fugus *Phymatotrichopsis omnivora*.

Keywords: *Carya illinoinensis,* ectomycorrhizal fungi, agronomic management, phosphorus

Biogenic synthesis of zinc based nanoparticles using *Aspergillus niger* and their efficacy in plant growth promotion

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We have reported an approach for green synthesis of Zinc oxide Nanoparticles (ZnONPs) from *Aspergillus niger* and its efficacy in seed germination, **in vitro** and **in vivo** plant growth promotion was studied on *Zea mays* at different concentrations. ZnONPs at 20 ppm showed improved seed germination (100%) and growth. The effect of ZnONPs was analyzed by measurement of plants height and chlorophyll **a** fluorescence using plant efficiency analyzer. The seedlings grown in MS medium supplemented with ZnONPs showed significant increase in shoot height and root length. Similarly, for *in vivo* studies, the enhanced shoot height and root length was recorded as compared to plants treated with their bulk counterpart. However, 20 ppm bulk Zn showed comparatively lower shoot height and root length. The chlorophyll **a** fluorescence measurements revealed that plants treated with ZnONPs showed maximum performance index and minimum dissipation as compared to control and plants treated with bulk Zn. In addition, atomic absorption spectrophotometric analysis performed for both **in vitro** and **in vivo** grown plants, revealed that leaves and roots of the plants treated with ZnONPs demonstrated higher Zn contents. Therefore, ZnONPs can be potentially used for enhancement of seed germination and seedling growth promotion.

Keywords: bio-fertilizer, *Aspergillus niger*, handy PEA, zinc oxide nanoparticles, plant growth promoter

Green silver nanoparticles for soybean seed treatment against bacterial pathogens

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Nanotechnology research oriented to agriculture is in its early stages worldwide. However, it is believed that the implementation of nanotechnology could transform current agricultural practices and address a broad range of challenges, including crop disease management. Green nanotechnology uses biological sources such as plant or microbial extracts for the synthesis of nanoparticles (NPs), avoiding the use of high concentrations of toxic chemical compounds as reagents. In this work, the potential of silver nanoparticles (AgNPs) synthesized from a cell-free filtrate of the fungus *Macrophomina phaseolina* to inhibit the growth of the bacterial pathogen *Pseudomonas syringae* was analyzed. The results obtained show that AgNPs inhibit the growth of *P. syringae* in different media. Starting from a dose of 25 µg/ml, the metabolic activity of the pathogen was reduced in a 25%, while with a dose of 50 µg/ml the reduction observed was of a 60%. Pre-treatment of soybeans seeds with the AgNPs had no negative effect, on the contrary treating the seeds with a dose of 100 µg/ml promoted germination by 14% versus the control from the first day. Finally, in the presence of the pathogen, the protection of the seeds was evidenced with all the doses of AgNPs tested, with an optimal dose of 200 µg/ml. These results suggest that the AgNPs tested not only have the ability to control *P. syringae* infection but also to induce germination of soybean seeds.

Keywords: nanotechnology, pathogen control, seed treatment, *Pseudomonas syringae*

In vitro phytopathogenic fungal inhibition assays and composition of the essential oils obtained from *Conyza* species belonging to the Argentine flora

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The genus *Conyza* belonging to the Asteraceae family is native to South America and it is widely distributed around the world. In Argentina, species of this genus are known to be important weeds but also they are used in traditional medicine by infusions as febrifuge, anthelmintic and insecticide, among others. Despite the extensive number of medicinal properties attributed, its use has not been proven against phytopathogens that affect fruits of worldwide importance. In this work, the essential oils (EO) obtained from *Conyza bonariensis* var. *angustifolia*, Conyza *bonariensis* var. *bonariensis* and *Conyza sumatrensis* were evaluated against five destructive phytopathogenic fungi: *Botrytis cinerea*, *Colletotrichum acutatum*, *Fusarium semitectum, Monilinia fructicola* and *Rhizopus stolonifer*.

The essential oil was extracted from leaves (100 g) of each species and variety, using a Clevenger-type distiller. The obtained products were evaluated using the agar diffusion method adapted for volatile samples: Petri dishes of 6 cm diameter were covered with 10 mL of PDA media; once solidified, a conidia suspension of 10^4 Colony Forming Units/mL was inoculated inside a well located in the center. Once the water from the inoculated conidia solution evaporated, 15 µL of each EO (treatment) or sterile water (control) was deposited on the center of the Petri dishes top. This quantity of EO applied represented a concentration of 1000 ppm. The Petri dishes prepared in this way were incubated upside down so that the EO, once evaporated, came in contact with the culture medium where the fungal strains were growing. Once the mycelium of the control plates completely covered the surface of the media (approximately 7 days), the measurements of the mycelium diameter developed in each plate previously treated with EO were carried out by scanning the plates for later analysis with ImageJ® software. Assays were performed by triplicate, and the percentage of fungal growth inhibition was calculated according to the following equation: I % =100(C-M)/C, where I% represents the inhibition percentage, C the average of the three control plates mycelia area and M the average of the three treated plates mycelia area. ANOVA was performed and statistical differences were analyzed by Tukey test. Results showed that the highest content of EO (0.12%) was obtained for *C*. *sumatrensis* followed by *C*. *bonariensis* var. *bonariensis* (0.09%) and *C*. *bonariensis* var. *angustifolia* (0.07%). Regarding fungicidal activities, *C*. *bonariensis* var. *bonariensis* EO showed the highest fungal inhibition against *M*. *fructicola* (93%) and *R*. *stolonifer* (89%). Furthermore, it was moderately active against *B*. *cinerea* and *F*. *semitectum* displaying 55% and 57% of growth inhibition, but resulted almost inactive for *C*. *acutatum* (21% of inhibition). *C*. *sumatrensis* EO showed high antifungal specificity against *M*. *fructicola* (90% of inhibition), being inactive against the rest of the fungi panel; while *C*. *bonariensis* var. *angustifolia* EO did not inhibit any evaluated phytopathogen by statistical comparison with the control growth. In addition, the chemical profile of each EO was analyzed by GC-MS and the major compounds were determined; in all the samples, (E)-*β*-Farnesene, Caryophyllene, (-) Germacrene-D, D-Limonene, Lachnophyllum ester, *α*-Cadinol and *β*-Ocimene were found.

Keywords: *Conyza*, essential oils, fruits, *Monilinia*, *Rhizopus*

Novel species of *Actinobacteria* as a potential biocontrol agents against fungal phytopathogens

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Two isolates, strains SL13 and SL54^T, derived from pine forest soil near Torun, Poland, were studied using polyphasic approach to determine their taxonomic status. The antimicrobial potential of these isolates was also evaluated. Isolates SL13 and SL54^T formed a well supported clade within the *Streptomyces* 16S rRNA gene tree and were most closely related to strain of *S. yeochonensis* DSM 41868^T but were distinguished from it using combinations of phenotypic properties. The digital DNA-DNA hybridization (dDDH) and average nucleotide identity (ANI) values between the isolates and its closest related phylogenetic neighbours, were low below cut off points indicating that the isolates belong to different genomic species. Analysis of biosynthetic gene clusters (BGCs) in the genomes of isolates SL13 and SL54^T showed presence of 96 and 91 gene clusters, respectively, related to natural product synthesis. The isolates showed high activity against important fungal phytopathogens *Rhizoctonia solani* (Kühn)*, Fusarium oxysporum* (Schlechtendal ex Fr.)*, Fusarium culmorum* (Smith W.G.)*,* which cause large losses in agriculture and forestry*.* Therefore, the isolates can be considered as a biocontrol agent against fungal pathogens in agriculture and/or forestry practices.

Keywords: Actinobacteria, *Streptomyces*, fungal pathogenes, biocontrol agents

Biogenic silver nanoparticles as a tool to combat bacterial and fungal plant pathogens

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Crop pathogens reduce the yield and quality of agricultural production. Microbial disease leading to serve yield loss in the number of crop plants. Therefore, to overcome these problems there is an urgent need to develop an eco-friendly, and sustainable approach for the effective management of plant pathogens to avoid the crop yield losses. Biosynthesized silver nanoparticles could become an alternative strategy for traditional agrochemicals.

The study included myco-synthesis of silver nanoparticles (AgNPs) and evaluation their antimicrobial activity against common fungal and bacterial plant pathogens. Bio AgNPs were characterized by using UV-Vis spectroscopy, Transmission Electron Microscopy (TEM) and Fourier Transform Infrared Spectroscopy (FTIR). Antibacterial activity of biogenic AgNPs was evaluated by determination of minimum inhibitory and minimum biocidal concentrations (MICs and MBCs) against *Pectobacterium carotovorum, Xanthomonas campertris, Agrobacterium tumefaciens* and *Pseudomonas syringae*. Disc diffusion and well diffusion methods were used to determine antifungal activity of AgNPs (concentration 3 mg ml $^{-1}$).

Six fungal strains were selected for effective synthesis of AgNPs, namely *Fusarium culmorum, F. oxysporum, F. tricinctum, F. solani, Phoma lingam, Trichoderma sp.* and *Colletrotrichum acutatum*. Bionanoparticles showed a peak with a maximum absorbance at wavelength in range 420 - 435 nm which is specified for AgNPs. TEM analysis proved that the AgNPs average size ranged from 9 to 25 nm. FTIR analysis confirmed the occurrence of proteins on the surface of AgNPs. Myco-synthesized silver nanoparticles exhibited antibacterial activity (MIC of 2 – 256 µg ml $^{-1}$, MBC of 32–1024 µg ml $^{-1}$). The inhibition zones of fungal growth were in range of 1 - 15 mm. AgNPs showed the highest antifungal activity against *Botritis cinerea, Sclerotina sclerotiorum, Phoma lingam* and *Rhizoctonia solani* 476.

The fungal extracts were found to have potential for the biological synthesis of silver nanoparticles through a non-toxic, economical and environmentally friendly method. Silver bionanoparticles in view of their unique properties, have potential as a promising agent to eliminate or reduce bacterial and fungal plant pathogens.

Keywords: biosynthesis; silver nanoparticles; antimicrobial activity; plant pathogenes

Session III

„Plant lipids engineering for sustainable future”

Session Chair: PhD Agnieszka Zienkiewicz, Prof. Assoc. at NCU

Session Organizer: PhD Edyta Deja-Sikora

Guest Speakers

1. Prof. Patrick Horn (East Carolina University, USA)

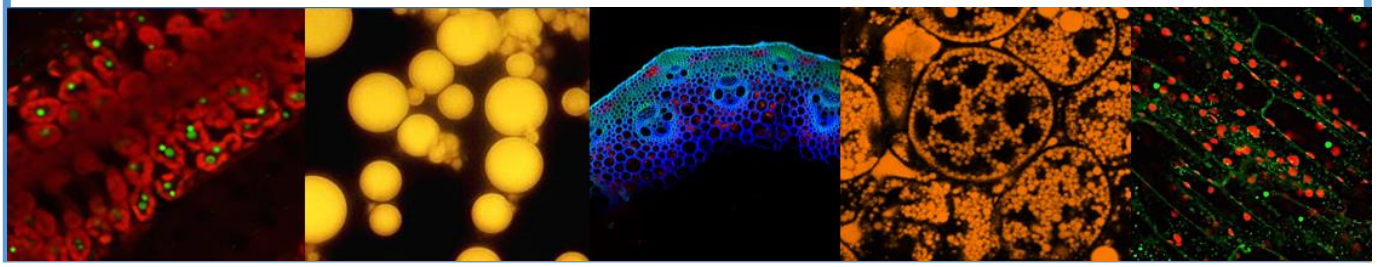
„Big Data Overload: Deriving Structure-Function Insights within Plant Lipid Metabolism through Analyses of Diverse Plant Genomes"

2. PhD Magdalena Miklaszewska (University of Gdańsk, Poland)

„The key enzymes in metabolic engineering for production of wax esters in plants"

3. PhD José Manuel Martínez Rivas (Instituto de la Grasa (CSIC), Spain)

„Differential contribution of *DGAT* and *PDAT* genes to triacylglycerol biosynthesis in olive fruit"



Session III

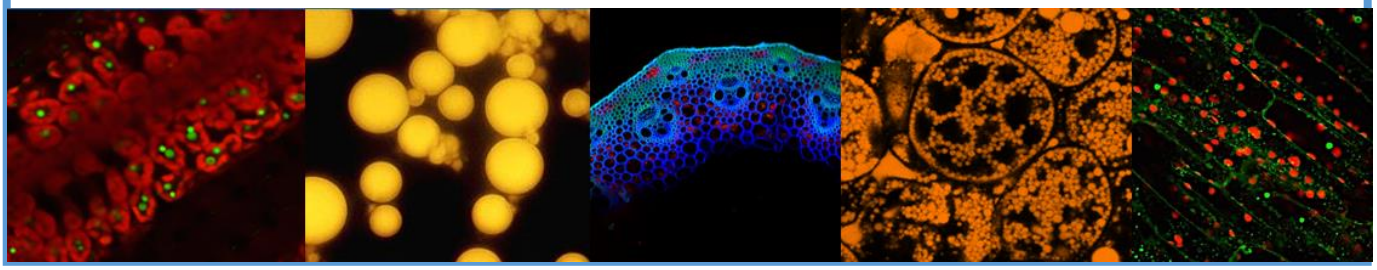
„Plant lipids engineering for sustainable future”

The current global trend oriented towards production and use of sustainable lipid-based products is the result of many diverse factors acting directly on economies in both, developing as well as developed countries. Of these, the most important are: 1) rapidly growing human population, 2) strong reduction of arable land resulting from recent negative climatic changes, 3) gradual exhaustion of global fossil fuels and unstable petroleum prices. The major advantage of plants is the natural ability for CO2 assimilation and its conversion to lipids of high-energy content, mainly in the form of triacylglycerol (TAG). Thus, they gained a strong attention as a potential source of energy-rich lipids. These lipids in turn are the sustainable feedstock for food and biofuels production. However, the dilemma of choice between using plants for energy or food production requires development of novel strategies oriented towards boosting the lipid production in plants. One of the most powerful tools to achieve this goal is modern genetic engineering which allows for efficient regulation and modification of pathways governing lipid synthesis and accumulation in diverse plant tissues.

Research subjects includes:

- molecular aspects of lipid synthesis and accumulation in plants,
- genetic control of lipid homeostasis in plant cells,
- biotechnology of plant lipid metabolism,
- employment of synthetic biology for increasing plant energy density,

use of plant biomass as a lipidic feedstock.



Session III - presentations

Big data overload: deriving structure-function insights within plant lipid metabolism through analyses of diverse plant genomes

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Rapid advances in sequencing technologies have resulted in an increasing number of sequenced and annotated plant genomes. Each plant genome provides a plethora of information for better understanding how the encoded information impacts its unique growth and developmental characteristics. From a protein sequence point of view, the addition of representative genomes across the plant kingdom has enabled a range of questions on protein structure-function conservation and diversification. Integrating this information with recent advances in protein structure homology modeling has further opened a Pandora's Box of questions, such as "Do structural differences in Your Favorite Protein across different plant species result in physiologically relevant differences in functionality and optimization?" and "Just how conserved are the enzymes in plant lipid metabolism?". In this presentation, I will present progress towards performing comparative sequence and structural analyses on enzymes important for fatty acid biosynthesis and modification. It will consider current limitations and translation of this *in silico* information to validation studies. Integrating these principles and findings into metabolic engineering strategies should further contribute to targeted alteration of lipid composition and amounts in model and crop plants in the future.

Keywords: lipids, plant genomes, homology modeling, redox, protein structure

Differential contribution of *DGAT* and *PDAT* genes to triacylglycerol biosynthesis in olive fruit

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Plant oils, mainly composed of triacylglycerols, are mostly used for edible applications (food and feed), although there is an increasing interest in their use as renewable raw materials for the production of biofuels, biolubricants, and other bioproducts. For that reason, the global demand for plant oils is rapidly growing. To meet this demand, one of the possible strategies is to improve the oil yield in the main oilseed and oil fruit crops.

In higher plants, triacylglycerols are synthesized in the endoplasmic reticulum by the sequential incorporation of fatty acids in the form of acyl-CoAs into the glycerol backbone. The final rate-limiting step of this acyl-CoA-dependent pathway, commonly known as the Kennedy pathway, is catalyzed by the acyl-CoA:diacylglycerol acyltransferase (DGAT). Additionally, an alternative acyl-CoA independent reaction catalyzed by the phospholipid: diacylglycerol acyltransferase (PDAT) has been described for triacylglycerol synthesis.

Unlike oilseeds, information about the relative contribution of DGAT and PDAT enzymes to triacylglycerol biosynthesis in oil fruit is very scarce. From a biotechnological point of view, oil fruit mesocarp possesses the advantage, compared to oilseeds, of altering TAG content and composition without affecting germination rates. In olive, two *DGAT* genes have been previously described, whereas no *PDAT* genes have been cloned and characterized to date.

In the present study, the isolation and characterization of two novel olive *DGAT* genes and three *PDAT* genes have been carried out. Sequence analysis of these genes indicated that they code for DGAT and PDAT enzymes, respectively. In addition, transcriptional analysis of these genes during olive fruit development and ripening, and in different trophic conditions (heterotrophic and autotrophic) combined with distinct irrigation treatments (well-watered and water-stressed) have been performed. The differential contribution of olive *DGAT* and *PDAT* genes to triacylglycerol biosynthesis in olive fruit will be discussed. This information will help to design molecular markers for the marker-assisted selection of novel olive cultivars with increased oil content in olive breeding programs.

Keywords: olive fruit, olive oil content, DGAT, PDAT, gene expression, triacylglycerol synthesis

The key enzymes in metabolic engineering for production of wax esters in plants

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Wax esters, esters of (very) long chain fatty acids and fatty alcohols, are important industrial lipids used as feedstocks for production of lubricants, pharmaceuticals and cosmetics. Large-scale production of wax esters is based on chemical catalysis or enzymatic processes and has a negative environmental impact. Comparably small amounts of natural wax esters can be obtained from *Simmondsia chinensis* (jojoba), the only plant known to use wax esters as major storage lipids. Despite recent advances in lipid biotechnology, a platform for a bio-based production of wax esters is not available till today. Metabolic engineering of oilseeds for wax ester accumulation represents a promising strategy for renewable, sustainable and environment friendly production of lipids tailored to industrial applications.

The formation of wax esters from acyl-CoA/ACPs and fatty alcohols requires the activity of only two enzymes: a fatty acyl reductase (FAR) and a wax synthase (WS). Numerous studies demonstrated the establishment of the wax ester biosynthetic pathway in seeds of non-food plants, such as *Arabidopsis thaliana*, *Lepidium campestre*, *Camelina sativa* and *Crambe abyssinica.* However, seeds with high amounts of wax esters showed a reduced germination rate and defects during post-germinative growth, most probably due to poor wax ester catabolism and accumulation of potentially toxic free fatty alcohols.

The current approaches aimed at production of tailor-made wax esters in oilseeds focus mainly on the two pathways: wax ester synthesis and mobilisation. The isolation of FARs and WSs with different specificities from various organisms opened the possibility to modify to some extent the chemical structure of the wax esters accumulated in the seeds. Meanwhile, wax ester mobilisation in seeds was studied in jojoba and led to identification of three enzymatic activities required in this process: a lipase, a fatty alcohol oxidase (FAO) and a fatty aldehyde dehydrogenase (FADH). These enzymes could be used to improve wax ester catabolism in seeds with high wax ester content.

Here, I will review strategies for engineering wax ester production in seeds with particular reference to utilisation of enzymes involved wax ester synthesis and hydrolysis. The data on the substrate specificity of the selected FARs and WSs and on the wax ester-hydrolysing activity of lipases from jojoba, *C. sativa* and *C. abyssinica* will be also discussed.

Keywords: wax esters, wax synthase, fatty acyl reductase, lipase, jojoba, metabolic engineering

Microbial lipases and phospholipases and their use as biocatalysts in modifying plant lipids

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Currently, certain chemicals from different industries pose serious problems for human health and the environment. Biotechnology has enabled these sectors to develop new or better products, save time and energy, and be more environmentally friendly. Microorganisms, omnipresent in our environment, play a fundamental role in the functioning of natural ecosystems thanks to a considerable number of active molecules. Among these, lipolytic enzymes (lipases and phospholipases), biocatalysts of a protein nature having catalytic properties. Unlike chemical catalysts, enzymes have high specificity and operate under mild conditions of temperature and pressure. They constitute a biological alternative to chemical agents traditionally used in industries, oil mills and vegetable oil refineries. These advantages explain the recent development of research on industrial applications of lipolytic enzymes.

This work is based on an original approach combining nutritional and technological aspects. The general objective is to validate the health benefits of enriched vegetable oils and to develop an integrated enzymatic refining process. Indeed, the construction of overproducing strains of lipase and phospholipase enzymatic activities, as well as the optimization of the conditions of production, stabilization and formulation of these enzymatic preparations and making available to vegetable oil refineries an enzymatic cocktail (of phospholipases and lipases) fairly stable under unconventional conditions of temperature, pH, or in the presence of organic solvents and detergents, which can be partially or completely substituted for conventional methods of degumming.

Keywords: *B. thuringiensis* PLC, *Serratia sp. W3* lipase, thermostability, substrate specificity, refined vegetable oils, oil degumming

Oleaginous microalgae – the green gold for the sustainable development

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Microalgae gained a considerable interest as a potentially carbon neutral biofuel resource, since potentially they can provide sufficient liquid fuels using only a sunlight and water. The key feature underlying this potential is the ability of these photosynthetic organisms to produce and accumulate substantial amounts of neutral lipids, reaching from 20% to -50 % of their dry weight. These lipids are represented mainly by triacylglycerols (TAGs) and can be directly used as a precursor for biodiesel production. I will talk about the progress in our understanding of how oleaginous microalgae produce and accumulate oil in their cells. A special emphasis will be placed on the molecular machinery directly related to TAGs biosynthesis and to mechanisms of their accumulation. Moreover, I will characterize the available molecular toolbox designed for microalgae to engineer their energy density. I will also describe how these achievements can be used to meet the challenges of the modern world in relation to sustainable development.

Keywords: lipids, microalgae, triacylglycerols

Session III – posters

The response of genes encoding diacylglycerol acyltransferases of type 2 from *Nannochloropsis oceanica* to diverse stress conditions

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Photosynthetic microalgae are considered as a very promising third generation biofuel feedstock as under nutrient stress they can produce massive amounts of triacylglycerols (TAGs), reaching from 20% to 50% of their mass. These TAGs can be directly used as a substrate for biodiesel production. Our study aimed at deciphering the role of extremely rich set of genes encoding enzymes directly involved in the final steps of TAG synthesis – diacylglycerol acyltransferases of type 2 (DGAT 2s), present in the genome of a model oleaginous microalgae *Nannochloropsis oceanica*. This strain encodes 13 DGAT-encoding genes meanwhile most of living organisms contains only single copies. To address the biological rationale of such high number of DGAT-encoding genes, we analyzed the expression profiles of 11 of them under diverse stress conditions, like nitrogen and phosphate deprivation, high temperature and osmotic (salt) stress conditions. Our results confirmed that the nitrogen deprivation is the most potent trigger of DGAT expression. However, other stresses have also been found to specifically induce the expression of selected DGAT-encoding genes in *N. oceanica*. Our results, as first, revealed a stress-specific pattern of NoDGAT expression in response to salt stress and high temperature, and thus open potentially novel avenues of research lines oriented towards understanding the functional nature of diverse DGAT isoforms encoded by *N. oceanica* genome. This knowledge is crucial for developing novel strategies of boosting the sustainable and carbon neutral production of oil using microalgal biomass.

Keywords: diacylglycerol acyltransferases, DGAT, *Nannochlorpsis oceanica*, microalgae, abiotic stress, lipids

Biotechnological potential of diacylglycerol acyltransferases from the green microalgae *Nannochloropsis oceanica*

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Nannochloropsis oceanica CCMP1779 is becoming a popular model organism for oleaginous microalgae biotechnological research. The exceptional ability of this marine microalgae to synthesize and accumulate significant amounts of neutral lipids, primarily in the form of energy-rich triacylglycerol (TAG), combined with a complete genome sequence and improved genetic tools, makes it potentially useful for direct use in food, feed, and industrial applications. The genome of *N. oceanica* CCMP1779 has an unusually big number of genes that encode metabolic machinery involved in oil production. Type 1 and type 2 acyl-CoA:diacylglycerol acyltransferases (DGAT1s and DGAT2s/DGTTs accordingly) have a particular position among these genes since they catalyze the final step of TAG production. DGAT genes are found in most plants and animals, mainly in single copies. On the contrary, *N. oceanica* stands alone among all living species since its genome contains up to 13 DGAT-encoding genes (*No*DGATs).The biological reason behind such a high number of DGAT-encoding genes remains unclear. However, it might be the result of a sophisticated evolution of *N. oceanica* species and an exceptional capacity to accumulate large amounts of oil and perhaps more advanced mechanisms to manage this process. To verify this idea, we used transcriptomics data to analyse the expression patterns of *No*DGATs under various culture conditions. A variety of *in silico* techniques was used as well to investigate the *No*DGAT proteins' probable structure, location, and alterations. Our findings not only reveal the functional specialization of *No*DGATs, but also indicate their complex evolution and varied genomic origins.

Keywords: diacylglycerol ancyltransferases, DGAT, *Nannochloropsis oceanica*, microalgae, triacylglycerol, TAG

Session IV

„Advances in analysis and technology of food”

Session Chair: Prof. Aleksandra Szydłowska-Czerniak

Session Organizer: PhD Dobrochna Rabiej-Kozioł

Guest Speakers

1. Prof. Mohamed Bouaziz (Sfax Tunisia - University of Sfax, Tunisia)

„High added values compounds from olive by-products: Food and therapeutic application"

2. PhD Jan Kyselka (University of Chemistry and Technology in Prague, Czech Republic)

„Industrial innovation in the production and processing of vegetable oils”

3. Prof. Magdalena Rudzińska (Poznań University of Life Sciences, Poland)

„The thermo-oxidative stability and cytotoxicity of distigmasterol-modified acylglycerols as the new structured lipids

Session IV

„Advances in analysis and technology of food”

Advances in analysis and technology of food is focused on new analytical challenges and the innovation of food production. Conference will give an opportunity for presentation of the international and domestic activities on the improvement of the best technologies, knowledge development on food products analysis and characteristics. The session III subject is in the main stream of efforts for the sustainable growth and the best usage of natural resources.

Research subjects includes:

- characteristic of antioxidants in food products,
- studies of antioxidants activity mechanism and nutrition properties,
- implementation of components with antioxidant properties to functional food production,
- production and technology aspects of food with high antioxidant capacity,
- legislation issues of adding natural extracts to food products,
- marketing of food products with components of high antioxidant capacity.

Session IV - presentations

Olive by-products: valuable nutrients, drugs and functional bioactive compounds

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Phenolic compounds, present in plants, are an essential part of the human diet due to their antioxidant properties. These compounds posses an aromatic ring bearing one or more hydroxyl groups and their structures may range from that of a simple phenolic molecule to that of a complex high-molecular weight polymer. Olive oil and olive by-products are the major sources of phenolic compounds in the Mediterranean countries. Indeed, Olea europaea L. organs and by-products such as: leaves, olive mill wastewater, wood, stems and roots represent a major disposal problem for the industry concerned, but they are also promising sources of phenolic compounds which have been associated with numerous in vivo and in vitro biological activities and used for traditional medicinal purposes. In fact, olive oil and some of its by-products has been the subject of investigations and have proven to be effective sources of phenolic antioxidants. Principally, biological activities and characteristic flavour and aroma are due to the presence of unique bioactive compounds both in olives and extra virgin olive oil phenolic compounds such as oleuropein, hydroxytyrosol, verbascoside and derivatives etc., and tocopherols and carotenoids. Several factors, such as agronomical conditions, climate, and level of ripening, olive cultivar and type of production process have the main effects on the profile and activities of bioactive compounds. Accumulating evidence suggests that EVOO may have health benefits; it can be considered as an example of a functional food containing a variety of biologically active phenolic components that may contribute to its overall therapeutic characteristics. This chapter highlights the potential of olive oil and selected by-products as a source of phenolic compounds and their biological and functional properties.

Keywords: olive by-products, phenolic compounds, biological activities

Industrial innovation in the production and processing of vegetable oils

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On the threshold of the 21st century, leading manufacturers of machinery (Desmet Ballestra, Alfa Laval, GEA, HF Press+LipidTech, Olexa, French), reactors (Cavitation Technology Inc., Arisdyne, BUSS ChemTech), adsorbents (Clariant, Mineral Technologies Inc., Sepiolsa Minerva Group, Oil-Dri Fluids Purification), hydrogenation catalysts (BASF Catalysts, Johnson Matthey, Evonik) and immobilized enzymes (Novozymes) became the carriers of technological progress in the refining and modification of vegetable oils and fats. Steeply increasing, seemingly sustainable oilseed production, consumer demands and stringent food safety requirements motivate current developments. New processing-induced contaminants, 3-monochloropropane-1,2-diol (3-MCPD) esters and glycidol esters (GE), were discovered in 2006 and 2010, and at the same time the Food and Drug Administration (FDA) regulation 68 FR 41434 on mandatory *trans*-MK labeling was adopted effective January 1, 2006. Pilot plants unable to adapt have been and will be closed. As a result, collaboration between the commercial and academic communities has once again intensified. Where the analytical end of modern instrumentation ends, applied research begins, focusing on new machinery and innovative process techniques. Successful removal of undesired process contaminants from oils and fats cannot be achieved without properly designed reaction mechanisms or kinetics, simulation of semi-scale experiments, and organic synthesis of commercially unavailable standards. Such an approach can be considered as a serious solution to engineering problems.

Keywords: palm oil, refining, 3-MCPD esters, glycidol esters

Effects of polyphenols on N^{ε} -(carboxymethyl)lysine and pyrazines formation in a model wheat bread system

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Heat treatment of foods is a key operation in industry and results in the development of a wide range of flavors and tastes through the Maillard reaction. However, through the Schiff base and Amadori products, advanced glycation end products (AGEs) are also formed. One of the better known AGEs is N^{ε}-(carboxymethyl)lysine (CML), which is present in biological systems and in many heat-processed foods. Recently, CML has been associated with major pathogenic processes in diabetic complications, atherosclerosis and Alzheimer's disease.

The goal of the study was to explore the antiglycation activity of phenolic compounds ((+)-catechin and quercetin, and gallic, ferulic, and caffeic acid) added at four different levels (0.1, 0.5, 1.0, and 2.0 g per 100 g of flour) to model bread samples, with regards to the inhibition of CML formation from the glycation reaction. In order to further explore the antiglycation mechanism, the percentage recovery of phenolic compounds and the lysine content available in crust and crumb were also evaluated. The formation and elimination of volatile pyrazines formed by Maillard reaction when adding AGE inhibitors were also studied.

Phenolic compounds were found to significantly reduce CML (31.77% – 87.56%), even at the lowest concentration, with the exception of ferulic acid. The strongest inhibitory effect of ferulic acid (~62%) appeared when concentration was increased to 1.0 g/100 g of flour. The available lysine losses (0.00% – 90.51%) showed a significant correlation (0.853 – 0.990) with effectiveness of CML inhibition, except in the case of samples with ferulic acid. (+)-Catechin reduced CML levels the most, probably due to its structure–antioxidant activity relationship, its thermal stability (~51% loss), and its reactivity with ε-lysine side chains (~40.77% loss). Although the bread supplemented with PCs contained low levels of CML, this process may adversely affect bread flavor, reducing the formation of pyrazines (1.10%–80.77%).

Overall, natural phenolic compounds are promising antiglycation inhibitors worthy of further study, and should be using in the food industry to reduce CML levels in food.

Keywords: phenolic compounds, bread, CML, available lysine losses, pyrazines

Fluorescence spectroscopy – tool to evaluate the quality of rapeseed oils fortified with phenolipid during storage

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Fluorescence spectroscopy is a simple, cost-effective, rapid, and non-destructive method for the analysis of oxidation processes of oils during storage. This technique was often applied in edible oils analysis for quantification of fluorescent components, monitoring of thermal and photooxidation reactions, assessment of quality, detection of adulteration, and others [1,2].

Rapeseed oil is one of the most important vegetable oil on the global market. It is a rich source of omega-3 fatty acids, antioxidants other phytonutrients essential for good human health. Unfortunately, most of the bioactive compounds are removed during the technological process [3]. Therefore, the addition of liposoluble antioxidants to refined oil can improve its quality and extend its shelf life [1].

In the present study, phenolipid - octyl sinapate was synthesized and added to refined oil at two final concentrations of 200 - 5000 ppm. These oils were stored under different conditions. The quality of rapeseed oils with octyl sinapate and BHA, as well as control oil (with antioxidants), was analyzed by fluorescence spectroscopy. Three-dimensional fluorescence spectra technology and synchronous spectra were employed to rapidly and efficiently detect the presence of oxidation products in the studied oils. Additionally, the antioxidant capacity of oils was determined by the DPPH method.

Oxidation parameters of rapeseed oils without and with antioxidants depended on the concentration of the added antioxidants and storage conditions. Antioxidants added to rapeseed oil and oxidation products can be easily detected by synchronous fluorescence spectroscopy. There was a correlation between the intensity of synchronous spectra and the antioxidant capacity of the analyzed oils. The synthesized octyl sinapate could be used as an efficient antioxidant in the oil industry to delay oxidation reactions and improve its antioxidant properties.

Keywords: fluorescence spectroscopy, rapeseed oil, phenolipids, storage

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Funding:
The authors wish to thank the National Science Centre, Poland for the financial support: Grant No. 2018/29/N/NZ9/02748

Effect of deep-frying of potatoes and tofu on thermo-oxidative changes of cold pressed rapeseed oils

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One of the commonly used food preparation methods is frying. Fried food is admired by consumers due to its unique taste and texture. Deep-frying is a process of dipping food in oil at high temperature, usually 170-190°C, and it requires relatively short time. The aim of the study was to analyze the thermo-oxidative changes occurring during deep-frying of products such as potatoes and tofu in cold pressed rapeseed oil, high oleic cold pressed rapeseed oil and palm olein. Characterization of fresh oils (after purchase) and oils after 6, 12 and 18 hours of deep-frying process of a starch product (potatoes) and a protein product (tofu) was performed. The quality of oils was analyzed by determining: peroxide value, acid value, p-anisidine value, content of carotenoid and chlorophyll pigments, polar compounds, smoke point, color (CIE L*a*b*), fatty acids composition and oxidative stability index (Rancimat). Cold pressed high oleic rapeseed oil was more stable during deep-frying compared to cold pressed rapeseed oil, but much less stable than palm olein. In addition, more thermo-oxidative changes in the tested oils occurred in the case of deep-frying the starch product (potatoes) compared to the deep-frying of the protein product (tofu).

Keywords: frying, cold pressed oil, high oleic rapeseed oil, palm olein, oxidative stability

The thermo-oxidative stability and cytotoxicity of distigmasterol-modified acylglycerols as the new structured lipids

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Plant sterols, referred also as phytosterols, have been known as bioactive compounds with lowering cholesterol level in human blood since 1950s. These compounds in a free form as well as esters, glycosides or acyl glycosides are natural components of nuts, seeds, edible oils and vegetables. Looking for a new derivatives of phytosterols with high thermo-oxidative stability, new structured acylglycerols, in which two fatty acid parts were replaced by stigmasterol residues were synthetized. The degradation of those new lipids after heating at 60 and 180°C was compared with free stigmasterol and stigmasteryl esters. Residue of stigmasterol and fatty acid parts, the content of stigmasterol oxidation products and composition of polar and non-polar fractions were determined using chromatographic methods. After heating at both temperatures, the dStigS-OA was the most stable compound follow the Stig-PA>Stig-OA> dStigS-PA>dStigC-PA>dStigC-OA. The process of dStigMAs degradation was the combined reaction for stigmasterol and fatty acids parts. Obtained data showed that formation of thermo-oxidative derivatives depend on, not only the temperature, but also the chemical structure of lipids. dStigMAs were more stable than stigmasteryl esters and free stigmasterol. The dStigMAs bonded by the succinate linker showed no cytotoxic activity to human normal cells.

Keywords: structured lipids, phytosterols, fatty acids, oxidative stability, cytotoxicity

Bioactive gelatin/PVA films containing black cumin cake extract and zinc oxide nanoparticles

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Nowadays packaging is an essential element of food product. Consumers' willingness to eat low-processed and, at the same time, fresh, high-quality food with an extended expiration date necessitates the development of novel packaging with enhanced primary functions. Therefore, scientists' research has focused on obtaining new active or intelligent packaging in the last years. Moreover, the less-waste trend draws attention in various branches of chemistry because by-products of the food industry can be implemented as an active agent in packaging materials, precursors for biosynthesis of chemistry substances, e.g., metals and metal oxides nanoparticles.

In the light of the above facts, the research aimed to develop new food packaging materials based on gelatin and poly(vinyl alcohol) (PVA) containing black cumin cake extract and zinc oxide nanoparticles. Firstly, zinc oxide nanoparticles (ZnONPs) were obtained via green synthesis, using water black cumin cake extract as a reducer and stabilizer. Nanoparticles were characterized using UV-VIS spectroscopy and SEM-EDS imaging method. The antioxidant activity of the obtained films was investigated within the CUpric Reducing Antioxidant Capacity (CUPRAC) method using the QUick, Easy, New, CHEap & Reproducible approach. Additionally, the mechanical and optical properties of materials were analyzed.

The addition of the ZnONPs and the black cumin cake extract to the prepared polymeric materials increased the antioxidant properties of films ($QUENCHER_{CUPRAC}$ = 502.38 ± 10.83 µmol TE/100g), as well as caused a slight increase of the elongation at break (EAB = 141.45 ± 7.55%) in comparison to the control film ($QUENCHER_{CUPRAC}$ = 325.53 ± 11.65 µmol TE/100g; EAB = 137.03 ± 6.73%). The active film was also more opaque (O = 3.41 ± 0.07) than film without additives (O = 2.60 ± 0.02). Since the obtained packaging possessed desired antioxidant, mechanical, and optical properties, they can be considered as an interesting alternative to traditional packaging.

Keywords: food packaging, active films, natural antioxidants, black cumin seed extract, zinc oxide nanoparticles

Effect of antioxidants on physicochemical properties of emulsions

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Plant-based diet is a growing trend in recent years. It cause an increasing production of food without any animal products. One of these products is mayonnaise. Oil-in-water emulsions like mayonnaise contains 70-80% of fat. Because of its high oil content it is vulnerable to oxidation. The most important factors affecting lipid oxidation are: metals, high temperature, light, pH and structure of used lipids. Elimination of these factors and addition of antioxidants can increase shelf life of mayonnaise.

The aim of this work was to evaluate effect of antioxidants on emulsions. The egg-less mayonnaise based on aquafaba and refined rapeseed oil was prepared. The shelf life test was carry out in 4°C for new mayo with addition of active film with black cumin cake ethanol extract and synthetic antioxidant with amphiphilic properties (octyl caffeate). The effect of addition of antioxidants were compared with commercial egg-free mayo and control aquafaba-based mayo without antioxidant at time intervals for 4 weeks. Antioxidant properties of emulsion were determined using QUick, Easy, New, CHEap and Reproducible (QUENCHER-DPPH and QUENCHER-ABTS) method. The amount of primary, secondary oxidation products and the amount of free fatty acids in a mayonnaise fat were determined by the official methods, PV, p-AnV and AV, respectively. Changes in colour of emulsions were also determined.

At the end of storage, control samples showed peroxide value, anisidine value, conjugated diene and triene and acid value, which were less than those of commercial mayonnaise sample. Addition of active film decrease the amount of free fatty acid and at the beginning of storage it cause decreasing of oxidation process. The mayonnaise containing octyl caffeate has the highest antioxidant activity (AA) ($QUENCHER_{ABTS}$ = 3886 ± 131 μmol TE/100g $QUENCHER_{DPPH}$ = 2887 ± 139 μmol TE/100g). The lowest AA at the end of storage has commercial mayonnaise ($QUENCHER_{ABTS}$ = 1301 ± 65 μmol TE/100 g $QUENCHER_{DPPH}$ = 704 ± 14 μmol TE/100 g). The oxidative stability of mayonnaise with addition of synthetic antioxidant was the lowest.

Keywords: mayonnaise, antioxidant activity, shelf-life test

Session IV – posters

OVOBIOM: Elucidating mode of probiotic and prebiotic action in chicken gut through early microbiome modulation *in ovo*

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Healthy gut is needed to combat the stresses associated with intensive poultry production. An optimal microbiota and microbiome in poultry can be maintained by sustaining a healthy gut flora, which can be stimulated with probiotics and prebiotics. As well as aiding in digestion and nutrient absorption, the gastrointestinal tract controls the immune system and provides a favorable environment for beneficial bacteria colonization. also controls the immune system, acts as a strong barrier against pathogens, and provides a favorable environment for beneficial bacteria colonization in poultry.

Selected poultry probiotic bacteria were investigated to check which prebiotic can increase growth rate and improve bacterial cell surviving. It was observed that prebiotics can have both positive and negative effect on probiotic growth depends on incubation time and source of bacteria. We selected some synbiotics that can may directly benefit poultry producers by lowering the mortality rates or improving feed efficiency. Prebiotics promote the growth of beneficial microbiota but also enhance the physiological health of the gut (peristalsis, local immunity, deprive excess mucus). Therefore, synbiotics delivered *in ovo* would exert a synergistic effect on the host cells. For this reason further research will be concentrated on probiotic survival in the chicken gut and analyse fitness of healthy birds.

Keywords: probiotic, prebiotic, chicken, intestine, microflora, microbiota, *in ovo*

Funding:
The research is financed under National Science Centre UMO-2019/35/B/NZ9/03186.

Prunus avium L. and *Prunus cerasus* L. as sources of flavone C-glycosides

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A large variety of *Prunus* species, e.g. *Prunus avium* L. (sweet cherry) or *Prunus cerasus* L. (sour cherry) are widely cultivated all over the world because of the delicious fruit used to make preserves, juices and to be important ingredients of cakes and other food products. However, besides the fruit, also the bark of *Prunus* species is attractive material since it has been shown that the extracts of *Prunus* species bark show interesting properties. Flavonoid C-glycosides are regarded as very prominent and promising bioflavonoid type compounds because in contrast to the flavonoid O-glycosides, they cannot be easily hydrolyzed by the enzymes present in human body, moreover C-glycosylation can enhance some of the benefits of flavonoids on human health, like antioxidant potential.

The main aim of the study was to analyze the extracts from the bark of *Prunus avium* and *Prunus cerasus* by using high pressure liquid chromatography/electrospray ionization mass spectrometry (HPLC/ESI-MS). The plant material for the experiment was obtained from the Przybroda Experimental Station located in the north-central part of the Poznan Lakeland in western Poland (52°31'N, 16°38'E). The bark from selected *Prunus* trees in a portion of 2 g was extracted with pure methanol and 5% methanolic solution of hydrochloric acid. The HPLC/ESI-MS analyses were performed using a Waters model 2690 HPLC pump (Milford, MA, USA), a Waters/Micromass ZQ2000 mass spectrometer (single quadrupole type instrument equipped with electrospray ion source, Z-spray, Manchester, UK).

On the basis of the characteristic fragmentation patterns of $[M-H]^-$ and $[M + H]^+$ ions, for the first time three flavone C-glycosides, namely vicenin-2, isovitexin and chrysin-8-C-glucoside, have been unambiguously identified in the extracts of *Prunus cerasus* and *Prunus avium* bark. Taking into account the widely studied biological activities of flavonoid C-glycosides, the barks of these common fruit trees seem to be interesting materials of potential medical or cosmetic application.

Keywords: *Prunus avium*, *Prunus cerasus*, flavone C-glycoside, electrospray ionization, mass spectrometry

Photochemical stability of selected plant-derived food colorants

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Food production and consumption are inseparable from the sense of sight. The appropriate and attractive color of all types of food is desired by consumers. However, due to the fact that the color may change during the production or processing of food, colorants may be necessary. Coloring food by using edible natural compounds can be a healthier and ecological alternative to artificial colorants. There are increasing consumers demand to purchase food products colored by natural instead of artificial colorants. The first ones, which are plant-derived include vegetables, fruits and other edible plants. Apart from providing stable and permanent color of food, dyes of plant origin due to the content of antioxidant compounds can act as valuable food additives.

In the study antioxidant activity of plant-derived colorant was examined before and after UVC radiation. Two colorants for food applications obtained by physical manufacturing process conducted with water were used in the examination: red containing chokeberry, elderberry and apple extracts and purple containing blueberry and carrot extracts. 0.1% water solutions of both colorants were prepared. Determination of antioxidant activity was performed using two methods: CUPRAC (Cupric Reducing Antioxidant Capacity) method and DPPH method. Both methods are based on SET (single electron transfer) mechanism. Results obtained for red and purple colorants before UVC radiation were 2.60 ± 0.25 mg and 4.21 ± 0.31 mg/50 mg colorant expressed as caffeic acid, respectively. After 5 minutes of UVC radiation results were obtained: for red colorant 22.79±3.29 mg and purple colorant 25.50± 1.75 mg/50 mg colorant expressed as caffeic acid. After 15, 30 and 60 minutes of UVC radiation the results got stable and similar values were obtained: for red colorant were 75.09 ± 1.73; 82.87 ± 0.57 and 82.46 ± 2.79mg/50 mg colorant expressed as caffeic acid and for purple colorant 76.67 ± 3.56; 79.60 ± 7.16 and 82.27 ± 4.97 mg/50 mg colorant expressed as caffeic acid, respectively. Results of antioxidant activity determined by DPPH method were similar for two examined colorants: 10.25 ± 0.42% DPPH/50mg colorant for the red one and 9.97 ± 0.29% DPPH/50 mg colorant for the purple one. For prepared concentration of colorants solutions the determination of antioxidant activity by this method was not possible after UVC radiation.

Keywords: food colorant, plant-derived colorant, antioxidant activity, CUPRAC method, DPPH method

The potential application of plant-based protein-polysaccharide hydrogels in the food sector

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The purpose of this study was to emphasize the significance of plant-based hydrogels as a structure-forming component in new plant-based food products, including animal-free alternatives. Although the use of hydrogels in the biomedical and tissue engineering sectors is extensively documented in the literature, the inclusion of biopolymeric hydrogels science in food systems is still limited. Hydrogels are proven to perform as a structural network into which bioactive compounds can be inserted while simultaneously improving the stability of the new product. The use of plant-driven proteins (pea protein, wheat protein, etc.) and polysaccharides (such as, inulin, maltodextrin, pectins, psyllium, tara gum, etc.) may allow the development of protein-polysaccharide structures that can have a big potential in the quality enhancement and texture modification of food products, bioactive compounds encapsulation and delivery, cells immobilization (*in vitro* meat), as well as the improvement of food packaging. Advances in other disciplines, such as biomedical and tissue engineering, must be incorporated to promote the development of hydrogel science in the food applications.

Keywords: food structure, food ingredient, hydrogel, protein-polysaccharide interaction

Study of total phenolic content variability in Extra Virgin olive oil produced from three cultivars '*Chétoui*', '*Chemlali*' and '*Arbequina*' according to Maturation index

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The UNESCO has recognized the Mediterranean diet as a Cultural Heritage of Humanity, and it has been defined as the healthiest diet in the world. Actually, the olive oil is one of its major components. This product is distinguished by its nutritional and biological properties with a large part coming from minor compounds, more specifically the phenolic fraction. For this reason, olive oil has been recently approved to be considered as a Functional Food. The phenolic fraction depends on several factors such as the genetic origin, agro-climatic conditions and fruit ripening. In this context, this study aims to determine the fluctuation of total phenolic content of two cultivars '*Chétoui*' and '*Chemlali'* mostly cultivated in Tunisia as well as '*Arbequina*', a Spanish cultivar introduced in Tunisia during the last two decades. This study was carried out during three successive harvest years 2017/18, 2018/19 and 2019/20. Extra virgin olive oils were randomly obtained from different olive groves according to the geographical representativeness of each cultivar across the country. The samples '*Chétoui*' (n=45), '*Chemlali*' (n=22) and *'Arbequina'* (n=31), were processed in the laboratory using an ABENCOR extraction system after the determination of Fruit Maturation Index. A percentile ranking was previously performed which allowed sample classification according to the stage of ripening of each cultivar. Total phenolic fraction extracted and measured by spectrophotometric analysis revealed a high variability among and within cultivars. However, '*Chétoui*' showed to have the highest phenolic content ranging between 110.53 ppm and 781.35 ppm with an average value of 421.87 ppm, while *'Chemlali*' and '*Arbequina*' showed lower values with an average of 175.10 and 233.14 ppm respectively. Due to the high diversity of samples, no clear tendencies of phenolicevolution according to ripening progress have been observed in this study excepting a decrease revealed by '*Arbequina*' cultivar when the maturation index reached 1.46. Comparative studies under similar growing conditions are required to obtain relevant conclusions on the evolution of the phenolic fraction in each cultivar. However, it is demonstrated that the genetic origin is one of the most fundamental factors that determine the phenolic profile of the extra virgin olive oil along with the capacity to transfer these phenolic compounds from the fruit to the oil during the extraction process which is also related to the water content of the fruit.

Keywords: cultivars, phenolic content, maturation index

Selection of protein amino acids derivatization procedure conditions for chromatographic determination in food samples

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Amino acids (AAs) are essential biomolecules found in food, beverages or dietary supplements. The analysis of these compounds allows assessing the nutritional and sensory quality of the products and transformations that occur during food processing and storage. AAs contribute to the final flavour and colour of food products and can be used for their authenticity assessment. Based on the literature, high-performance liquid chromatography (HPLC) is the most common method of these acids determination. However, due to the absence of chromophore or fluorophore in the structure and low ionization efficiency, a derivatization step is necessary for chromatographic determination of AAs.

Amino acids (AAs) are essential biomolecules found in food, beverages, or dietary supplements. The analysis of these compounds allows assessing the nutritional and sensory quality of the products and transformations that occur during food processing and storage. AAs contribute to food products final flavor and color and can be used for their authenticity assessment. Based on the literature, high-performance liquid chromatography (HPLC) is the most common method of these acids determination. However, due to the absence of chromophore or fluorophore in the structure and low ionization efficiency, a derivatization step is necessary for chromatographic determination of AAs.

In this study, we tested conditions of amino acids derivatization procedure with 1-fluoro-2-nitro-4-(trifluoromethyl)benzene (FNBT). The solutions of amino acids were mixed with FNBT in the presence of borate buffer, and temperature and time of reaction were tested. The derivatives of AAs were synthesized and characterized by ^{1}H, ^{13}C and ^{19}F NMR. The optimal conditions of reaction were selected based on the purity of obtained derivatives and conversion of the reactions. The selected synthesis conditions were applied for chromatographic determination of free amino acids in beer. It is the most widely consumed fermented beverage and is considered a good source of nutritional compounds (such as AAs), antioxidants, vitamins. Moreover, the nutritional value, aroma and flavour of beer depend significantly on the proteolytic events resulting in each beer having a particular amino acid composition.

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Keywords: amino acids, 1-fluoro-2-nitro-4-(trifluoromethyl)benzene, food analysis, ^{13}C, ^{1}H, ^{19}F NMR, RP-HPLC

Effect of the heating method on selected quality parameters of fruit and vegetable mousses

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Fruit and vegetables are an essential part of our diet. They are a source of substances that positively impact health and add colour, scent, and flavour. Regrettably, most of them belong to perishable raw materials, sensitive to storage and transport, which often results in a deterioration of their quality.

Seasonality of harvests and the tendency to spoil quickly have contributed to fruit and vegetable processing development. Temperature and heating time are essential factors that may affect a loss of nutritional value of fruit and vegetables or their organoleptic properties. The improperly processed raw material loses its quality, which is connected with a change in the product chemical composition and a loss of nutritional substances.

The aim of the study was to determine how the method of heating fruit and vegetables influences the quality of the obtained purees. The microwave and steamer were applied to make mousses from apples, pears, bananas and courgette. The dry mass, contents of vitamin C, pectins and total polyphenol, extract, acidity and antioxidant activity were determined in obtained mousses. The obtained results for discussed mousses were compared with conventional ones.

Keywords: fruit and vegetable mousses, heating method, quality parameters

Oxidative stability analysis of selected oils from seeds of herbs and vegetables

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The aim of the study was to test the quality, including especially oxidative stability of selected oils from seeds of herb and vegetables (basil, fenugreek, coriander, tomato, garden cress, parsley and dill). The oils were tested for oxidation degree (acid value, peroxide value, anisidine value, TOTOX indicator specific extinction under UV light), colors and content of carotenoid and chlorophyll pigments, fatty acid composition, indicators of lipid nutritional quality, oxidative stability and oxidation kinetics parameters (Rancimat test). Statistical methods were used to assess the influence of tested parameters on the oxidative stability of oils.It was found that the most resistant to oxidation was coriander seed oil, containing mainly MUFA acids, whose content was strongly and positively correlated with the oxidative stability of oils (rXY =0.89).a strong negative correlation (rXY =-0.88) was fund between the PUFA acids content and the oxidative stability. The oil that was the least resistant to oxidation was basil seed oil, with the highest amount of PUFA

Keywords: oxidative stability, cold pressed oils, quality of oils

The effect of technological factors on the content of lignans in triticale products

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Lignans are secondary plant metabolites formed from two cinnamic acid residues or their biogenetic equivalents. These components are present in cereals as glycosides, esterified glycosides, bio-oligomers, and aglycones. Although the biological function of plant lignans is not fully understood, they are thought to be intermediates or by-products of the pathway of lignin formation. Lignans' diphenolic ring give them a structural similarity to endogenous estrogens. They undergo conversion to enterodiol and enterolactone as a result of deglycosylation, dehydroxylation, and demethylation by human gut microbiota.

Many studies have looked at the lignan content of cereals, usually rye or wheat, but there has been little investigation of lignin in cereal products, so the aim of this study was determination of the influence of different technological process, such as milling, sprouting, malting, baking, extrusion and pasta making on lignan content in triticale products.

Syringarezinol was found to be the most abundant lignan in triticale products. The lignan levels in triticale bran were almost three times those found in the grain; in flour, there as one fifth or even one tenth as much, whereas the shorts had similar levels as the grain. After three days of germination, the amount of lignans in the triticale grain increased by 17%–32%. A greater increase in lignan content (by factors of 1.4 and 2.3) was found in triticale after extrusion cooking. Fermentation led to lignan concentrations increasing slightly (2-14%), but this was then reduced in the baking process. This shows that these compounds lack thermostability in baking conditions. Dry pasta contained similar or lower amounts of lignans than did the raw material, but their concentration was higher in cooked pasta extracts (14%–47%). This suggests greater extractability and probably greater bioavailability of lignans from cooked pasta.

Our findings have shown that technological processes modyfy the lignans content in triticale products and their extractability, and have also shown that triticale is rich in lignans and that consumption of triticale products may be a significant source of lignans in the human diet.

Key words: lignans, milling fraction, technological process, triticale

Sensory quality of cold pressed camelina oils.

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The aim of the poster presentation was to compare the sensory quality of cold pressed camelina oil from Polish market. A quantitative descriptive analysis (QDA) was developed to characterize the sensory quality of a set of 8 cold pressed camelina oils present on the Polish market. The sensory lexicon for sensory evaluation of cold pressed camelina oils were established including 9 attributes (woody-like, nutty, cabbage-like, bitter, fruity, fusty, mustard-like, overall taste intensity, earthy). Moreover, attributes were divided into positive and negative sensory terms. To determined overall quality of cold pressed camelina oils the 5-point quality scale starting from "very bad quality sensory-1" to "excellent sensory quality-5" were developed based on available method DGF-C II 1 (14) and AOCS CG. Some of the oils were characterized by dominant positive sensory notes typical of cold pressed camelina oils (mustard-like, cabbage-like, slightly nutty or fruity), while others (CO2,CO6) by negative sensory attributes (fusty,). The QDA developed in this work is useful for characterization of the sensory quality of commercial cold pressed camelina oils

Keywords: sensory quality, cameline cold pressed oil

Using a hemp oil cake as an addition to bakery products

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Currently, cold-pressed hemp oil is an increasingly popular low-processed product. According to Polish and EU law, industrial hemp (*Cannabis sativa* L.) belongs to plants of the hemp species, in which the content of the Δ9-tetrahydrocannabinol (THC) compound is below 0.2% by dry weight. Therefore, hemp seeds are safe, healthy and not addictive; thus, they can be added to food. Currently, another popular trend is protein-rich products, such as puddings, soups, and baked goods, which are additionally enriched with protein. Therefore soy, pea or hemp protein are added to such products. Hemp oil cake obtained from hemp seeds in the oil cold pressing process is characterized by high protein content. About 65% of hemp proteins are globulins and 35% albumin, which are valuable ingredients for the human body. Fat is also an important ingredient obtained in hemp oil cake. Among polyunsaturated fatty acids (PUFA), essential fatty acids dominate, linoleic acid (LA) belonging to the n-6 family and fatty acids belonging to the n-3 family – alpha-linolenic acid (ALA). In addition, hemp cake is a rich source of dietary fiber.

The aim of this study was to use the by-products of hemp oil pressing to increase the nutritional value of bakery products such as bread. The hemp seed oil cake obtained after the cold pressing process was used for the project. An attempt was made to add husked and unshelled seeds in the amount of 5%, 10%, 15% to wheat bread. Before adding the oil cake to the bread, it was tested for fat and protein content. In the obtained products, the organoleptic characteristics of the bread, the firmness of the bread crumb, and the texturometric characteristics (TPA) - double compression were assessed and analyzed. In addition, an assessment of consumer acceptance was also carried out.

Keywords: hemp seeds, oil cake, bakery products

Physicochemical, antioxidant, microstructural properties of dark chocolate with plant extracts

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Chocolate with plant ingredients could be part of the diet significantly influencing the health of consumers. Therefore, the effect of three plant extracts (chokeberry fruit extract, elderberry fruit extract, elderberry flowers extract) on the physicochemical (moisture content fat content, and viscosity) and antioxidative parameters (total phenolic content (TPC)antioxidant capacity (AC)) were estimated. Both dried plant extracts and chocolates were analyzed with antioxidant capacity (AC) using four different analytical methods: 2,2'-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid) (ABTS), 2,2-diphenyl-1-picrylhydrazyl (DPPH), cupric ion reducing antioxidant capacity (CUPRAC), and ferric reducing antioxidant power (FRAP), while total phenolic content (TPC) was determined by Folin–Ciocalteu (F–C) assay.The results of AC for plant extracts were in the range from 229.8 ± 4.5 μmol TE/g (elderberries extract, FRAP method) to 113882.3 ± 303.1 μmol TE/g (chokeberries extract, CUPRAC method). TPC results for plant extract was in the range 32.5 ± 1.3 mg GA/g(elderberries extract) to 3506 ± 2.3 GA/g (chokeberries extract). The results of AC forchocolates were in the range from 66.5 ± 0.7 μmol TE/g (dark chocolate, FRAP method) to 12945.7 ± 132.2 μmol TE/g (chocolate with chokeberries extract, CUPRAC method). TPC results for chocolates was in the range 11.7 ± 0.5 mg GA/g (dark chocolate) to 70.9 ± 2.2GA/g (chocolate with chokeberries extract). Moreover, the influence of plant extracts on physicochemical parameters such as moisture content (from 0.30 ± 0.01% in dark chocolate to 0.73 ± 0.02% in chocolate with elderberries extract), fat content (from 29.12 ± 0.22% in chocolate with chokeberries extract to 32.91 ± 0.35% in dark chocolate) and viscosity (from 2979.24 ± 48.84 mPa•s in dark chocolate to 4509.56 ± 28.19 mPa•s) of chocolates was estimated.

Keywords: dark chocolate, plant extracts, antioxidant capacity, phenolics content

Antioxidant activity and the processing scale of white mulberry leaves

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The review of historical and scientific evidence indicates that white mulberry leaves are a valuable source of bioactive compounds, especially antioxidants. Technological processes, such as shredding, drying, the equipment can change the activity of important components and bioactivity.

The study aimed to compare the antioxidant activity of white mulberry leaves, processed in two scales: laboratory and semi-technical.

White mulberry leaves from Polish var. żółwińska wielkolistna were picked manually at the mulberry tree farm in Pętkowo (Institute of Natural Fibres & Medicinal Plants), near Poznan. The raw leaves were shredded using a chopper. The laboratory-scale experiment was conducted in the Department of Gastronomy Science and Functional Foods (PULS), using a convection oven (temperature 60˚C). The semi-technological processing of mulberry leaves was conducted at the Institute of Agricultural and Food Biotechnology in Poznan. The chopped leaves were air-dried in the tunnel dryer at inlet temperature 90˚C and outlet temperature 60˚C.

The leaves in both variants were characterized by a similar content of reducing compounds. However, in tests of $ABTS^{+\cdot}$ inhibition, iron chelation and reducing power, the leaves scored higher after laboratory drying. Only in the $DPPH^{\cdot}$ scavenging test, the trials on the semi-technical scale outperformed those on the laboratory scale. It was found that the scale of the processes affected the final antioxidant activity of leaf products.

Keywords: white mulberry, production process, leaves, antioxidant activity

Safety and quality of cold-pressed camelina oils

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The camelina oil (*Camelina sativa* L.) is registered in EU as Traditional Speciality Guaranteed - TSG. Camelina oil is an excellent edible oil rich in ω3 fatty acids. However, variable seed quality and technological difficulties (cold-pressing, no chemical refining procedure) have an unfavourable impact on final oil quality, oxidative stability, and safety.

The aim of this study was to assess the safety and physicochemical quality of cold-pressed camelina oils purchased in retail outlets in Poland (May 2021). Cold-pressed camelina oils were initially characterized by safety and quality parameters: acid values (AV), peroxide value (PV), anisidine value (AnV), fatty acids composition, oxidative stability using Rancimat test and Pressure Differential Scanning Calorimetry (PDSC), carotenoids and chlorophyll content, there were also determined Totox indicators.

The analyzed oils were characterized by good quality, meet the standards of requirements of the Codex Alimentarius (2009) for cold-pressed oils. The acid value varied from 0.86 -3.67 mg KOH/g, peroxide value between 2.6 – 6.3 meq O_2/kg, and anisidine value between 0,26-1,10. The oxidative stability index (100ºC) of camelina sativa oils varied from 2.91 to 5.21 h. The content of PUFAs was more than 55%, of which more than 33% of the ALA.

Keywords: *Camelina sativa* oil, oxidative stability, Rancimat

Influence of the Rancimat apparatus operating parameters on oxidative stability determination of cold-pressed camelina and hemp seed oils

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The study investigated the impact of operating parameters such as temperature (90, 100, 110, 120°C), airflow rate (10, 15, 20 L h^{-1}), and sample weight (3, 6, 9 g) on the oxidative stability of cold-pressed camelina and hemp seed oils using the Rancimat apparatus. Based on the conducted analysis, a significant influence of temperature on the induction time of oils was found. Moreover, that higher airflows should be selected at high analysis temperatures. Based on the calculated parameters of the oxidation kinetics, it was shown that hemp oil had higher activation energy (Ea) values than camelina oil. Based on response surface methodology (RSM), it was found that in order to minimise the determination time of analyse for camelina oil, the following analysis conditions should be selected: SW = 3-3.5g, AF = 20 L h^{-1} and T = 120°C. However, for hemp oil, these parameters should be respectively SW = 5.5-6 g, AF = 15 L h^{-1}, and T = 120°C. In addition, the RSM analysis confirmed that the induction time depends mainly on the temperature and airflow. The sample mass does not have a significant impact on the stability in the Rancimat measurement.

Keywords: camelina oil, hemp oil, induction time, Rancimat, response surface methodology

Antidiabetic values of *Prunus padus* L. fruit and bark and their bioactive compounds - effect for alpha-glucosidase inhibitors

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The search for natural raw materials and their beneficial properties has recently become very popular. Bird cherry (*Prunus padus* L.) is a plant that grows mainly in Europe. The properties of its individual anatomical parts stem from the content of numerous characteristic compounds. The aim of the study was to assess the content of polyphenolic compounds in water extracts from the bark and fruit of bird cherry, and to assess the ability to inhibit alpha-glucosidase. It was demonstrated that ferulic acid, p-coumaric acid, hydroxybenzoic acid and gallic acid predominated among polyphenols in aqueous extracts, together with quercetin and catechin, whose presence and proportion of occurrence probably determined the inhibitory activity against alpha-glucosidase, whose activity for bark extract was determined at the level of 44.98 IC_{50} mg/mL. According to the study results, IC_{50} for acarbose was lower by more than 20-fold compared to the analyzed extracts. Bird cherry bark and fruit may be ingredients in antidiabetic preparations that support pharmacological treatment. The effectiveness of the mixtures may be due to synergism of action between active compounds.

Keywords: bird cherry, bioactive compounds, antidiabetic, alpha-glucosidase inhibition, polyphenols

Session V

„Different approaches to enhance food security and food safety”

Session Chair: PhD, DSc Grażyna Dąbrowska, Prof. Assoc. at NCU

Session Organizer: PhD Agnieszka Mierek-Adamska

Guest Speakers

1. Prof. Claudia A. Blindauer (Warwick University, UK)

„Zinc in plants: Homeostatic proteins and their potential for biofortification”

2. PhD Dragana Jakovljević (University of Kragujevac, Republic of Serbia)

„Basil improvement through tissue culture- cultivar specific response”

3. PhD Asfaw Degu (College of Natural and Computational Sciences, Addis Ababa University, Ethiopia)

„Physiological response of grapevine towards water stress"

Session V

„Different approaches to enhance food security and food safety”

In the face of a growing world population food security and food safety are one of the most important global challenges nowadays. These complex socio-economical issues are defined as the availability of sufficient quantities of safe and nutritious food for everybody, produces in sustainable way. Food security and safety are inextricably linked with the quality of food products, they include all aspects of plant- and animal-based food production, storage, and utilisation. Changing climate, growing world population, and environmental stress factors are only few existing and future threads for food security and food safety. Fighting against food insecurity should be multidimensional and diversified approaches to the problems will be present during this session.

Research subjects includes:

- current and future challenges to achieving food security and food safety,
- molecular mechanisms underneath crop yields and animal productivity,
- biofortification of crop plants as a tool for fighting against microelements deficiency,
- genetically modified organisms in the context of food security,
- food safety in the context of storage in polymer packages.

Session V – presentations

Zinc in plants: Homeostatic proteins and their potential for biofortification

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Zinc is an essential micronutrient for all organisms including plants and animals. Zinc deficiency is highly prevalent, especially amongst populations with a largely cereal-based diet. To combat “hidden hunger” (caused by diets sufficient in calories but not micronutrients and vitamins) in low-income countries, but also to move towards more plant-based diets in high-income countries, it is desirable to enhance not only total content, but also bioavailability of zinc in edible plants. The latter is strongly diminished by high levels of phytate, which is a particular problem in cereal crops.

This presentation will introduce some fundamental insights into the importance of zinc in human health, and proteins involved in zinc homeostasis in plants, before focusing on one particular class of intracellular zinc-binding proteins, namely type 4 plant metallothioneins, their biophysical properties, and their roles in zinc homeostasis and drought resistance.

Keywords: zinc, biofortification, metallothionein

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Physiological and biochemical response of grapevines towards water stress

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Drought as a result of global warming is currently a major concern for the agricultural sector, with a heavy impact at the socioeconomic level. A shortage of water resources, unpredictable rainfall, and increased average temperatures constitute the major components of the desertification process. Most of wines producing regions are experiencing high frequency of seasonal drought which eventually affects fruit development, metabolism and crop quality, i.e. the wine. In order to investigate the influence of deficit irrigation on grape physiology and berry metabolism a field experiment was conducted on two *Vitis Venifera* cultivars, Shiraz and Cabernet Sauvignon. Global and specific changes in central and secondary metabolism were assessed during the course berry development. Physiologically, the two cultivars exhibited contrasting hydraulic behaviors. CS was characterized by exploiting the soil water content to a lower extent while maintaining higher leaf water potential and reduced stomatal conductance, compared with Shiraz. Primary metabolite profiling revealed similar developmentally regulated metabolic patterns in the two cultivars. Nevertheless, towards maturity, the extent of the changes in the major organic acid and sugars (i.e., sucrose, trehalose, malate) and the precursors of aromatic and phenolic compounds, such as quinate and shikimate, was greater in Shiraz than in Cabernet Sauvignon. The comparative metabolite profiles and RNAseq analysis of two physiologically different dark-skinned grape varieties revealed the underlying commonalities and cultivar-specificities of berry metabolism and its regulation. Enhanced stress related metabolism, e.g. trehalose, stilbene and ABA in Shiraz berry-skin corroborate its relatively higher susceptibility to environmental cues.

Keywords: metabolite profiling, grapevine physiology, metabolomics, GC-MS, LC-MS

Phytohormonal balance disturbances during oat (*Avena sativa* L.) doubled haploids development

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Doubled haploids (DHs) technology allows a significant shortening of the breeding process and acceleration of new cultivars production. In oat (*Avena sativa* L.) distant crossing with maize (*Zea mays* L. var. *saccharata*) seems to be the most promising technique for obtaining of DH plants. A particularly critical step of this method is the haploid 'embryo rescue'. Anatomical cross-sections of oat haploid embryos examined under a light microscope and the endogenous profiles of phytohormones determined with UHPLC (MS/MS) were used to study the factors determining the haploid embryo development. Microscopic and phytohormonal analysis revealed that poor conversion of oat haploid embryos into plants was due to their immaturity, irregular anatomical structure as well as low content of endogenous auxins. These results may suggest some disturbances in auxin signaling. On the other hand, high levels of stress-related hormones may indicate oxidative stress occurring in the haploid embryos. Our findings are essential for further improvement of the 'embryo rescue' technique and allow for a better understanding of the mechanism of haploid embryos development.

Keywords: oat, haploid embryo, embryogenesis, doubled haploids, endogenous phytohormones, embryo anatomy

Biophysical studies of small molecule interactions with zinc binding metallothioneins from plant *Arabidopsis thaliana*

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Metallothioneins are small cysteine rich proteins. Type 4 metallothionein from plant *Arabidopsis thaliana* has two seed specific homologs, MT4a and MT4b. The proteins have been expressed in *E.coli* and the purified proteins were found to bind six zinc ions, similar to their homolog E_c from wheat and *Brassica napus*. MT4a and MT4b are found exclusively in reproductive tissue, and it is believed that these proteins release zinc to biomolecules or other proteins during seed germination to help seedling growth. Hence to get an insight of zinc transfer dynamics from these two homologs, an attempt has been made to study zinc transfer from these protein isoforms to exogenous ligands. Kinetic and equilibrium studies suggested that MT4a transfers zinc faster than MT4b, and MT4a releases metal ions more co-operatively than MT4b.

Keywords: Plant proteins, Metallothioneins, Zinc

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Acknowledgement:
Thanks to Professor Peter Goldsbrough (Purdue University, USA) for providing the expression plasmid of MT4a and MT4b. Part of the equipment used in this research was obtained through Birmingham Science City with support from Advantage West Midlands and the European Regional Development Fund. HTI thanks the University of Warwick and the Department of Chemistry for a Chancellor's scholarship for PhD studies, and UK catalysis Hub and EPSRC for postdoctoral funding.

Basil (*Ocimum basilicum* L.) improvement through tissue culture – cultivar specific response

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The establishment of *in vitro* tissue culture with the aim of production of compounds of interest in recent years has been intensified, primarily due to the efficient production of particular metabolites at significantly higher concentrations. Basil (*Ocimum basilicum* L.) plants contain many valuable bioactive compounds (including phenolic compounds – phenolic acids and flavonoids) with antioxidant activity, and basil extracts are of great practical importance in the food and pharmaceutical industries. Still, differences regarding the cultivation processes and mineral conditions lead to a significant decrease in basil yield and productivity. To address the possibility of synthesis of valuable bioactive compounds from different basil cultivars we tested different approaches of tissue culture methods in various basil genotypes. It is shown that seedling culture is a suitable method that provides, in a short period of time, significant concentrations of economically important biologically active secondary metabolites, particularly rosmarinic and caffeic acid. In addition, results showed major biochemical and physiological changes in basil plants which are related to the tested cultivar. Callus culture, cell suspension, and adventitious root culture can be successfully applied on various basil genotypes. However, growth, biomass production, and content of phenolic compounds are related to the type of tissue culture, level of stress, as well as cultivar. In the future, the use of an appropriate tissue culture method for a particular genotype is assumed to be a promising strategy to provide the quantity and quality of important biologically active compounds without the need for soil fertilization and the use of supplements.

Keywords: *Ocimum basilicum* L., secondary metabolites, phenolics, seedlings, callus, cell suspension

Funding:
This work was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia (Grant No: 451-03-9/2021-14/200122).

The expression of oat metallothioneins increases under osmotic stress

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Oat (*Avena sativa* L.) is used both in the production of food for humans and as animal feed. This species is considered as phytosanitary plant that tolerates poor-quality soils. However, water scarcity is the most limiting factor of oat growth. The aim of the research was to determine the role of metallothioneins in the tolerance of oat to osmotic stress. Metallothioneins are proteins rich in cysteine residues. They are involved in many physiological processes in the cells, among other metallothioneins protect plants from oxidative stress by scavenging of reactive oxygen species. The oat genome has not yet been sequenced therefore degenerate primers were used for PCR and RT-PCR reaction. The PCR products were sequenced and subjected to bioinformatic analysis. The amino acid sequences of AsMT1, AsMT2 and AsMT3 contained 12, 14 and 10 cysteine residues respectively. The arrangement of Cys residues was characteristic of the specific types of metallothioneins. The expression of genes encoding AsMT1-3 was checked by qRT-PCR technique in the roots and shoots of plants growing in a hydroponic culture in the presence of factors inducing osmotic stress - PEG 6000 (180 g/l) and mannitol (69 g/l). In the presence of mannitol, an increase in AsMT1-3 expression was observed in both roots and shoots, except for the AsMT1 gene in the root, where the expression did not change. In plants growing in the presence of PEG, an increase in AsMT2 expression in the shoots was found. Functional analysis in the prokaryotic system for the studied genes showed that *Escherichia coli* bacteria containing AsMT1-3 grew better under optimal conditions. Under osmotic stress induced by PEG, growth of bacteria was impaired, except for *E. coli* expressing AsMT2, which showed better growth. These results suggest the possible involvement of AsMT2 in the response of *A. sativa* to osmotic stress.

Keywords: *Avena sativa* L., metallothioneins, osmotic stress

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Funding:
Research financed from basic research activity of the Department of Genetics.

Photosynthetic productivity under fluctuating light

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World's population grows relentlessly and soon will excide the number of 8 billion people. As area of agricultural fields is limited, some agronomical innovations have to be provided to fulfill world's food demand. Crop's yield improvement can be achieved by introduction of new cultivars, obtained using various breeding methods. Not only plants' photosynthetic productivity needs to increase, continuously warming climate forces plants to adjust themselves to unfavorable conditions like droughts and heat waves, what makes the challenge even more complicated. Xantophylls cycle is the mechanisms protecting plants against damages due to high light, as zeaxanthin (qZ) is one of the components of non-photochemical fluorescence quenching (NPQ). It is biochemical process, which allows harmless dissipation of excessive excitation energy as a heat. Another component of NPQ is qE, closely related with PsbS protein which is triggered by ΔpH. Accumulation of reducing power builds up when amount of available intracellular CO_2 is insufficient to continue photosynthesis process. It happens during drought or exposition to high light intensity, when plants close their stomata to prevent further water loss by transpiration. In such conditions excessive harvested energy cause formation of reactive oxygen species and other toxic radicals. To avoid cells damage energy is dissipated in involving carotenoids reaction of NPQ. Induction of this process is almost instantaneous, but relaxation takes significantly longer time. In field conditions older, lower crop leaves are usually irradiated by the light of low or moderate intensity, so photosynthesis rate is at low to moderate level. Rapid changes in light intensity, so-called fluctuations, resulting from movement of leaves, cause periodic increases in light irradiation and instead of using it in photosynthesis, energy is dissipated in NPQ. It was shown (Kromdjik et al. 2016, Grieco et al. 2020) that dynamics of NPQ under fluctuating light is crucial for crops productivity. Acceleration of NPQ relaxation may reduce crop looses up to 15%. Here we analyzed response of model plant Arabidopsis thaliana wild type (wt) and it's NPQ mutants (npq1 and npq4) exposed to illumination of light fluctuations (LF) (55/530 mmol m^{-2} s^{-1} PAR) in comparison to constant light of intensity of 280 PAR. We focused on parameter of quantum yield of regulated energy dissipation (Y(NPQ)), which represents the amount of energy dissipated as heat in reaction of NPQ. As to evaluate contribution of various components of NPQ in the process of dissipation of fluctuating light energy we used mutants of Arabidopsis thaliana lacking zeaxanthin and PsbS protein. Measurements were taken under controlled laboratory conditions using PAM fluorometer. Our results indicate that dissipation of constant light irradiance differs in term of dynamic to dissipation of light fluctuations of similar average intensity. There were significant differentiations in response to LF of mutants lacking zeaxanthin and PsbS, especially clear during initial period of irradiation. Npq4 mutant lacking PsbS was characterized by the strongest inhibitor of the changes in Y(NPQ) with the switch from low to high light.

Keywords: photosynthetic productivity, light fluctuations, drought stress, NPQ

Innovative biodegradable films with birch tar for plant protection

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Cultivated plants, during growth and after harvest, are exposed to diseases caused by microorganisms, which reduces the harvest and worsening their quality and increases plant production costs. The World Food and Agriculture Organization estimates that losses in plant production caused by plant diseases and pests amount to approximately 30% annually worldwide. The aim of the research was to develop a method of obtaining innovative polylactide (PLA) films with anti-fungal properties. PLA films containing 1%, 5% and 10% tar addition, a product of dry distillation of bark and birch wood, were produced using the solvent method. The innovative films were characterized by a brown color, the intensity of which depended on the content of tar. The films were characterized in terms of their selected physicochemical properties. The tests carried out in accordance with ISO 846 showed the antifungal activity of the new tar films against the pathogens of cultivated plants, *F. culmorum* and *B. cinerea*. In the presence of tar film, the growth of *F. culmorum* was inhibited more strongly than that of *B. cinerea*. As the tar content in the polymer matrix increased, the antifungal properties of the produced polymer materials increased. Pathogen growth was most severely limited in the presence of film with 10% tar content. The results of the research indicate that the new materials can be used as films for use in agriculture and horticulture to protect crops against the adverse effects of fungal plant pathogens.

Keywords: birch tar, biodegradable films, plant protection, agricultural quality, antifungal properties

Funding:
The project "Innovation Incubator UMK_4.0" implemented under the Ministry of Education and Science called. "Incubator of Innovation 4.0" as part of a non-competitive project entitled "Support for the management of scientific research and commercialization of R&D results in research units and enterprises", implemented under the Intelligent Development Operational Program 2014-2020 (Measure 4.4), co-financed by the European Regional Development Fund.

Seed germination, antioxidant enzymes activity, proteins, and sugars content during *Brassica napus* L. development

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Ensuring food security still requires the development of new methods to increase crops yield. Understanding the mechanisms underlying processes such as plant flowering and seed development are essential for yield increasing. Oilseed rape (*Brassica napus* L.) is an important oil crop in the world, greatly contributes to providing animal feed, edible vegetable oils, and biodiesel. The aim of this study was evaluation the germination power of rape seeds at different stages of development and their biochemical characterization. Seeds samples at different stages of development were collected on 35, 56, 63, 70 and 80 days after flowering. The proteins, sugars, and phenolic compounds concentrations and antioxidant enzymes activity: peroxidase (POD), catalase (CAT), and superoxide dismutase (SOD) were analysed. The results of this experiment indicate that during seed development, the highest germination rate (92%) was recorded at 80 days after flowering, 20-fold higher than at earlier stages, whereas the highest content for proteins, sugars and phenolics were observed at 70 days after flowering. Furthermore, it is demonstrated that among examined antioxidative enzymes, only POD activity decreases while germination percentage increases during seed development. These results suggest that differential regulation of proteins, oligosaccharide metabolism and enzymatic antioxidant defences occurs between different developmental phases o *B*. *napus* L. seeds. Better understanding of this differential regulation will lead to improve rapeseed quality and productivity.

Keywords: *Brassica napus*, seed development, food security, antioxidant enzymes

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Funding:
The research was financed by the Nicolaus Copernicus University fund for basic research activities.

Session V – posters

Aquaporins of *Coffea arabica* – putative functions identified by promoter *in silico* analysis

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Aquaporins (APQs) belong to the major intrinsic protein superfamily. These proteins play an important role in the transport of water, gases and other small molecules across cell membranes. Coffee is one of the most important global agricultural export commodities. *Coffea arabica* is the allotetraploid with 44 chromosomes, and it is the result of hybridization between the diploids *Coffea canephora* and *Coffea eugenioides*.

On the basis of sequences contained in the NCBI genome of *C. arabica* identified 52 putative aquaporin genes assigned to five subfamilies including 10 plasma membrane intrinsic proteins (PIP), 13 tonoplast intrinsic proteins (TIP), 20 NOD26-like intrinsic proteins (NIP), 4 small basic intrinsic proteins (SIP), and 5 X intrinsic proteins (XIP). *In silico* analyzes of the promoters of the *C. arabica* aquaporin genes were performed using the PlantCare database. The *cis*-elements of the light response (G-box, Box4, TCT-motif, GATA, I-box, ACE, GT1, Sp1, MRE, 3AF1) were the most abundant in the *CaAQP* promoters. Apart from the light response elements, ABRE sequences were present in almost all the analyzed promoter sequences - the abscisic acids responsiveness, ARE - essential for the anaerobic induction. 85% of *CaAQP* promoters contain a *cis*-element involved in the MeJA responsiveness (CGTCA and TGACG sequences). The following elements are often found in CaAQP promoter sequences: TGA, AuxRR- auxin responsive elements, P-box - gibberellin responsive elements, LTR – low temperature, O_2 site – zein metabolism regulation, AACA-motif – element involved in endosperm expression, RY-element - seed specific regulation, HPZIP1 – differentiation of the palisade mesophyll cells, CIRCADIAN – circadian control, MSA – cell cycle regulation. More than half of the studied *CaAQP* genes in promoters contain the *cis*-element MBS - MYB binding site involved in drought inducibility.

This study was the first to characterize promoters of aquaporin genes in *C. arabica*. *In silico* analyzes showed that *CaAQPs* play major roles in the regulation of plant water balance, as well as in growth regulation and response to abiotic stress factors. This study, provide insights for biotechnological approaches to increase tolerance to drought.

Keywords: Aquaporins, *Coffea arabica, in silico* analyzes, promoters, water channel

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Biodegradable tar film to protect food

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The interest in organic food is growing year by year. Simultaneously with this process, the demand for ecological products in the area of production of polymeric materials for packaging such food is increasing. Packaging made of foil containing a natural substance with properties limiting the growth and development of microorganisms, especially those adversely affecting human health, is appearing on the market more and more. In this study, a new polymer material (PLA) was analyzed in order to extend the shelf life of food. Tests in which tar films were used to package bread and lettuce showed that these products remained fresh for a longer period compared to products packed in unmodified films (without tar). Microbiological analyzes of both the food and the foil used for packaging showed the absence of microorganisms after two weeks of storage. On the other hand, in the case of unmodified film, microorganisms were present after 7 days of bread storage. The above research is aimed at limiting the use of preservatives, which will allow the production of food with higher nutritional and health-promoting values. The results of the analyzes show that the polymer material with tar can be used in the food and packaging industry.

Keywords: biodegradable films, birch tar, protect food

Funding:
The project "Innovation Incubator UMK_4.0" is implemented under the program of the Ministry of Education and Science entitled "Incubator of Innovation 4.0"(contract number MNISW/2020/331/DIR) as part of the non-competitive project entitled "Support for the management of scientific research and commercialization of the results of R&D works in research units and enterprises", Intelligent Development Operational Program 2014-2020, Measure 4.4, co-financed by the European Regional Development Fund.

Effects of rapeseed humidity on oil quality

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Refined rapeseed oil's high smoke point make it one of the best oils for frying and baking. Cold-pressed rapeseed oil, which is suitable for consumption without thermal treatment, is increasingly widely available. Research into rape varieties that yield oil with the best properties has been ongoing for a number of years. Both the variety of rape and the quality of the seeds used for pressing is crucial if oil of good quality is to be obtained.

Oil quality is determined by the degree of maturity, contaminant content, damaged seed content, seed moisture during storage and after harvest, and storage conditions. Low-quality seed can have low oil yield with increased contamination with phospholipids (especially nonhydrating phospholipids), free fatty acids, dyes (especially chlorophyll), and auto-oxidation products. The process of rapeseed germination also has a significant impact on the quality of the oil.

This experiment compared the quality of oil obtained from germinating and nongerminating rapeseeds. Comparing the acid value of oil from germinated seeds with that from ungerminated seeds, it can be stated that rapeseed oil from germinated seeds is not suitable for consumption, due to its excessively high level of free fatty acids. At the same time, the levels of tocopherols and sterols in the sample decreased, which lowered the bioactive value of the product. In the case of germinated seed oil, the level of canolol phenolic compounds was also lower.

Keywords: rapeseed oil, seed germination, oil quality

In silico analysis of gene and promoter sequences of metallothioneins type 4 in mono- and dicotyledons plants

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Metallothioneins are low molecular weight proteins containing a large number of cysteine residues capable of binding heavy metals. They increase the nutritional value of plant raw materials, while protecting plants against the negative effects of environmental stresses, including drought. In plants, due to the arrangement of cysteine residues, metallothioneins are divided into 4 types. Metallothioneins type 4 (MT4) are a particularly interesting type of MT. These proteins are specifically expressed in seeds and in early stages of seedling growth. MT4 was characterized in detail in *B. napus* L. In this study, 25 MT4 amino acid sequences were analyzed *in silico* (10 in monocotyledons and 15 in dicotyledons, including 7 trees). To determine the putative functions of these genes, 25 promoter sequences of MT4 genes were analyzed using the PlantCARE database. The amino acid sequences were examined for the content and arrangement of cysteine residues. It was found that the percentage of cysteines in the amino acid chain of the studied MT4 was in the range of 15–21%. Cysteine residues in the analyzed amino acid sequences were grouped into three separate domains. *In silico* analysis showed that *cis*-elements of the heavy metal response are located in all analyzed promoters. The CuRE motif involved in the plant response to the presence of copper ions was present in the promoters in multiple copies. This suggests that type 4 metallothioneins are responsible for the plant response to the presence of this element. Apart from the elements responsible for the response to metals, the most frequent elements in the analyzed promoters were the regulatory elements of the response to light and abiotic stress. In some of the analyzed promoters, putative regulatory elements specific to the development of organs and cells as well as cell cycle control were found. The analyzed promoters contained *cis*-elements of the response to phytohormones (abscisic acid, gibberellins, auxins) and the regulation of the circadian rhythm. Elements responsible for the response to heavy metals dominated in monocots and trees. In dicotyledonous plants, on the other hand, elements responsible for the response to light accounted for a higher percentage. Drought response *cis*-elements were found in monocotyledonous plants in seven promoters and in dicotyledons in eight promoters.

Keywords: metallothioneins, *cis*-elements, monocotyledons, dicotyledons, trees, heavy metals

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Funding:
The research was financed from the project “Universitas Copernicana Thoruniensis In Futuro – the modernisation of Nicolaus Copernicus University” as part of the Integrated University Programme (project No. POWR.03.05.00-00-Z302/17-00) being conducted as part of the Knowledge Education Development Operational Programme.

Contribution to the valorization of some varieties of local cereals from Khénifra and Tétouan regions in Morocco

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The Moroccan diet is of Mediterranean type, characterized by biological and cultural diversity and a culinary heritage allowing to save in Moroccan cuisine diversified dishes based on a complementarity between different food groups of which the most present group is that of cereals and cereal products.

Objective: The objective of this work is to contribute to the identification and the study of knowledge on certain local cereals as well as their use in traditional dishes in two regions of Morocco: Khenifra and Tetouan.

A survey was carried out in two regions, the province of Khénifra in the Middle Atlas and the province of Tétouan in northern Morocco. The survey involved a sample of women and men from 250 urban and rural households in the two provinces. Using a focus group, information was also collected on the cereals' ethnobotanical and culinary knowledge, the period of consumption, uses as well as a description of the recipes that include them, and their consomption now or in the past.

The results show that more than 40 traditional recipes have been recorded, where local cereals are the main ingredients, especially durum wheat, common wheat, barley, white corn and red corn. Most of the cereals mentioned are eaten frequently, others are less so. Participants report that the latter grains were previously consumed and used in recipes consumed during times of food shortage. A significant diversity of traditions and culinary culture is observed and can explain the dietary diversity observed in the two regions studied, hence the need to enhance by nutritional analyzes on each variety to save this richness.

Conclusion: The results of the study are discussed in relation to the content of each variety analyzed in nutrients in comparison with conventional varieties. These data contribute to the nutritional value of these cereals and the culinary preparations of the dishes which includes them. The enhancement of these varieties would help diversify food, encourage the consumption of local products and fight against the loss of local cereal heritage.

Keywords: cereals, variety, local, nutritional valorisation, diet diversity

Tar: historical material - modern approach in innovative technologies

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Tar is a polymer of natural wood origin. It is a product of the dry distillation of wood with a very high viscosity and a specific, intense smell of burnt wood, reminiscent of fire. Tar has been used in the past for wood preservation, medicine, and technical applications, in food and textiles, like personal care products. Tar is found in many archaeological sites not only in Europe, but also on other continents. Advanced technology was used for its production in the past. This proves the great importance and popularity of this product in the past.

Currently, we are returning to natural forest products in various areas of life. We are looking for the possibility of replacing petroleum products with natural ones. Historical products which, due to their natural origin, are making a comeback are potash, charcoal, and wood tar. Wood tar was and is known for its salutary and healing properties. Along with the latest analytical method for determining its chemical composition and specific properties, including antioxidants, tar can find its place in the modern world and replace synthetic substances with similar properties used in the food industry, wood protection, and cosmetics. In this research, we want to identify new ways to use the material that mankind has used for centuries, but it is not fully used in our time.

Keywords: tar,chemical composition, properties, utilisation

Phytochemical composition and antioxidant activity of children-dedicated low-volume beverages enriched in *Cornus mas* L., *Berberis vulgaris* L. and *Prunus spinosa* L. fruits

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Low-volume beverages, commonly known as “vitamin shots” are drawing raising consumers’ attention every year. The high content of vitamins and polyphenols in them results from usage of super-foods ingredients. The scope of the work was to design vitamin shots dedicated for children with use of rare-known plants: cornelian cherry (*Cornus mas* L.), barberry (*Berberis vulgaris* L.) and blackthorn (*Prunus spinosa* L.). The obtained shots were observed as high anti-oxidant scavenging actors and rich source of anthocyanins and flavonoids. The highest results were noted for sample enriched in cornelian cherry and blackthorn: 6.83 mg C3G/L and 101.48 mg QE/L for sample GDJH.

Keywords: functional food, antioxidant properties, low-volume beverages

Funding:
The research was realized as a part of the Project: “Novel line of low-volume <<shot>>-type products based on fruit juices with concentrated nutritional value, dedicated for children”, realized as a part of The Project “Innovation Incubator 4.0”, implemented under the non-competition project established by the Minister of Science and Higher Education entitled "Support for the management of scientific research and commercialization of R&D results in research units and enterprises", co-financed by the European Union under the Intelligent Development Operational Program 2014–2020 (Measure 4.4).

Comparison of grain composition of oat doubled haploids and oat × maize addition lines

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The oat (*Avena sativa* L.) production currently ranks sixth in the world grain production statistics following corn, wheat, barley, sorghum, and millet. This important crop is used not only as cattle feed, but also for the production of pharmaceutical products and biomaterials. The use of oat in the human diet is mainly due to the rich nutritional value of oat grains and their proven health-promoting properties. In the production of oat doubled haploid (DH) lines by crossing with maize it is possible to find lines with added maize chromosomes. Such oat × maize addition (OMA) lines are frequently stable and fertile hybrids. So far, differences in plants morphology, leaf anatomy, cell membrane structure and variation in functioning of the photosynthetic apparatus among DH and OMA lines were reported. Our experiment was performed in order to compare the nutrition value of obtained DH and OMA grains. Thus, the proteins, fat, β-glucan, soluble sugars, phenolic compounds content and total antioxidant activity were determined in the dry matter of grains. The obtained results demonstrate differences in the chemical composition among tested DH and OMA lines. The highest amount of β-glucan and soluble sugars were observed in the DH lines, while the content of proteins was higher in the OMA lines. The content of fats, phenolic compounds, and antioxidant activity remained at a similar level in both kinds of lines. This is the first report where the nutritional values of grain produced by the DH and OMA lines were compared.

Keywords: *Avena sativa* L., grains, DH lines, OMA lines, nutrition value, antioxidant activity

Funding:
The research was funded by The National Centre for Research and Development, PBS3/B8/17/2015.

Is tap water healthy and safe? The view of Polish consumers.

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Water, as the basic component of the human body, is one of the most important elements of the daily diet. The growing awareness of environmental pollution, including the production of plastic packaging, contributed to a noticeable increase in interest in tap water consumption. Dietary water deficiency can lead to negative health consequences. Ease of access to drinking tap water seems to be a solution for water deficiency in the diet, but tap water is not everyone's preference.

Bottled water consumption continues to rise in many countries. The production of 1 liter of bottled water requires about 2,000 times more energy than producing 1 liter of tap water. Bottled water production is related to the emission of approximately 1 kg of CO2 to the environment and the consumption of 3 liters of water.

The aim of the study was to determine consumers' opinions on the safety and health of tap water drinking in Poland.

The study was conducted using the proprietary questionnaire. The survey was conducted online in the first half of 2020. The respondents were people aged 18-95 living in Poland. For statistical analysis, data from 2888 respondents were included.

Most people use tap water for cooking food (n = 2575, 89%) and preparing hot drinks (n = 2527, 86%). Before drinking the tap water, 575 participants boil it (20%). The main reason for this is the presence of impurities coming from the fittings (n = 507, 17,55%). The vast majority declared that drinking tap water is safe (n = 1539, 53%), but 557 participants declared that it is safe only after filtering (19%). Not all respondents also declared knowledge about the tap water treatment and periodic water quality tests. The respondents declared insufficient knowledge about the safety and health aspects of drinking tap water in Poland.

To conclude it is to state that the opinion of consumers in Poland about the safety and health of drinking tap water is varied. Despite the majority of Polish consumers state that tap water drinking is safe, still two fifths of Poles boil or filter it before drinking. Tap water is often used for consumption but is not the sole source of drinking water. It is recommended to increase nutritional education in order to raise awareness of the environmental impact of bottled water production and health aspects of drinking tap water and its safety in Poland.

Keywords: water, drinking water, tap water, bottled water, environment pollution

Consumer preferences regarding the type of fortified vegetables

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Iodine and thiamine are essential nutrients for the proper functioning of the human body. Iodine deficiencies are common in the world due to specific circulation of iodine in the environment and problems with its supply with the diet. Salt iodization is one of the most common and effective programs to prevent its deficiency. However, after the WHO decision in 2007 to limit salt intake to 5 g per day, concerns arose about the effectiveness of the current prophylaxis model based on table salt iodination. Thus, there was a need to search for new, equally effective carriers of iodine salts. When designing this type of carriers, it is necessary to take into account the instability of thiamine in the presence of iodine salts, which cause its oxidation to its inactive form. Vegans are particularly vulnerable to deficiencies in these nutrients due to dietary restrictions. The aim of the study was to assess preferences of people on a vegan diet to the consumption of vegetables enriched with iodine and thiamine. The measurement was made on the basis of the proprietary questionnaire. The study involved 676 people declaring the use of a vegan diet, including 386 women (57%) and 290 men (43%). The respondents were asked about the frequency of consumption of various types of vegetables, the frequency of consumption of the vegetables after heat treatment and their opinion on the willingness to eat vegetables enriched with iodine or thiamine. On the basis of the obtained results it was found that the most frequently consumed vegetables were carrots and potatoes and the most frequently declared thermal treatment of vegetables was boiling them in water. Approximately 75% of the respondents declared the will to eat vegetables enriched with thiamine, and more than 60% of those enriched with iodine. The most preferred enriched vegetable was carrot, both in the case of iodine and thiamine. The obtained results may be helpful in planning research aimed at placing vegetables fortified with iodine or thiamine on the market and products with their addition.

Keywords: fortification, vegetables, iodine, thiamine, consumer preferences

Session VI

„Urban soils – Towards to sustainable use and management”

Session Chair: PhD Piotr Hulisz, Prof. Assoc. at NCU; PhD Przemysław Charzyński,

Prof. Assoc. at NCU

Session Organizer: MSc Sylwia Pindral

Guest Speakers

1. PhD Hadi Pirasteh-Anosheh (National Salinity Research Center; Yazd, Iran)

„Biosaline Agriculture: A system for Rereading Environmental Resources”

2. Prof. Tatiana V. Prokofieva (Lomonosov Moscow State University, Russia)

„Importance of soil physical properties for urban soil management strategy"

3. PhD Remigio Paradelo Núñez (University of Santiago de Compostela, Spain)

„Knowledge of urban soils morphology and properties for sustainable land use in the city”

Session VI

„Urban soils – Towards to sustainable use and management”

Nowadays, 55% of the world’s population lives in urban areas, a proportion that is expected to increase further. During the development of cities, fertile soils, predominantly used for agricultural purposes and providing a wide range of ecosystem services such as food and biomass production, dilution, filtration and sequestration of pollutants, nutrient resources, storing genetic materials, and use for recreation, information and knowledge archives are being transformed into SUITMAs (soils of residential, traffic, industrial and commercial areas). The designation of new places for settlements usually leads to the soil degradation and a loss of valuable soil resources. That is why monitoring of changes in urban soil cover, reasonable spatial planning and protection of the soil environment are important aspects of an effective urban management, especially in relation to the potential and possibilities of producing food in cities.

Research subjects includes:

- ecosystem services provided by SUITMAs,
- urban agriculture challenges,
- soil hazards in the city,
- urban soils management strategies.

Session VI – presentations

Anthropogenic soils in the context of elements circulation in urban environment

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The contemporary city is complicated system of areas under the different form of use. A part of the urban total area is dedicated to land cultivation and green areas construction. The cultivated areas are strongly dependent on soil conditions. In urban areas these conditions are varied, modified by different human activities and partly possible to being improved or changed. There are soils with diversified structure as well as chemical, physical and physico-chemical properties. Some of them exhibit morphology and properties similar to those found outside urban areas. Others are characterized by various anthropogenic transformations (Greinert et al., 2013; Greinert, 2015; Hulisz et al., 2018). Mechanical transformations of the soil profile are commonly found. Most often, they result in mixing soil horizons or layers vertically and horizontally, and addition of foreign materials to the soil, mainly municipal and C&D (construction and demolition) waste. The deposition has often a layered structure, which strongly changes the conditions of migration of water and components in the soil. The phenomenon of the soil profile shortening, usually by removing the humus horizon is frequently observed in investment areas. In shallow soils, just the bedrock can be left, so the soil practically ceases to exist. Covering the profile with solid materials (bituminous, concrete surfaces, cobblestone or precast cubes on cement ballast) or loose ones (organic or mineral) dramatically changes the circulation of matter and redox conditions in soil. Finally, the compaction of soil horizons by heavy construction equipment changes the rate and direction of movement of water and chemical elements in soil.

The main characteristics of soil makes the cultivation conditions heterogeneous, even not expected for an observer today. Based on data from Zielona Góra, the texture of urban soils is mainly sand and loamy sand, with a very different skeleton content – 0-96%, bulk density in a range from 1.20 to 1.84 $g \cdot cm^{-3}$, total N content from trace content to 0.56%, TOC 0.2-6.4%, C:N 6-40, pH 3.5-8.6, CEC 0.9-30.9 $cmol \cdot kg^{-1}$ and BS 32-100%. Very different characteristics are noted not only in different soils, but also in different horizons, even located close to each other in one soil profile. Some of the urban soils are also contaminated with different chemical elements and compounds. Nitrogen in agroecosystems is one of its basic resources in terms of the possibilities of farming and livestock husbandry. Both, natural and human induced impacts affecting the nitrogen inflows, outflows and deposits in the urban environment. As a part of international NCN project UNCNET, the circulation of nitrogen in Zielona Góra has been investigated. There were observed differences between the City of Zielona Góra and the Zielona Góra New District in context of nitrogen inflows, outflows and stock. One can notice a number of characteristic features, especially for the built-up part of the city. They result both from legal restrictions on the use of urban areas (fertilizing with mineral compounds and pre-prepared horticultural materials only), as well as different needs of the city (cultivated land in a form of green areas and allotment gardens) in relation to typical rural areas and other open landscape. The problem is the precise identification of nitrogen migration routes from cultivated soils to waters, mainly due to the complicated land use and soil spatial systems as diverse formation of anthropogenic horizons in soils as well.

Keywords: Technosols, Anthrosols, N circulation, grain-size composition, water regime.

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The impact of metallic trace elements on the soil physicochemical and microbial properties in the vicinity of abandoned mines

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Mining activities constitute a serious risk for all the environmental components and pose a global ecological challenges. This industry release high levels of metallic trace elements (MTE) into the surrounding soils threating their physicochemical and microbial properties. The purpose of this work is to study the impact of MTE of mine tailings on both the physicochemical and the microbial properties of the soil in the vicinity of abounded mines, by reviewing the most relevant papers to the subject. According to the results of many authors, contaminated soils in mining areas are usually characterized by an acid pH, deficiency in organic matter (6.83±0.54%), low nutrient content, high electrical conductivity (EC) (average value of 6478 $\mu S \cdot cm^{-1}$), and more importantly high levels of MTE, for example the average concentrations of MTE in mining tailings of the abandoned sphalerite mine in Chengde (China) were: 31.1 (Cd); 77.1 (Cr); 302 (Cu); 4.46×10^3 (Fe); 0.52 (Hg); 4.77×10^4 (Mn); 2.86×10^3 (Pb) and 7.65×10^3 (Zn) $mg \cdot kg^{-1}$, exceeding the reference concentrations of non-contaminated soils. Since they're known by their toxicity, persistent, and bio-accumulative properties, MTE affect negatively the microbial communities of the soil surrounding mining areas, through the decrease of the soil enzymes activity (mainly dehydrogenases, urease and phosphatases), the disturbance of their structure, as well as the reduction of the microbial biomass, density, and soil respiration, causing an intensive negative selective pressure leading to the establishment of MTE resistant microbial populations and consequently decreasing the soil diversity. The study of the contaminated soils from mining sites allows us to understand the real risk of MTE on the ecological system including the soil and microorganisms, and open new perspectives to develop recovery strategies at different levels, among them the use MTE resistant species as a tool for the bioremediation of degraded soils in the mining areas.

Keywords: mining activity, metallic trace elements, metals toxicity, microorganisms, soil properties

Effect of natural and synthetic antifungal substances on soil fungal assemblages

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To protect the soil and water environment against adverse effects of pesticides new EU program, Green Deal was launched recently. One of its strategies is to replace high-risk xenobiotics with products based on active substances present in plant extracts or with products containing microorganisms or insect pheromones. After a thorough revision, of all pesticides available for farmers in the past 25 years, more than 600 active substances were withdrawn so far.

The main objective of our study was to determine the effect of a new formulations based on active substances (AS) of natural origin on soil microbiota and compare their performance with commercially available fungicides.

Out of four AS naturally present in plants of *Brassicaceae* (p coumaric acid, ferulic acid, rutin, and quercetin purchased from Merck), p-coumaric acid (p-CA) showed the best antifungal characteristics against *Fusarium solani, Fusarium oxysporum, Fusarium culmorum, Botrytis cinerea, Alternaria alternata, Phoma lingam,* and *Sclerotinia sclerotiorum*.

Based on the results of minimal inhibitory concentrations and minimal fungicidal concentrations, p-CA-containing formulation (final concentration in soil 9.1 $\mu m/g_{wet\ mass}$) dissolved in Dassoil (0.2% v/v) was prepared. This plant protection product, as well as classical fungicide Porter 250 EC (Innvigo) with difenoconazole, at the manufacturer's recommended dose of 0.6 l/ha, were applied to garden soil in laboratory conditions to assess and compare their impact on the soil microbiome that is crucial for soil health. Fungal community composition were studied with the Next Generation Sequencing (NGA) of the Internal Transcribed Spacer (ITS) using MiSeq (Illumina).

Our research showed that the two examined formulations had no negative effect on fungal diversity indices (Shannon-Wiener, Simpson) in soil neither at the time of application nor after two weeks or one month. However, detailed analyses revealed that both plant protection products significantly altered the structure of fungal communities at any of the times examined (T0, T14, T28). The greatest effect of the formulations was noted after four weeks of treatment. Two ASVs assigned to *Chromelosporium* and *Botrytis,* recognized as plant pathogens, as well as unidentified ASV from *Diversisporales* (arbuscular mycorrhizal fungi), were significantly depleted in soil samples treated with p-CA compared to difenoconazole and *Lasiosphaeris* was enriched.

Keywords: fungi, biodiversity; p-coumaric acid; difenoconazole; fungicides, NGS, ITS

Funding:
The research was financed by the Universitas Copernicana Thoruniensis in Futuro - modernization of the Nicolaus Copernicus University as part of the University's Integrated Program. Project number: POWR.03.05.00-00-Z302 / 17-00 of 08.12.2017

Knowledge of urban soils morphology and properties for sustainable land use in the city

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Urban soils are an insufficiently recognized resource for the conception and construction of sustainable cities: they are primary components of cities and main supports and suppliers of a large range of ecosystem services, but their properties are very rarely taken into consideration in urban planning. However, soil scientists and urban planners should cooperate in order to guarantee the best possible use of natural resources. Similarly to what happens in agricultural or forest areas, the availability of a thorough knowledge of soil morphology and properties is a very valuable tool also in the cities. In this sense, relevant information would include soil fertility, the presence and concentrations of pollutants, physical properties and compaction, soil depth or organic matter contents. These aspects will be discussed in the presentation using examples taken from the city of Santiago de Compostela, in northwestern Spain.

Keywords: urban soil, pollution, urban agriculture

Assessment of agricultural land losses related to the city's territorial expansion using the pedodiversity index

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Pedodiversity is referred to as a variation of soil properties, units, or types within an analyzed area (Ibáñez et al., 1995). In this study, we used our original approach to urban pedodiversity analysis based on the landscape metrics (Pindral et al., 2020). The research was conducted in Inowrocław, a medium-sized city located in north-central Poland. The aim was to assess agricultural land losses related to the city's territorial expansion during the 20th and 21st centuries using the pedodiversity index (PI) (Pindral et al., 2020). Based on GIS techniques and statistical analyzes, we provided maps of land cover changes and urban pedodiversity.

The results showed that the total area of agricultural land was decreased decades by decades from 70.5% in 1934 to 47.1% in 1978, and to 37.5% in 2016. This implies that between 1934 and 1978 8.78 km^2 of the most fertile soils (Mollic Gleysols, Mollic Phaeozems) were transformed into land intended for purposes other than agriculture, i.e. buildings, industry, and urban greenery (> 2 km^2 each). Between 1978 and 2016, a significantly lower decrease of arable land was recorded (4.02 km^2). In 1934, the highest values of the pedodiversity index (PI 10-12), linked to the strong anthropogenic soil transformation, were recorded in 15.9% of the city area while it was 17.3% in 1978 and 20.9% in 2016. The increase in the highest values of the PI index was inversely correlated with the decrease in the share of agricultural areas (in total over 14 km^2, which is almost 1/3 of the present city area) and the increase in the fragmentation of the soil cover structure. Finally, it can be concluded that the proposed index may be useful not only for the assessment of soil transformations but also for the assessment of dynamics of the city's spatial development. Therefore, the proposed procedure can be useful for decision-makers to manage the urban space, especially to prevent the spread of uncontrolled built-up areas.

Keywords: city development, soil degradation, SUITMAs, urban soil mapping

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Biosaline agriculture: A system for rereading environmental resources

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Due to limited fresh water and improper use of soil and water resources, the quality and quantity of the resources have experienced a declining trend. As a result, less quality of water and soil lead to reduced production in different areas of the world. One of the practical approaches for sustainable use of resources is to change the attitude towards the huge saline water resources and use in biosaline agriculture systems. Biosaline agriculture or haloculture is briefly defined as “economic and sustainable use of very saline environments”. In fact, biosaline agriculture is a sustainable and economical approach to exploitation of high saline water and soil resources with emphasis on environmental aspects. In these systems, unusable soil and water resources in conventional agriculture are used in saline environments to produce some plant, animal and aquatic and algae species. The main components of biosaline agriculture systems are species of halophyte, livestock, aquatic, and algae, resource of water and soil and socio-economic conditions of the region. The most important component of biosaline agriculture is halophytes; plants with the ability to grow in saline environments due to their high adaptability and different tolerance mechanisms. In this presentation, I enumerate the important components by introducing the biosaline agriculture system. In the following, I review the successful examples of biosaline agriculture systems in the world and point to the institutions active in this field.

Keywords: haloculture, halophyte, saline, sustainable

Importance of soil physical properties for urban soil management strategy

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The United Nations has announced a Decade on Ecosystem Restoration from 2021-2030. The soil cover is one of the significant part of ecosystems. The importance of soil physical properties for the development of plants and other soil-living organisms requires special attention for them when studying urban soils and restoring ecosystems in urban areas.

The objects of the study were clay and loamy soils of Moscow and other cities of the Russian Federation with previously unexplored soil cover (Syktyvkar, Krasnodar, Maykop, Sochi).

The features of the physical properties for the diagnostic horizons previously identified by morphological properties were found. Attention is drawn to the difference in the physical properties of the horizons of re-deposited materials untreated by soil formation and humus horizons of soils which were formed gradually on the soil surface exposed to sunlight. Horizons of both types differ from the natural soil horizons and sediments in density, penetration resistance, and saturated hydraulic conductivity.

The trends found for the soils of Moscow are confirmed by studies in cities of various natural zones. The density of human-made and natural horizons of sediments is higher than the density of humus urban soil horizons. The hydraulic conductivity is lower. The conditions for the occurrence of cases of very high infiltration rates are formed in old urban soils with a large thickness of humus horizons and a significant amount of waste inclusions.

The trends of both improvement and deterioration of some physical properties of the horizons of reclaimed soils over time have been detected. The improvement is due to the activity of root systems and soil animals. Deterioration is as a result of people recreation and urban atmospheric fallouts (dust).

Modern methods of urban soil management in the Russian Federation include constant soil material change and soil reclamation. A large number of young reclaimed soil-like bodies human-constructed on the technogenic sediments of the city make the study of physical soil properties especially relevant.

Keywords: Urbic Technosols, diagnostic horizons, bulk density, saturated hydraulic conductivity, penetration resistance, urban soil reclamation, ecosystem restoration

Funding:

This research was performed according to the Development program of the Interdisciplinary Scientific and Educational School of M.V. Lomonosov Moscow State University ‘The future of the planet and global environmental change’. The study was supported by the Russian Foundation for Basic Research: Projects №№ 19-04-01298 (the study of general trends in the formation of physical properties of urban soils) and 19-29-05252 (study of the properties and short-term evolution of constructed soil-like bodies).

Child risk assessment of selected metal(loid)s from urban soils using in vitro UBM procedure

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In city agglomerations significant pollution results from fossil fuel combustion from heat and power plants, transportation, and boilers in households. In this context, pollution from recalcitrant, environmentally accumulative metal(loid)s can be a critical human health risk. In day-care centers, playgrounds, kindergartens, schools, and sport facility areas children may ingest significant quantities of potentially polluted soil and dust, increasing incidence of health disorders or diseases. The objective of this study was to assess the oral bioaccessibility and human health risk of As, Cd, Pb, Cr, Ni, Cu, and Zn from potentially polluted urban topsoils by applying gastrointestinal Unified Bioaccessibility Method (UBM) protocol. Total content of studied elements was relatively low and none of studied elements exceeded Polish legal limits for urban soils. According to the Enrichment Factor (EF), studied sites were characterized from minimal to significant degrees of soil pollution by analyzed metal(loid)s in the order: Pb>Zn>Cu>Cd>As>Ni>Cr. Concentrations of the metal(loid)s in bioaccessible phases were varied, and higher for gastric than gastrointestinal bioaccessibility. Metal(loid) bioaccessibility in soils of Bydgoszcz was highly correlated with total concentration. Almost no correlation was found between concentration of these phases and parameters like soil pH, texture, $CaCO_3$, TOC, or CEC. A relationship did exist with landform where the lower positions had greater concentrations. These locations are those with the highest traffic density and operation of old coal heating systems leading to the highest deposition of airborne contaminants. Higher landscape positions are favored for new facilities in newer residential districts. Exposure and health risk from soil ingestion given normal ingestion scenario at any site investigated was very low. Non-carcinogenic and carcinogenic risk was identified only for soil pica behavior. Soil pica ingestion scenario might be considered for children with lapses of adult.

Keywords: urban soils, bioaccessibility, heavy metals, pollution, risk assessment

Session VI - posters

Selected properties of agricultural used soils in the city of Rzeszów

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The progress of civilization is inherently connected with the development of cities and the expansion of urban infrastructure. The result of this condition is an increase in the built-up area and, consequently, a reduction in the acreage of arable soils, often of very high agricultural value. Nevertheless, within the administrative boundaries of most cities, it is possible to find areas used for the production of agricultural products. However, the proximity of many sources of undesirable substances emission creates the possibility of soil contamination and a threat to the quality of the harvested crops. This is also the case in Rzeszów, the main urban-industrial center in south-eastern Poland.

The aim of the research was to assess the quality of agricultural soils located within the administrative boundaries of Rzeszów. 24 research points were selected for the research, located within fields under the cultivation of cereal plants, on plots with an area of at least 1000 m^2, from which soil samples were taken at a depth of 0-20 and 20-40 cm for laboratory tests. In the collected material, the basic physicochemical and chemical properties of soils were determined using commonly used methods.

The tested soils were generally characterized by graining of various types of loams or silts deposits and were significantly acidified – 69% of the samples had a pH_{KCl} below 5.5 and qualified as acidic or very acidic (pH_{KCl} ranged from 3.8-7.0). These were usually soils rich or very rich in assimilable Mg (75% of the total samples; the range of found content 23-345 mg Mg kg^{-1}), moderately abundant in assimilable K (46%; 68-275 mg K_2O kg^{-1}) and poor or very poor digestible phosphorus (98%; 9-94 mg $P_2O_5 kg^{-1}$). There were no exceedances of the permissible content of heavy metals in the tested soils according to the standards in force in Poland, but taking into account the criteria used by the Institute of Soil Science and Plant Cultivation in Puławy (Poland), approximately 12.5% was characterized by an increased content of Cu, 20.8% by an increased content of Zn, 4.2% by an increased content of Cd, 25% with increased Cr content. As much as 41.7% of the soil samples were characterized by an increased content of Ni, while 8.3% could be classified as poorly polluted, but it was most likely related to the abundance of this element in the parent rocks. The most favorable properties (neutral or slightly acidic reaction, generally low acidity, high capacity of the sorption complex, higher than other regions of the city content of assimilable forms of P, K and Mg, total forms of Ca, K, Mg and total and soluble in 1 M HCl content of Fe, Mn, Zn, Cu, Ni) was found in the soils from the southern part of Rzeszów.

Keywords: urban soil, macroelements, microelements, heavy metals

Impact of a motorway on content and spatial distribution of mercury in adjacent agricultural soils

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The presence of mercury in the soil environment may be caused by natural or anthropogenic factors. The source of mercury in urbanised areas is pollution derived from the burning of fuels and industrial and transport waste, while in agricultural areas, it is constituent in mineral fertilisers and crop protection products.

The research objective was to evaluate the content and spatial distribution of mercury in arable soils adjacent to the A1 motorway in Poland.

The research material consisted of 40 soil samples taken from 20 test points on four transects at distances of 5, 10, 25 and 50 m from a noise barrier and in the direction of an arable field, and 10 m from the noise barrier in the direction of the motorway. Total mercury content was determined by atomic absorption spectrometry using an AMA 254 analyser. The spatial relationship between adjacent observations of variables was assessed using Moran's I overall autocorrelation coefficient. Probability maps of mercury distribution in the field and pollution indicators were elaborated in ArcGIS 10.4.1. using Inverse Distance Weighted interpolation. Analysis of the spatial correlation of Moran's I showed a lack of spatial dependence between tested points, which may evidence that the motorway does not affect mercury contents in the soil. The elevated mercury content at a single test point may indicate a random event unrelated to the motorway's operation.

Keywords: mercury in agricultural soils, highway traffic pollution, Moran's I autocorrelation coefficient, pollution index

The time-dependent effect of salinity on biochemical parameters of *Tripolium pannonicum*

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Soil salinization is a rapidly growing agricultural problem, with an estimated minimum of 800 Mha of arable land currently damaged by salinity. Salt stress is one of the major environmental factors impairing crop production. In the present study, we examined short- and long- time effect in the leaves of *Tripolium pannonicum* under greenhouse conditions. 3-months plants were treated in the 800 mM NaCl. Leaves were harvested at 1, 3, 5 and 24 hours (short period of time) and 48 h, 7 days, and 10 days (long period of time) after NaCl application. The stressful salinity conditions were evaluated based on biochemical parameters. We measured the activity of antioxidant enzymes: ascorbate peroxidase (APX) and peroxidase (POD); the concentration of the reactive oxygen species (ROS)- H_2O_2, proline and protein. We observed the highest activity of APX and POD after 3h from NaCl treatment (short time period) and 48h (long time period). The highest concentration of H_2O_2 and proline were after 48 h and 5 days after salinity treatment, respectively. The concentration of protein in the leaves was the highest in 5th and 7th days of the NaCl addition. Our results demonstrated that the first answer of cell to salinity stress is the increase in the activity of antioxidant enzymes (the early cellular stress response) while the changes in the concentrations of osmoprotectant, proteins and ROS follow subsequently as a part of the late cellular stress response.

Keywords: salinity, *Tripolium pannonicum,* ascorbate peroxidase, reactive oxygen species, proline

Effect of natural and synthetic antifungal substances on soil bacterial assemblages

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To combat fungal diseases synthetic fungicides are often used in agriculture. Their overuse leads to environmental pollution, soil degradation and reduction of microbial biodiversity. To address this problem, we examined the effect of *p*-coumaric acid (*p*-CA) as an environmentally safe alternative for difenoconazole on soil bacterial community and the abundance of N cycle genes using the Next Generation Sequencing of the 16S rRNA gene and quantitative PCR.

Difenoconazole is an active substance present in Porter 250-EC, which is a popular commercial fungicide. It is used against fungal diseases in many fruits (apples), vegetables (sugar beet, potato), cereals (winter wheat, winter rape) and other field crops. p-CA is a phenolic compound that can be found in plants such as tomatoes, carrots, basil, and garlic.

Plants extracts are today recognized as a valuable alternative for synthetic pesticides, and their use is important in the context of the Green Deal, the EU's new strategy, to significantly reduce pesticides that are dangerous to the environment.

Here we report that p-CA at the final concentration of 9.1 μmol/$g_{wet\ mass}$ suspended in Dassoil, the adjuvant (0.2% v/v) may positively affect the functioning of the soil concerning its microbiome. Research results indicate that p-CA does not reduce bacterial diversity and has no effect on the abundance of N cycle genes. What is more, p-CA influences the structure of the soil microbiome by stimulating the proliferation of bacteria with the ability to promote plant growth, and supporting the elements' circulation, which seems to play an important role in improving soil functions. In addition, the effects of p-CA were shown to be more potent but shorter in duration than Porter 250 EC, allowing faster recovery of soil microbiome after treatment. However, to determine the safety of p-CA use, further research is needed on the environmental effects of p-CA such as environmental persistence or toxicity to aquatic and terrestrial organisms.

Keywords: biodiversity, p-coumaric acid, difenoconazole, fungicides, N-cycle, microbiota

Funding:
The research was financed by the Universitas Copernicana Thoruniensis in Futuro - modernization of the Nicolaus Copernicus University as part of the University's Integrated Program. Project number: POWR.03.05.00-00-Z302 / 17-00 of 08.12.2017

Workshops

Trainer: MSc Sylwia Pindral

Workshop 1 „Introduction to GIS techniques with QGIS”

This 6-hour workshop will allow to fully understand the basics of Geographic Information Systems (GIS) and Remote Sensing, learn how to use the open-source program QGIS and how to get and download freely available sources of geodata. All participants will gain experience in vector and raster data preparation, layout development, and finally, maps creation.

1.Downloading, installation and using the QGIS program. 2. Data import. 3. Displaying and visualization of data. 4. Digitization of spatial data. 5. Interpolation of spatial attributes. 6. Selection and searching of the data. 7. Databases' management and the basics of SQL. 8. Computing basic spatial statistics. 9. Preparation and export of maps.

Workshop 2 „Basics of satellite image analysis in QGIS”

This 8-hour workshop is designed to guide through and learn participants with the practical knowledge of land use and land cover mapping, which is one of the core skills for any Geographic Information Systems and Remote Sensing analysis. Land use and land cover maps can be an input data for other environmental spatial analyses. After the workshop, you can gain a background of land use mapping and detection of land use/land cover changes. The course is ideal for professionals such as geographers, soil scientists, geologists, and GIS technicians, and all other experts who need to use land use maps in their field and would like to learn the fundamentals of Remote Sensing. The course program includes the use a classification algorithms and map algebra tools for advanced spatial analysis.

1. How to find and download data. 2. Supervised and unsupervised methods in remote sensing and how to reclassify land use/land cover, classes. 3. Creating land use maps. 4. Detecting land use changes and calculating spatial statistics. 5. Creating and exporting maps. 6. Additionally, calculating indices, such as NDVI (Normalized Difference Vegetation Index), NDWI (Normalized Difference Water Index), SAVI (Soil Adjusted Vegetation Index).

Workshops

Workshop 3 „Mapping the species distribution and diversity”

This 6-hour workshop is dedicated to biologists (ecologists) who are interested in the practical use of QGIS in biodiversity and species distribution. The aim of the workshop is to use advanced techniques and QGIS plugins to analyze and visualize the vector data for environmental monitoring purposes. It is aimed at those who want to learn how to integrate GIS tools into their species distribution and biodiversity modelling projects. The workshop assumes that you have a basic knowledge of GIS. The course program includes: an introduction to the concept and practical application of species distribution and biodiversity modelling using QGIS software, including selection of environmental variables, processing data, creating spatial visualisations, and validating the biodiversity within selected area.

1. Importing vector and raster data. 2. Creating grid of squares. 3. Calculation of Shannon’s Diversity Index. 4. Methods of calculating and visualization of species distribution. 5. Creating and exporting maps.