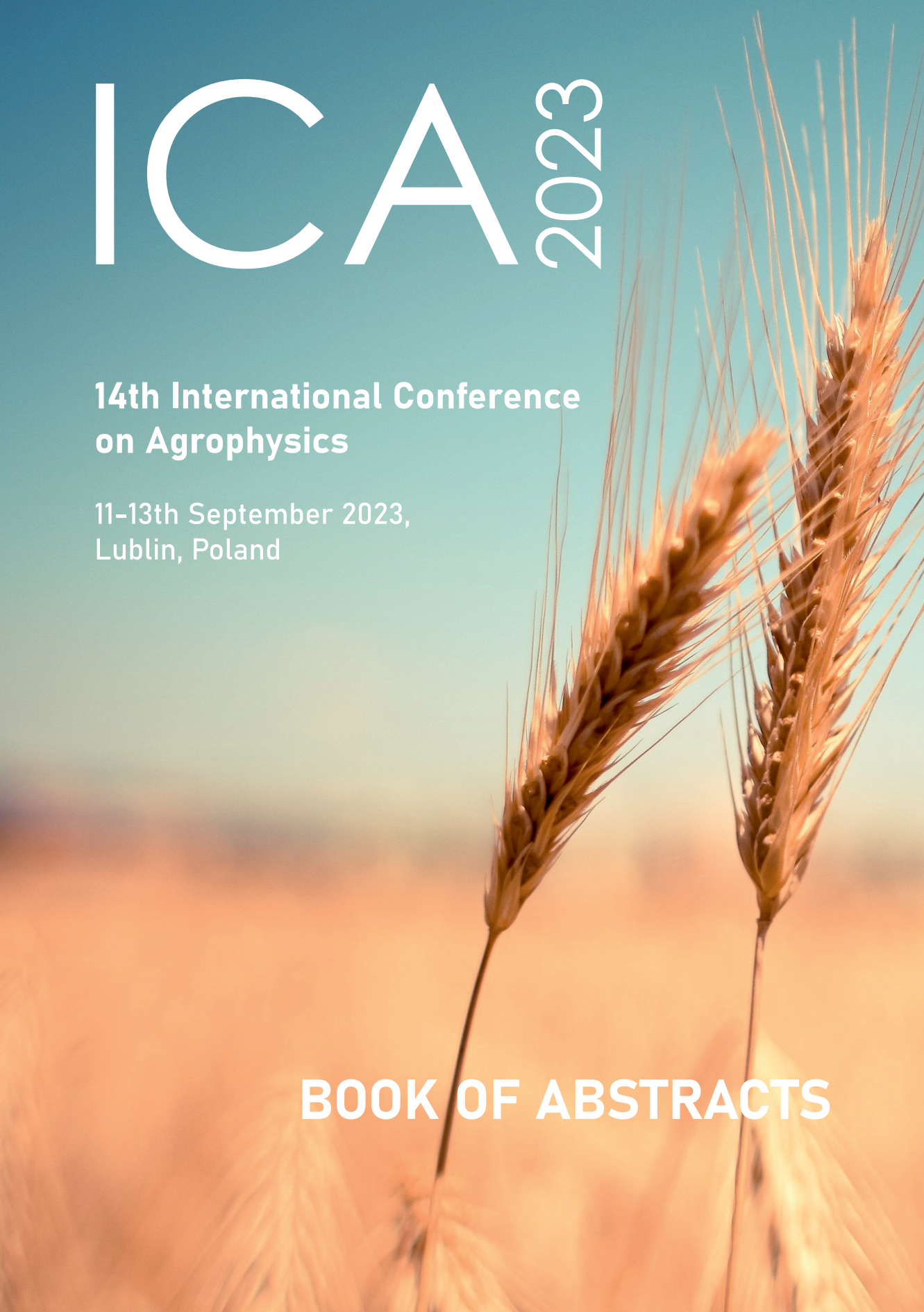
ICA 2023

14th International Conference on Agrophysics

11-13th September 2023,
Lublin, Poland



BOOK OF ABSTRACTS

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PAN POLSKA AKADEMIA NAUK ODDZIAŁ W LUBLINIE

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LUBLIN, 2023

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Biology of the Change – Microbial Processes Related with Greenhouse Gases Transformation in Natural and Agroecosystems

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GENERAL INFORMATION

Meeting venue

Hotel Mercure Lublin Centrum***
12 Racławickie Ave.
20-037 Lublin, Poland

Meeting Secretariat

Institute of Agrophysics PAS
Tel: +48 81 744 50 61 w. 179
E-mail: ica@ipan.lublin.pl
Web. www.agrophysics.org

Internet access

Free Wi-Fi connection is provided throughout the meeting venue.

Lunches and coffee breaks

Lunches and coffees/teas and light snaks are included in the registration fee.

Certificates and attendance

After 14th International Conference on Agrophysics certificate of attendance will be sent to your email

MEETING HOURS

Sunday 10th	
18:00 - 21:00	registration, welcome reception

Monday 11th	
8:00 - 9:15	registration
9:15 - 9:30	opening ceremony
9:30 - 10:00	opening lecture
10:30 - 17:50	sessions
15:20 - 16:20	poster session
17:50 - 19:50	poster session

Tuesday 12th	
9:00 – 16:00	sessions
15:50 – 17:00	poster sessions
18:00 - 0:00	FOLKOLORE EVENT (for signed up participants)

Wednesday 13th	
9:00 – 15:30	sessions
14:00 – 16:30	poster sessions

Program scheme

14th International Conference on Agrophysics

11-13 September 2023, Lublin, Poland

Day 0 - Sunday, September 10, 2023

18:00 - 21:00 Registration, Welcome reception

Day 1 - Monday, September 11, 2023

8:00 - REGISTRATION	
9:15 - OPENING CEREMONY - room A	
9:30 - OPENING LECTURE Marc Hendrickx - room A **The impact of processing on quality and health related aspects of foods** *The event is carried out with the financial support of The City of Lublin, as part of the Visiting Professors in Lublin Program*	
COFFEE BREAK **10:00 - 10:30**	
3rd Fruit Structure Workshop **room A** **10:30 - 12:30**	**Microbial Biodiversity and Resilient Plants Workshop** **room B** **10:30 - 12:30**
LUNCH **12:30-13:30**	
3rd Fruit Structure Workshop **room A** **13:30 - 15:20**	**Microbial Biodiversity and Resilient Plants Workshop** **room B** **13:30 - 15:20**
COFFEE BREAK **15:20 - 15:40**	
3rd Fruit Structure Workshop **room A** **15:40 - 17:50**	**POSTER SESSION** **Microbial Biodiversity and Resilient Plants Workshop** **15:20-16:20**
POSTER SESSION **3rd Fruit Structure Workshop** **17:50 - 19:50**	

Day 2 - Tuesday, September 12, 2023

3rd Fruit Structure Workshop **room A** **9:00 - 10:50**	**Biology of the Change – Microbial Processes Related with Greenhouse Gases Transformation in Natural and Agroecosystems Workshop** **room B** **9:00 - 10:45**
COFFEE BREAK **10:50 - 11:10**	
Metrology and Modelling of Agrophysical Processes Workshop **room A** **11:10 - 13:00**	**Microbial Biodiversity and Resilient Plants Workshop** **room B** **11:10 - 13:00**
LUNCH **13:00-14:00**	
Metrology and Modelling of Agrophysical Processes Workshop **room A** **14:00 - 15:50**	**Microbial Biodiversity and Resilient Plants Workshop** **room B** **14:00 - 16:00**
POSTER SESSION **Metrology and Modelling of Agrophysical Processes Workshop** **15:50 - 17:00**	**POSTER SESSION** **Biology of the Change – Microbial Processes Related with Greenhouse Gases Transformation in Natural and Agroecosystems Workshop** **16:00 - 17:00**
FOLKOLORE EVENT **18:00 - 0:00**	

Day 3 Wednesday, September 13, 2023

Physico-chemical Properties of Plant Materials Workshop **room A** **9:00 - 10:50**	**Physical Chemistry of Soil Degradation and Remediation Workshop** **room B** **9:00 - 10:50**
COFFEE BREAK **10:50 - 11:10**	
Physico-chemical Properties of Plant Materials Workshop **room A** **11:10 - 13:00**	**Physical Chemistry of Soil Degradation and Remediation Workshop** **room B** **11:10 - 13:00**
LUNCH **13:00-14:00**	
Physico-chemical Properties of Plant Materials Workshop **room A** **14:00 - 15:30**	**POSTER SESSION** **Physical Chemistry of Soil Degradation and Remediation Workshop** **14:00 - 15:00**
POSTER SESSION **Physico-chemical Properties of Plant Materials Workshop** **15:30 - 16:30**	

Detailed program of workshops:

3rd Fruit Structure Workshop

Day 1 - Monday, September 11, 2023 - room A

10:30	**Marc Lahaye** — French National Institute for Agriculture, Food, and Environment **Cell wall organization and tissue water contributions to fleshy fruit texture**	
11:00	Umehara Akira — Gifu University **Modification of carrots pectic substances associated with cell membrane damage induced by low temperature blanching**	
11:20	Izabela Staniszewska — University of Warmia and Mazury in Olsztyn **Pulsed vacuum as a technique supporting osmotic dehydration of fermented beetroot slices**	
11:40	Emel Hasan Yusuf — Wroclaw University of Environmental and Life Sciences **Can Different Morphological Parts of the Prunus persica be used for Future Food Applications?**	
12:00	**Kalina Tamara Haas** — French National Institute for Agriculture, Food, and Environment **Optical nanoscopy on the cell wall polymers brings to light new structures and new concepts**	
12:30	**Lunch**	
13:30	Pieter Verboven — MeBioS Postharvest Group, KU Leuven **A microscopic look at the deformation of apple tissue in 4 dimensions**	
13:50	Fumina Tanaka — Kyushu University **Simulation of heat and mass transfer in persimmon fruit based on X-ray CT mapping**	
14:10	Jolanta Cieśla — Institute of Agrophysics, Polish Academy of Sciences **Aggregation Index as an indicator of a gel point**	
14:30	**Candelas Maria Paniagua Correas** — University of Malaga **The Role of Cell Wall Modifying Enzymes during Strawberry Ripening**	
15:00	Nataliia Kutyrieva Nowak — Institute of Agrophysics, Polish Academy of Sciences **Molecular & microscopic tools to study fruit cell walls**	
15:20	**COFFEE BREAK**	
15:40	Krzysztof Rutkowski — The National Institute of Horticultural Research **The influence of storage conditions and 1-MCP postharvest treatment on cell structure and fruit firmness of 'Cortland' apples**	
16:00	Jan Zdulski — The National Institute of Horticultural Research **The usefulness of VIS/NIR techniques and skin color measurements for monitoring firmness changes of 'Alexander Lucas' pear during storage**	
16:20	**Alexis Peaucelle** — French National Institute for Agriculture, Food, and Environment **New plant growth model: Pectin nanofilament expansion drives cell wall expansion**	
16:50	Patrycja Pękala — Institute of Agrophysics, Polish Academy of Sciences **Spectroscopic studies of the structure and distribution of apple cell wall polysaccharides at different developmental stages**	
17:10	Vadym Chibrikov — Institute of Agrophysics, Polish Academy of Sciences **Mechanical properties of bacterial cellulose-hemicellulose plant cell wall analogues – a numerical simulation study**	
17:30	Wojciech Wrzosek — Labsoft Sp z o.o. **Advanced atomic force microscopy technique for measurement biology samples.**	
	POSTER SESSION: 17:50-19:50	

Day 2 - Tuesday, September 12, 2023 - room A

09:00	**Marc E.G. Hendrickx** — KU Leuven **Process structure function relations of cell wall materials in food systems** *The event is carried out with the financial support of The City of Lublin, as part of the Visiting Professors in Lublin Program*	
09:30	Malgorzata Nowacka — Institute of Food Sciences, Warsaw University of Life Sciences **The physical and structural changes in apples obtained in the laboratory scale drying and compared to the industrial scale**	
09:50	Marianna Giancaterino — Austrian Competence Centre for Feed and Food Quality, Safety and Innovation, Institute of Food Technology, University of Natural Resources and Life Sciences **The potential use of Pulsed Electric Fields (PEF) at low and medium electric field strength to modify tomato pectin nanostructure.**	
10:10	Katarzyna Rybak — Institute of Food Sciences, Warsaw University of Life Sciences **The impact of pulsed electric field and ultrasound pre-treatment on cold formulation process with aloe vera juice and selected properties of porous apple tissue**	
10:30	Aleksandra Matys — Institute of Food Sciences, Warsaw University of Life Sciences **The impact of pulsed electric field pretreatment on texture and structure of vacuum-dried apples and strawberries**	
10:50	**COFFEE BREAK**	

Detailed program of workshops:

Microbial Biodiversity and Resilient Plants Workshop

Day 1 - Monday, September 11, 2023 - room B

10:30	**Maria Teresa Ceccherini** *University of Florence* **Microbial Biodiversity for Sustainable Plants Production** **Soil sciences: a history of conquests from the Neolithic to the present day, to understand how closely man and the soil are**
11:00	**Eligio Malusa** *Research Institute of Horticulture in Skierniewice* **Biodiversity Indicators in Agriculture and Horticulture**
11:30	**PRACTICAL WORKSHOP** **Łukasz Dziewit** *University of Warsaw* **Next generation sequencing techniques and tools** **Investigating Arctic and Antarctic microbiomes for eco-epidemiological and bioprospecting purposes – novel tools and approaches**
11:50	**PRACTICAL WORKSHOP** **Przemysław Decewicz** *University of Warsaw* **Next generation sequencing techniques and tools** **Towards an efficient evaluation, verification and curation of genetic mobile elements in (meta)genomic datasets**
12:20	**SUMMARY & DISCUSSION & QUESTIONS**
12:30	**Lunch**
13:30	**Magdalena Frąc** *Institute of Agrophysics, Polish Academy of Science* **Soil and Plant Microbiomes under Changing Environment**
14:00	Monika Kordowska-Wiater *University of Life Sciences in Lublin* **The microbiota of Polish red grape wines of spontaneous fermentation in the light of metagenetic and culturomic studies**
14:20	Weronika Kursa *University of Life Sciences in Lublin* **The impact of plant extracts in the form of spraying on the biodiversity of fungi colonizing seedlings of winter wheat (Triticum aestivum L.) and selected quality parameters of seedlings in phytotron conditions**
14:40	**PRACTICAL WORKSHOP** **Grzegorz Koczyk** *Institute of Plant Genetics of the Polish Academy of Sciences* **Bioinformatics Methods in Environmental Microbiology** **Reproducible metagenomic data analysis in a browser - a short tour**
15:10	**SUMMARY & DISCUSSION & QUESTIONS**
15:20	**COFFEE BREAK**
	POSTER SESSION: 15:20-16:20

Day 2 - Tuesday, September 12, 2023 - room B

09:45	**COFFEE BREAK**
11:10	**Krzysztof Treder** *Plant Breeding and Acclimatization Institute–National Research Institute, Bonin* **Plant Responses to Stress Factorst** **Potato as a model crop for studying plant responses to stress factors**
11:40	**PRACTICAL WORKSHOP** **Stefanie Vink** *GreenFinch Research* **Bioinformatics Methods in Environmental Microbiology** **Using next generation sequencing to study microbial communities in environmental science: the importance of bioinformatics**
12:10	**PRACTICAL WORKSHOP** **Stefanie Vink** *GreenFinch Research* **Bioinformatics Methods in Environmental Microbiology** **Using next generation sequencing to study microbial communities in environmental science: a pipeline step-by-step**
13:00	**Lunch**
14:00	**PRACTICAL WORKSHOP** **Alberto Acedo** *Biome Makers Inc.* **Next generation sequencing techniques and tools** **Development a guide of good practices on soil metabarcoding data generation**
14:30	**PRACTICAL WORKSHOP** **Alberto Acedo** *Biome Makers Inc.* **Next generation sequencing techniques and tools** **Interactive workshop concerning NGS steps in laboratory and data elaboration and submission results to databases**
15:15	**PRACTICAL WORKSHOP** **Piotr Koper** *Maria Curie-Sklodowska University in Lublin* **Biostatistics in Environmental Research** **Microbial Transcriptomics. Start-to-Finish RNA-seq analysis using R and Bioconductor**
15:35	**PRACTICAL WORKSHOP** **Jacek Panek** *Institute of Agrophysics, Polish Academy of Sciences* **Biostatistics in Environmental Research** **How to approach biodiversity analysis in metagenomic studies**

Detailed program of workshops:

Metrology and Modelling of Agrophysical Processes Workshop

Day 2 - Tuesday, September 12, 2023 - room A, ground floor

10:50	**COFFEE BREAK**	
11:10	**Jose Enrique Fernandez Luque**	*Irrigation and Crop Ecophysiology Group (REC group), Institute of Natural Resources and Agrobiology of Seville (IRNAS)*
	Irrigating for Sustainable Intensive Agriculture: Technological Approaches	
11:40	Claas Nendel	*Leibniz Centre for Agricultural Landscape Research (ZALF)*
	A multi-model ensemble to project the future for soybean in Europe	
12:00	Jaromir Krzyszczak	*Institute of Agrophysics, Polish Academy of Sciences*
	The AGRICORE suite: a novel policy assessment tool combining agent-based and biophysical modelling	
12:20	Kálmán Rajkai	*Institute for Soil Sciences, Centre for Agricultural Research*
	Developing fractal dimension-based estimates on the HunSSD database	
12:40	Jarosław Grodowski	*INTERTECH POLAND*
	Ecosystems modeling & monitoring with the isotopic measurements capabilities	
13:00	**Lunch**	
14:00	**Scott B. Jones**	*Utah State University*
	Optimizing root zone water management using strategic sensor placement and machine learning algorithms	
14:30	Renata Kuśmierek-Tomaszewska	*Bydgoszcz University of Science and Technology*
	Forecasting the production effects of plant irrigation based on meteorological measurements and long-term results of field experiments for maintaining ecosystem services	
14:50	Marcin Kafarski	*Institute of Agrophysics, Polish Academy of Sciences*
	Development of the system for complex permittivity spectrum measurements in the radio and microwave frequency range	
15:10	Agnieszka Szypłowska	*Institute of Agrophysics, Polish Academy of Sciences*
	Segmented linear calibration function for soil moisture estimation using microwave dielectric measurements	
15:30	Arkadiusz Lewandowski	*Warsaw University of Technology*
	Wireless IoT probe for soil moisture and salinity estimation based on dielectric spectrum measurements	
	POSTER SESSION: 15:50-17:00	

Detailed program of workshops:

Biology of the Change – Microbial Processes Related with Greenhouse Gases Transformation in Natural and Agroecosystems Workshop

Day 2 - Tuesday, September 12, 2023 - room B, first floor

09:00	**Cornelia Welte**	*Radboud University*
	Climate change microbiology: novel insights into methane-cycling microorganisms	
09:30	**Prof. Bruce Osborne**	*UCD School of Agriculture and Food Science*
	Land use/cover modifications and climate change mitigation: What we know, or think we know, and a lot of what we don't really know	
10:00	Jan Hupka	*Gdansk University of Technology*
	Kitchen waste as feed for anaerobic digestion	
10:15	Gergana Kuncheva	*SSAPP "Nikola Pushkarov" Sofia*
	Changes in soil greenhouse gas emissions, organic matter and soil microbiota under the influence of erosion control and conventional tillage systems	
10:30	Sivasankar Palaniappan	*Poznan University of Technology*
	Isolation of methane oxidizing bacteria from diverse environments	
10:45	**COFFEE BREAK**	
	POSTER SESSION: 16:00-17:00	

Detailed program of workshops:

Physico-chemical Properties of Plant Materials Workshop

Day 3 Wednesday, September 13, 2023 - room A, ground floor

09:00	**Sylwia Mildner-Szkudlarz** *Poznań University of Life Sciences* **Formation of advanced glycation end-products in foods**
09:30	Magdalena Krekora *Institute of Agrophysics, Polish Academy of Sciences* **The influence of flavonoids and their glycosides on the structure of gliadins**
09:50	Emilia Janiszewska *SGGW* **Analysis of the effect of the salt addition during the lactic acid fermentation process on the textural properties of fermented red beets**
10:10	Aleksandra Żytek *Institute of Agrophysics, Polish Academy of Sciences* **Effect of consolidation level on organic volatile compound emissions from maize during storage**
10:30	Grzegorz Józefaciuk *Institute of Agrophysics, Polish Academy of Sciences* **Physicochemical properties of plant tissues and their changes under abiotic stresses**
10:50	**COFFEE BREAK**
11:10	**Eutiguio Gallego** *Universidad Politécnica de Madrid* **Friction phenomena in silos**
11:40	**PRACTICAL WORKSHOP** **Michał Wojtal** *Endego Sp. z o. o.* **Designing Agricultural Machinery with EDEM**
13:00	**Lunch**
14:00	**Krzysztof Dwiecki** *Poznan University of Life Sciences* **The role of association colloids in autoxidation of vegetable oils**
14:30	Joanna Wiącek *Institute of Agrophysics, Polish Academy of Sciences* **Controlled discharge of granular material from a flat floor silo with converging orifice**
14:50	Marek Molenda *Institute of Agrophysics, Polish Academy of Sciences* **Discharge rate influenced by shape and friction of particles in a shape of spheres and dimers**
15:10	Antoni Miś *Institute of Agrophysics, Polish Academy of Sciences* **Susceptibility of gluten network to mechanical destruction during dough mixing depending on its chemical dehydration by dietary fibre additives**
	POSTER SESSION: 15:30 -16:30

Detailed program of workshops:

Physical Chemistry of Soil Degradation and Remediation Workshop

Day 3 Wednesday, September 13, 2023 - room B, first floor

09:00	**Milena Kercheva** *Institute of Soil Science, Agrotechnology and Plant Protection "N. Poushkarov"* **Role of plant materials for improving of soil water retention properties**
09:30	Horabik Józef *Institute of Agrophysics, Polish Academy of Sciences* **Discrete Element Method modeling of structure and strength of soil aggregates**
09:50	Maria Skorupka *Institute of Agrophysics, Polish Academy of Sciences / Grupa Azoty* **Sulphur compounds as a mean to decrease nitrogen losses from urea fertiliser**
10:10	Sylwia Kukowska *Institute of Agrophysics, Polish Academy of Sciences* **Adsorption capacity of waste-derived soil conditioners towards cadmium ions**
10:30	Angelika Gryta *Institute of Agrophysics, Polish Academy of Sciences* **Digestate as an organic additive modifying the structure of model soil aggregates**
10:50	**COFFEE BREAK**
11:10	**Mike Gorbounov** *Brunel University London* **To DoE or not to DoE? Roadmap for Improvement & Optimisation of Experimental Campaigns**
11:40	Katarzyna Szewczuk-Karpisz *Institute of Agrophysics, Polish Academy of Sciences* **Assessment of agricultural waste biochars for remediation of degraded soil environment**
12:00	Olena Siryk *Institute of Agrophysics, Polish Academy of Sciences / Ovcharenko Institute of Biocolloidal Chemistry of NAS of Ukraine* **Hybrid polysaccharide-biochar hydrogels for agriculture: the impact on soil water retention and plant growth**
12:20	Grzegorz Józefaciuk *Institute of Agrophysics, Polish Academy of Sciences* **Soil surface properties and their changes in degradation processes**
12:40	**WORKSHOP SUMMARY & DISCUSSION**
13:00	**Lunch**
	POSTER SESSION: 14:00 -15:00

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ORAL PRESENTATIONS

3rd Fruit Structure Workshop

The impact of processing on quality and health related aspects of foods

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Food processing (industrial processing and (home) preparation) is designed to result in safe, high quality (taste, flavor) and healthy end products. Al together a balance is strived for between desired and detrimental effects. This presentation will highlight a number of recent evolutions showing analytical and modelling approaches to evaluate the impact of processing and storage (raw materials and end products) on food quality and health related aspects as influenced by food composition, food structure and reactivity.

The first part of the presentation will shortly discuss methodological approaches integrating targeted and untargeted (omics) approaches at the analytical side and single and multi-response models to quantify the impact. The second part will illustrate this approach with fruit, vegetable and legume based foods thereby focusing on the role of raw materials and their interactions, all-in one versus split stream processing and conventional versus novel technologies. The third part of the presentation will illustrate this approach with examples on the impact on health related aspects including micronutrient bio-accessibility and macronutrient digestion.

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Cell wall organization and tissue water contributions to fleshy fruit texture

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Fleshy fruit offer divers texture qualities to consumers and food processors. Knowledge on the underlying structural determinants of textures is required to help developing pertinent varieties, production practice, post-harvest management and processing to fit with new environmental and societal constraints and thus, making full use of productions without waste. Cell wall polysaccharide and water compartmentalization are known key contributors of fruit texture. In cell wall, pectin has been highlighted as a major determinant of fruit firmness in relation with water compartmentalization and cell wall organization. Cell wall remodeling occurs all along fruit development, notably of pectic polysaccharides. A focus on the dynamics of water, pectin, hemicellulose and cellulose during fruit development will be discussed in relation with the ripe fruit texture.

Modification of carrots pectic substances associated with cell membrane damage induced by low temperature blanching

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Low temperature blanching (LTB) can improve texture of fruits and vegetables by promoting pectin methylesterase (PME) activity and alternating pectin structure. However, despite optimum temperature of PME is around 50 °C, LTB at 50 °C often shows insufficient effect. We hypothesized that it is necessary to enhance the leakage of intracellular ions by causing cell membrane disruption at higher temperature to activate PME properly inside of the tissue structure. Thus, we investigated cell membrane conditions and pectic substance structure of carrots after treated LTB.

Carrots samples were cut into cylinder (20 mm diameter, 4 mm height). These samples were applied LTB in 200 mL deionized water at 50 °C and 60 °C, respectively. Degree of cell membrane damage was evaluated by determination of cell membrane capacitance (*C*m), extracellular resistance (*R*e) and intracellular resistance (*R*i) conducted by electrical impedance spectroscopy (EIS) and equivalent circuit analysis. Furthermore, water soluble pectin (WSP), chelator soluble pectin (CSP) and diluted alkali soluble pectin (DASP) were extracted from samples sequentially. The pectin nanostructure was observed by means of atomic force microscopy (AFM).

Results of EIS showed decreasing cell membrane capacitance (*C*m) at 60 °C more than 50 °C significantly. Besides, the ratio extracellular resistance to intracellular resistance (*R*e/*R*i) increased by LTB. These indicated cell membrane disruption and electrolyte flow were occurred due to LTB at 60 °C more than 50 °C. Pectin observed by AFM showed highly branched and complexed structure at 60 °C. Then, total branched chain length in each particle of CSP was calculated. It showed higher contents of branched chain of LTB at 60 °C more than at 50 °C. This result suggested highly branched pectin structure was formed owing to the LTB at 60 °C.

Pulsed vacuum as a technique supporting osmotic dehydration of fermented beetroot slices

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To obtain fermented beet chips, the fermented beets can be osmotically dehydrated and dried. To ensure the best product quality, it is necessary to determine the optimal osmotic dehydration parameters. There is a lack of research on pulsed vacuum osmotic dehydration (PVOD) for fermented beet material. Moreover, most research focuses only on the properties of the dehydrated material. Understanding the influence of parameters on the physicochemical properties of the material and solution will allow for a comprehensive study. Therefore, the aim of this study was to determine the optimal parameters of PVOD of fermented beetroots in terms of dehydrated tissue as well as osmotic solution. The response surface methodology (RSM) was used to optimize PVOD and improve the efficiency of the process.

The optimal parameters of the PVOD process were valid only in the selected experimental domain, which was in the range 20-40°C of temperature (T), 40-60 % of sugar concentration in osmotic solution (SC), 10-50 min of vacuum impregnation time (VT) and 2-6 mm of slice thickness (ST). PVOD was optimized in terms of properties of beetroot tissue (hardness, H_T, redness, a^*_T, water loss, WL, solid gain, SG) and osmotic solution (dry matter content, DM_S, redness, a^*_S). The optimum qualities of beetroot tissue (H_T=202.0 N, a^*_T=11.8, WL=55.5 %, SG=7.1 %) and osmotic solution (DM_S=57.3 %, a^*_S=38.9) were obtained at T=20°C, SC=60 %, VT=10 min, ST=6 mm and T=40°C, SC=60 %, VT=50 min, ST=2 mm, respectively.

Optimal PVOD conditions of fermented beet slices from this work may be beneficial for producers of fermented products. Future studies should include non-thermal methods such as ultrasound to investigate their effects on mass transfer and quality of fermented beet slices.

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Can different morphological parts of the *Prunus persica* be used for future food applications?

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Climate change may cause some issues, such as inadequate food resources to feed vast amounts of human mass. Therefore, alternative food materials are explored for nutritional and health-promoting features. ln this study, three peach cultivars with different parts (fruit, fruit skin, kernel and leaves) were explored for their polyphenolic, sugar and cyanogenic glycoside (amygdalin and prunasin) contents with antioxidant, antidiabetic and antiaging activities. According to the study results, the fruit of the Harbinger cultivar had the highest total sugar content; the Springtime cultivar demonstrated the highest anthocyanin content for both whole fruit and fruit skin. According to the ORAC antioxidant assay, the kernel of the Harbinger cultivar had the highest activity different from other parts of the fruit and other peach cultivars as well. The α-amylase and acetylcholinesterase enzyme inhibition activities were the highest in the kernel of the Kijowska wczesna cultivar. Moreover, cyanogenic glycosides are toxic in high amounts, but in recommended doses, they are used for cancer treatments. In the current study, the kernel of the Kijowska wczesna cultivar exhibited the highest amounts of amygdalin and prunasin contents. Thus, the study provides information for novel food applications to increase the health benefits of foods with different parts of plants.

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Optical nanoscopy on the cell wall polymers: Unveiling new structures and concepts in cell wall expansion

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The extracellular matrix (ECM) stands as a pivotal frontier in the realm of biology. The plant ECM, the cell wall (CW), orchestrates vital processes encompassing growth, morphogenesis, stress responses, and symbiosis. Moreover, the CW determines the quality and transformation efficiency of plant-derived food, feed, materials and is also an inspiration for biomimetic engineering. The assembly of cell wall components into specific patterns underlies its functions. Consequently, a paramount challenge lies in comprehending the architectural basis of the CW relevant for their function. The emergent characteristics of the CW arise from the interplay of physical and chemical properties of the polymers, but most notably from the interaction and organization into a coherent yet dynamic (composite) matrix[1]. Our limited knowledge of the structure-function relationship of CW, and ECM in general, is due to the lack of tools to study the native nano- and mesoscale topology in intact tissues. In my presentation I will first introduce the concept of single molecule localization microscopy techniques. I will then show how 3D stoichiometric multicolor nanoimaging empowers our understanding of plant growth by enabling high-density mapping of cell wall polymers with molecular specificity[2,3].

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A microscopic look at the deformation of apple tissue in 4 dimensions

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The firmness of fruit tissue largely determines its quality. Fresh fruit is crunchy and juicy. Decayed fruit is often soft and mealy. These differences have to do with how the fruit tissue deforms during compression when chewing, something that we can also test mechanically on a universal testing machine. The compression behavior is a result of how the cells in the tissue move relative to each other and whether or not they break. We have developed an in situ setup to visualize cells deformation by compressing tissue samples in a X-ray micro-CT scanner. In this way we see in real time, i.e. in 4D, the three-dimensional structure of the tissue collapse during compression, while measuring the mechanical properties. We tested the set-up on small pieces of apple (cv. Jonagold) cortex, fresh and after 2 weeks of display at 18°C. The scans were taken with an image resolution of 9 µm, so that we can distinguish the cells and the pores in the tissue. Compression took 17 minutes at a compression rate of 0.1 mm/min. A total of 27 scans were taken; it took 35 seconds for one scan. After image processing we can see how the cells are compressed and the porosity gradually decreases. In the fresh apple sample, fracture occurs in the midplane. In the soft tissue after shelf life, however, we see major damage where the tissue is pressed against the compression platform. We also visualize the deformation during the compression process by a digital volume correlation of the successive scans. The difference in behavior of the cells during compression translates into different deformation curves, with significantly lower elasticity and peak force for the soft tissue. We will next link these results to the microstructure properties of the tissue and benchmark the results against discrete element model simulations.

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Simulation of heat and mass transfer in persimmon fruit based on X-ray CT mapping

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Since fruit and vegetables maintain their vital activities such as respiration and transpiration even after harvesting and gradually deteriorate in quality, it is necessary to establish optimal storage and transportation methods to preserve fruit and vegetables. To suppress respiration and transpiration, a low-temperature environment is desirable. Respiration can also be suppressed by controlling the composition of gases such as oxygen and carbon dioxide to suppress respiration. To establish an optimal environment, it is important to understand the surrounding environment of the fruit and vegetables as well as changes in the internal environment of the fruit and vegetables.

Therefore, in this study, in order to clarify the internal structure and distribution of various physical properties in fruit and vegetables, CT images of persimmons were taken using an X-ray CT device, and physical properties related to thermal and mass transfer were obtained from the CT value. In addition, a cellular tissue model was reconstructed in three dimensions on a computer using the CT images, and heat and gas transfer analysis was performed. Furthermore, the rate of O2 consumption by respiration was measured by covering persimmons with glue to block the inflow of O2 from the outside and measuring the change in O2 concentration in the persimmon fruit. We also conducted O2 transfer and consumption simulations in the fruit using the model under the same conditions as those used for these measurements, and verified the gas transfer model including O2 consumption by comparing the actual measurements with the analytical values.

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Aggregation Index as an indicator of a gel point

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The ability of polysaccharides to self-organize their molecules in liquid dispersions and form regular three-dimensional networks makes these biopolymers widely used, e.g. in the food, pharmaceutical and cosmetic branches of industry. The gelation is affected by many factors connected with the chemical properties of macromolecules, the composition of liquid medium and the process conditions (Moslemi, 2021).

Monitoring of the viscosity changes is most often used for determination of a gel point (McNaught and Wilkinson, 1997). However, the results of investigations, that were performed for diluted alkali-soluble pectin (DASP) sequentially extracted from the plant cell wall material, revealed the applicability of the Aggregation Index (AI) for this purpose. It was confirmed by the rheological, AFM and FTIR analyses (Cieśla et al., 2021).

AI is based on the analysis of back- and forward- dynamic light scattering. It could be a new "tool" in the study of the behavior of biopolymers in liquid dispersions. The method of AI determination as well as the results obtained so far will be presented.

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The role of cell wall modifying enzymes during strawberry ripening

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Strawberry (*Fragaria x ananassa*) is one of the economically most important soft fruits. The main production area of Spanish strawberry is located in the southwest of Spain, in Huelva province, where strawberry production exceeds 300,000 tonnes annually, contributing to a total production of 360,570 tonnes in Spain. This accounts for approximately 90% of Spain's strawberry production and 21% of the entire European production (1). Unfortunately, the strawberry delicate texture imply a limited shelf life and poses a challenge due to its rapid softening, which leads to a decline in fruit quality caused by bruising and fungal infections. Additionally, strawberries are classified as non-climacteric fruits, making post-harvest ripening impossible and hindering long-distance transportation and exportation. These factors combined result in substantial economic losses each year (2,3).

In general, the softening process stands as a primary factor in reducing the fruit's shelf life. As a result, efforts in fruit breeding programs are focused on delaying this process. Previous studies have demonstrated that textures changes which leads to softening entails changes in cell wall integrity, cell turgor, fruit-water status, hydrostatic pressure, and the accumulation and distribution of osmotically active solutes. During fruit ripening, textural changes primarily occur due to the breakdown of the middle lamella, reduction of adhesion between cells, and the weakening of parenchyma cell walls. These changes are facilitated by the activity of cell wall modifying enzymes (4, 5, 6).

This work entitled "The Role of Cell Wall Modifying Enzymes during Strawberry Ripening" will provide a summary of the impact of these cell wall modifying enzymes during strawberry fruit ripening and their role on the softening process. Additionally, as a part of a new project, the role of callose metabolism will be targeted in order to enhance fruit quality. Previous results showed that differences in callose accumulation, during specific stages of fruit development, modifies symplastic transport and, subsequently, could also change the accumulation and distribution of osmotically active solutes and other substances such as amino acid, proteins, lipids, RNAs and hormones in the fruit cells. All these changes in symplasmic transport and cell-to-cell communication could have a crucial impact on fruit ripening and shelf-life and the overall quality of cultivated strawberries (7).

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Molecular & microscopic tools to study fruit cell walls

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The cell wall is a complex structure consisting mainly of cellulose microfibrils bound by polysaccharides and proteins (i.e. HRGPs, including arabinogalactan proteins – AGPs) [1]. The structure of the cell wall is still under ongoing studies, and molecular and microscopic methods make it possible to determine the structure and function of extracellular matrix constituents. Cell wall components can be analysed by numerous *in situ* and *ex situ* techniques. Immunocytochemistry is one of the most effective approaches for studying cell walls in fruit tissues [2]. *Ex situ* methods, such as immunoblotting, immunoprinting on the membrane, and glycome profiling (ELISA), enable molecular characterisation and quantitative detection of different cell wall epitopes. On the other hand, *in situ* methods, like immunofluorescence labelling and immunogold technique allow visualisation of the localisation and distribution of cell wall components at the cellular (CLSM) and subcellular (TEM) levels. The aforementioned methods are based on particular antibodies that specifically recognise epitope targets [3]. These methods typically involve three steps: (1) sample preparation, (2) reaction with primary and secondary antibodies, and (3) signal detection and data analysis. Immunocytochemical techniques are important for the analysis of AGPs because they are proteoglycans with unusual structures. Molecular and microscopic tools allow for precisely determining the molecular and structural cell wall modifications occurring in fruit tissues. As confirmed in our studies, AGPs participate in numerous physiological processes, including fruit ripening and senescence during postharvest storage.

The development of new antibodies in future research, including those against the protein domain of AGPs, will enable a more thorough analysis of changes in the fruit cell wall and interactions between different cell wall components during the physiological programme occurring in fruit.

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The influence of storage conditions and 1-MCP postharvest treatment on cell structure and fruit firmness of 'Cortland' apples

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During the experiment, apples of the 'Cortland' cv were picked on two harvest dates. Then half of them were treated with 625 ppb of 1-methylcyclopropene (1-MCP). The treated and untreated fruits (control) were stored under regular (air) and controlled atmosphere (2%O_2 + 2%CO_2, 0.8%O_2 + 0.8%CO_2 and dynamic controlled atmosphere with chlorophyll fluorescence (DCA-CF) low oxygen stress detection). At harvest and after storage fruit firmness was measured among other various quality parameters. Regardless of those measurements, the reaction of apple-fruit surface on storage conditions and postharvest treatments was examined using a stereoscopic light microscope (LM). On chosen fragments of apples the histological study was done using LM with polarization and pictures were taken using a digital camera for further analyses. The structure of the apple-fruit epidermis and parenchyma tissue was also analyzed with a scanning electron microscope (SEM). Anatomical preparations were made using the paraffin method. Fragments of apple fruits (epidermis with parenchyma of mesocarp) were fixed in CrAF (chromic acid, acetic acid, formalin), dehydrated in ethanol, and prepared for LM and SEM analysis. The first part of the prepared fragments was then embedded in paraffin, cut and stained with safranine and fast green for LM investigation. The next part of the apple fragments was desiccated with Critical Point Drying CO_2 and sputter coated with gold and next examined with the SEM in the Laboratory of Electron Microscopic in Nencki Institute of Experimental Biology in Warsaw.

The results of the experiment indicated that the storage conditions and postharvest treatments of apples with 1-MCP affected the firmness of the fruits and the cell structure of 'Cortland' apples.

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The usefulness of VIS/NIR techniques and skin color measurements for monitoring firmness changes of 'Alexander Lucas' pear during storage

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The usefulness of nondestructive methods based on VIS/NIR spectroscopy and skin color measurements for monitoring of changes of flesh firmness of 'Alexander Lucas' pear was evaluated. Within the experiment, measurements were performed using two devices based on VIS/NIR spectroscopy - DA meter (Sintéleia, Italy) and CP Pigment Analyzer PA1101 (Control in Applied Physiology GbR., Germany), and VIS spectroscope MiniScan XE PLUS, model 45/0-S (Hunter Associates Laboratory, USA). The following indices were gathered: the DA index (DA meter) - calculated using formula DA=A670-A720 (A670 and A720 are absorbances at 670 and 720 nm), and Normalized Difference Vegetation Index calculated as NDVI=(I780-I660)/(I780+I660) and Normalized Anthocyanin Index NAI=(I780-I570)/(I780+I570) (I570, I660, and I780 are reemittances at 570, 660 and 780 nm - CP Pigment Analyzer). Using the MiniScan XE PLUS device, the L*, a*, b* coordinates of color were obtained and chroma (C*) and hue angle (h) were calculated.

For the experiment, pears from 10 orchards were harvested in 2022. The fruits were stored under regular air (RA) and controlled atmosphere (2%O_2 + 0.7%CO_2) conditions (CA). Additionally, fruits were postharvest treated with 1-methylcyclopropene (312.5 and 625 ppb for RA and 312.5 ppb for CA). After harvest and after storage, skin colour, fruit firmness, and measurements based on VIS/NIR spectroscopy were done.

During storage fruit firmness, DA, NDVI, and NAI indices steadily decreased, and the color of the skin changed from green to yellow. The rate of changes strongly depended on postharvest treatment and storage conditions.

The obtained results indicated that the non-destructive techniques based on VIS/NIR spectroscopy are more useful for the raw estimation of flesh firmness changes than for accurate firmness measurement.

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New plant growth model: Pectin nanofilament expansion drives cell wall expansion

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One of the fascinating aspects of plants is how the remarkable diversity of shapes and sizes of plant organs is obtained exclusively through the growth and division of pressurized cells surrounded and glued together by strong cell walls. In this respect, a central question, which applies to all walled organisms, is how cells can expand while maintaining the mechanical integrity of their cell walls. We will present our results indicating that the cell wall confers an intrinsic growth capacity linked to the reorganization of homogalacturonan crystal following chemical changes[1]. We will discuss how general is this growth model and how it integrates with the existing vision on plant cell growth.

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Spectroscopic studies of the structure and distribution of apple cell wall polysaccharides at different developmental stages

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Apples, especially in Poland, are of great interest to consumers. They are a storable fruit and therefore need to maintain high quality over a given storage period. It is known that the cell wall of plants significantly affects the texture of the fruit and its mechanical properties. It is thus important to have a complete picture of the structure of its components and the interactions between them.

The architecture of the plant cell wall is a remarkable creation of nature. The primary plant cell wall consists mainly of cellulose, hemicelluloses, and pectins. The non-cellulosic polysaccharides have a diverse structure and can have many different monosaccharide branches. In addition, they have a number of substituents, including an acetyl group (of our research interest) and a methyl group. Notably, the degree of acetylation of non-cellulosic polysaccharides influences their conformation, which in turn affects their adsorption onto cellulose microfibrils and, consequently, the integrity and mechanical properties of the cell wall. The structure and composition of cell wall polysaccharides undergo some changes during fruit ripening and development. Mainly, there is softening on a macro scale and a decrease in firmness due to the loosening of the polymer network.

Investigations into the structure of the cell wall polysaccharides of two apple varieties at different stages of physiological development were carried out. The development stages were chosen as follows: apples ripening on the tree, from the optimum harvest date and in a three-month cold storage facility. Raman microscopy, infrared and Raman spectroscopy were used. A PCA statistical analysis was also carried out. The spectral data showed the presence of acetyl groups in the hemicelluloses and differences in the intensity of the band originating from the vibration of the glucose rings against different apple maturity dates.

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Mechanical properties of bacterial cellulose-hemicellulose plant cell wall analogues – a numerical simulation study

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The primary plant cell wall (PCW) is highly ordered and specialized network, evolved to control plant mechanical responses. Despite the undeniable role of cellulose and hemicellulose polysaccharides in the formation of the PCW scaffold, the role of individual polysaccharides and their interactions should be reconsidered according to the current view of PCW structure.

Here, the structural and mechanical properties of PCW analogues were investigated at the nano- and macro-scale using model systems of bacterial cellulose and hemicellulose polysaccharides. At the nano-scale, the structure of PCW analogues was investigated by atomic force microscopy (AFM), while the mechanical properties of individual fibres were determined by AFM nano-indentation tests. At the macro-scale, uniaxial tensile tests were performed.

The results showed that both glucomannan and xyloglucan increased the fibre diameter by adsorption/entrapment, thus weakening inter-fibre interactions and decreasing the macro-scale mechanical properties of PCW analogues. Xylan and arabinoxylan additives increased macro-scale mechanical properties of PCW analogues due to the nano-reinforcing effect, enhancing inter-fibre interactions.

The experimental results were supported by the numerical simulation, using the discrete element method in conjunction with coarse-grained molecular dynamics. The results showed that fibre length and the force of the inter-fibre interaction had the highest influence on the mechanical properties of the modelled PCW analogues. Longer fibres interacted with a greater number of adjacent fibres, resulting in an increase in elastic modulus, strain hardening modulus, and stress at the elastic limit of the modelled PCW analogues. Longer fibres resulted in extended reorganization and straightening phases, leading to an increase in strain at elastic limit. Inter-fibre slippage generated higher maximum stress for longer fibres. The force of inter-fibre interaction had the greatest effect on the mechanical properties of the modelled PCW analogues, resulting in a statistically significant increase.

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Advanced atomic force microscopy technique for measurement biology samples

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Labsoft Sp z o.o.

Atomic force microscopy is a strong and powerful technique for measurement: topography, mechanical, electrical and chemical properties of the samples. Presentation is focuses on short explanation how AFM work and how different mode can be used for characterization biology samples. There will also presentation of new models of AFM/AFM IR designed for biology environment.

Process structure function relations of cell wall materials in food systems

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Cell wall materials play a crucial role in the transformation of plant resources into plant based foods and ingredients. In our research we focus on the transformation of fruit, vegetable and legume raw materials into food systems and/or ingredients.

The first part of the presentation will focus on the *in situ* management of cell wall materials steering functional properties through processing in fruit, vegetable and legume based foods. The principles will be illustrated with examples on the effect of traditional (e.g. thermal processing) and novel technologies (high pressure processing and pulsed electric field processing) on texture properties and digestion of foods.

The second part of the presentation will focus on cell wall based food ingredients through the use of side streams from food processing (e.g. side streams of cell wall rich residues from the juice industry). The principles will be illustrated with examples on traditional pectin extraction and its functional properties in food systems and the functionalization of the pectin depleted residue by high pressure homogenization to create novel ingredients for use in food and non-food applications.

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The physical and structural changes in apples obtained in the laboratory scale drying and compared to the industrial scale

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Scaling up food drying processes can present certain challenges and considerations. Thus, the aim of the study was to compare the chosen physical properties and structural changes in apples obtained on the laboratory scale and industrial scale.

The samples were subjected to convective drying (CD, 85°C) and infrared-convective drying (IRCD, 60°C). Additionally, the pulsed electric field (PEF) treatment was applied according to optimization studies with the energy equal to 5.8 and 6 kJ/kg for CD and IRCD, respectively. The drying process was carried out using laboratory-scale drying and using a small industrial-scale mobile unit design by CEDRUS company. The quality assessment was based on rehydration rate, hygroscopic properties, texture, and acoustic properties, as well as structural changes with the use of scanning electron microtomography (SEM) and microtomography (μCT).

The method of drying, as well as applied PEF treatment, has an effect on specific properties of the apple tissue. The CD apple tissue was more shrank in comparison to IRCD, which was confirmed by structure photos (SEM and μCT) of the plant tissue. Additionally, the PEF treatment also impacts structural alteration. Additionally, lower rehydration properties were observed for samples obtained with the use of PEF technology as well as those obtained on the industrial scale. Furthermore, the drying method had an effect on the texture properties, while the PEF treatment did not significantly change this parameter. However, acoustic properties showed that PEF-treated samples were a bit softer than those without PEF.

In conclusion, the use of process optimization help with planning the process, however still some variations in the quality of the dried material can still arise between laboratory-scale and industrial-scale operations.

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The potential use of Pulsed Electric Fields (PEF) at low and medium electric field strength to modify tomato pectin nanostructure.

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PEF technology is a non-thermal food processing technique that is gaining popularity for treating fruits and vegetables. However, there has been little investigation into the impact of PEF on the biomolecular components of plant tissues. This study aims to assess the influence of PEF at low and medium intensities on the physicochemical parameters of pectin fractions isolated from tomatoes at two stages of maturity. The ultimate objective is to collect data on PEF-pectin interactions to construct sustainable and customized food processes that rely on the functional properties of pectin (e.g., the peeling process). Monopolar exponential decay pulses of 1.0 and 10.0 kV/cm (specific energy input = 1.5 and 151 kJ/kg, respectively) were applied to alcohol insoluble residue (AIR) recovered from tomatoes at two distinct maturity stages (green and red pericarp). Topography and recognition imaging of three pectin fractions was performed using atomic force microscopy (AFM): water-soluble pectin (WSP), chelator-soluble pectin (CSP), and diluted alkali-soluble pectin (DASP). AFM images were used to characterize the geometrical properties of pectin fibers and aggregates. An HPLC-UV/VIS system was used to determine the monosaccharide content of the three pectin fractions. PEF treatments generated considerable structural alterations in all three pectin fractions; however, the effect varied depending on the stage of tomato ripening. WSP fibers in red tomatoes significantly reduced in length as the strength of the electric field rose (up to 50% shorter). The reverse result was seen in green tomatoes, where the length of the WSP fibers tends to increase as the applied electric field increases. The monosaccharide composition analysis showed that applying PEF reduced pectin linearity, regardless of the fruit ripeness stage. The research proved that PEF might modify nanostructures to improve particular food processes. PEF can reduce pectin length depending on the stage of fruit development, mimicking the natural ripening process.

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The impact of pulsed electric field and ultrasound pre-treatment on cold formulation process with aloe vera juice and selected properties of porous apple tissue

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Aloe vera juice contains a lot of biologically active compounds and stands as a valuable functional component. This allows using it in the cold formulation process, which involves the application of a vacuum to enhance the absorption of liquid into the pores of food products.

The aim of the study was to investigate the impact of ultrasound (US) and pulsed electric field (PEF) treatments on structural and textural changes as well as chosen physical and chemical properties of vacuum-impregnated apples in aloe vera juice.

Apples were used as an example of porous plant tissue. Pretreatment with the use of a pulsed electric field (PEF) and ultrasound (US). Different parameters were used for PEF (intensities of 125, 212.5, or 300 V/cm) and US (25 or 45 kHz for 10, 20, or 30 minutes). Then, the apples were subjected to a process conducted under a vacuum pressure of 200 mbar with the use of aloe vera juice (adjusted to apples' Brix with trehalose). The textural and structural changes with the use of scanning electron microtomography, microtomography as well as fluorescence microscopy to evaluate the cell viability after processing.

The results showed that non-thermal technics (PEF and US) as well as the vacuum formulation process caused structural alterations in the material. These changes had a direct impact on the texture of the product. PEF and US applied before the main process resulted in softening or hardening of the plant tissue, respectively. Also, there was an observed loss of cell viability due to the application of different treatment conditions.

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The impact of pulsed electric field pretreatment on texture and structure of vacuum-dried apples and strawberries

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Introduction

Electroporation induced by the action of a pulsed electric field (PEF) leads to the changes in various properties of treated material. The changes caused at the structural level may affect, for example, the texture of the analyzed food products.

Materials and methods

After the PEF pretreatment (PEF energy input of 1 and 6 kJ/kg in case of apples, 1 and 4 kJ/kg in case of strawberries), materials were dried in vacuum dryer (temperature: 55°C, pressure: 4 kPa). Moreover, reference process, carried out without PEF pretreatment, was performed for comparison purpose. Mechanical properties of obtained dried materials were evaluated on the basis of penetration test. Structure was recorded with the usage of Scanning Electron Microscopy (SEM) and X-ray Computed Tomography (XRCT).

Results

The results of the penetration test showed that the maximum force decreased from 10.1 to 7.9-8.7 N for apples and from 20.4 to 7.2-8.9 N for strawberries due to the applied PEF pretreatment. It could be stated that PEF decreased the hardness of vacuum-dried apples and strawberries by 13.1-21.1% and 56.4-64.7%, respectively, when compared to the untreated samples. The softer structure of the PEF-pretreated samples can be explained by the increased pore formation due to PEF (images obtained via SEM and XRCT), which could lead to reduced shrinkage and higher porosity of the samples.

Conclusion

PEF applied as a pretreatment, by increasing the porosity of the treated tissues, led to a significant reduction in hardness of dried apples and strawberries (in relation to untreated samples).

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ORAL PRESENTATIONS

Microbial Biodiversity and Resilient Plants Workshop

Soil sciences: a history of conquests from the Neolithic to the present day, to understand how closely man and the soil are

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Soil has strong ties with the mankind but, it has been curiously neglected in the history of agriculture. In fact, one of the first treatise on "Soil Conditions and Plant Growth" was first published by E. J. Russell only in 1912. Currently, however, the importance of soil for the well-being of human communities has been rediscovered and it is essential to provide a historical perspective of soil science, especially for young people who are preparing to undertake research on this topic; to let them know that a soil evolves over thousands of years, it can erode rapidly, thus, studying the soil also means learning about its past and present evolution, in order to determine its future. It is equally important to extend the knowledge that we researchers have, also to citizens in general, maybe using a more popular language, but still based on scientific evidences. Apologies for the many reviews I could not cite but, readers can imagine how vast the topic is.

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Biodiversity indicators in agriculture and horticulture

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Protection of biodiversity has become a top priority world-wide and particularly within European Union agricultural policies as a result of the increased awareness of the benefits that a wide diversity can provide to agricultural production and of the risks deriving from biodiversity losses. However, to protect biodiversity and to efficiently take advantage of it require the establishment of benchmarks to which comparing monitoring data. Moreover, biodiversity in horticultural crops can be assessed at different trophic levels, considering the soil and above ground organisms. The interactions among organisms present in the life web can help identifying indicators that could represent an overall level of biodiversity, but frequently the evaluation of each trophic level provides additional information useful also for the professionals (farmers and advisors). Indeed, crop management systems (e.g., integrated or organic), as well as individual agronomical practices (e.g. cover crops or application of biological inputs) can strongly affect the overall biodiversity of an orchard or plantation. Nevertheless, the surrounding landscape can also impact and interact with the cropping system shaping a specific biodiversity framework at farm level. The presentation will provide an overview of the possible biodiversity indicators that can support the improvement of management practices of horticultural crops, along with examples of the impact that different practices can exert on both below- and above-ground biodiversity. These will be discussed considering the recently proposed EU Directive on Soil Monitoring and Resilience and the concept of integrating “biotics” approaches to fully exploit the potential of microbial biodiversity.

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Investigating Arctic and Antarctic microbiomes for eco-epidemiological and bioprospecting purposes – novel tools and approaches

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Investigations of microbiomes (and especially these of extreme environments, like Arctic and Antarctica) enable understanding of ecological interplays, metabolic and biotechnological potential and mechanisms of bacterial adaptation. In our studies we focus on: (i) antibiotic and metal resistance in Arctic and Antarctic regions for the eco-epidemiological assessments and (ii) bioprospecting. Performed analyses revealed that: (i) antibiotic and metal resistance genes are common not only in anthropogenically-shaped environments but also in pristine ones; (ii) bacterial plasmids are important vectors enabling the transfer of antibiotic and metal resistance genes in Arctic and Antarctica; (iii) antibiotic resistance genes from Arctic bacteria are active in various hosts. Our works have also methodological impact, that will be emphasized during the presentation. Several new tools for environmental microbiology have been developed, including: (i) databases of PCR primers for the detection of antibiotic and metal resistance genes (LCPDb-ARG and LCPDb-MET); (ii) novel pipeline for the genome-based bioprospection; (iii) novel set of PCR primers for the detection of genes conferring resistances to antibiotics of the last resort.

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Towards an efficient evaluation, verification and curation of genetic mobile elements in (meta)genomic datasets

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DNA sequencing has taken hold in laboratories around the world for good. The development of this biotechnological division, increasing throughput, and thus decreasing the price of the service, has resulted in years of an exponential increase in the amount of publicly available (meta)genomic datasets. While demands for data generation grow with more projects funded so does its analysis. One of the major challenges is deciphering the composition of whole microbial communities, including not only specific microorganisms and their metabolic properties but also their mobile genetic elements like plasmids or bacteriophages that highly influence relations between them and drive their evolution. To understand that, one must be able to differentiate them and annotate their genomes accurately.

While there are well-established automatic annotation systems and tools for identifying various mobile genetic elements, they are limited to the reference databases they depend on. Although machine-learning-based tools have already established their usefulness in overcoming limitations of exclusively reference-based approaches they will be as good as the reference datasets they were trained on and these require researchers to carefully, often manually, validate their data.

To correctly annotate a given sequence, each scientist must employ a variety of different programs and databases which makes manual annotation a tedious and time-consuming task. In our work, we aimed to tackle this problem by combining the advantages of both automatic and manual annotation systems. We developed MAISEN - a web-based annotation curation system that aims to combine output from multiple programs in one place to boost the efficiency of manual, *de novo* (meta)genome annotation. It was designed to allow users to verify their data and create curated collections. For instance, we employed SigMa for identifying prophages in bacterial genomes that can instantly use identified prophages for better annotations in the following analyses.

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Soil and Plant Microbiomes under Changing Environment

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Soil and plant microbiomes play very relevant role in sustainable agriculture and healthy plant production, especially under changing climate. Healthy soils with high biodiversity of beneficial microbiomes are key to production of healthy food and are crucial to protection of crops against plant diseases and pests. Research on soil and plant microbiomes has increased steadily over the last 10 years, but information on their diversity, structure, mechanisms of interactions, and especially functions influenced by changing environmental conditions remain limited.

As soil microbial biodiversity is critical for all soil processes as a part of integral, multifunctional component of all terrestial ecosystems, the study os bacterial and fungal communities give us more insight into understanding their role for sustainable agriculture. The importance of climate change-borne plant pathogens and the ways of plant protection without chemicals are also crucial for climate-resilient future. Very important part of research in the context of 4.0 Agriculture is also atrificial inteligence methods for prediction of plant health and pathogens monitiring in agriculture and horticulture.

Moreover, the strategies of plant breeding and cultivation with connection of soil microbiomes and plant holobiont can give us new solutions and opportunities for more healthy food production. Beneficial microbiomes can support plant growth and protection by nutrients provision, production of plant stimulators, increasing plant resistance to pathogens and pests and improve rooting and plant germination.

Therefore, under different projects implemented in our Institute we focus on research problems concerning increasing knowledge of the soil-plant microbe interactions under various climate conditions and under different agricultural management practices.

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The microbiota of Polish red grape wines of spontaneous fermentation in the light of metagenetic and culturomic studies

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Spontaneous fermentation of grape must takes place with the participation of many microorganisms constituting the fruit microbiota. Yeasts that carry out ethanol fermentation, such as *Saccharomyces cerevisiae*, and others that affect the aroma and taste of wines, such as *Metschnikowia* sp.or *Pichia* sp. play a significant role here. Some bacteria such as genera *Oenococcus, Lactobacillus, Lactococcus* and *Leuconostoc* also have a positive effect on the aging process of the wine by carrying out malolactic fermentation and contribute to improving the taste of wines. On the other hand, some microorganisms cause undesirable sensory changes (wine diseases). There are two ways to acquire knowledge about microbiota: isolation of microorganisms on culture media and their identification by various methods (currently called culturomics) and metagenomic analysis based solely on DNA isolation, amplification and bioinformatics analyses. Both methods were used in the study of wines obtained from grapes grown in Lublin province. The culture method involved inoculation of diluted wine samples on microbiological media dedicated to lactic acid bacteria and yeast. DNA was isolated from obtained colonies, followed by sequencing and identification. In the metagenetic method, DNA isolation from wine samples was carried out, and the obtained amplificons were sequenced and in silico identification was performed. The following yeasts were obtained in the culture method: *Saccharomyces cerevisiae, Hanseniaspora uvarum, Metchnikowia pulcherrima, Pichia kluyveri, Starmerella bacillaris*. In the metagenetic method, i.a. the following species: *S. cerevisiae, Saccharomyces cariocanus, H. uvarum, Torulaspora delbrueckii, Metschnikowia sinensis, Kazachstania servazzi* were identified. Among the lactic acid bacteria that were tested by both methods, the metagenetic analysis showed the presence of *Lactiplantibacillus plantarum, Apilactobacillus kunkeei, Leuconostoc pseudomesenteroides, Lactococcus lactis, Fructobacillus tropaeoli*, whereas culture methods showed *Leuconostoc pseudomesenteroides, Lactococcus lactis and Fructobacillus tropaeoli*. Differences may be due to the difficulty of culturing some microorganisms and the limited culture methods used in research.

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The impact of plant extracts in the form of spraying on the biodiversity of fungi colonizing seedlings of winter wheat (*Triticum aestivum* L.) and selected quality parameters of seedlings in phytotron conditions

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The search for alternative preparations for plant protection requires the assessment of their effectiveness and impact on microorganisms and plant quality parameters. The research aimed to determine the use of plant extracts in the form of spraying on the biodiversity of fungi colonizing seedlings of winter wheat (*Triticum aestivum* L.) and the effect of this extract on the dry and fresh weight of plants, as well as the content of plant pigments in the leaves. A mixture of plant extracts from sage, hemp and tansy (M10, M20) and hemp extract (H10, H20) were used at concentrations of 10% and 20% to spray wheat seedlings in laboratory conditions. M10, M20 extracts did not affect the number of rhizosphere fungi, while after the application of the H10 extract, an increase in the number of beneficial fungi, such as *Trichoderma* spp., was observed, especially after the application of the H2O extract. The analysis of the above-ground parts of the plants showed a greater biodiversity of fungi and a lower number of pathogenic fungi in the experimental combinations compared to the control. The dominant species were: *Giocladium catenulatum* and *Trichoderma hamatum*. Plant extracts had a significant effect on the growth of fresh-weight of seedlings. The highest fresh weight of seedling roots was in combination with H20, and the lowest fresh weight of leaves was in combination with H10 and differed significantly only from the control. There were no significant differences in seedling dry matter for the experimental combinations. The highest concentration of plant pigments in leaves was found in seedlings sprayed with M10 (chlorophyll A), M20 (chlorophyll B and A+B), and H20 (carotenoids). The results are preliminary research to further field experiments to determine the fungistatic effect of the extracts in field conditions and the possibility of their use in plant protection.

Reproducible metagenomic data analysis in a browser - a short tour

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The goal of the lecture is to provide a brief and straightforward primer to using open-source tools in the field of reproducible metagenomic data analysis. In order to do this, it offers a step-by-step example of amplicon metagenomics analysis using open-source tools and databases. It highlights the handling of rDNA datasets, a common method for studying microbial community structures.

Participants will be guided through the use of QIIME2 ecosystem of tools for metagenomic analysis. Process will be conducted within a browser-based notebook environment, a platform allowing for open collaboration, interactive and reproducible data analysis. Lecture also involves brief discussion of principles and reasoning behind the successive steps of the analysis as well as the individual tools and data sources.

Potato as a model crop for studying plant responses to stress factors

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Plants cope with a plethora of biotic and abiotic stresses. Our team focused on understanding plant responses to drought, high temperatures, and viral infection with potatoes as a model plant and potato virus Y (PVY) as a model viral pathogen.

Potato is a species with high water demand but has a broad genetic diversity. We selected two potato cultivars, sharing one among their ancestors but strongly differing in response to the drought (cv. Gwiazda - tolerant, cv. Oberon - susceptible). The expression level of the housekeeping genes varied, with EF1α being the most stable and cullin 3A induced to a level similar to stress-responsive RAB18. Here, we have found that drought has induced the expression of the RAB18 gene to a greater extent than high temperature. Moreover, the expression level of this gene was generally higher in cv. Oberon, but its peak occurred significantly later than in cv. Gwiazda. This fits the model where the tolerant cultivar responds faster to stress than the susceptible one.

PVY is a typical Potyviridae member, the most prominent plant virus family. PVY genome is a +ssRNA molecule (9800 nt) with a covalently attached protein called VPg at the 5'-end and a poly-A tail at the 3'-end. The virus is the most critical potato pathogen. Additionally, PVY infects tomatoes, peppers, and tobacco. As a typical "quasi-species," it is characterized by a high frequency of point mutations and frequent recombination events resulting in fast virus evolution. In our work, we explore the hypothesis that new genetic variants of the virus can be induced by cultivating resistant potato cultivars. Our preliminary data indicate that in resistant cultivars, the virus mutates explicitly in the P1 and HCPro proteins coding region, which can impact the rate of virus spread.

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Using next generation sequencing to study microbial communities in environmental science: the importance of bioinformatics

Vink S.N.

GreenFinch Research

The advent of next generation sequencing (NGS) has revolutionized the study of microorganisms and has greatly improved our understanding of the ecology of microbial communities. However, the large increase in data that is generated using NGS has also led to greater challenges (and opportunities) when using these molecular approaches.

In this presentation I will focus on the bioinformatic pipelines used to process sequencing data and discuss various approaches to NGS, the underlying requirements and choices that are necessary, the downsides as well as the potential that these pipelines offer.

Using next generation sequencing to study microbial communities in environmental science: a pipeline step-by-step

Vink S.N.

GreenFinch Research

One of the most crucial steps in assessing microbial communities using amplicon sequencing is the processing of raw data to a format that can be used for data and statistical analysis. Although the process of sequencing analysis has become much more accessible and streamlined in recent years, this part can still be quite opaque and daunting for many researchers.

In this workshop I will give a general overview of the steps necessary to process sequencing data. For this I will use a popular and much-used pipeline in the bioinformatic analysis of microbial communities, QIIME2, and go through the different available steps and options. We will start by discussing the prerequisites for using this platform and end with how to produce data for statistical analysis and cover (almost) everything in between. The goal is not only to give a general overview but also to improve your understanding of each step involved in the process.

Development a guide of good practices on soil metabarcoding data generation

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Soil research is a powerful tool that can help us to improve soil health. It provides valuable insights into soil biodiversity and its dynamics, enabling the development of soil management practices that are more respectful to belowground organisms, ultimately benefiting humanity and the planet.

In recent years, numerous collaborative projects have emerged with the aim of exploring soil microbiome, for example: Fields4Ever initiative, Earth Microbiome Project, Indian Soil Microbiome Project, LUCAS or AGROECOseqC project as examples.

To progress towards this ambitious goal, it is of utmost importance that the data generated in each of many large projects involved soil microbiome research be optimally comparable.

Next-generation sequencing (NGS) technologies are providing a powerful approach to achieve a more complete understanding of the complexities of microbial communities and their impact on plant growth, disease resistance/susceptibility, climate adaptation and environmental remediation.

There is not a consensus on what is the optimal NGS approach used to examine the soil biodiversity. Metabarcoding or amplicon sequencing of marker genes is the most popular method on soil microbiome research. Differences on selected gene primers, DNA isolation protocol, sequencer, polymerase produce bias to aggregate sequencing data from different studies and to generate more robust conclusions.

To facilitate data comparison, quality and reproducibility we aim to propose a guide of good practices and a classification of the Metabarcoding variants using a statistical method named Coefficient of Sequencing Variation. It measures the dispersion of repeated results generated under specific rules, showing the precision and reproducibility of a process, where a lower coefficient means better reproducibility.

To test it, we selected different NGS data from the same samples, that was produced under the same metabarcoding protocol and also we changed some steps of the protocol, like DNA Isolation process or sequencer machine.

Interactive workshop concerning NGS steps in laboratory, data generation and submission results to databases

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Soil biology is directly involved in ecosystem services (organic matter transformations, nutrient cycling, biocontrol agents) and have effects on plant and crop physiology through microbial-plant interactions (i.e., they generate bioactive phytochemicals, and they regulate pathogen occurrence). A detailed understanding of soil microbe interactions in agriculture requires a precise characterization of environmental crop-associated microorganisms.

Next-generation sequencing technologies are providing a powerful approach to achieve a more complete understanding of the complexities of soil microbial communities and their impact on plant growth, disease resistance/susceptibility, climate adaptation and environmental remediation. This technology is enabling to simultaneously obtain information on thousands of taxa as opposed to targeted approaches that detect only a taxonomically predefined group.

Metabarcoding or amplicon sequencing of marker genes is the most popular method on soil microbiome research. Any soil metabarcoding project involves soil data collection, raw sequencing generation and analysis. This process needs to be described with precision in other to guaranty the true and reproducibility of any study published.

In this workshop we aim to explain good laboratory practices, common steps on data generation and to submit a soil metabarcoding project to NCBI, including information for submitting sequences to the Sequence Read Archive (SRA) and GenBank, and registering BioProjects and BioSamples. Also, We will open the discussion about the minimum extra metadata linked with Bio Samples, that should be added to BioSamples and Bioprojects.

Microbial Transcriptomics. Start-to-Finish RNA-seq analysis using R and Bioconductor

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Recent advancements in high-throughput sequencing technologies have revolutionized our understanding of bacterial gene expression dynamics through RNA-Seq analysis. This workshop presents a comprehensive overview of bacterial RNA-Seq, highlighting its pivotal role in deciphering transcriptional landscapes.

RNA-Seq enables quantitative assessment of RNA molecules in a sample, providing insights into gene expression, alternative splicing, and novel transcript discovery. In this workshop, we present a standard data analytics pipeline using the R programming language and the Bioconductor suite of tools for robust RNA-Seq analysis [1].

Typical pipeline encompasses essential steps, including quality control, read alignment, quantification of gene expression levels, differential expression analysis, and functional enrichment. Leveraging Bioconductor packages such as 'DESeq2', statistical methods are applied to identify differentially expressed genes, unveiling molecular responses to diverse conditions [2].

Furthermore, we demonstrate the utilization of 'clusterProfiler' package for functional enrichment analysis, elucidating biological processes, pathways, and Gene Ontology terms associated with differentially expressed genes. The integration of R and Bioconductor streamlines analysis, enabling researchers to extract meaningful biological insights from complex transcriptomic datasets [3].

In conclusion, bacterial RNA-Seq stands as a pivotal tool in understanding gene expression dynamics in response to environmental changes or therapeutic interventions. This workshop underscores the significance of RNA-Seq and provides an accessible framework for data analysis, facilitating researchers in unraveling the intricate mechanisms governing bacterial transcriptional responses using the power of R and Bioconductor.

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How to approach biodiversity analysis in metagenomic studies

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In recent years, metagenomic studies have become increasingly popular. This is mainly due to innovations in molecular biology techniques and scientific equipment. In addition, a significant increase in the volume of data generated in recent years, coupled with a reduction in the cost of analysis, has made these studies even more accessible.

Metagenomics - the term was first used in 1998 (1) and can be defined as the study of the entire genetic material of an environmental sample, be it a plant, animal, water or soil sample. Such methods, in contrast to traditional microbiology and molecular biology techniques, allow researchers to determine the composition of almost all the organisms sought in the sample, even those that cannot be cultivated in the laboratory (2). Nowadays, there emerged two trends in metagenomics - "shotgun" sequencing with its derivative metagenome-assembled genomes (3) and targeted amplicon sequencing, called metataxonomics.

Biodiversity is inherently related to metagenomics and is defined as the variety of all organisms, species and populations. Tools, methods, calculations and indices have been developed and used to study and measure biodiversity. However, each approach to biodiversity analysis contains more or less implicit biases, errors, misinterpretations or assumptions. Therefore, in order to standardise biodiversity approaches, the aim of this work is to scrutinize commonly used ways of treating and analysing biodiversity in metagenomic studies.

Acknowledgements

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ORAL PRESENTATIONS

Metrology and Modelling of Agrophysical Processes Workshop

Irrigating for Sustainable Intensive Agriculture: Technological Approaches

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Proper irrigation scheduling requires and accurate determination of when and how much to irrigate. This is crucial in a context of sustainable intensive agriculture, where management decisions have a great impact on crop development and production. The issue becomes specially challenging when the water available for irrigation is below the crop water requirements and a deficit irrigation strategy must be applied. Under these conditions, the choice of both the irrigation strategy and the scheduling irrigation method highly determines the success of irrigation. Here we focus on high performance methods to assess the crop water stress and to schedule irrigation, based on measurements in the soil, in the plant or in the atmosphere. We review both the fundamentals and characteristics of new sensors and related equipment, including installation, maintenance and data processing requirements. We pay especial attention to plant-based sensors related to sap flow, trunk diameter variations or leaf turgor pressure, due to the potential of using the plant as a biosensor for assessing water stress. Then we address how these methods should be combined with remote imagery, since identifying the spatio-temporal variability within the orchard, of soil and plant variables related to water stress, is crucial for precision irrigation. Finally, we address socio-economic aspects related to the level of acceptance of these new methods by growers.

Acknowledgements

We thank both the Spanish Ministry of Science and FEDER “A way to make Europe” for funding the ISADORA research project, reference PID2021-124651OB-I00. We also thank the *Junta de Andalucía*, the UE Operational Programme for Youth Employment and the European Social fund, for funding personnel related to this work.

A multi-model ensemble to project the future for soybean in Europe

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The EU strives to increase the production of protein crops to (i) to further diversify cropping systems to enhance ecosystem services and (ii) reduce the dependency on imports from foreign countries. Soybean exhibits great economic potential for its large content of proteins, which is currently underutilised in Europe. Under expected climate warming, agronomists assume that the potential to successfully grow soybean in Europe to achieve competitive yield levels will increase significantly. Here we explore the potential productivity under future climate based on multi-model simulations.

We used experimental soybean growth data from Germany, France, Poland and Serbia to calibrate four crop models for early to very early maturity groups. Soybean data represented maturity groups ranging from 0000 to II. The data was split to calibrate and test the models. We simulated a 30 year time period and analysed the phenology and the response to average temperature, cold spells, rainfall at harvest and drought. Based on this distribution we produced a yield map across Europe that exerts the yield produced by the most likely maturity group per grid cell.

Results demonstrate the northward shift of soybean production across the European continent and how the overall yield potential increases with the higher potential to grow high-yielding maturity groups in central Europe, where water scarcity is still not limiting the production. We also demonstrate that the potential area for rainfed production of soybean is expected to decrease in Southern Europe, with less water being potentially available in the soils.

We conclude that the overall potential to grow soybean across Europe will increase significantly under climate change, based on the new areas becoming available in central Europe outweighing the areas that will be lost to drought in the South. This will increase Europe's potential to become less dependent on soybean imported from overseas.

The AGRICORE suite: a novel policy assessment tool combining agent-based and biophysical modelling

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The Common Agricultural Policy has prioritized enhancing support for rural development across the European Union, integrating environmental requirements, and promoting market-oriented agriculture. As policymakers and researchers increasingly recognize the need for more targeted and specific agricultural policies, there is a growing demand for a comprehensive understanding of their economic and environmental impacts at both detailed and geographical levels. To address this, the AGRICORE project aims to develop an innovative tool that leverages advancements in modelling approaches to improve the capacity for policy modelling in agriculture. Specifically, the AGRICORE tool will employ an agent-based approach, wherein each farm is treated as an autonomous decision-making entity. Farms will individually assess their own circumstances and make decisions based on their current situation and expectations. One of the distinctive aspects of the AGRICORE framework lies in its utilization of biophysical models to evaluate the dynamic agro-environmental status and productivity of individual farms. By integrating biophysical modelling into the ABM, the AGRICORE tool will enable a more comprehensive assessment of the impacts of agricultural policies on both economic and environmental factors. The development of the AGRICORE agent-based model (ABM) involves establishing connections between the biophysical and socio-economic modules. Additionally, meteorological scenarios will be carefully considered to account for the diverse weather conditions that impact farming operations. By defining various technological alternatives for crop activities, the ABM will generate production scenarios, optimizing the agro-economic performance of individual farms within the AGRICORE framework.

In this presentation, we will discuss the fundamental assumptions of the AGRICORE suite and outline how the integration of biophysical modelling with the ABM will occur. We will also demonstrate the practical application of the planned modelling approach that assumes the creation of yield tables by exploring simulated yield patterns under climate change using response surfaces.

Acknowledgements

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Developing fractal dimension-based estimates on the HunSSD database

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For characterization of the most important soil types in Hungary, representative soil profiles were excavated and survayed at 73 sites, from which disturbed and undisturbed soil samples of 326 soil horizons were collected. In addition to basic soil properties, the hydrophysical properties (water retention and hydraulic conductivity) of samples were determined and structure of the soil samples were investigated with different methods. On these analyses, the first nationally representative database of soil physics and hydrology were compiled with the soil structural and morphological properties. Using collected soil data of Hungarian Soil Structural Database (HunSSD), a novel domestic experiment was started to estimate water retention properties of soil from particle size distribution (PSD) data and other easily measurable soil characteristics, such as bulk density. In the case of the novel pedotransfer functions, we first calculated the mass fractal dimension (Dm) of PSD data determined by traditional pipette method. Dm was calculated according to Tyler and Wheatcraft (1992). To calculate DM fractal dimension of the measured water retention and Dm of pore size distribution data, we used measured relevant data of the HunSSD. DM was calculated according to Tyler and Wheatcraft (1989). Since the correlation of the fractal dimensions DM and Dm is highly significant (R2=0.84), we expect a good estimation of the water retention data or function using pedotransfer function that will be determined by fractal dimensions of the soils.

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Ecosystems modeling & monitoring with the isotopic measurements capabilities.

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(Jaroslaw Grodowski, PICARRO Inc. and UGT GmbH Representative)

PICARRO

Innovative, protected by over 30 patents, new class of CRDS spectrometers are adapted for work in the field. CRDS (Cavity Ring-Down Spectrometry), in many cases, can be an alternative to the expensive and complicated IRMS technique in ecosystem monitoring.

The CRDS guarantees high precision and sensitivity with the measuring range from ppt to %. Result can be transmitted in real time to through GPRS network.

PICARRO spectrometers measure isotopes: carbon C-12 and C-13, nitrogen N-14 & N-15, hydrogen, deuterium and oxygen O-16, O-17 and O-18 in the air and water. Concentration measurement of NH_3, CO_2, C_2H_4, H_2CO, HF, H_2S.

Remote, maintenance-free operation, durability and resistance to temperature, pressure and vibration changes allow operation in the harshest environmental conditions. `An optional incineration module allows solid sample analysis.

UGT

EcoLab flex – modern chambers for observing the entire ecosystem to simulate climate and ecological scenarios.

UGT's Ready-To-Go lysimeter sampling technplogy, transfers the intact soil monolith taken from the field to EcoLabf.

Monitor and change scenarios quickly from anywhere thanks to the innovative PLC control system for all modules (e.g. lighting, irrigation, air conditioning).

Water isotope probes (WIP) are used for direct, non-destructive in situ measurements of stable water isotopes d18O and d2H with PICARRO spectrometers.

Optimizing root zone water management using strategic sensor placement and machine learning algorithms

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Efficient water management plays a vital role in sustainable agriculture, especially in regions facing water scarcity. Conventional irrigation scheduling approaches typically rely on fixed scheduling, which can result in inefficient water usage and suboptimal crop yields. We are developing an approach for optimizing root zone water management through the integration of targeted sensor placement, historical sensor data, and machine learning algorithms. We employ crop root density profiles to inform strategic single soil moisture sensor depth placement within the root zone. Additionally, historical water content data provides a pathway to estimation of the soil profile hydrodynamics. Machine learning algorithms are used to analyze these complex data patterns and learn relationships between our historical sensor data and local soil hydraulic properties. By leveraging historical sensor data, we derive soil-specific hydraulic properties leading to estimation of root zone soil profile water content. The integration of targeted sensor depth, historical sensor data, and machine learning algorithms holds great potential for precision irrigation and sustainable water management. By accurately estimating soil hydraulic properties and predicting soil profile water content, this approach can revolutionize water management practices, conserving water resources and increasing food production in water-limited regions.

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Forecasting the production effects of plant irrigation based on meteorological measurements and long-term results of field experiments for maintaining ecosystem services

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Irrigated agriculture contributes significantly to the provisioning ecosystem services of food, feed, and fiber production.Therefore in light of climate change it is important to investigate the effects of irrigation on agricultural production in the future. The aim of the research was to indicate the period in which precipitation conditions and precipitation-thermal conditions had the greatest significant impact on the increases in yields of selected field crops under the influence of irrigation. It was assumed that if significant weather-yield dependencies were found, they would be helpful in forecasting the effects, and thus in programming the development of plant irrigation in regions of conditions comparable to central Poland regarding soil and climate.

The effects of plant irrigation were modeled on the basis of the results of field experiments carried out in 2005-2020 carried out in the Research Center of the Bydgoszcz University of Technology located nearby the city Bydgoszcz (ϕ=53°13', λ=17°51', h=98.5 m asl). In terms of the climatic criterion it is the area with the lowest precipitation, and therefore with the greatest average precipitation deficits and needs for supplementary irrigation in Poland. The experiments were carried out on light soil on compact subsoil. Taking into account the soil conditions the applied irrigation had an interventional character, typical for the climatic conditions of central Poland. It supplements eventual periodic shortages of precipitation during the period of high water needs of plants

Data from agri-meteorological monitoring was used in the analysis. Measurements were carried out in accordance with WMO procedures, at the measuring point, located near the experimental field. Data are free from the influence of urban anthropogenic factors. The research covered the following crops: malting spring barley, grain maize, mid-early potato, faba bean, winter rapeseed, sugar beet and soybean.

The findings presented above can contribute to the development of the provisioning ecosystem services.

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Development of the system for complex permittivity spectrum measurements in the radio and microwave frequency range

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There are many different dielectric sensors and methods using for complex dielectric permittivity spectrum measurement. They differ in accuracy, type (measurements in time or frequency domain) and in useful frequency range. The use of particular type of sensor is mostly dependent on measured material type. For liquids the most common is an open ended probe, for granular material – like soil – the best are probes with rods because of their quite big sensitivity zone. However, probes with large sensitivity zone usually have smaller useful frequency range than an open ended probe. The most optimal solution is using a large-diameter coaxial cell. This type of sensor consist of two coaxial tubes with measured material placed between of them. Such cell is connected to a vector network analyser (VNA), which measures scattering matrix parameters (S-parameters). Based on S-parameters, complex dielectric permittivity spectra can be obtained. This type of sensor can be used for measurements of different material types, like fluids, powders or solids. Moreover, coaxial cell can work in a wide frequency range from a single MHz up to several GHz.

We have developed a system of six coaxial cells which enables measuring six samples simultaneously. In the prototype of the system, each of cell was connected to the VNA by a multiplexer using semi rigid cables. In the newer version of the system, each cell will be operated by a separate reflectometer and an electronic calibration unit. That solution will ensure better accuracy and reliability because of lack redundant elements like multiplexer or cables. Moreover such construction is more compact and convenient to use.

Acknowledgements

The research was supported by the project: System for complex dielectric-permittivity-spectrum measurements of powdery, liquid, and solid materials in 1 MHz – 3 GHz frequency range, funded by National Center for Research and Development within programme TANGO V, agreement no. TANGO-V-C/0007/2021-00.

Segmented linear calibration function for soil moisture estimation using microwave dielectric measurements

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Dielectric measurement methods allow for almost non-invasive soil moisture estimation. A variety of probes operating at various frequencies and employing various specific measurement techniques are utilized. These devices are generally easy to use and many of them can be utilized in monitoring stations.

Dielectric soil moisture probes differ in measurement accuracy. Typically, the best devices operate in the time domain and provide accuracy of about 0.02 m^3/m^3 with factory calibration functions. This could translate to high relative error in the case of dry soils. Moreover, there are many soil-specific and environmental factors, such as temperature, soil salinity, density and texture, which may interfere with the sensor readouts. Adaptation of dielectric permittivity-volumetric water content function to given specific conditions, especially by performing soil-specific calibration, increases the measurement accuracy.

Most of the popular calibration functions utilized in dielectric sensors are either polynomial functions of the real part or apparent dielectric permittivity, such as the Topp equation, or linear functions with respect to the square root of the real part or apparent dielectric permittivity. The presented research investigated the benefits of a calibration function consisting of two linear segments. This function was parameterized with the use of the real part of complex dielectric permittivity obtained at frequencies from 20 MHz to 3 GHz. Dielectric measurements were performed using coaxial-transmission-line cells connected to a single-port vector-network-analyzer. The samples of three soils of various moisture content and salinity were measured at controlled temperatures in the range from 0.5 to 40°C. The investigated calibration functions proved to be superior to the standard linear calibration, especially at high frequencies.

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Wireless IoT probe for soil moisture and salinity estimation based on dielectric spectrum measurements

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We present a novel wireless soil moisture and salinity sensor. This sensor determines the soil parameters based on 0.05-2 GHz dielectric spectrum measurements. The sensing part of the device is constructed as a multiconductor open-ended transmission lines section filled with the soil dielectric. The sensor is battery power and sends its read outs through Bluetooth and/or the LoRA IoT transmission protocol. In this paper we present some details on the sensor design and preliminary measurement results.

Acknowledgements

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ORAL PRESENTATIONS

Biology of the Change – Microbial Processes Related with Greenhouse Gases Transformation in Natural and Agroecosystems Workshop

Climate change microbiology: novel insights into methane-cycling microorganisms

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Methane is a potent greenhouse gas that is produced by microorganisms living in the absence of oxygen, the methanogenic archaea. The amount of emitted methane is controlled by a powerful biological filter where aerobic and anaerobic methane oxidizing microorganisms thrive. In our work, we aim to understand the biochemistry, physiology and ecology of methanogens as well as anaerobic methanotrophic (ANME) archaea that are both key to understanding and eventually mitigating methane emissions into the atmosphere.

Land use/cover modifications and climate change mitigation: What we know, or think we know, and a lot of what we don't really know

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Historically, land use/cover changes have had a large negative impact on global greenhouse gas emissions (GHG) and ecosystem carbon sequestration. Land use changes associated with agricultural expansion alone may have increased GHG emissions by around 25% over the last two decades. Nevertheless, the judicious use of changes in land use/cover within the landscape could make a significant contribution to climate change mitigation strategies. Although afforestation is widely touted as the major way in which we could reduce GHG emissions and enhance soil C sequestration it is evident that grasslands could, in many cases, also act as an effective way of storing carbon that may be less vulnerable to extreme climatic events. Also, afforestation could decrease soil and ecosystems stores of carbon in soils with a high organic carbon content. Less attention has also been paid to the effects of land use/cover changes on the fluxes of the other two major GHGs, nitrous oxide (N_2O) and methane (CH_4), or their microbiological drivers, both of which can make a significant contribution to the total GHG budget. The ability of some forest and grassland soils to act as a sink for CH_4 could be significant as many agroecosystems are dominated by CH_4 emissions from livestock. Whilst most climate mitigation strategies have focussed on managed lands unmanaged/low impacted lands may contribute over 50% of the terrestrial ice and snow free terrestrial surface area so that any changes in land cover in these areas could have a major impact on global GHG emissions. Of the well documented changes in land cover on low impacted land are the increasing global spread of introduced plant species, which can have dramatic effects on ecosystem GHG emissions but remain largely unquantified. Whilst most of the focus of climate-mitigating land-based strategies has been directed at changes in GHG emissions and carbon stocks, any change in land use/cover will also result in biophysically related changes. Changes in albedo, for instance, are an almost inevitable consequence of land use/cover changes and have the potential to reduce or even negate any benefits associated with an enhanced C sequestration or a reduction in GHG emissions. Overall, the appropriateness of any land use/cover changes will require a holistic approach if these are to provide an effective climate change mitigation strategy.

Kitchen waste as feed for anaerobic digestion

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Kitchen waste (KW) is a favorable substrate for anaerobic digestion since provides biogas with high yield and calorific value as well as nutreous digestate having desired fertilizing potential. Selectively collected KW still requires cleaning besides size reduction of the biomass. Both unit operations can lead to microplastics which are being considered emerging pollutants. The research was carried out as part of the project entitled *Methane fermentation of biomass containing biodegradable polymeric material* (DIGEST-PLAST).

Prior to mashing in a cutting mill with a capacity of 300 kg/h, the KW was cleaned from paper, plastic, aluminum foil, glass and mineral matter. Simultaneously, the microbial contamination of the KW was evaluated. The share of the bio fraction was in the range of 77% - 99% by mass, plastic waste - mainly plastic and scarcely bioplastic bags - accounted for 1% to 23% by mass, paper - from 1% to 15% by mass. The remaining impurities of the kitchen waste were less than 1% by mass. The components of the biomass feed were usually residues or peelings of vegetables and fruits, bread, fats, dairy products and meat products. The dry matter content ranged from 20% to 28%, and the volatile compounds were from 85% to 91% of the dry matter.

FTIR and thermogravimetric analyses of representative KW samples - after removal of macro-pollutants, mashing and drying - did not show the presence of bioplastics in an amount exceeding the accuracy of the determination. In this regard, studies on the impact of bioplastics on methane fermentation were carried out with selected polymeric substances intentionally introduced into the reaction medium.

The biomass research demonstrates that the preparation of a representative bioreactor feed from selectively collected kitchen waste has been appropriate for anaerobic digestion for the entire project continuation.

Acknowledgements

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Changes in soil greenhouse gas emissions, organic matter and soil microbiota under the influence of erosion control and conventional tillage systems

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Water erosion is the most significant degradation process of Epicalcic Chernozems. To prevent and reduce the negative consequences of water erosion in agricultural lands, a number of practices and technologies are applied. An experiment with wheat and maize in rotation with the application of up-and-down slope culture (T0), traditional contour tillage (T1) and crop specific erosion control contour tillage (T2) has been performed for two years. The T2 variant includes minimum tillage, direct sowing and pre-crop after wheat harvest and before maize sowing. The content of total organic carbon, labile organic matter, the number of main groups of soil microorganisms, as well as CO_2 and N_2O soil emissions were monitored.

A higher amount of ammonifying, spore-forming, cellulose-degrading microorganisms, actinomycetes and nitrogen-fixing bacteria, were reported in T2 variant under maize, compared to T0 and T1 variants. Minimum tillage (T2) under wheat resulted in higher numbers of actinomycetes, mineral nitrogen-utilizing bacteria, and cellulose-degrading microorganisms during the spring and summer months. Soil CO_2 emissions under wheat were the lowest (29.2 kg ha^{-1} day^{-1}) in the minimum tilled variant, followed by T0 (33.2 kg ha^{-1} day^{-1}) and T1 (32.3 kg ha^{-1} day^{-1}) variants. The average emissions under maize at T0 variant, compared to the variants T1 and T2, were lower, due to the compaction of the surface soil layer, which in turn provoked more intensive erosion processes. The N_2O emissions among the different variants were insignificant, but overall they were the lowest in the T2 variants. Total organic carbon on average of all measurements at two depths (0-10, 10-20 cm), in T2 maize variant was the highest.

The conclusion of the obtained results is that the minimum tillage for maize and wheat growing on slope lands with the inclusion of pre-crop in the rotation, had a positive effect on soil organic matter, microflora and GHG emissions.

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Isolation of methane oxidizing bacteria from diverse environments

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Research problem

It has proven challenging to isolate methane-oxidizing bacteria due to their cohabitation with non-methanotrophic cocultures. As a result, existing isolation procedures are ineffective for isolating monocultures of methane-oxidizing bacteria (MOBs). Our study intended to improve isolation methodologies that would aid in the elucidation of methanotrophic diversity as well as the identification of new MOBs with bioprocess application potential.

Methods

Pre-enriched methanotrophic communities from three different samples (landfill biocover, peatbog soil, and activated sludge) were used. Initial isolation was performed using regular basal NMS medium that contains essential minerals and vitamins along with methane as the sole source of carbon. Subsequently, recovery of a pure monoculture of *Methylocystis* was tested through modifications in several factors, including medium composition, pH, CH4%, temperature, and the addition of essential nutrients. Nanopore sequencing was used for both identification of microbial diversity using 16S rRNA amplicon sequencing and draft genome assembly of novel methanotrophic species.

Results and conclusions

Initially, a single mixed culture of *Methylocystis* was recovered from the Landfill biocover sample. Moreover, 95 non-methanotrophic bacteria were obtained, cultivated as part of microbial consortia feeding solely on methane as a carbon source. Modified vitamin-deficient media resulted in the acquisition of two additional pMOA positive colonies. 16S rRNA gene amplicon sequencing revealed that both were mixed methanotrophic cultures. Futher isolation step included cultivation of these three *Methylocystis* cocultures using dNMS media with trace level of yeast extract. 26 pMOA positive clones were recovered from solid media and amplicons of 16S rRNA gene sequenced - various degree of *Methylocystis* genera was identified. The five cultures exhibiting highest purity were subjected to shotgun sequencing and 3 turned out to be monocultures of *Methylocystis*. Surprisingly, one among three monocultures, found to be novel species of *Methylocystis* and the remaining 2 had a high similarity to *Methylocystis hirsuta.*

ORAL PRESENTATIONS

Physico-chemical Properties of Plant Materials Workshop

Formation of advanced glycation end-products in foods

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The spontaneous post-translational modification of proteins or amino acids through reducing sugars is called the Maillard reaction (in food sciences) or protein glycation (in health and medicinal sciences), and the products resulting from exposure to reducing sugars are called advanced glycation end products (AGEs).

Apart from sensory modifications, the Maillard reaction impacts the nutritional and toxicological properties of food. One of the better known nonfluorescent AGEs is Nε-(carboxymethyl)lysine (CML), which is present in biological systems, such as plasma, urine, tissues, skin collagen, and in many heat-processed foods. Recently, CML has been associated with major pathogenic processes in diabetic complications, atherosclerosis, Alzheimer's disease, and normal aging.

Therefore, various strategies for controlling Maillard reaction have been investigated over the years. However, the development of efficient strategies for the control of Maillard reaction in foods requires an understanding of reaction mechanisms and how reaction conditions affect Maillard reaction. Obviously, the concentration of AGEs in food is affected by many factors, including temperature, length of the period of heating, pH, concentrations and reactivity of the components present, water content, and the presence of inhibitory compounds. Phenolic compounds have been proposed as effective inhibitors of AGEs formation in both model and thermally treated systems. Most studies suggest that the inhibitory effect of polyphenols on Maillard reaction is caused by the dicarbonyl trapping, antioxidant capacity towards Maillard-derived radicals, blocking of amine groups by quinones, and trapping of specific Maillard reaction products, such as Strecker aldehydes and furfural compounds. However, among the parameters affecting the level of AGEs in foods, the effects of antioxidants have not yet been satisfactorily elucidated. Thus, the mechanism of action still remains unclear.

Since the diet is a major source of exogenously formed AGEs, reduction of those components in foods is a main target of both industries and researchers.

The influence of flavonoids and their glycosides on the structure of gliadins

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Flavonoids are secondary plant metabolites. In nature, they are often found in the form of glycosides. Due to their antioxidant properties, these compounds can have a positive effect on the human body. One way of delivering polyphenols to the body can be food fortification. Bread, which is one of the main components of the diet, may be a suitable carrier of these compounds. However, supplementation of wheat dough with various substances may disturb the proper structure of the gluten network (gliadin and glutenin), and thus deteriorate the quality of bread.

The aim of the research was to investigate the effect of selected flavonoids (quercetin, naringenin, hesperetin) and their glycosides (rutin, naringin, hesperidin) on the secondary and tertiary structure of gliadins. Polyphenols were added in three concentrations 0.05%, 0.1% and 0.2%. The dough samples were prepared in the farinograph. Then, the gluten was washed out from the model dough. Next, gluten was frozen, lyophilized and pulverized. Then, gliadins were extracted from the gluten samples according to the Both and Ewart method. The samples of gliadins in the form of powder were tested using FT-Raman spectroscopy.

The analysis of Raman spectra showed that flavonoids and their glycosides cause changes in the secondary and tertiary structure of gliadins. Naringenin and hesperetin induced similar changes in the gliadin structure. On the other hand, quercetin caused a slightly different kind of change. This is probably due to the presence of a double bond on the C ring and an additional OH group on the B ring in the quercetin structure. In addition, the type of changes induced by glycosides depended on the location of attachment of the sugar part in the glycoside structure. Both flavonoids and their glycosides caused a significant increase in the content of disulfide bridges in the g-g-g conformation.

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Analysis of the effect of the salt addition during the lactic acid fermentation process on the textural properties of fermented red beets

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Our objective was to investigate the impact of salt addition on the texture and water distribution in fermented red beetroot tissue during lactic acid fermentation. We varied the salt concentration from 0 to 6% and assessed the results to determine the optimal concentration for the ideal texture and the effects of high salt concentrations on the raw material. We monitored selected physical properties of the fermented beet tissues such as texture, pH, dry matter and water conditions on specific days (4, 6, 8, 11) and after two months of storage.

Our findings reveal that the addition of salt does not significantly affect the pH measurement, but it does increase the dry matter content. Furthermore, the lactic acid fermentation process reduces hardness, elasticity, cohesiveness, and chewiness. The hardness of the fermented beets decreased even further after storage. Through TD-NMR analysis, we were able to observe the distribution and integrity of water within the red beet cells. Our results indicate that the quantity of bound water, water in the cytoplasm, and released water are all linked to the salt content of the silage and the duration of the fermentation process.

Ultimately, we found that 2-3% concentrations of salt resulted in the best textural properties for fermented beets while maintaining water distribution similar to raw beets.

Effect of consolidation level on organic volatile compound emissions from maize during storage

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The aim of this study was to determine the emission of organic volatile compounds from maize grain as a function of granularity and packing density of bulk material in conditions imitating processes occurring in silos. The study was carried out with the use of a gas chromatograph and an electronic nose, which was designed and constructed at the Institute of Agrophysics of PAS and has a matrix of eight MOS (metal oxide semiconductor) sensors. A 20-L volume of maize grain was consolidated in the INSTRON testing machine with pressures of 40 and 80 kPa. The control samples were not compacted, and the maize bed had bulk density. The analyses were carried out at a moisture content of 14% and 17% (w.b.—wet basis). The measurement system facilitated quantitative and qualitative analyses of volatile organic compounds and the intensity of their emission during 30-day storage. The study determined the profile of volatile compounds as a function of storage time and the grain bed consolidation level. The research results indicated the degree of grain degradation induced by the storage time. The highest emission of volatile compounds was recorded on the first four days, which indicated a dynamic nature of maize quality degradation. This was confirmed by the measurements performed with electrochemical sensors. In turn, the intensity of the volatile compound emission decreased in the next stage of the experiments, which showed a decline in the quality degradation dynamics. The sensor responses to the emission intensity decreased significantly at this stage. The electronic nose data on the emission of VOCs (volatile organic compounds) as well as grain moisture and bulk volume can be helpful for the determination of the quality of stored material and its suitability for consumption.

Physicochemical properties of plant tissues and their changes under abiotic stresses.

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Institute of Agrophysics

Physicochemical properties (surface area, charge, acidity, charge density, fractal dimension, nanopore characteristics) of plant materials will be discussed and methods of their estimation will be outlined. Changes of the above properties mainly under drought and aluminum toxicity stresses will be shown.

Friction phenomena in silos

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Steel silos are widely used to store all kind of granular materials, which have a different behavior from other material states, e.g. liquid or solid. In particular, frictional forces appear because of wall – particle contact, and this significantly affects the structural design of the walls or the flow of material. Besides, steel silos with corrugated walls are widely used because of savings produced in material costs. The friction phenomena between the bulk material and the corrugated silo wall can differ from those produced in smooth walls. This can affect wall pressures at rest, the location of the shear band or the value of the effective wall friction coefficient. The authors have designed a silo model and performed Discrete Element Method (DEM) simulations to analyze the influence of corrugated walls on the aforementioned variables.

A silo model with corrugated steel walls, a square cross section and different bottom configurations has been designed. The vertical section of the silo model consisted of two independent modules, each one having 0.75 m in height and 0.45 m width and length. Depth and wavelength of corrugations were 13 mm and 75 mm, respectively. A flat bottom with a centric square outlet with 0.06 m was used, and 3 oblique hoppers with different outlet eccentricities were also designed. Three different materials have been used for tests: wood pine pellets, maize and plastic pellets.

Only one of the vertical sections was considered for DEM simulations because of the large computing resources required. Different depths and wavelength of corrugations have been considered, while flat bottom configuration was adopted in all simulations. Wood pine pellets has been used as the granular material. The influence of corrugation dimension has been checked with regards to several variables, e.g. pressures at test panels, or particle velocity profiles.

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Designing agricultural machinery with EDEM

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Endego Sp. z o. o.

This presentation is about EDEM software and how it can be used for the design, performance testing, and optimization of agricultural machinery. Tractors, combines and forage harvesters are all designed to work with a range of granular materials such as crops, seeds and soils. These materials can impact the performance of the machine and its durability. EDEM software, powered by the Discrete Element Method (DEM), accurately simulates the behavior of grains, seeds, crops and soils and provides engineers with crucial insight into how materials will interact with a piece of equipment during a range of operation and process conditions.

The agricultural machinery market is a highly competitive one. Manufacturers of agricultural equipment need to continuously increase the quality and reliability of their machines but also innovate and deliver solutions that are tailored to the demands of the agricultural sector.

One challenging aspect relates to the range of operations and conditions that machines have to perform in. All machines are designed to work with a range of bulk materials which may vary in properties depending on the location and seasonal conditions. The variability of these materials can have a strong effect on the performance. Predicting the bulk behavior of materials and their impact on the machine is critical to achieve efficiency and performance.

Using physical testing of new equipment designs is expensive and limiting, especially when considering testing against crops in the field where missing a seasonal testing window due to adverse weather conditions can significantly delay the time to market for new designs.

Powered by the Discrete Element Method (DEM), EDEM software enables engineers to simulate and analyze the behavior of granular materials. EDEM simulation provides crucial insight into how those materials will interact with equipment during a range of operation and process conditions.

The role of association colloids in autoxidation of vegetable oils

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Lipid autoxidation is one of the main factors involved in the deterioration of vegetable oils. Among other effects, this process leads to the formation of unpleasant taste and odor as well as loss of nutritional value, and possibly formation of potentially toxic products. Autoxidation is a free radical process and its chemical mechanism is well understood. However, still not much is known about the physical aspects of the phenomenon. One of these is the presence of association colloids. Association colloids are structures formed from amphiphilic compounds (phospholipids, free fatty acids, diacylglycerols, monoacylglycerols etc.) which self-aggregate in a nonpolar environment of bulk oil with a low water content. These structures in vegetable oils may affect the process of lipid autoxidation and the effectiveness of antioxidants action.

This presentation will provide an overview of the current state of knowledge concerning the formation of association colloids, the types of structures formed, their effects on the oil autoxidation process, interactions with antioxidants (phenolic compounds, tocopherols) and the influence on their activity. Analytical methods applied to study association colloids will be also discussed, as well as research perspectives and possible practical implications.

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Controlled discharge of granular material from a flat floor silo with converging orifice

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Granular materials are of significant importance in various industries such as agriculture, food or pharmaceutical sectors. Silo structures, in which these materials are typically stored, often experience significant issues related to their structural integrity and material flow problems. Therefore, over the last few decades many investigations have been conducted to study a mass discharge rate (*MDR*), the flow patterns and pressure distributions in silos. The *MDR* is one of the crucial parameters for the design and control of processes involving flow of granular materials. The flow rate through the orifice was found to be determined by the shape of the volume contained within the orifice and its vicinity. The need of deeper understanding of the kinematic transition region near the outlet in the silo is important for a precisely controlled discharge rate.

The objective of the reported project was to carry out a study of the flow through a conical converging orifice with various values of thickness and half cone angle. Agricultural granular materials and plastic PLA beads were tested. A series of DEM simulations corresponding to the performed experiments was conducted with a largely extended set of experimental discharge conditions. A possibility of replacing the hopper bottom by the flat bottom equipped with converging discharge orifices in silo has been investigated.

In the case of the constant thickness of the insert, the discharge rate initially increased with an increase in the half cone angle of the converging orifice and then the tendency reversed. The application of proper orifice geometry may allow precise control of the flow rate of granular material discharged from the silo. The fairly close compliance between the results of the experimental measurements and the simulations shows that DEM can be used to design equipment in systems involving granular flow.

Discharge rate influenced by shape and friction of particles in a shape of spheres and dimers

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We use distinct element method to study mass discharge rate (*MDR*) of dimer shaped particles outflowing from flat floor cylindrical container. The volume of the dimers is kept constant. The influence of particle aspect ratio (*Ar)* and friction (μ) on the *MDR* is analyzed. Coefficients of friction in a range from 0 to 1 and *Ar* from 1 to 1.6 are tested. One of the most widely accepted relationships between the *MDR* and the diameter of the discharge orifice (*D*) Beverloo's equation was used in simulations. It takes the form of $MDR = C\rho bg0.5(D - kd)2.5$, where: *d* is particle diameter, ρb is bulk density, *g* is gravity, *C* and *k* are fitting parameters. Our simulations have shown that in the case of spheres *Ar* = 1.0 and coefficient of friction varying in a range from 0 to 1.0 *C* decreased from 0.69 to 0.48, while *k* increased in a range from 1.05 to 1.43. In the case of dimers with μ = 0.3 for *Ar* varying from 1.0 to 1.6 *C* was found decreasing from 0.53 to 0.47, while *k* increased from 1.43 to 1.58. Thus it was shown that an increase in friction, as well as increase in aspect ratio results in a decrease in *C*, while produces an increase in parameter *k,* hampering *MDR*.

Susceptibility of gluten network to mechanical destruction during dough mixing depending on its chemical dehydration by dietary fibre additives

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The developed method for analysis of farinograms (Miś et al. 2020) allows not only determination of the course of physical and chemical redistribution of water in the bread dough supplemented with dietary fibres, but also assessment of the mechanical destruction of gluten network during the dough mixing. The aim of the present study was to determine the effect of fibre additives on the course of mechanical destruction of the model starch-gluten-fibre dough during mixing and find its dependence on the process of chemical dehydration of gluten proteins.

Six commercial dietary fibres were applied as air-dried and pre-hydrated preparations in the amounts of 3, 6, and 9 %. Most of the analysed fibres had a destructive effect on the consistency of the dough. With the increase in the dose of fibre and mixing time, the level of destruction of the dough's gluten network increased. At the 9% fibre dose and at the end of the 40-minute mixing, the dough consistency change indicator - *TRC* ranged from 0.49 to 0.79 for oat and cacao fibre, respectively. Only carrot fibre exhibited a strengthening effect on the consistency of the dough.

The analysis of correlations showed that the fibres with the highest chemical reactivity, measured both by the level and rate of dehydration, also induced very intensive destruction of the gluten network. Additionally, it was found that in cases when the fibre moisturizing was applied, maximum rates for destruction occurred at the same times or slightly later than those for dehydration. In cases when air-dried fibres were used, the appearance of the maxima for dehydration was delayed by about 2 minutes, while those for destruction were significantly accelerated, even by 12 minutes. It may indicate that non-hydrated fibre particles considerably accelerate the onset and increase intensity of the mechanical destruction process.

ORAL PRESENTATIONS

Physico-chemical Properties of Plant Materials Workshop

Role of plant materials for improving of soil water retention properties

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Plant materials can be purposely incorporated in soil as green manure and different kinds of amendments (biochar, compost, etc.) for improving the soil fertility. The naturally remained in soil roots and residues, and the amended plant materials are the main source of food for soil microorganisms. They have different recalcitrance to the microbial degradation and hence different contribution to soil the organic matter accumulation and effects on the other soil properties. The aim of this study is to estimate the role of green manure, biochar, compost and peat on water retention characteristics of two soils with different physico-chemical properties. Both soils are with poor soil structure and low water holding capacity. The moderately eroded Silty Loam Epicalcic Chernozem, alkaline, was subjected to the experiments with plant materials leading to a lowering of soil pH: a pot experiment with amending of compost, peat, peat culture of *Azotobacter vinelandii*, and peat culture of *Trichoderma viride*; 3-years field experiment under wheat and maize rotation with incorporation of pre-crop as green manure before maize sowing. The soil sampling under the field experiment was done in April and October each year which allowed to trace the persistence of the green manure on water retention properties. The Sandy Loam Fluvisols, moderately acidic, was amended with biochar produced by different feedstock and a laboratory and 5-years field experiments were carried out. The changes of soil water retention were compared with changes of the soil organic matter content, and some soil physico-chemical and microbiological parameters. The applied plant materials lead to an increase in adsorption properties and quantity of fine capillary pores that create conditions for soil water retention and microbial growth. The data from the field experiment confirmed the positive role of the plant materials to prevent high rates of evaporation and preserve the soil water.

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Discrete Element Method modeling of structure and strength of soil aggregates

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The Discrete Element Method (DEM) has been successfully employed to model numerous natural and technological processes across various fields of science and technology. Specifically, DEM has found application in modeling a wide array of biosystems engineering operations: from soil tillage and crop harvesting to post-harvest processing of seeds, straw, and other agricultural materials and products. Interactions within the soil, modeled at different scales (ranging from micro- to meso-), have revealed the influence of internal structure, soil composition, particle size, and cohesive interactions between soil particles on the behavior of soil aggregates and the overall response of soil during complex interactions with tools employed in plowing, fertilization, seeding, and more. Soil strength affects seedling emergence, root growth, the stabilization of crops against biomechanical failure, soil compaction, friability, susceptibility to erosion, and soil interactions with tools and machinery.

The application of the Bonded Particle Model (BPM) to simulate interactions between particles has allowed for a more accurate approximation of real processes. The BPM model has proven to be highly valuable in simulating interactions within the bodies of modeled objects subjected to external loads. This includes testing the strength of soil aggregates, compacted biomaterials, grinding and milling of materials (such as aggregates and grains), fruit damage, and other scenarios. This approach has provided novel and deeper insights into the connections between the micro- and macro-properties of materials when subjected to external loads.

In this study, the strength of soil aggregates containing varying proportions of kaolinite and feldspar was determined through experimental uniaxial compression tests. These aggregates were also modeled using DEM equipped with BPM. The micro-parameters governing interactions within the aggregates (mean normal and tangent bond forces, as well as critical bond force) established connections between the modeled behavior and the actual response of the aggregates under external loading.

Sulphur compounds as a mean to decrease nitrogen losses from urea fertiliser

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The necessity to increase crop productivity due to growing food demand could be, at least partially, realised through the reduction of ammonia emissions and the associated nitrogen losses from soil after fertilisation with urea based fertilised. National Emission Ceilings (NEC) established regulations according to use of nitrogen fertilisers with introduction of progressive steps in reduction of N losses due to ammonia emission [1].

The constant progress in research of substances reducing urease activity, allowed to point out a range of chemicals with potential in reduction of ammonia emissions e.g. phosphoramidates, hydroquinone, quinones, (di)substituted thioureas, benzothiazoles, coumarin and phenolic aldehyde derivatives, and vanadium hydrazine complexes, together with boron, copper, sulphur, zinc, ammonium thiosulfate, silver nanoparticles, oxidized charcoal, and others [2-5]. Despite efficiency, agricultural use of many of these substances is limited due to their harmful impact on soil health [6].

The aim of our research was to evaluate efficiency of sulphur based compounds, their concentration on emission of ammonium from soils of various acidity fertilised with urea.

The survey of the recent findings in the field of efficiency of various urease inhibitor like substances, as well as our laboratory experiments on efficiency of urea inhibitors allowed us to point out a sulphur based compounds as the chemical reducing N losses from soils of various acidity.

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Adsorption capacity of waste-derived soil conditioners towards cadmium ions

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Heavy metal presence in soils limits significantly their agricultural potential. This is why, scientists are trying to develop environmentally friendly and sustainable soil additives limiting ions mobility. In this study, the materials produced from different waste were investigated. There were synthetic zeolite from fly ash (NaX UP) and two activated carbons from chokeberry seeds prepared in conventional (ACK) or microwave (ACM) furnace. Fly ash is generated in power plants as a result of hard coal combustion, whereas chokeberry seeds are waste from the fruit and vegetable industry. The experiments included solid characterization using nitrogen adsorption/desorption, Fourier transform infrared spectroscopy, potentiometric titration, etc. as well as measurements of adsorption capacity of selected materials towards cadmium ions (Cd). The results obtained for final products were compared with their precursors.

Adsorption capacity of the selected materials varied significantly. Fly ash adsorbed the lowest amount of Cd, i.e., 15.5 mg/g. Chokeberry seeds bound slightly higher amount of trace metal equal to 19.7 mg/g. Biomass pyrolysis and activation contributed to clear increase in adsorption capacity of the final material. ACK had adsorption capacity of 29.3 mg/g, while ACM showed 30.8 mg/g. This was definitely dictated by more developed texture of activated carbons compared to the biomass. Among all tested materials, NaX UP was characterized the highest ability to bind Cd. Its adsorption capacity was even 188.7 mg/g due to high content of micropores in the structure (87%).

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Digestate as an organic additive modifying the structure of model soil aggregates

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The constantly increasing area of soils with various forms of degradation, creates the need to develop methods of soil properties enhancement. For this reason, various soil enrichment techniques are being tested, which include the application of waste and the products of their processing. One such additive may be digestate - a by-product formed in agricultural biogas plants during anaerobic methane fermentation of biomass (Skic et al. 2020). Digestate can be a valuable fertilizer due to the presence of organic matter necessary for soil structure formation and the proper functioning of the soil microorganisms, and macro and microelements that are directly available to plants (Cooke et al. 2023). While the spatial arrangement and pore size distribution play crucial roles in the accumulation and protection of organic matter in the soil, the way in which digestate modifies the pore structure is poorly understood.

Our research aims to determine the effect of post-fermentation sludge on model soil aggregate structure and porosity. The organic sludge was taken from the agricultural biogas plant and mixed with soils at different rates. From that mixtures, model soil aggregates were prepared in special plexiglass forms. The changes in soil structure were investigated by mercury porosimetry and scanning electron microscopy observations.

The results revealed that organic sludge affected the pore size distribution of model aggregates. In general, the addition of digestate caused an increase in the porosity, total pore volume, total pore area, and average pore diameter and diminished aggregate bulk density. Gradually increasing doses of post-fermentation sludge caused a shift of the pore size distribution towards the pores of a larger diameter. In some cases, bimodal pore size distribution was created. The intensity of observed changes depended on organic sludge concentration and soil type.

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To DoE or not to DoE? Roadmap for Improvement & Optimisation of Experimental Campaigns

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Design of experiment (DoE) techniques are invaluable tools which allow for efficient optimisation of processes *via* simultaneous evaluation of a combination of input parameters. Such approaches can yield positive results whilst minimising the number of resources and amount of time spent. Further, when designing the experiments intelligently, information about interactions between the variables could be gathered, therefore, allowing for a more in-depth understanding of the process and identification of the "key players". However, these methods of conducting experimental campaigns are, unfortunately, underused or often misused. Herein, a brief description of the most popular experimental design techniques with an explanation and a simple visualisation is provided in order to facilitate a greater understanding and appreciation of these powerful optimisation tools, and to depict the best practices upon their employment.

Assessment of agricultural waste biochars for remediation of degraded soil environment

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Biochar production can bring many benefits to natural ecosystems and society as a whole. Firstly, it allows the management of large amounts of different wastes, aiding the circular economy. Secondly, the synthesized product may prove to be an effective soil conditioner improving physicochemical properties of the soil as well as supporting remediation of polluted water-soil environment. In this study, two biochars from potato (P-BC) and raspberry (R-BC) stems were obtained. Also, their potential as remediation agents for degraded soils or polluted surface and groundwater was investigated in detail. The performed experiments included analyses of biochar physicochemistry and dissolved organic carbon (DOC) release. Adsorption capacity of P-BC and R-BC was measured in two-adsorbate solutions of copper (Cu), teracycline (TC) or carboxin (CB), which represented an innovation.

It was observed that P-BC exhibited better textural parameters and surface chemistry than R-BC and, as a result, characterized by higher adsorption capacity towards impurities. The extractable DOC released from BCs was predominantly constituted of substances of large molecular weight and high aromaticity. These compounds are considered as very helpful in sorption processes occurring in soils. The adsorbed amounts of Cu, TC and CB in the two-adsorbate systems were different from those measured in the one-adsorbate solutions. In most cases, the examined BCs adsorbed higher amounts of ions and molecules in the complex solutions containing pollutants of different properties.

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Hybrid polysaccharide-biochar hydrogels for agriculture: the impact on soil water retention and plant growth

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Hydrogels are widely used in modern agricultural technologies. Their application improves water retention of soil and allows for the prolonged release of inorganic fertilizers and pesticides. Hydrogels based on natural materials, namely polysaccharides, have high absorption capacity, are safe and biodegradable, but also characterized by low mechanical strength. This problem can be solved by adding fillers, e.g., biochar, which can increase the adsorption capacity of hydrogels additionally. This study was aimed at the synthesis and characterization of hybrid hydrogel composites based on natural polysaccharides (alginate and guar gum) with biochar obtained from agricultural wastes (straw) as well as the investigation of their impact on soil properties and plant growth. For the investigation, the most common Polish soil – Haplic Luvisol, was chosen. The plant experiment was carried out using spring wheat.

A series of sodium alginate/straw biochar (Alg/BC) and guar gum/straw biochar (GG/BC) hydrogels with different cross-linking degrees and biochar content were synthesized successfully. The swelling degree of both hydrogels decreased with increasing biochar content and cross-linking agent concentration. The BC addition to Alg decreased the swelling degree and sorption capacity of Alg, while the BC presence in the GG structure contributed to its better adsorptive abilities towards Cd(II). The addition of 1 % of hydrogels improved water-holding properties of Haplic Luvisol. Both hydrogels increased root biomass allocation to the deeper soil, which is a good indicator of plant performance during drought. What is more, Guar/BC was found to have a positive impact on root growth rate.

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Soil surface properties and their changes in degradation processes

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Methods of estimation of soil surface properties including surface area, adsorption energy, fractal dimension, variable and actual charge, nanopore volume, and size distribution will be outlined briefly.

Effect of selected degradation processes on soil surface properties will be shown and linked to changes in mineral and organic matter content and composition. The main attention will be placed on soil acidification.

POSTER PRESENTATIONS

How does the start and the end of the vegetation season affect the chemistry and the mycobiome structure of soils under monoculture maize cultivation?

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The goal of this study was to determine changeability of chemical factors (pH, TOC, forms of N, P, selected elements – K, Mg, Ca) and soil mycobiome structure as influenced by time of the vegetation season on the example of maize monoculture. The study site was located in Janin (53°10′21″N 17°46′40″E) on the agricultural area belonging to Potulicka Foundation Economic Center. Representative soil material were taken form 10-ha field two times a year: in spring (March 2022 – before maize sowing – start of vegetation season), and autumn (November 2022 – after maize harvesting – end of vegetation season). Potulicka Foundation Group has implemented advanced precision farming systems thanks to which soil samples taken in each terms originated from the same locations (sampling points marked with GPS tracker). Soils (0-20 cm layer) were taken using an automatic sampler Wintex 1000 equipped with an Egner stick. DNA extraction was performed within 24 h after sample collection using DNeasy PowerLyzer PowerSoilKit (Qiagen, Germany). The fungal ITS region was amplified using primers: 5.8S and ITS1FI2. The diversity of soil mycobiome was analyzed through amplicon sequencing on an Illumina MiSeq (Genomed S.A., Warsaw, Poland) using the PE technology with 2 × 300 nt with v3 chemistry, according to manufacturer's suggestions. Correlation analysis was performed using Spearman's correlation test and RDA analysis. Differences between results from different sampling time were presented as ANOVA test. All statistical analyses were prepared in R v4.1 using the microeco package.

It was found that at the end of vegetation season, soil pH, TOC, N-NH_4, P, Ca, Mg, and K contents increase whilst N-NO_3 decreases. RDA reveals that P-PO_4 content was the factor differentiated the soils taken before sowing. *Saitozyma* were present in higher abundance before sowing. In contrast, post-harvest soil contained higher levels of *Humicola, Vishniacozyma, Mycosphaerella*, and *Epicoccum*.

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Cell wall polysaccharides effect on structural, mechanical, thermal and water sorption properties of bacterial cellulose hydrogels

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The production of cellulose by biosynthesis using the bacteria *Komagateibacter xylinus* provides a cost-effective and environmentally friendly alternative to standard methods of extracting cellulose from plant materials. Bacterial cellulose (BC) additionally possesses high purity, high degree of crystallinity and large water-binding ability, which increases its attractiveness for many applications. This biomaterial can replace many polymers based on fossil fuels due to its high mechanical strength. What is more, BC is fully biodegradable and can be synthetized using rich in glucose agricultural waste materials. BC may undergo a variety of modifications to adjust its properties to very specific requirements. In the present experiment, BC was produced in a culture medium containing cell wall polysaccharides, namely pectic compounds and hemicelluloses. Water-soluble pectin, arabinan and rhamnogalacturonan were used as pectin compounds. The model hemicelluloses were arabinoxylan, glucomannan and xyloglucan. HPLC, AFM, FT-IR, DSC, water and water vapor sorption tests and mechanical tests were used to characterize the resulting composites.

Determination of the monosaccharide profile of BC composites with cell wall polysaccharides showed that the polysaccharide components were effectively bound to BC microfibrils. Glucose was the dominant sugar, but significant amounts of galacturonic acid, arabinose, rhamnose, galactose, mannose and xylose derived from pectin and hemicelluloses were also observed. The addition of cell shear polysaccharides affected the thermal properties of BC, causing a decrease in heat resistance, with the effect of hemicelluloses being more significant. Analysis of AF M images showed that BC nanofibrils were altered by pectin and hemicelluloses, which resulted in a reduction in geometric dimensions such as skeletal length and fibril height. Changes at the macromolecular level of the BC structure clearly affected its sorption properties, as well as its crystallinity and mechanical properties in a tensile test. Hemicellulosic compounds showed greater ability to modify the physical properties of BC than pectic compounds.

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Detection of hypoxic stress of apples based on laser speckle imaging technique

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Apples (*Malus x domestica* Borkh.) are usually stored in cold rooms under a controlled atmosphere (CA) in which O_2 levels are reduced to maintain fruit quality. Studies show that storage in oxygen-reduced atmosphere conditions is beneficial in maintaining adequate levels of product firmness, vitamin, organic acid and sugar content and preventing or reducing the risk of storage damage, especially surface scald. Fruit storage methods such as dynamic controlled atmosphere (DCA) technology enable adjusting the level of oxygen in the storage room, according to the physiological state of the product to slow down the ripening process. However, the successful application of DCA requires precise and reliable sensors of the oxidative stress of the fruit. In this study, respiration rate and chlorophyll fluorescence signals were evaluated after introducing a novel sensor of apples' hypoxic stress based on laser speckle imaging technique (LSI). The study showed that the processed signal from the scattered laser light phenomena was a better predictor of the oxidative stress of the apples. Descriptive and modelling analyses showed better prediction capabilities of oxidative stress for near-infrared laser than laser with red light. Moreover, LSI processing methods based on the dynamics of changes in speckle pattern content were better indicators of stress than conventional methods based on measurements of changes in the brightness of individual pixels. This study showed that the proposed method has great potential as an alternative sensor of fruit oxidative stress, which can be applied in modern storage systems with a dynamically controlled atmosphere.

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Low oxygen stress affects structure and mechanical properties of apple fruit cell walls

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Long-term storage inevitably raises the risk of the fruit developing physiological disorders leading to significant drops in quality and the loss of large batches of apples. New techniques such as ultra-low oxygen (ULO) and dynamically controlled atmosphere (DCA) storage have been developed to address this problem. The common feature of DCA and ULO is that the oxygen level in the storage atmosphere is kept above the anaerobic compensation point (ACP). Below the ACP the risk of severe quality loss increases due to anaerobic metabolism. However,several studies have shown beneficial effects of short exposure of oxidative stress for stored fruit, such as better preservation, increased firmness, preservation of polyphenolic compounds, and reduced risk of postharvest disorders such as bitter pit and superficial scald in apple.

The effect of various levels of oxidative stress on cell wall structure and mechanical properties of apple fruit was investigated. Apple fruit of three cultivars were exposed to hypoxic storage conditions of various lengths to induce anaerobiosis. The response of apple fruit to short-term oxidative stress was evaluated by means of cell wall immunolabeling and atomic force microscopy (AFM). In addition, the antioxidant capacity and antioxidative activity of apple peels was assessed. Oxidative stress levels showed no effect on the antioxidant capacity and antioxidative activity of apples. Exposure to short-term stress resulted in the remodeling of cell wall pectic polysaccharides. This was observed as an increase in the size and complexity of extracted oxalate pectin corresponding to the length of exposure to oxidative stress. Structural changes in the cell wall resulted in an increase in Young's modulus of the cell wall material. Triggering the plant defense mechanism by Damage Associated Molecular Patterns (DAMP) molecules is proposed as explanation of the beneficial effect of short-term anaerobiosis prior to the cold storage of apples.

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Synthetic microorganism community (SynCom) as a component of a biopreparation to support the functioning of the wheat holobiont

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There are fossil records of endophytes dating back more than 400 million years, indicating that these microorganisms are involved in host plant adaptation to habitat changes (Card et al. 2016). New molecular tools provide new insights into microbial interactions. The plant microbiome assists the host under stressful conditions, enabling it to adapt to new environmental conditions, thereby balancing the functioning of the holobiont.

The main goal of the study was to present genetic analysis of selected strains for maintenance as a synthetic community of microorganisms for direct use as a component of biopreparation.

Bioinformatics analysis was based both on amplicon sequencing variants (ASVs) and on operational taxonomic units (OTUs) for microbial communities analyses.

On the basis of a preliminary analysis, the obtained reads were grouped into OTUs on the basis of sequence divergence at the 3% level. In this way, clusters were determined, which were labelled CL. In the bioreactor culturing six clusters were separated, one of which included the genus *Pseudoclavibacter* whilst five different clusters were classified as *Bacillus*.

ASV metabarcoding analysis allowed on the classification of 9 different ASVs belonging to *Bacillus* species in genetic material isolated from bioreactor cultures. Furthermore, an ASV specific to species in the genus *Seratia* was also identified. We point out that in the OTU metabarcoding mentioned species were not identified.

The ASV method reflects slightly richer of the sequence diversity of a given gene in the cultures.

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Next-generation sequencing in the study of the biological weathering

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Soil microorganisms are essential components of the environment and perform a number of positive functions in it. Both bacteria and fungi can affect plant growth and development, soil structure, and productivity.

The study's main objective was to evaluate the impact of bacteria and fungi in the environment on the process of biological weathering. The sampling area was located in the watershed of the Poprad River in the southern part of the Beskid Mountains. Soil samples were taken in 2021.

The structural diversity of microorganisms was determined using next-generation sequencing methods. DNA was isolated using commercially available kits. In-depth bioinformatics analysis made it possible to determine differences in the microbial composition of samples taken from areas showing features of biological weathering compared to control areas.

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The use of essential oils and fruit hydrosols in the manufacture of cosmetics

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Essential oils and hydrosols are one of the most valuable ingredients obtained from fruit in the cosmetics industry. These products can be obtained by steam distillation.

In the presented research, essential oils and hydrosols from blackcurrant, strawberry and cherry were obtained. From the obtained raw materials, moisturizing hand gels were made. This product was prepared by extinguishing the hydrosol with guar gum, glycerin was also added to the product, which was responsible for moisturizing properties. The properties of the hydrosol were investigated by pH measurement while the stability of the finished product was tested using turbidimetric techniques. The stability of the product was tested for 24 hours, immediately after preparation, subsequent tests were performed 3 months after receipt. The measure of stability was TSI (Turbiscan stabilty index), in each case it had a low value, which indicated high stability of the obtained product. For each product series, sensory tests were performed on a group of testers. The testers gave positive feedback on the properties of the samples evaluated.

Dried under different conditions and powdered red cabbage pomace: granulometric distribution and color changes

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The particle size and granulometric distribution of food powders have a significant impact on the physicochemical and sensory properties of the products in which these powders are incorporated. The aim of this study was to evaluate the particle size distribution (PSD) and color of powders obtained from dried and powdered red cabbage pomace (RCP). RCP, which is derived from juice pressing, was subjected to contact drying at temperatures of 40°C (with 50 W microwaves), 60°C, and 80°C, as well as freeze-drying at plate temperatures of 20°C, 40°C, and 60°C, followed by grinding. The powders were analyzed for PSD using laser diffraction (Malvern Mastersizer 3000), and PSD parameters such as d10, d50 (median), and d90 were determined. Color analysis of fresh and dried pomace was also conducted using an NR20SE colorimeter, and L*, a*, and b* parameters were determined.

Both the drying method and drying temperature influenced the PSD of RCP powder. Freeze-dried powders had smaller particle sizes compared to contact-dried powders. The finest particles were observed in the freeze-dried powder at 20°C, where 10% of particles had sizes less than 39 µm, and 90% of particles were smaller than 456 µm. Conversely, the contact-dried powder at 80°C had the largest particles, with 10% of particles less than 79 µm and 90% of particles below 579 µm. The median particle size generally increased with an increase in drying temperature. Contact-dried powders were characterized by a higher median particle size than freeze-dried RCP powders. The method and temperature of drying had a relatively small impact on the color of the powders. However, freeze-dried powders were brighter, less red, and slightly more blue compared to contact-dried RCP powders. Importantly, in most cases, the drying temperature had no significant influence on the color coordinates of RCP powder.

Parameters of flavonoid + nonionic surfactant mixtures adsorption and micellization

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Flavonoids which can be found mainly in blue and red fruits as well as vegetables have many very important properties for the functioning of the human population. Among the flavonoids, quercetin (Q) and rutin (Ru) play the important role in their practical applications. However, these applications are limited due, among others, to the poor flavonoids solubility in water. As follows from the literature data flavonoids stability can be improved by the addition of nonionic surfactants. Of these surfactants polysorbates (Tweens) and Tritons seem to be the most proper for this purpose. These nonionic surfactants are biodegradable and characterized by great physicochemical stability and large water solubility. For this reason, they are widely used in the pharmaceutical, cosmetic and even food industries. These applications are related, among others, to their adsorption and aggregation properties.

The adsorption of surfactants and other compounds at the water-air interface and micelle formation in the bulk phase depend on the surface tension of the surfactants, additives and water. It is impossible to find the components and parameters of the Q and Ru surface tension in the literature. On the other hand, to explain the tendency of the flavonoid + nonionic surfactant mixtures to adsorb at the water-air interface and to form micelles in the bulk phase, the knowledge of the thermodynamic parameters is useful. For determination of these parameters the measurements of the surface tension of the aqueous solution of the flavonoid + nonionic surfactant mixtures at minimum three different temperatures is needed. Therefore, the aim of the presented studies was to determine the surface tension isotherms of the aqueous solution of Triton X-114 (TX114) and Tween 80 (T80) with the addition of quercetin and rutin at temperatures equals to 293, 303 and 313 K.

Interactions between nonionic surfactant and chosen flavonoids

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Plants are virtually, inexhaustible sources of biologically active compounds, which are their defense mechanisms against microorganisms, insects and herbivores. Flavonoids are a large group of polyphenols which occur ubiquitously in plant-based foods and mostly of herbal remedies. Flavonoids exhibit a wide spectrum of biological activities, either as antioxidants or modulators of cell signalying, and the influence of their metabolism on these properties is key to the evaluation of these potent biomolecules as antioxidants and anti-inflammatory agents, cardioprotectants, and inhibitors of neurodegeneration [1]. One of the main problems of solvent extraction of antioxidants from natural sources is the purity of the final extracts. The low purity is generally due to the fact that most of the used solvents are alcohols and their mixture with water in different proportions yields a significant co-extraction of concomitant substances such as proteins [2,3].

The recent growing interest in the application of surfactants for separation processes is due to the fact that they generally have low energy requirements, can be recycled and are capable of treating easily degraded materials, representing an interesting solution for the recovery and/or purification of polyphenols from wastewaters and plant extracts. Thus, the purpose of the presented studies was to determine the interactions between the nonionic surfactant, Tween 80, with quercetin and rutin in aqueous solutions by the spectroscopic methods.

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Xyloglucan-cellulose interaction: impact of molecular weight, hemicellulose/cellulose ratio and fine structure

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Fleshy fruit cell wall biomechanics underly the diversity of texture felt by consumers and impacting processes. The structure of cell wall polysaccharides, their interaction and organization as well as the tissue water compartmentalization are determining textures. If the major role of pectin has been clearly highlighted in fruit texture, that of hemicellulose remains to be elucidated in regard to its fine structural remodeling occurring during fruit development.

Using xyloglucan 5(XyG) isolated from apple pomace and model cellulose fibers (CNF), interaction of the hemicellulose on cellulose was shown by adsorption isotherm, HPSEC and HPAEC analyses to rely on MW, concentration and fine structure of the polysaccharide building blocks. The extent of XyG adsorption on CNF was found to be driven by MW and XyG/CNF ratio. Regardless of XyG/CNF ratio, adsorption increased with increasing XyG MW. At XyG/ CNF > 0.05, the CNF surface area available for high XyG MW populations adsorption gradually saturated, while adsorption of low MW XyG populations kept increasing likely due to their penetration and adsorption in pores of CNF aggregates. Although cellobiose/longer unbranched glucan (DP > 3) and XLLG represented minor structures in apple XyG, they showed the highest binding affinity to CNF. Following xyloglucanase degradation of the XyG-CNF complex, most of the XLLG motif was found in “loops and tails”, whereas most of the XyG unbranched glucan segments interacted directly with CNF and were recovered after alkali extraction of the enzyme degraded complex.

These results question the role of enzymes and notably the different families of galactosidases in apple on the structural remodeling of XyG during fruit development and on the consequences of XyG interaction with cellulose. They also question the origin and distribution of the short cellulose segments in XyG and their possible role in regulating cell wall mechanical properties.

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Comparison of the effects of simulated flood conditions on the biological activity of differently cultivated Fluvisols

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Fluvisols are soils developed from fluvial sediments characterized by a great diversity of morphology and properties. They are commonly regarded as fertile soils and are therefore largely used for agriculture.

The aim of this study was to identify the biological activity in fluvisols from the Vistula River valley (Lubelskie Voivodeship) subjected to the stress of a simulated flooding. The study material consisted of two different fluvisols (light - F1; medium - F2) sampled in two variants: agriculturally used (blackcurrant cultivation; -A), and not cultivated (meadow; -M). Soils taken in the form of soil blocks, which were placed in transparent containers and then simulated flood conditions by flooding them with river water to the height of 5 cm above the soil surface, were used for the model experiment. The water stagnation was maintained for 14 days. For analyses, samples were taken after 2, 4, 7, 9, 12 and 14 days from flooding as well as fresh soils.

In fresh samples and from the simulated flood experiment, dehydrogenase activity (DHa), acid (AcP) and alkaline (AlP) phosphatases, and also pH and soil moisture were determined.

Enzyme activity varied over the course of the experiment. DHa increased statistically significantly in both fodders in both cultivation variants, although in F1-A and F1-M there was a decrease in DHa on day 7 of flooding; and in F2-A on day 12 of flooding, and in F2-M on day 14 of flooding. AcP activity varied both over time and between variants. However, a decrease in AcP on day 7 of inundation and an increase in AcP after 14 days were recorded in all soils tested. AlP activity in both F1 variants followed a similar pattern, with an increase recorded after 2 and 9 days of inundation, while the other dates were associated with a decrease in its activity. In F2, the common denominator was an increase in AlP activity after 2 days of inundation and a decrease after 14, with other values differing between use variants.

The results show that simulated flooding affects the enzymatic activity of Fluvisols, and that the mode of cultivation has a role in the process of these changes.

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The impact of the addition of selected osmoprotectants on the enzymatic activity in soil environment during different moisture conditions

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Osmoprotectants are molecules that balance the osmotic difference between the extracellular and intracellular organism without interfering with the enzymatic function of proteins or other biomolecules.

The aim of the presented research was to determine the effect of selected osmoprotectants on the biological activity of soils with different moisture levels.

A model pilot experiment was performed under partially controlled conditions on a vegetation hall using three osmoprotectants: ectoine, myo-inositol and betaine. In soil samples dehydrogenase activity (DHa), acid (AcP) and alkaline (AlP) phosphatases.

The results show that the addition of myo-inositol and betaine caused an increase in DHa and AcP in the soil 7 and 21 days after the introduction of stress conditions (drought and flooding) and under optimal conditions (60% FC) compared to the control without any additives. Of which inositol caused more significant changes. In the case of AlP, the addition of betaine and ectoine increased the value of AlP after 7 and 21 days of drought stress (40% FC) compared to the control; and in the case of flooding (100% FC), the stimulating effect was noted for betaine.

The results suggest that commercially available osmoprotectants affect the enzymatic activity of the soil environment under hydrological stress and that their effect may be stimulatory.

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Molecular & microscopic studies on fruit microstructure during the ripening program and postharvest senescence

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Structural changes in cell walls during fruit development, ripening, and senescence are caused by a variation in the content of polysaccharides and proteins. The major impact on the physical properties of the cell wall is ascribed to the strictly arrange framework that plays roles in the formation of an overall structure as well as the maintenance of interactions between cell wall components (Tan et al., 2013). The goal of this research was to create a pattern of the cell wall assembly of apple fruit and tomato fruit. In *Malus* x *domestica* as a model for studies on physiological alternations in postharvest senescence and in *Solanum lycopersicum* as a model for studies on the ripening process. The arrangement of the examined epitopes was analyzed using immunochemistry approaches with specific monoclonal antibodies. For *in situ* studies, observations were carried out after the immunofluorescence technique with a confocal laser scanning microscopy imaging and for *ex situ* studies, enzyme-linked immunosorbent assay was performed. Results obtained allow to prepare patterns of spatio-temporal changes in the arrangement of particular cell wall constituents and *to* determine their concentration and molecular characteristics. Observed modifications of cell walls are associated with significant changes in homogalacturonan content and distribution in particular cellular compartments. Mentioned alternations concern mainly low methyl-esterified homogalacturonan, suggesting that calcium ion migration is an essential factor in the cell wall network during fruit modification.

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Metabolic changes of *Neosartorya* spp. (anamorph: *Aspergillus* spp.) in response to incubation with sodium metabisulfite

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Fungal contamination poses a significant threat to various industries, including food production and agricultural practices. Among the diverse group of fungi, *Neosartorya* spp. (anamorph: *Aspergillus* spp.) is known for its ability to cause spoilage and produce harmful mycotoxins. Sodium metabisulfite, a widely used preservative, has demonstrated antifungal activity against various fungal species e.g. *Fusarium oxysporum, Macrophomina phaseolina, Rhizoctonia solani, Sclerotinia sclerotiorum* (Türkkan & Erper, 2014; Arslan 2015). However, the metabolic response of *Neosartorya* spp. to sodium metabisulfite remains unknown. Therefore, this study aims to investigate the metabolic changes of *Neosartorya* spp. in response to sodium metabisulfite.

Five isolates of *Neosartorya* spp. were incubated for 10 days in the presence of sodium metabisulfite in the media (test group) and on media without this preservative (control). The metabolic activity of the fungal isolates was assessed using a fluorescence-based method with FDA. Fluorescein diacetate (FDA) is a substrate for cell-permeant esterases that can function as a viability indicator capable of assessing both enzymatic activity and cell membrane integrity. FDA component degradation and therefore fluorescence was measured using Infinite® 200 Pro reader.

Our findings revealed alterations in the metabolic activity of *Neosartorya* spp. upon exposure to sodium metabisulfite. Fluorescence analysis demonstrated a substantial reduction in FDA conversion to fluorescence, indicating a decline in metabolic activity compared to the control group. These results suggest that sodium metabisulfite adversely affects the metabolic processes of tested fungal strains from *Neosartorya* genus.

Understanding the metabolic responses of *Neosartorya* spp. to sodium metabisulfite is essential for developing effective antifungal strategies and preserving the quality and safety of various products susceptible to fungal contamination. Further investigations into the molecular mechanisms underlying the observed metabolic alterations will provide valuable insights into the adaptive strategies employed by *Neosartorya* spp. in response to environmental stressors, aiding in the development of targeted antifungal interventions.

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The importance of plant extracts in shaping of bacterial communities in two types of soils

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Chemical compounds present in plant extracts can affects soil microorganisms. The aim of the studies was to determine the effects of blueberry and black mulberry fruit extracts on the diversity of bacteria found in luvisols and podzols.

Fruit extracts were obtained by alcohol extraction and characterized by a high content of polyphenolic compounds. They were applied in 2 doses (pre-sowing and in the phase of wheat stem elongation) to the pots filled with luvisols and podzols, where wheat was sown. Soil samples were collected after 11 weeks of wheat growth, DNA was extracted, and the region V3-V4 16S rRNA was sequenced after amplification on Illumina MiSeq platform.

In the luvisols there was observed significant impact of blackberry extract on increase of species richness. The use of both tested extracts in luvisols resulted in an increase in the remaining biodiversity indicators (Pielou index, Shannon-Wiener, taxonomic diversity) compared to the control. Moreover, the type of soil had a significant impact on the abundance of bacterial communities. In luvisols, abundance of *Myxococcota* were significantly higher after the addition of blueberry extract than in control soil. The use of blueberry extract significantly reduced the number of *Patescibacteria* compared to the control. In the podzolic soil, a significantly higher number of *Bdellovibrionota* and *Patescibacteria* was observed in the objects with blueberry extract than in the control samples. Soil samples were grouped primarily by soil type (54% similarity). In the case of podzols, the control soil and the soil with mulberry extract formed one cluster, and the soil with blueberry extract grouped separately. In the case of luvisols, the control soil formed one cluster and the samples with extracts another cluster. The PERMANOVA analysis showed a significant effect of both soil type and extracts on the bacterial community.

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Life in the soil: effects of crop residues incorporation, soil compartment and sampling term

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Crop rotation and incorporation of crop residues into the soil are one of the most important factors that enable to maximize the quantity and quality of plant production while maintaining or increasing soil fertility. In this study we evaluated the effects of residues of faba bean (*Vicia faba* L.) and wheat (*Triticum aestivum* L.) under conventionally tilled fields on the fungal community (Next Generation Sequencing). Bulk and rhizosphere soils were taken two times during second subsequent crop cultivation. Soil analyzes (P, K, Mg, Ca, S, N, Corg, SOM, pH) and enzyme activities (dehydrogenase, ß-glucosidase, cellulase, urease, protease and acid phosphomonoesterase) were done. Diversity indices of fungi species were mainly affected by residue type and growth phase. Growth phase has also the greatest impact on phyla abundance. A nMDS plot showed distinct separation of fungal species by residue, growth phase and soil compartment, and significant effects (PERMANOVA $p=0.0001$) of all factors was noted. Cluster analysis revealed, that the main grouping factor separating samples was growth phase. At stem elongation samples with faba bean and wheat residues grouped at two separate clusters, while at maturity bulk soil was separated from the rhizosphere soil. Samples from each treatment clustered mostly in one group ($p<0.05$). BEST analysis confirmed the importance of selected variables for microbial structure. The correlation coefficients from a combination of subsets of biochemical parameters to the fungi species abundance was high (form 0.728 to 0.852, depending on factor). The combination of variables connected with P transformation best explains the pattern of fungi community composition under residue type. Quite different variable sets best correlated with fungi under soil and term factors. The results improve our understanding of the fungi reactions on plant residues under subsequent crop vegetation indicating that each study factor modify fungal community in different degree, depending on parameters analyzed.

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Genotype effect on molecular interactions in Langmuir monolayers of camelina oil

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Camelina sativa is an oil plant whose seed oil is rich in vitamins, unsaturated fatty acids (EFA), phytosterols and polyphenols. In this study the camelina oils obtained from the seeds of winter and spring camelina were analysed. The starting method during the research was the Langmuir technique by means of which thin monolayers of the camelina oil were produced at the water-air interface. For each type of the camelina oil surface pressure versus mean molecular area (π–A) isotherms and their hysteresis were recorded. The analysis and characterization of the interactions between the components of the thin surface layers produced by this method required the use of several complementary research techniques. For this purpose, UV-VIS spectroscopy and Brewster microscopy were used to characterize thin films made of the camelina oil. These techniques allow to assess the structure of the monolayer, physicochemical properties and determine the relationship between the chemical structure of the deposited coatings. In addition, by means of oscillating barriers method the viscoelastic properties of the camelina oil monolayers occurring at the water-air interface were measured.

The role of rhamnose and arabinose for the structure and rheology of pectin, and cell wall mechanics

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Structure of pectin is one of main factors influencing mechanical properties of plant cell walls. It is also crucial for understanding of pectin gelling properties. In this study we evaluated the impact of rhamnose and arabinose on (1) the structure of molecules of diluted alkali soluble pectin fraction (DASP, rhamnogalacturonan I rich fraction extracted from carrot and apple), (2) rheology of pectin in solutions and (3) mechanics of the cell wall (CWM). DASP was treated with arabinofuranosidase, RG-I acetyl esterase and RG endolyase to induce rhamnose and arabinose related structural changes in RG-I backbone and side chains. AFM was used to determine nanostructure of pectin and CWM stiffness. Oscillatory test was applied to describe the rheology of pectin gels.

Results showed complex, enzyme-related effects on the nanostructure and rheology of pectin solutions. An increase in cell wall stiffness was observed for the control samples during the incubation time. However, action of the enzymes resulted in an average two-fold decrease in CWM stiffness compared to control after total 120 min of incubation. A possible role of rhamnose and arabinose for nanostructural features of molecules, rheology and stiffness of CWM will be discussed based on obtained results.

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The adsorption of different polysaccharide fractions on apple microfibrillar cellulose

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Binding assays of commercially available hemicelluloses and pectins, and microfibrillar cellulose isolated from apple parenchyma were prepared. Initial studies showed that among all of the non-cellulosic polysaccharides examined, only the hemicelluloses (xyloglucan, xylan, glucomannan, ß-D-glucan) showed the ability to adsorb on microfibrillar cellulose. Among several adsorption models tested, the best fit was obtained for the Redlich-Peterson isotherm. Moreover, the linear vs. the branched structure and the size of the hemicelluloses have an influence on the extent of the adsorption on cellulose. The FTIR and Raman spectra showed that a rather weak interaction took place between the hemicelluloses and cellulose. Also, the differential scanning calorimetry and the light scattering method results showed that after adsorption, cellulose has less mobility.

The next stage of the study involved the modification of the adsorption system. The ternary system consisted of cellulose and hemicellulose with high affinity for the adsorbent and second polysaccharide, which previously did not interact with cellulose. It has been shown that hemicelluloses such as xyloglucan, xylan, β-D-glucan that adsorb on cellulose are promoters that allow this adsorption complex to interact with selected pectin and other hemicelluloses. This depends on the concentration ratio of these polysaccharides. Finally, the adsorption of polysaccharide fractions directly isolated from the apple cell wall on microfibrillar cellulose was conducted. The polysaccharide fractions were characterized by vibrational spectroscopy and chromatography. The positive adsorption was obtained only for fractions rich in hemicellulosic polysaccharides.

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The content of bioactive compounds in cold-pressed oil from rapeseed sprouts

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The germination process of rapeseed is influenced by external factors like temperature, oxygen, moisture content, and light. This study aimed to assess the impact of germination with and without light access on the quality and bioactive compound content of cold-pressed rapeseed oil. Rapeseeds were germinated at 22°C for 3 days. Variant I involved germination without light access, while Variant II had alternating 12-hour periods of light and darkness. Sprouts were dried at 60°C, and oil was extracted using cold-pressing. The peroxide value, acid value, p-anisidine value, TOTOX, fatty acid composition, phytosterol content, tocochromanols, phenolic compounds, canolol, and thermo-oxidative oil's stability were analyzed.

Germinating rapeseeds significantly increased the content of free fatty acids in the cold-pressed oil, particularly in Variant II with light access, reaching 3.28 mg KOH/g. However, it remained below the maximum limit of 4 mg KOH/g according to Codex Alimentarius. The germination process did not significantly affect the fatty acid composition and phytosterol content of the oils. Oil from rapeseeds germinated with light access showed a statistically significant increase of 32% in α-tocopherol content. Additionally, oil from sprouts without light access exhibited a 2.5-fold increase in PC-8 content. The content of phenolic compounds in the control oil (from ungerminated seeds) was 92 µg/100g, while sprout oils showed a 4-6 times increase (343 µg/100g in Variant I and 524 µg/100g in Variant II). Oils from sprouts also contained canolol and its dimer. The oil obtained from seeds germinated with light access had a 25-fold increase in canolol, while the variant without light access had a 45-fold increase. Oils from germinated seeds exhibited a 3-fold higher oxidative stability at 140°C (20 min for control oil and 60 min for sprout oils). Undoubtedly, the increased bioactive compound content led to enhanced antioxidant activity and oxidative stability in the analyzed oils.

Review of data fusion methods for soil moisture obtained for multiple temporal and spatial scales

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Soil moisture (SM) is one of the Essential Climate Variable (ECV) pointed in Global Climate Observing System by World Meteorological Organization. Current state of the environmental science give us ability to assess SM values for wide range of temporal and spatial scale. Using in-situ instrumentation and satellite-based remote sensing techniques, we are able to measure SM from point to global scale, with time stamp ranging from second to days. Furthermore, a new methods to provide SM data in 'medium' scale are still developed and validated. One of the method providing 'medium' scale SM data is in-situ remote sensing including Cosmic-Ray Neutron Sensing (CRNS) stations. Taking into account the wide range of methods, theirs different working principles and variety in spatial and temporal characteristics of results, there is a strong need for developing methods of SM fusion. In the framework of SoMMet (**So**il **M**oisture **Met**rology - Metrology for multi-scale monitoring of soil moisture) project we provided a complex review of various methods that could be used in the process of data fusion for multi-temporal and multi-spatial SM data. Basing on our investigation, the most adequate data fusion approach for combining point, "medium" and global scale SM retrievals was proposed. Our interest covered a wide range of methods, from the most basic to the most complex, including those involving Neural Network. In the results of our review we provide a advantages and disadvantages of various data fusion methods considered for application for SM data. Reviewed methods are presented regarding the abilities for SM data improvements comparing to the resources needed for the particular method evaluation. In presented work we summarized the results of performed review giving indication for the best data fusion practice taking into account cost to capabilities ratio. The advantages and disadvantages of the most effective methods were highlighted.

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New biotechnological solutions in biocontrol and molecular diagnostics of *Neofabraea* spp. in apples – a review

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The most important requirement for apple producers is to ensure the best possible apple quality after storage. Growers must comply with several regulations in the field of food and environmental safety. In the production of apples, it has been observed that financial losses are related to the occurrence of latent storage diseases caused by phytopathogenic fungi of the genus *Neofabraea* (bull's eye rot). Therefore, investors in this sector require new solutions supporting rational apple management, with a particular focus on pro-ecological methods of controlling *Neofabraea* sp. pathogenic representatives and methods for the early detection of these pathogens, especially when there are no symptoms of disease in the apple. This review summarizes the activities being undertaken to increase sustainable production in horticulture. What is more, the up-to-date significance of apple production and the various ways of counteracting bull's eye rot were also described. Next, biopreparations based on microorganisms in horticulture applications are characterized, with special attention being paid to the preparations preventing the development of *Neofabraea* spp. The various methods used to detect fungal phytopathogens are explored towards *Neofabraea* spp. detection using genetic markers. Finally, expectations and future directions in the quest for new biotechnological solutions in the area of the biocontrol and molecular diagnostics of *Neofabraea* spp. in apples were presented. In particular, the need for targeted biocontrol biopreparations and an early detection method of *Neofabraea* spp. in apples to evaluate the risk of the occurrence of apple bull's eye rot was highlighted.

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Soil enrichment with biochar changes the methanotrophic bacterial community

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The addition of biochar to soils may contribute to improved soil properties and the mitigating of greenhouse gas emissions. How this impacts on the biological oxidation of methane (CH_4) in arable soils is particularly important given the high warming potential of CH_4, and the potential inhibition of methanotrophy due to nitrogen fertilizer applications. To assess this under laboratory conditions, silty soils were incubated at 15°C and 25°C, with a soil moisture content corresponding to 60% water holding capacity and included treatments with and without the addition of biochar. To examine the effect of fertilization soil samples were taken from adjacent sites that were either unfertilized, or subjected to mineral and organic manure. A chromatographic method was used to measure changes in CH_4 concentrations in the headspace over time. Methanotrophy was found to be inhibited in the control soils which was stimulated by enrichment unfertilized soil with biochar. Analysis of the microbial community structure revealed that the unfertilized soil with biochar was a habitat for the genera *Methylobacter, Methylomonadacea*e (recently confirmed to harbour methanotrophic species) and *Methylocaldum.* Biochar application increased the proportion of methanotrophs in the soil microbial community, although this reduced their diversity in fertilized soil. Biochar-amended soil was particuarily favourable for *Methylobacter* which were the dominant methane-oxidizers with an abundance almost doubled that compared to the control. This study shows that the addition of biochar to silty soils has the potential to stimulate methanotrophy and change the methanotrophic bacterial community. Given the complexity of the soil environment, it would be worth conducting these analyses on different soil types, taking account of both the environmental effects and the altered microbiological populations.

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Changes in the structure and antioxidant capacity of the gluten network modified by hydroxycinnamic acids

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The gluten network is a complex system composed of multiple components that possesses unique aggregation properties. The three-dimensional structure of gluten is essential for conferring desirable characteristics to wheat-based products. Given the widespread consumption of wheat products, they provide an excellent medium for incorporating beneficial nutritional compounds such as phenolic compounds, which can have positive effects on human health. Among plant phenolic compounds, phenolic acids are the most commonly studied and have gained considerable attention due to their relatively high antioxidant activity and easy absorption in the intestines. These compounds can be added to food as ingredients in dietary fibre preparations or polyphenol extracts.

The aim of the research was to examine the effect of hydroxycinnamic acid supplementation on the structure and antioxidant properties of the gluten network. The phenolic acids were added to the model flour at concentrations of 0.05%, 0.1%, and 0.2% (w/w). The model flour consists of commercially available wheat starch and wheat gluten in proportions of 80:15. For the preparation of the model dough samples, a farinograph was utilized. To obtain gluten samples, the gluten was extracted from the model dough through washing and subsequently lyophilized. The secondary structure of the gluten was determined using FTIR spectroscopy. The antioxidant properties of the samples were evaluated using the ABTS and FRAP assays.

The present studies have shown that the addition of hydroxycinnamic acids to the model dough alters the structure and biochemical properties of the gluten network. The impact of phenolic acids on the gluten network depends on the type of functional groups attached to the aromatic ring of the phenolic acid. The findings suggest that the presence of an additional double bond in the structure of hydroxycinnamic acids, along with the additional -OH group in PCAT and CAF, significantly affects the antioxidant properties of gluten proteins.

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Breakage strength of wheat straw pellets determined experimentally and by means of DEM simulations

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Waste biomaterial pellets are an important source of renewable energy. Their mechanical strength is a crucial property. In this study, the breakage strength of wheat straw pellets was determined experimentally and via DEM simulations. Relaxed pellets with a diameter (D) of 6.23±0.05 mm and a height ($h0$) of 11.9±0.3 mm were compressed uniaxially and diametrally at a constant displacement velocity of 1.5×10−5 ms^{-1}. The average density of the pellets was 1120±24 kgm^{-3}. The compressive strength determined in the uniaxial compression test was σz = 9.51±2.83 MPa. The tensile strength determined in the diametral compression test was σx = 2.33±0.80 MPa. In the uniaxial compression test, the failure strain was $\Delta h/h0$ = 0.332±0.082, and in the diametral compression test, the failure strain was $\Delta L/D$ = 0.189±0.022. The Drucker-Prager failure locus of wheat straw pellets, $q = p \tan(\varphi) + c$, was determined from both the diametral and uniaxial compression tests, where q is the stress deviator, p is the hydrostatic stress, φ is the angle of internal friction (φ = 34.2±11.9º), and c is the cohesion (c = 7.36±2.52 MPa). The cohesion and angle of friction are two material parameters independent of the type of breakage test performed. They represent the overall effect of binding forces between the ingredients of the pellet on its breakage strength. The pellet breakage process was successfully simulated using DEM equipped with the parallel bonded particle model. The simulations accurately reproduced the results of laboratory testing and provided a deeper insight into particle-particle bonding mechanisms.

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Dielectric measurements of moisture and temperature of the surface layer of the soil profile

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Soil dielectric permittivity is temperature dependent mainly because of the unique properties of water. Measurement of the moisture content of the surface soil layer using dielectric sensors enables to observe the temperature impact on soil dielectric permittivity and consequently on the output of the sensor. The upper 5 cm of surface soil layer is the most susceptible to large temperature variations. This layer transports water to the deeper layers of the soil profile. It absorbs rainfall and dew deposits. There is also evaporation that varies with insolation and air movement. Thus, it is the layer with the highest rate and amplitude of changes in moisture and temperature. Dielectric measurement of moisture in this layer is therefore inherently subject to some lack of selectivity with respect to temperature. It is also extremely important in satellite measurements of soil moisture.

The purpose of this study was to determine the magnitude of the error caused by the temperature influence just after rainfall over several days when moisture changes are the greatest. It occurred that there was an error of about 1% in volumetric water content, which decreased as water content decreased. This small value of error effectively makes it difficult to study subtle phenomena occurring on the soil surface, such as dew deposits. Moreover, soil temperature coefficients for a specific monitoring location were determined. Practical application of this type of research allows for preliminary characterization of soil under field conditions, which would be further examined with the use of the coaxial cell laboratory system.

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An alarming abundance of *Pilidium* sp., an emerging phytopathogen, in organic strawberry farms in Poland

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The rise in global ambient temperature due to ongoing global warming has been linked to the proliferation of fungal pathogens to the new areas and increased incidence of fungal diseases in recent years (Bebber et al., 2013; Velásquez et al., 2018). Consequently, the challenge of safeguarding crops against the spread of phytopathogens has intensified. Previously unaffected regions are now grappling with new plant pathogens, leading to severe agricultural losses. To address this issue, metataxonomic sequencing has emerged as a valuable tool for monitoring the presence of various microorganisms, including phytopathogens, in the environment. This technique circumvents the limitations associated with identifying non-laboratory-culturable microorganisms that exist in large numbers in the environment.

In this study, we investigated the mycobiome structure in 13 organic strawberry farms, analyzing soil (bulk soil and rhizosphere) as well as plant (roots and phyllosphere) niches using Illumina MiSeq platform-based sequencing of ITS1 amplicons (2x300). Our findings highlight the prevalence of the *Pilidium* genus as one of the most abundant fungal microorganisms observed in the analyzed samples. This observation raises concerns, as these fungi have been documented so far as plant pathogens in warmer climate zones such as China (Geng et al., 2012), Iran (Ayoubi et al., 2016), and Brazil (Lopes et al., 2010).

These results underscore the urgent need to address the implications of global warming on the geographic distribution and prevalence of fungal pathogens. By employing metataxonomic sequencing, we gain valuable insights into the composition of the mycobiome, facilitating early detection and proactive management of emerging threats to crop health. Such knowledge is crucial for the development of effective strategies aimed at protecting agricultural systems in the face of changing climatic conditions.

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Maximizing agricultural sustainability: exploring the multifaceted benefits of intercropping in contemporary farming systems

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In modern agriculture, the pursuit of sustainability has never been more critical. Intercropping, a dynamic farming strategy, emerges as a versatile tool with profound implications for enhancing agricultural sustainability. This poster investigates the multifaceted benefits of intercropping, particularly focusing on legumes and wheat, within the context of contemporary farming systems.

One of the primary advantages of intercropping, especially with legumes and wheat, is the potential for significantly increased yields. By carefully selecting compatible crop combinations, such as wheat and nitrogen-fixing legumes like peas or lentils, farmers can harness synergies that lead to improved overall productivity. The legumes enrich the soil with nitrogen, benefiting the subsequent growth of wheat and reducing the need for synthetic fertilizers [1].

Furthermore, intercropping legumes with wheat fosters resource efficiency by optimizing land use and reducing nutrient and water wastage. The deep root systems of legumes help in preventing soil erosion and enhancing soil structure, creating a more resilient farming environment [2].

Additionally, the intercropping of legumes and wheat promotes biodiversity, creating a balanced ecosystem that supports beneficial insects, enhances soil health, and contributes to long-term environmental resilience [3].

Our research highlights the holistic benefits of intercropping, particularly the synergies between legumes and wheat, showcasing its role in shaping a sustainable and resilient agricultural future.

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Legume-cereal intercropping as a tool for improving soil quality and plant health

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The challenges of modern agriculture, such as biodiversity loss and increasing food demand, require innovative solutions that will enable the preservation of high-quality arable soils. Legume-cereal intercropping, which represents a sustainable approach to cultivation, is gaining popularity due to its benefits for both the soil and plants. The literature data indicate that such cultivation strategy has a beneficial impact on the soil microbiome, increasing the diversity and activity of soil microorganisms that play crucial roles in maintaining microbial balance in the soil. Furthermore, legume-cereal intercropping offers the potential for reducing soil-borne pathogens, which leads to a decreased risk of plant diseases. Taking into account the development of sustainable agriculture, it is also worth mentioning the potential ecological benefits that come with the legume-cereal intercropping such as the reduction of mineral fertilizers usage and improved nitrogen utilization efficiency.

Intercropping in practice include various species of cereals and leguminous plant e.g. maize was cultivated together with soybean, faba bean or peanut, oat with soybean or mung bean, wheat with faba bean, pea, clover or lentil, sugarcane with soybean or peanut, barley with clover or barrelclover, sorghum with dry bean or cowpea and rice with mung bean. Such a cropping strategy was also used for vegetable crops including cucumber (cultivated with alfalfa, trifolium or pole bean), cherry tomato (cultivated with jack bean, sun hemp, dwarf velvet bean or mung bean), cabbage (cultivated with faba bean), spinach (intercropped with lentil) and carrot (intercropped with pea). However, successful adoption of cereal-legume intercropping necessitates careful crop selection, appropriate planting configurations, and effective management practices. The further research is necessary to enhance the long-term sustainability of agricultural systems based on the intercropping.

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Restriction fragments create a genetic fingerprints of soil microbiome - tool to assess the basic genetic diversity of the soil microorganisms

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Communities of soil microorganisms perform key functions in biochemical processes that enable the circulation of elements and plant growth. The proper functioning of the soil ecosystem is closely related to the metabolism of microorganisms and the ability to adapt to changing environmental conditions. The metabolic activity of bacteria, fungi and archaea is responsible for the biochemical state of the soil. Knowledge about the soil microbiome is important in assessing changes in the environment and actions aimed at improving soil quality. The use of molecular methods, based on DNA isolated from the soil, allows to assess the condition of microbial communities without the stage of cultivation in laboratory conditions. The soil microbiome includes bacteria, fungi and archaea, and the interactions between these components are extremely important and affect biochemical processes. For this reason, the multitaxonomic assessment of microbial communities can help us to understand the structure and biodiversity of microbes and to go insight into their interactions.

The terminal restriction fragment length polymorphism technique (t-RFLP) is widely used for the assessment of soil microbial diversity as it provides a quick insight of the microbiome. The t-RFLP analysis could be a source of information of changes in soil microbial communities in response to different fertilization strategies. What is more, t-RFLP is fast and offers highly reproducible results. This technique was designed to assess the basic genetic diversity of the soil microorganisms.

The aim of the research in the Sompacs project is to evaluate the impact of various soil management methods in diverse soil and climatic conditions in Europe on the microbial activity as well as the structure and functions of soil microorganisms.

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The impact of in situ modification with divalent metal ions on physical properties of BC-Pectin films

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Bacterial cellulose (BC) synthesized by many species of aerobic bacteria is a promising biomaterial what is related to its specific characteristics such as high purity or good mechanical properties.

In this experiment, the impact of three different pectins fractions (water-soluble pectins WSP, diluted alkali-soluble pectins DASP, oxalate-soluble pectins OSP) and divalent ions (Ca^{2+}, Fe^{2+}, Mg^{2+}, Zn^{2+}) on mechanical, thermal, and structural properties was evaluated.

Obtained FT-IR spectra provided information about BC-composites functional groups and the state of bonds in their structure. Characteristic peaks for polysaccharides are present, but all spectra had a similar pattern with no clear differences. BC-films enriched with all pectins fractions was was characterized by an increased Young modulus and tangent modulus compared to pure BC. A similar effect was observed for most BC-pectin conjugates with divalent metal ions except for DASP combined with iron. In the BC_WSP_Mg variant, the highest increase in elastic limit was noticed in relation to pure BC. In the remaining variants, a similar but lower pronounced effect was observed. During the tensile test, the BC_DASP_Fe variant broke at the lowest stresses, while most additives increase the stress at the break of BC-composites. Differential scanning calorimetry was used to investigate the thermal behavior of produced composites. A slight decrease in thermal degradation temperature was observed in variants with addition of pure pectin fractions. However, the lowest value was noted for BC_WSP_Mg and BC_DASP_Ca, while the highest for BC_OSP_Fe, BC_OSP_Mg, and BC_OSP_Zn.

Based on the obtained results, it can be concluded that divalent metal ions increased the mechanical strength of most BC-pectin conjugates. Pectin fractions reduced the temperature of thermal degradation, however, zinc and iron ions prevent this effect for WSP and OSP. The experiment showed various possibilities for tailoring BC thermal and mechanical properties using specific pectin fractions and divalent metal ions.

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Sewage sludge from an IRMS perspective

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Isotope Ratio Mass Spectrometry (IRMS) is a method that enable high precision measurement of stable isotopes abundance in a given material. It is widely used in various fields: palaeontology, archaeology, forensics, hydrobiology, climate change, soil science etc.

IRMS enables accurate determination of both gaseous, liquid and solid samples. This analytical technique provides an ever-deepening understanding of a wide range of environmental processes since biological, enzymatic activities leave a "footprint" in the form of non-equilibrium isotope distribution of substrates and metabolites. IRMS results can be a tool for evaluating biological processes and conditions occurring in wastewater treatment plant sludge.

The presentation, summarizes current knowledge on the implementation of IRMS in the field of wastewater treatment, with particular emphasis on the potential of using measurements of 13C/12C stable carbon isotope ratios in the monitoring of wastewater treatment plant technology. The literature data provide the background for the subsequent presentation of results of stable isotope ratios studied at the Hajdów municipal WWTP plant in Lublin.

The material for the study was collected in different seasons of the year. Six points of the sludge treatment line were chosen, representing consecutive stages of sludge processing. Results of the δ13C allow to conclude that the sediments taken from different points in the sludge process line are characterized by different stable C isotope ratios.

Further studies are necessary to establish an isotopic composition inventory of sludge from various technologies and to investigate the biological processes taking place in the sludge.

The prospects for using the IRMS method to analyze wastewater treatment and the environmental impact of the process are discussed.

Infrared spectroscopy analysis of physically modified potato starch with the addition of lysozyme

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Starch is one of the most common biopolymers in the world. It is one of the main sources of energy used in the human diet, and due to its biodegradability, it is a good product for the production of plastics. This work presents the results of novel research focusing on the influence of the power of the electromagnetic wave on changes in starch-water-protein interactions in 5 % starch-lysozyme gels. Lysozyme is applied as an additive in various products thanks to its bacteriostatic and antibacterial properties. The presence of α-(1,4) glycosidic bonds, important for starch grain, was shown, which, depending on the modification, gradually disappear. For starch subjected to microwave power of 125 W/g, they show the highest absorption intensity in relation to the remaining samples and native starch. Infrared analysis allowed to observe a significant change in CH stretching vibrations at wave number 2930 [cm-1], which may result from protein binding with starch.

The modification of native potato starch with the use of microwave radiation leads to changes in the hydrophobic-hydrophilic properties of the biopolymer, what is related to the reorganization of water molecules in crystallographic structures. The conducted research indicates the possibility of using lysozyme dimer as a component that improves structural properties of the biopolymer lattice.

Effect of compost and mineral materials on content of trace elements in soil contaminated with petrol

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The global use of petroleum hydrocarbons as raw materials and an energy sources in industry is causing serious environmental, health, and ecological problems. Consequently, there is a growing interest in the development of technologies for the remediation of contaminated areas. This study was undertaken in order to determine the effect of different phytostabilising materials (compost, bentonite, and CaO) on the trace element content in soil contaminated with petrol (0, 2.5, 5, and 10 cm^3 per kg of soil). The doses of petroleum applied to the soil were based on the previously conducted preliminary experiment. Soil samples for analysis were collected during harvesting of maize at the tasseling stage. The content of the trace elements was analysed by the flame atomic absorption spectrophotometry (FAAS).

The contamination of soil with petrol significantly modified the trace element content in the soil. The highest petroleum dose (10 cm3 per kg of soil) significantly reduced the chromium, zinc, and cobalt content in the soil. Petroleum increased the cadmium, lead, nickel, and copper contents in the soil. The materials used for phytostabilisation (compost, bentonite, calcium oxide) had a significant effect on the trace element content in the soil. The application of mineral materials (bentonite and calcium oxide) was more effective than the application of compost, compared to the control series (without soil amendments) as they reduced the contents of cadmium, chromium, nickel, and cobalt in the soil to the greatest extent. The reducing effect of bentonite and calcium oxide on the content of these trace elements in the soil was stronger than that of compost.

Influence of soil density on complex dielectric permittivity spectrum measurements

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Complex dielectric permittivity spectra can be measured using several type of dielectric sensors connected to a vector network analyser (VNA). The most popular sensors are multi-rods probes, coaxial cells and open-ended probes. Complex dielectric permittivity spectrum of soil enables to obtain some soil parameters like moisture or salinity. Soil moisture is usually expressed as volumetric water content, which determines the value of complex dielectric permittivity. For a sample of given mass water content different dielectric permittivity spectra are obtained under different compression levels because of the change in volumetric water content and the change in soil porosity.

The issue of soil compaction was investigated in the present work using a specially designed and constructed plastic cylinder, which was filled with soil samples of given moisture contents. At the bottom of the cylinder an open-ended probe with antenna was mounted and connected to a one-port VNA. The cylinder closed from the top with a piston was placed on a hydraulic press and measurements were taken at various piston positions. The piston position was precisely controlled and sample density was calculated for several compression levels. For every single soil density, reflection parameters were recorded and complex dielectric permittivity spectra were calculated. Significant differences for obtained spectra both in real and in imaginary part were observed with the change in the sample compression levels.

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Modelling of water transport in materials for food applications.

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Water is a major component of food products, and it plays a key role in the processes occurring in both the finished food and its components. The transport of water in food systems is studied using Nuclear Magnetic Resonance (Low Field - NMR and PGSE - NMR) techniques. From these techniques, we obtain information on the state of rotational and translational water in the system. Another important parameter is water activity, the results presented showed that it is related to water transport in food.

In this study, parameters showing water transport were determined based on a developed model[1]. The development of the model was based on the analysis of changes in water activity during measurement for model polymer systems. The validity of the model was checked by comparing water transport rates and water self-diffusion coefficients measured by PFG-NMR. The results obtained confirmed the possibility of direct modelling of parameters describing water transport.

In the subsequent stages of the study, parameters describing water transport in selected foodstuffs were determined. Water activity curves were compared for products of different compositions.

Determination of dielectric permittivity spectrum in 10-500 MHz range as a function of moisture content for selected seed species

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Moisture content is one of the basic parameters of seeds. It determines when a crop is harvested and impacts the final price of a given batch of the produce. Moisture content is also a key parameter in the process of seed storage. Too high value leads to a significant shortening of the storage time of a given batch of material. It also leads to self-heating of the material and develops decay processes. Therefore, it is important to control this parameter on ongoing basis.

There are many methods and techniques for measuring seed moisture content available on the market. The gravimetric method is considered as the reference. This method, although highly accurate, is unfortunately time-consuming. Methods in which moisture content is determined almost immediately are rapidly being developed. These are indirect methods, most of which involve measurement of electrical parameters such as resistance or dielectric permittivity. Due to increasing availability of low-cost vector network analyzers, they are also finding their way into fast and portable seed moisture measurement.

In the presented research a vector network analyzer with an antenna probe was used to determine seed moisture. The dielectric permittivity spectrum in the range from 10 MHz to 500 MHz as a function of moisture content was determined for several selected seed species such as rapeseed, phacelia and flax. Based on the obtained measurement results, it can be concluded that the use of VNA allows the determination of seed moisture content. In addition, it can be noted that this method is characterized by high sensitivity.

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Spectroscopic investigation of Camelina sativa oils of different genotypes

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Camelina is an annual oil plant from the *Brassicaceae* family. It is widely spread, especially in Eastern Europe and Western Asia, due to its high resistance to poor weather and soil conditions. Camelina's winter and spring forms are known and easy to grow and maintain, but the spring forms are the most common. Moreover, the seeds and oils obtained from *Camelina* are rich in health-promoting and bioactive compounds, especially unsaturated fatty acids, and phenolics, whose composition depends not only on the specific form (spring or winter) but differs between the different cultivars due to different genotypes of the plant.

This study is devoted to the spectroscopic investigation of cold-pressed *camelina* oils of both winter and spring forms obtained from different genotype plants. Steady-state UV-VIS, fluorescence, and FTIR spectroscopy was applied, with special emphasis on total fluorescence assays of bulk samples were performed, in order to reveal differences in spectra originating from different genotypes of the plant. The total amount of 61 different oils was investigated in that manner and slight differences in the spectra, especially between spring and winter forms were found. The results obtained also revealed the differences in the quantitative composition of different compounds, dependent on the plant genotype.

Mycorrhizal fungi and interactions of soil microbes in the cultivation of solanaceous plants

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The purpose of this study was to evaluate the influence of mycorrhizal inoculation on biological properties of tomato and sweet pepper rhizosphere soil in organic field cultivation. A field experiment with tomato plants (in 2015-2017) and sweet pepper (in 2016-2018) was carried out on an organic farm in Grądy in central-eastern Poland. Tomato seedlings were inoculated with the mycorrhizal fungus *Claroideoglomus etunicatum*. Mycological analysis of the tomato rhizosphere was conducted using only traditional Warcup's method. Sweet pepper seedlings were inoculated with a commercial mycorrhizal inoculum Mycoflor. An analysis of the microbial community in the rhizosphere was carried out using traditional and modern analysis methods such as extraction of total DNA, PCR Reaction, and Next-Generation Sequencing.

Saprotrophic fungi such as *Trichoderma* ssp., *Mucor* spp. and *Penicillium* spp. were often more isolated from the rhizosphere of tomato plants inoculated with *C. etunicatum* than controls. The *C. etunicatum* strain had a direct impact on the increase in fungal biodiversity in the tomato rhizosphere. The microbiological analysis of the sweet pepper rhizosphere showed that the average bacterial population in the years ranged from 17.86·106 CFU·g^{-1} soil DW (with mycorrhizae) to 22.43· 106 CFU·g^{-1} soil DW (control) which indicates that the mycorrhizal inoculum inhibited bacterial growth in the pepper rhizosphere. A smaller number of fungal colonies was observed in the mycorrhizal soil samples (7.92·103 CFU·g^{-1}) than in control (9.75· 103 CFU·g^{-1}). However, Warcupa method showed that more fungal species colonies were isolated from the rhizosphere of mycorrhizal plants than in control. Biodiversity indices calculated from next-generation sequencing (NGS) of the internal fragment of the transcribed spacer (ITS) showed the highest value of Shannon (H') and Fischer indices in combinations with the mycorrhiza than in the control. Promising results were obtained in the metagenomic studies, which showed an increase in the biodiversity of rhizosphere fungi after mycorrhiza application (especially *Trichoderma* spp., *Mucor* spp., *Acremonium* spp., nd *Mortierella* spp.).

Soil thermal properties of Luvic Chernozems under long term field experiment with mineral fertilization and crop rotation

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The aim of the current study was to estimate the soil thermal properties of Luvic Chernozems under long term field experiment with mineral fertilization and crop rotation in the experimental field of the Institute of agriculture and seed science “Obraztsov Chiflik”, Ruse, North Bulgaria. The soil thermal properties were measured using KD2Pro device at surface 0-5 and 15-20 cm soil layers and estimated by two indirect methods in variants with N and NPK fertilizations, non fertilized (Control) variant and under adjacent grassed land (Grass) of the standard meteorological observatory. The experimental data for soil water content, soil bulk and particle densities, particle size distribution, soil organic matter were used for estimation of soil thermal conductivity (λ) by de Vries model (de Vries, 1963). The mean effective thermal diffusivity (a) for the soil layer 0.02-0.20 m under grassed land was calculated by the annual soil temperature wave method (Marinova et al., 1990) using 10 years daily records of soil temperatures measured at 0.02 and 0.20 m at the meteorological observatory.

The highest λ values for Control (1.58 W/m/K), Grass (1.44 W/m/K) and NPK (1.41 W/m/K) variants were measured at depth 15-20 cm at water content retained at matric potential pF=1. The highest a values were measured at water held at pF=0.4 for all variants: NPK (a=0.54 mm^2/s) at depth 0-5 cm, followed by Control (a=0.53 mm^2/s), Grass (a=0.47 mm^2/s) and N (a=0.45 mm^2/s) variants at depth 15-20 cm. The highest volumetric heat capacity (Cv) values varied from 3.33 MJ/m^3/K in the Control to 3.60 MJ/m^3/K in NPK.

For all studied variants, the lowest values of thermal properties were recorded at air-dry conditions and varied for λ from 0.39 (Control) to 0.71 W/m/K (NPK); for Cv from 1.64 (Grass) to 2.48 MJ/m^3/K (N); for a from 0.19 (Control) to 0.36 mm^2/s (Grass).

Changes in physicochemical properties of *Dystric Cambisol* after its complex modification

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Nowadays, soil degradation is more and more common due to agricultural abuses and urbanization. As a result of this undesirable process, soils lose their physical, chemical or biological properties and become infertile. Many different practices can be applied to prevent and reverse soil degradation, including the addition of organic modifiers.

The main aim of the study was to determine the influence of complex modification, performed using biochar and macromolecular compounds, on physicochemical properties of *Dystric Cambisol* (*DC*). The measurements of contact angle, pH, variable surface charge and porosity of non-modified and modified soils were carried out. The biochars were prepared from wood waste (BC1) or sunflower husks (BC2) by pyrolysis at 650°C. Bacterial exopolysaccharide (EPS) as well as cationic (CT PAM) and anionic (AN PAM) polyacrylamides were used as polymeric modifiers.

The obtained results showed that all performed modifications affected physicochemistry of *DC*. The addition of 5% of BC and 50 ppm/L of macromolecular compound increased the contact angle of *DC*, which meant that the soil was more hydrophobic after the selected treatment. All modifiers made the reaction of *DC* higher as well as contributed to slight changes in the soil porosity and specific surface area. The application of both 5% of BC1 and 50 mg/L of AN PAM increased variable surface charge of the soil to the greatest extent.

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Impedance phase angle measurement reveals root stress response *in situ*

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Methodological constraints strongly limit access to the plant root system in undisturbed soil, so development of non-destructive investigation techniques, including dielectric methods, has been the subject of renewed interest in recent years (Cseresnyés et al. 2013). The present study aimed to demonstrate that the single-frequency (1 kHz AC) measurement of impedance phase angle (Φ) in intact root–soil systems is suitable for monitoring plant responses to environmental stresses *in situ*. Potted spring wheat and soybean plants were exposed to cadmium contamination, soil alkalinity and drought stress. Φ was detected at regular time intervals between a ground and a plant electrode during the plant development, at the end of which root and shoot biomass were measured destructively. Each type of stress significantly reduced both Φ and the root and shoot dry mass, to an extent proportional to the stress level. The decrease in Φ was attributed to various physical and chemical changes (*e.g*. permeability, lipid peroxidation) in root cell membranes, the accelerated maturation of the exo- and endodermis and altered root morphology. These stress modified the dielectric properties (*i.e*. complex relative permittivity) of the root tissues, influencing the ratio of apoplastic to symplastic pathways of the alternating electrical current inside the roots, and the impedance response accordingly (Grimnes and Martinsen 2015). The stress-induced increase in the amount of electrically insulating lignin and suberin in root tissues was considered to be an influential factor in decreasing Φ. The present results clearly demonstrated that in pot experiments the measurement of the impedance phase angle in intact root systems is a useful in situ approach for detecting dynamically the plant responses to stresses targeted the roots. The simple method is potentially applicable under field conditions, and deserves further attention in future research.

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Investigation of the cation exchange capacity and specific surface area in representative Hungarian soil types and their correlation with other soil properties

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In 2016, we started to develop a nationally representative database of typical Hungarian soils, focusing mainly on the soil physical and physico-chemical properties. In this publication, we investigated the cation exchange capacity (CEC) and specific surface area (N_2-BET) and their relationship with other soil properties.

We explored 60 soil profiles, and from each soil horizon we collected disturbed and undisturbed soil samples. The basic properties were determined according to the Hungarian standard.

The correlation analysis for the whole database revealed that the soil properties most closely related to CEC were (in decreasing order of importance): clay content, soil organic matter content, specific surface area. When the effect of soil properties was examined for each main soil type, different orders of importance were observed. For example, in the case of Skeletal soils, calcium carbonate content was the property that had the greatest (positive) influence on the CEC-value, whereas in the case of Lithomorphous soils, soil organic material content was the property that had the greatest (positive) influence on cation exchange capacity. With increasing clay content, the role of soil organic matter in the cation exchange capacity generally decreases, while in soils with high organic matter content the role of clay content is subordinate and may have negative effect on CEC value.

In the case of specific surface area, clay content, silt content, CEC value and soil organic matter quality were the most closely correlated properties.

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Physicochemical properties of the water-soluble polysaccharides extracted from the cell wall of various parts of onion

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Onion is a vegetable known for several thousand years. It enjoys unflagging popularity due to its taste, nutritional and medicinal properties (Kianian et al., 2021). The cell wall of onion consists mainly of cellulose, hemicelluloses (xyloglucan) and pectin (O'Neill and York, 2003). However, the cell wall composition is variable. It depends on the plant variety, organ, the stage of growth and development, and environmental conditions (Houston et al., 2016).

The aim of research was to compare the physicochemical properties of water-soluble polysaccharides extracted from the cell wall of storage organ and assimilation leaves of *Allium cepa* L.

The cell wall material and water-soluble polysaccharides were isolated from two parts of onion (plants obtained from a local producer) according to Chylińska et al. (2016). Aqueous dispersions of polysaccharides were prepared and characterized in terms of electrolytic conductivity and pH, molecular weight of polysaccharides, and hydrodynamic diameter and electrophoretic mobility of the dispersed particles, according to previous procedures (Cieśla et al., 2021).

The results allowed to extend the knowledge about the properties of water-soluble polysaccharides present in the cell wall of various organs of the onion.

Acknowledgements

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Application of machine learning to assess the quality of food products. Case study: Coffee Bean.

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The quality of coffee beans plays a key role in the selection of appropriate characteristics such as color, shape, taste and aroma. Currently, the coffee bean drink is one of the most popular beverages consumed by the consumer at the world. Modern machine learning methods were used to automate and improve the determination of an effective quality index for coffee beans. Machine learning algorithms can effectively recognize various anomalies occurring, among others, in a food product. The procedure for preparing the machine learning algorithm depends on the correct preparation and preprocessing of the learning set. The set contained coded information (i.e. selected quality coefficients) based on digital photos (input data) and a specific class of coffee bean (output data). Because of training and data tuning, an adequate artificial neural network obtained, which characterized by a high recognition rate of these coffee beans at the level of 0.90.

Effect of exogenus indolyl-3-acetic acid on changes in the biochemical composition of unicellular algal biomass under nitrogen limitation.

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The aim of the study was to investigate the response of the unicellular algae Eustigmatos calaminaris to different levels of nitrogen limitation and supplementation with indole-3-acetic acid (IAA) in the culture medium. The concentration of IAA in the BG 11 media was 10−4 M. The BG11 medium supplemented with IAA was modified in terms of the content of the nitrogen source (NaNO3): 100% N , 50 %N, 25%N. The experiments were performed in Erlenmeyer flasks in the following conditions: 80 µmol photons m−2 s−1, light/dark cycle 18/6 h, T 22 ± 1 °C, aeration with sterile air and orbital shaking in a phytotron chamber. The microalgal cells were grown for 17 days. Biomass accumulation was determined by measuring changes in optical density with UV/vis spectrophotometry. The content of simple sugars was determined colorimetrically with the anthrone. The lipid content was determined with a modified version of the Bligh and Dyer method. After lipid separation by solid phase extraction the fatty acid methyl ester content was determined by Ultra (Thermo Scientific) chromatograph coupled with a ITQ 1100 mass spectrometer (Thermo Scientific). The results show that the highest growth rate, the highest lipid content were noted at the nitrogen limitation up to 25% with IAA. The main fatty acids in *E. calaminaris* lipids were C16:0, C16:1, and C18:1. The IAA addition in the nitrogen limitation variants enhanced the content of TAGs in C18:1 and monounsaturated fatty acids

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Determining the hydrphobic character of a long-term field experiment Chernozem soil

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Soils' hydrophysical properties (water retention and hydraulic conductivity) can be strongly influenced by the wettability (hydrophobic/hydrophilic character) of soils. In our methodological experiments, we tested the wettability of a Chernozem soil from Hungary (20-years long term experiment), using a Krüss DSA 100 drop shape analyser. We measured the contact angle (cA) and water droplet penetration time (WDPT) – the excellent indicators of solid phase wettability. We also investigated the possible correlation of different agrotechniques (direct seeding, deep tillage, ploughing) with hydrophobicity, macro-aggregate stability and glomalin content. Two sample preparation methods found in the literature were tested in the preliminary experiments. In the pastille method (PM), distilled water was dropped onto soil disc samples, and the cA and WDPT were measured, in adhesive stripe method (ASM) only the cA was measured. The appropriate settings at PM method were also tested in the preliminary experiments. We measured the macro-aggregate stability with wet-sieving method, while micro-aggregate stability values were determined with laserdiffraction megthod. At the end of the experiment series, the measured hydrophobicity, aggregate stability, glomalin content data and possible correlations were compared. Krüss DSA 100 provides a simple method for characterising the wetting properties of the solid phase and it is expected that the indicators of soil wetting properties will be useful in soil physics, -chemistry, -biology and over time in agricultural practice.

Acknowledgements

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Organophosphonates and their influence on CH_4 cycle

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Organophosphonates (OPs) are a group of chemical compounds characterised by the presence of a bond between carbon and phosphorus (C-P) atoms. Compounds from this group occur naturally in nature, e.g. as an integral part of cell membranes of prokaryotic organisms. The most common natural OPs is methylphosphonate (MPn). OPs are also produced as a result of human activity. Compounds from this group exhibit chelating and bioactive properties, and therefore have found many applications in industry, medicine and agriculture. The most important of the anthropogenic OPs, due to their prevalence and volume of consumption, is the herbicide glyphosate.

The importance of OPs in the economy is constantly increasing, so it is essential to understand how they may affect the micro-organisms involved in the methane cycle, i.e. methanogens and methanotrophs. Firstly, all OPs, due to the presence of a phosphonate group, may stimulate the activity of these micro-organisms, especially in environments where phosphorus availability is a limiting factor. In addition, recent studies have shown that natural OPs are an important precursor in the new, until recently unknown process of biological methane formation. On the other hand, however, OPs, as chelators, may interfere with the availability of other elements (e.g. Cu, Fe, Ca) and thus inhibit the activity of important enzymes involved in the transformation of methane in the environment.

Methane accounts for approximately 20% of the observed global warming. Despite the importance of the issue, little is known about the impact of OPs on the biological transformation of CH_4 in the environment. Demonstrating knowledge gaps in this area is the aim of this presentation.

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Comparison of the functional diversity in fungal endophytes communities from the roots of the selected spring wheat cultivars

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Wheat is the most important cereal cultivated in Europe. Plant tissues of all wheat organs are inhabited by numerous endophytic fungi that live inside healthy tissues without causing visible disease symptoms and their interaction with the plant is mostly based on symbiosis. Fungal endophytes are known for their ability to:

- promote the plant growth,
- increase tolerance to high temperatures and drought,
- induce resistance to various types of biotic and abiotic stress factors including plant pathogens and pests.

The aim of the presented research was to compare the metabolic activity of fungal endophytes inhabiting the roots of six varieties of spring wheat grown in the ecological system, using BIOLOG FF plates.

Acknowledgements

The presented research was completed in the frame of the research project no. 1.08 entitled " Characteristics of fungal endophytes from selected spring wheat cultivars and determination of their potential in plant growth promotion and the limitation of plant pathogens development", financed from the statutory subsidy of IUNG-PIB, Puławy (2022-2025).

Ascomycota and Mortierellomycota abundance in response to different cropping systems and reduced rates of N fertilization in maize monoculture

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Ascomycota and Mortierellomycota are widely recognized as the dominant fungal phyla in the soil environment, while nitrogen (N) is an essential element for plant productivity; hence, it is abundantly applied to the soil in the form of organic or chemical fertilizers.

The main objective of our study was to investigate the structure and richness of the soil mycobiome at the taxonomic phylum level in the face of the application of different rates of N fertilization under two cropping systems: plowing (P) and no-till (NT).

In our study, we undertook sampling twice during a single growing season: before maize sowing (without fertilization) and after harvesting the crop (four different fertilization rates). The mycobiome structure was identified based on the Next Generation Sequencing (NGS) technique.

There is evidence that the relative abundance of Ascomycota and Mortierellomycota increases significantly in response to fertilization treatments (Liu et al., 2020). However, our study showed that in a maize monoculture crop, this may depend on the tillage system applied and N fertilization rates. We proved that after one growing season, the relative abundance of Ascomycota in the P system responded positively to increasing fertilization rates, and that the abundance of these fungi remained relatively comparable in the NT system (only a 20% reduction in N fertilization resulted in an increase in the relative abundance of Ascomycota). In contrast, the relative abundance of Mortierellomycota in the P system decreased significantly and declined with increasing N application rates, where, by comparison, in the NT system the richness of these fungi was highest at the maximal N application rate.

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Effect of tillage system on humic substance content and structure of humus-forming microorganisms in soil

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Humic Substances (HSs) are produced *in situ* due to chemical, physical, and microbial degradation, as well as (re)polymerization of phenolic and aromatic components such as lignin, tannins, and secondary metabolites. These organic molecules play essential roles in improving soil properties, plant growth, and agronomic parameters. The microorganisms involved in humification process are therefore highly important, having a significant impact on the dynamic and speed of the decomposition of carbon in the soil.

The aim of the study was to evaluate the relationship between the type of tillage (deep and strip tillage) and the content of HSs and the structure of humus-forming microorganisms in the soil under the rapeseed crop and the yield of rapeseed.

Isolation of HSs was performed by the Schnitzer method and their content was determined by spectrophotometry (at λ=465 and λ=665 nm). The measured absorbance values and indices were used as proxies for estimating the degree of humification (E4/E6). The analyzes were performed before sowing and after rapeseed harvesting.

It was shown that the content of HSs in the soil from deep tillage was on average 3.823±1.268 gHSs kg^{-1} before sowing and 4.167±0.856 gHSs kg^{-1} after harvesting. The content of HS substance in the soil from strip cultivation was higher and averaged 4.223±0.340 gHSs kg^{-1} before sowing and 4.836±0.837 gHSs kg^{-1} after harvest. Statistical analysis indicated a positive correlation between yield and the E4/6 ratio ($r=0.515$, $p<0.01$). The values of the E4/6 ratio show the ratio of substances in the early stages of decomposition to those in advanced humification. Among the potential humus-forming microorganisms in the soil, bacteria of the following genera *Pseudomonas*, *Nocardioides*, *Pseudarthrobacter*, *Promicromonospora,* and fungi of the genera *Tetracladium*, *Cladosporium,* and *Xylaria* were identified.

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Biodiversity of fungi as an indicator of potential biological and soil-forming weathering

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Rock weathering drives both landscape/landform formation and soil production/evolution [1]. Less studied biological component of weathering caused by tree root systems and soil production under trees is the main focus of the present study. Weathering by trees, which likely has been important in soil formation since the first trees emerged in the middle and late Devonian, is accomplished through both physical and biological means, like acids excreted by plants and exudates from associated bacterial communities [2, 3]. However, these processes are relatively poorly known. Our goal was to assess the impact of tree roots and associated microbiota on the potential level of biological weathering. As part of this study, we pose the question of the level of activity and biodiversity of fungi in root systems of trees and rock crack, and how it can affect biological weathering. The area of interest is the Poprad gorge in the southern part of the Beskid Sądecki, Outer Western Carpathians. The highest average number of classified genera were fungi performing simultaneously pathotrophic, saprotrophic and symbiotrophic functions. Agaricales, Cantharellales and Archaeorhizomycetales were the most numerous orders, but we also found a particularly high percentage of the order Mortierellales in one sample. The order Boletaceae and its family Boletaceae were significantly enriched in rock fracture samples, while the highest taxa abundance was found in the reference samples. Our study confirmed that the fungal community in the root zone is geochemically active, and organic acids secreted by plant roots in oligotrophic conditions and nutrient limitations significantly affect soil weathering.

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Biodiversity of soil microorganisms in forest and agricultural ecosystems

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Forests are natural ecosystems with multi-layered plant communities, dominated by trees. Because forests have many functions—including production, ecological, and social—it is important to preserve their species diversity and good health of stands for future generations [1, 2] . Soil is one of the basic elements of forest habitats that guarantees the proper growth and development of an ecosystem. The use of forest soil properties is the basis for sustainable and proper forest management [3].The aim of the research was the functional and structural characterization of microorganisms in forest and agricultural soil, and the comparison of these environments in terms of microbiological composition. It was shown that the species composition of soil microorganisms was closely related to the physical and biochemical properties of the tested soils, and also depended on the sampling site (a given ecosystem). The core microbiome of bacteria and fungi was ecosystem-specific. The increased biodiversity of the soil environment was closely related to the increased number of potential functions performed by soil microorganisms. Understanding the diversity of microorganisms living in the periroot zone of trees and the interactions between the microbiome and trees will facilitate the development of future forest protection strategies and finding appropriate indicators for assessing forest soils. The obtained test results are an additional source of information on the microbiological composition, enzymatic activity and some chemical properties of the soil of the mixed forest and the surrounding farmland.

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Detection of nutritional deficiency of sugar beet leaves by VIS – NIR – SWIR spectroscopy

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The quality of sugar beet plants depends on their nutritional status during the growth of plants. Macronutrient such as nitrogen, potassium and phosphours plays an important role in many physiological and biochemical processes, such as photosynthesis, osmoregulation, transport of metabolites, synthesis of enzymes, proteins, starches and cellulose and plant stress alleviation. It's monitoring in plants and soil as well as efficient application of mineral nutrients are crucial for ensuring crop yield and for minimizing the negative environmental impact of fertilization.

The main objective of this study was to investigate the potential of hyperspectral imaging method for discriminating nutritional deficiency of sugar beet plant. The leaf spectral reflectance were taken from an experiment that included a combination of four nitrogen, phosphorus and potassium contents of nutrient-deficient applied to sugar beet plants. The hyperspectral images of the plant leaves were captured using hyperspectral camera in the range of 400-2500 nm. Obvious differences in spectral reflectance existed between treatments within certain wavelength regions (400–1000 nm). In addition, the techniques of derivative analysis increased the separation of grasses with different fertility levels, providing the possibility of monitoring nutritional status. Combined with different pre-treatment and feature extraction methods, four classification models were established by k-nearest neighbours, support vector regression, random forest and linear regression. Finally, the best accuracy (higher than 80%) of the random forest method with the testing dataset pretreated using Savitzky-Golay second derivative method and correlation future selection algorithm were obtained. This results suggest that hyperspectral image combined with machine learning methods have a remarkable ability to accurately predict the leaf nutrient content.

The effect of soil microorganisms on polycyclic aromatic hydrocarbons derivatives content in biochar

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Biochar (BC) is frequently used as a soil addition, conditioner, and fertilizer [1]. However, during high-temperature processes of BC production, some toxins are formed, e.g. polycyclic aromatic hydrocarbons (PAHs) and their derivatives [2, 3]. The knowledge of the fate of hazardous substances in the environment is essential to assess the safety of the agricultural application of biochar. Thus the study aimed to evaluate the changes in the content of PAHs derivatives before and after the biological and enzymatic aging of biochar.

The activity of soil microorganisms and the enzymes (horseradish peroxidase) affects the physicochemical properties of biochar as well as its structure and chemical composition. Moreover, the content of the oxygen functional groups on the surface of BC increased, whereas the aromaticity decreased, which indicated that the ability to chemically interact with the compounds present in soil increased. The aging affects also the ash content in biochar. Enzymatic aging affects the studied parameters more than biological aging.

Biological aging increased the content of the total fraction of PAHs and their derivatives in BC as well as decreased the concentration of the bioavailable fraction of analytes, which is more essential from the point of view of the practical use of biochars. On the other hand, enzymatic aging decreased both fractions of the studied compounds. The results indicated that soil microorganisms play a significant role in biochar transformation, modification, and degradation processes in the soil environment.

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Organic waste-derived adsorbents for environmental application

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Nitazoxanide (nitrothiazolyl-salicylamide) is a small-molecule antiprotozoal drug available in markets as tablets and suspensions [1]. It has demonstrated wide-spectrum antiviral efficacy against various viruses e.g. the respiratory syncytial virus, parainfluenza virus, rotavirus, norovirus, hepatitis B virus (HBV), hepatitis C virus (HCV), dengue virus, yellow fever virus, and human immunodeficiency virus (HIV) as well as coronavirus [2] including SARS-CoV-2. Thus, the drug was tested to fight COVID-19 pathogenesis [2]. It is worth noting that nitazoxanide is able to promote a balance between pro-inflammatory and anti-inflammatory responses in humans, which is essential in COVID-19 due to the curb of the hyperinflammatory cytokine storm [2].

Due to the greater usage of nitazoxanide due to the pandemic, its content in the environment also increased. Thus, the issue of drug disposal is actual and very essential.

The study aimed to verify the effectiveness of thermally modified various organic wastes (wheat straw, sunflower, and the residues from biogas production) towards nitazoxanide sorption. The biochars were obtained via pyrolysis at 600ºC. The time to reach the equilibrium as well as the adsorption isotherms were investigated. Moreover, the effect of interfering ions (chloride, nitrate, phosphate, carbonate ions) and dissolved organic matter on the amount of adsorbed drug was studied. The experiments were carried out in aqueous solutions, but the effect of tap water and effluent from the municipal wastewater treatment plant was also established. The processes of sorption on three different biochars (wheat straw, sunflower, and residues from biogas production) were matched to the three different sorption models (Temkin, Dubinin-Radushkevich, and Langmuir, respectively). The amount of adsorbed nitazoxanide (the concentration of the initial aqueous solution of analyte: 20 mg/L) on studied materials was 8.15, 9.89, and 13.44 mg/L, respectively.

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Isolation and characterization of *Trichoderma* sp. from apple tree soil with potential for biocontrol of *Neofabraea* sp.

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Trichoderma species have gained significant attention as biocontrol agents due to their antagonistic properties against various plant pathogens. In this study, strains of *Trichoderma* sp. were isolated from soil samples collected from apple orchards under six different ways of land cultivation. The aim was to investigate the antagonistic potential of *Trichoderma* isolates against *Neofabraea* sp., a common fungal pathogen that causes bull's eye rot (BER).

Isolation of *Trichoderma* spp. was carried out by sowing soil samples on *Trichoderma* Selective Medium (TSM) and utilizing necromass from *Neofabraea* sp. as a source of attraction for the antagonistic isolates. The isolated *Trichoderma* strains were then screened for their antagonistic activity against *Neofabraea* spp.

Results underscored the presence of multiple *Trichoderma* spp. strains with varying degrees of antagonistic potential against *Neofabraea* spp. The study sheds light on the influence of different way of land cultivation on the diversity and effectiveness of *Trichoderma* isolates. Furthermore, the utilization of TSM medium within *Neofabraea* necromass as isolation strategies emphasizes innovative approaches for cultivating the most potent antagonistic strains.

In conclusion, this research contributes to our understanding of *Trichoderma* spp. as a promising biocontrol agent against *Neofabraea* spp. infections in apple orchards. The diverse isolation techniques and subsequent characterization offer insights into harnessing *Trichoderma* spp. as beneficial fungi for sustainable and eco-friendly disease management strategies in orchard ecosystems.

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Influence of yield size on labor inputs and their effectiveness in manual raspberry harvesting

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Poland is one of the leading producers of raspberry fruit. Most raspberry plantations in Poland are prepared for manual harvesting, which accounts for as much as 2/3 of the annual labor input. Therefore, labor costs are particularly important, especially harvesting, because this activity usually cannot be replaced effectively by another factor of production.

The aim of the work was to develop model solutions for the organization of manual raspberry fruit harvesting in the aspect of minimizing labor input, thus increasing efficiency and productivity as well as minimizing harvesting costs. The research was carried out on a plantation located in the province of Pomeranian, for 4 varieties, for 2 time periods, i.e. July and August. The selection criterion was its type, the area occupied in the tunnel, the type of substrate used as the production substrate and the number of seedlings in the production section.

The calculated performance indicators were used to conduct a computer analysis using metaheuristic algorithms, aimed at optimizing the manual collection.

As a research method, a simulation experiment was used with changing input parameters of the model distributed by means of statistical distributions, estimated on the basis of empirical research on the plantation. As a result of the research, it was found that the bottleneck of the work organization system is the weighing point. The proposed model allows to achieve the efficiency of the brigade at the level of about 90%. With a high yield of about 2t ha^{-1} the efficiency increases to 94%. It is worth considering setting up two weighing points when yielding more than 1 ton per hectare. Then the waiting time for weighing will be significantly reduced, and the fruit will reach the cold store faster.

The effect of the use of unconventional solutions for osmotic dehydration on selected properties of oranges

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The main reason for fruit and vegetable spoilage is high water content. To increase their durability, the osmotic dehydration process is used due to the properties of retaining vitamins, minerals, color, and taste. The most commonly used osmotic solution is the sucrose solution. However, the use of fruit concentrates for dehydration also has positive effects on food production, especially in terms of reducing the sugar content in products.

The aim of the work was to investigate the influence of unconventional solutions in the process of osmotic dehydration of oranges. There were used solutions of xylitol, fruit concentrates of strawberries, cherries, oranges, rosehip juice, and sucrose. The color difference, microstructure, vitamin C, polyphenols, antioxidant activity, and total variable count were examined.

It was found that the osmotic solutions used significantly impacted the change in the physical, chemical, and microbial properties of oranges. The most significant differences in color were observed for the cherry and strawberry concentrate solution, which may affect the attractive appearance of the final product after drying. The highest polyphenols content was obtained for oranges dehydrated in a solution of strawberry concentrate. The highest value of vitamin C was observed for the sample dehydrated in the rosehip solution, followed by strawberries and oranges concentrate. The osmotic dehydration used in fruit concentrate solutions resulted in a decrease in the total count of microorganisms by two log cycles, which may extend the storage period of the material. These parameters testify to the positive values of the final product dehydrated in fruit juices. The used osmotic solutions had more favorable values when comparing the results with fresh raw material because the osmotic dehydration process caused an increase of bioactive compounds in the sample tissue.

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Long-term impact assessment of tillage systems on agroecosystems

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Soil tillage practices have profound and enduring effects on agroecosystems, making it imperative to understand the nature and functions of the soil ecosystem under different tillage systems for sustainable farming. Although the short-term effects of soil tillage have received considerable attention, a critical knowledge gap exists regarding the long-term consequences on the soil ecosystem, encompassing both subsurface and surface dynamics.

The aim of research on soil tillage in Lithuania's distinct soil and climate conditions has yielded limited insights, leaving significant gaps in our understanding. This study aims to bridge these gaps by conducting a systematic assessment of long-term changes in agroecosystem sustainability using soil type Epieutric Endocalcaric Endogleyic Planosol (*Endoclayic, Aric, Drainic, Humic, Episiltic*) as classified by the World Reference Base for Soil Resources (WRB) 2014.

The study investigates the effects of long-term complex measures, straw incorporation, direct drilling with or without green manure, and direct drilling, on soil properties and the overall sustainability of the ecosystem. The findings reveal that these practices lead to a substantial increase in organic carbon stocks within the soil, thereby facilitating soil fertility restoration and mitigating the adverse impacts of agriculture on climate change.

Through a comprehensive assessment of soil tillage impacts on agroecosystems, this study underscores the significance of long-term evaluations and the adoption of sustainable soil management practices. It provides valuable insights for promoting farming approaches that enhance soil health, bolster ecosystem resilience, and contribute to climate change mitigation.

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A season-long snapshot of an organic apple orchard belowground biodiversity and soil nutrient status as affected by in-row living mulches

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Organic management is based on practices that are intended to boost biodiversity. However, specialization of intensive organic orchards has resulted in a conventional-like approach and increased use of external inputs, which are less conducive to overall biodiversity. Enhancing the functional biodiversity of both above and below ground communities can be achieved through an agroecological soil management approach e.g. by using living mulches.

The impact of living mulch grown on the tree row on aboveground and belowground communities, as well as on the apple trees and soil nutritional status and fruit yield, was assessed in an organic 12-year old apple cv. Gala/M9 orchard in 2022. Three species (*Alchemilla vulgaris*, *Mentha x piperita* and *Fragaria vesca*) were introduced into the tree understory area in 2019 and 2021 to evaluate long-term or short-term effects and compared to natural cover as a control. The orchard was drip irrigated, and localized fertilization was provided with organic fertilizers (dry bovine manure and stillage), applying a total of 12 g N/tree. Living mulches affected soil nutrient availability, bacterial activity and diversity and nematodes trophic communities. In the short term, they stimulated microbial activity and increased nutrient levels in soil. However, they started to compete with trees for soil nutrient resources after the fourth season. Most significant changes were observed during summer. Beside direct changes in microorganisms and nematodes abundance, the living mulches affected the functions of these communities as inferred through associations between amplicon-based biodiversity and microbial metabolic potential or nematodes taxa abundance. The findings are discussed considering the potential exploitation of the interactions between belowground life and soil management practices to improve organic horticultural cropping systems

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Preparation of clay, silt and sand content maps of a study area using pedotransfer functions and digital soil mapping techniques

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In our work, we used legacy soil data available from the geocoded Profile-level Database of Hungarian Large-Scale Soil Mapping (Hungarian acronym: NATASA) to map primary soil properties. For the characterization of soil texture, the legacy data provided information on the upper limit of soil plasticity, but no data on particle size distribution. Therefore, we derived pedotransfer functions (PTFs) to estimate clay, silt and sand content and applied them at profile level data. The PTFs were trained and tested on the Hungarian Detailed Soil Hydrophysical Database (Hungarian acronym: MARTHA). For the prediction i) additive Log-Ratio transformed clay, silt and sand content were used as the dependent variables and ii) soil type and subtype, upper limit of soil plasticity, calcium carbonate, organic matter content and pH in water were included as independent variables. We used recursive feature elimination computed on 10 fold cross-validation to select the most important independent variables. The PTFs were derived with random forest algorithm with parameter tuning. The derived PTFs were applied on the study area to add computed clay, silt and sand content.

The soil layer data of NATASA originated from different sampling depths, therefore the parameters to be mapped were converted to 6 standard layers (0-5; 5-15; 15-30; 30-60; 60-100; 100-200 cm) of GlobalSoilMap using mass preserving splines.

The spatial modelling was performed by random forest kriging. EU-DEM Digital Elevation Model and its morphological derivatives were used as numerical environmental auxiliary variables. Categorical variables were also involved: geological map, physical and chemical soil properties provided by the Digital Kreybig Map Information System (DKMIS), and the recently elaborated National Ecosystem Basemap, which provides land cover and land use information.

The performance of the clay, silt and sand content was characterized with root mean square error (RMSE) and coefficient of determination (R2) computed on the test dataset.

The evaluation of factors influencing outflow of mineral nitrogen from agricultural soils of Lublin Region

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Nitrogen is an important micronutrients, and one of the most important yield factors. Its content in Polish mineral soils ranges from 0,02 to 0,35%, while in organic soils from 1 to 4%, majority of which (over 90%) are organic compounds comprising the organic material, and only 1–5% nitrogen in the form of the mineral that is directly available to plants. These are ions or nitrogen ammonium compounds ($N\text{-}NH_4$) and nitrate nitrogen ($N\text{-}NO_3$).

The main purpose of the dissertation is to determine the relationship between certain factors, including the basic properties of the soil, and the outflow of nitrogen from the soil, which may not only result in water contamination but also in loss of an important, from manufacturing point of view, plant nutrition. The research has been carried out on the basis of the results obtained from mineral nitrogen monitoring conducted by the chemical and agricultural stations in the area of Lublin. The evaluation assessed the data from 320 points located on mineral soils based on the results of the analyzes in the 2021.

The study found that the content of mineral nitrogen in soils included in research in the layer 0–60 cm and 0–90 cm on average exceed 100 kg per hectare and was higher in autumn than in spring. The amount of outflow of mineral nitrogen beyond the main plant root mass can be used to assess the loss of this component from the crop production not only within the farm but also in larger scale spatial changes.

Multidirectional health-promoting properties of selected morphological parts of apples and quinces

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Fruits and vegetables, according to the current recommendations, should be the basis of our diet. They contain valuable ingredients that have a beneficial effect on our health. They include, among others, antioxidant compounds such as polyphenols, carotenoids, vitamins C and E, tocopherols, and selenium that neutralize the activity of free radicals, which can cause damage to cell and tissue structures and lead to the formation of cancerous changes. At the same time, scientific research reports that other morphological parts of plants, such as leaves, seeds, or stones, can also be rich in bioactive compounds. Apples and quinces seem to be interesting research materials in this context.

Apples are popular in Poland. Here, their average monthly consumption per person in 2021 was 0.93 kg. They are known for their high content of dietary fiber and polyphenolic compounds. Meanwhile, one study showed that quince juice contains almost 2.5 times more polyphenols than apple juice, and its antioxidant activity is almost 1.6 times higher. Other authors report that extracts from quince leaves are characterized by a higher antioxidant effect than extracts from quince fruits.

For this reason, the aim of the research was to compare the bioactive compounds content of the leaves, fruits, and seeds of apples and quinces (polyphenols, carotenoids, selected minerals and vitamins) and their health-promoting properties *in-vitro* (antioxidant activity as well as their ability to inhibit α-amylase, α-glucosidase, AChE and BuChE).

The research shows, among others, that in most cases, both the leaves and seeds of apples and quinces contain higher amounts of individual minerals than their fruits. In addition, their leaves possess the significantly highest antioxidant activity. The obtained results suggest that various morphological parts of apples and quinces can be potentially used as raw materials in the food industry and pharmacy.

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Impact of agricultural land use on glomalin content and physico-chemical soil properties

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The optimization of agricultural land use management contributes to both yield and soil security. Soil organic matter stock fundamentally determines soil fertility, it affects aggregates, water storage, chemical properties, protective functions of soil and it has an important role in the regulation of many atmospheric constituents. Glomalin produced by arbuscular mycorrhizal (AM) fungi forms a significant part of soil organic carbon. Glomalin has an essential role in building the soil structure and protecting soil carbon in aggregates. However, intensive fertilization and tillage harm AMF diversity and functions just like glomalin production.

The effect of soil management on glomalin (Easily Extracted Glomalin-Related Soil Protein; EE-GRSP) has been examined at sites of three long-term field experiments: (1) NPK fertilization experiment with and without farmyard manure treatments; (2) conventional and organic farming fields (Martonvásár; Hungary) and (3) no-tillage, mouldboard ploughing and deep cultivation (Józsefmajor; Hungary) treatments were tested.

The soil disturbance had the most significant effect on soil EE-GRSP. Close correlations were detected between the soil humus and nitrogen content, the pH and the dissolved organic carbon, the macroaggregate stability and the EE-GRSP. The soil glomalin ranged from 0.2 mg/g soil to 0.77 mg/g soil in different long-term experiments. The highest soil glomalin contents were found in the no-tillage system and N-fertilized plots.

The synthesis of our data could result in a land use effect assessment considering the quantity of soil glomalin. Glomalin is not just a C storage, but it is also a very important soil health indicator.

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Synergistic antifungal effects of hinokitiol and ε-polylysine and its application as gelatin/konjac glucomannan-based edible coating in inhibition of postharvest decay in satsuma mandarin

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Satsuma mandarin (*Citrus unshu*) is the most major citrus crop in Japan. However, postharvest decay caused by pathogenic fungi during transport and storage is a serious problem. Hinokitiol (β-thujaplicin; HT) is a terpenoid found in woody tissues of the Japanese hiba tree (*Thujopsis dolabrata*). HT, has a strong chelating ability in inhibiting microbial enzymes, is approved and used as a food additive in Japan. ε-Polylysine (ε-PL) is a positively charged cationic polymer in aqueous solution and has antimicrobial properties due to its electrostatic action. It is a food additive in Japan and is approved by the FDA as a GRAS. This study aimed to investigate the antifungal efficacy of the combination of HT and ε-PL against postharvest pathogenic fungi and to evaluate its applicability in edible coating for control the postharvest decay of satsuma mandarin. Satsuma orange fruits were coated with HT or/and ε-PL incorporated gelatin/konjac glucomannan based solutions after inoculating pathogenic mold and stored at 25oC for 8 days.

The minimum inhibitory concentrations (MICs) of HT and ε-PL against grey mold *Botrytis cinerea* were 7.82 μg/mL and 15.63 μg/mL, respectively. The MICs against citrus green mold *Penicillium digitatum* were 62.5 μg/mL (HT) and 500 μg/mL (ε-PL). Also, the MICs of these two bio-fungicides were 3.91 μg/mL (HT) and 15.63 μg/mL (ε-PL) against sooty mold *Cladosporium cladosporioides*, 31.25 μg/mL (HT, ε-PL) against citrus blue mold *P. italicum*. Checkerboard assays showed that the combination of HT and ε-PL exerted synergistic effects against *P. digitatum* with average fraction inhibitory concentration index (FICI) of triplicate of 0.29. On the other hand, they had no interaction effect against *B. cinerea* (FICI 0.83).

HT and ε-PL-added coatings inhibited the spread of *P. digitatum* inoculated on satsuma mandarins during storage, which indicated its applicability for control of postharvest decay in citrus fruits.

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Huminpol, the natural fermentation extract from mud deposits stimulates seed germination and development of vegetable plants

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As part of the search for preparations used in organic plant production, research was undertaken on the possibility of using the innovative Huminpol preparation, which is a fermentation extract from mud deposits used for medicinal purposes. The aim of the conducted experiments was to examine the effect of the Huminpol preparation (Ekorozwój, Poland) applied before sowing to seeds and then to plants and soil on the dynamics and germination capacity as well as the kinetics of emergence and growth of cucumber, bean, onion, carrot, parsley, kale and tomato, taking into account a key processes of their physiological activity. The research was carried out in controlled laboratory and greenhouse conditions and then verified in field.

The results of research carried out in laboratory, greenhouse and field conditions have shown that seed soaking for 20 minutes in Huminpol preparation (1:1; v:v) is highly effective in increasing dynamics and germination capacity as well as the emergence and growth kinetics of plants of the tested species. Plants obtained from such treated seeds and additionally watered, twice, after 30 and 60 days from seed sowing with Huminpol at a dose of 8 L/ha develop much faster, are much taller throughout the growing season, and show greater physiological activity (net photosynthesis, transpiration, stomatal conductivity, intercellular CO_2 content, index of chlorophyll content), and yield than in control variant. These treatments also proved to be highly effective in eliminating pathogenic microflora contaminating seeds and plants, which resulted in their high health. This indicates the high usefulness of Huminpol preparation in improving the sowing value of seeds of the tested vegetable species and their cultivation in ecological systems.

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Innovative methods of refining vegetable seeds and their impact on germination and emergence, growth and physiological activity of plants in organic farming

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Studies covered various methods of vegetable seed improvement: ozonation, treatment with radio waves, hydrothermotherapy as seed soaking in water at temperature of 45-50^{o}C and conditioning combined with biological treatment. The treated seeds were assessed in germination tests, Phytothoxkit and in greenhouse and field conditions where the dynamics of plant emergence, growth and physiological activity were assessed.

The results of laboratory tests on carrot seed refining indicate high protective effectiveness of the developed pre-sowing methods of seed processing and their sowing value improvement. Spectacular effects in reducing the infection of seeds were obtained after the use of ozonation and treating with radio waves. Pre-sowing treatment of seeds with hot water (hydro-thermotherapy) and decontamination with 2% HuwaSan preparation turned out to be very effective in eliminating pathogenic fungi contaminating the seed coat. As a result, a significant increase in seed quality (energy and germination capacity) and their healthiness was noted, as well as faster plant emergence in greenhouse and field conditions. The research results were confirmed also in the laboratory Phythotoxkit tests, where significantly greater differences were noted in the growth of seedlings and roots and their proper development (no abnormal and damaged seedlings) were observed. The protective effectiveness of ozonation, as well as other seed decontamination treatments, was confirmed in greenhouse and field experiments were the plant obtained from treated seeds developed faster than in control. The effects of seed refining treatments were visible not only in the early stages of plant growth and development, but were maintained throughout the growing season. This resulted in an improvement in the health of seedlings and plants compared to control objects (untreated) and in elimination of pathogens responsible for seedling blight and many pathogenic fungi transmitted from seeds to plants.

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Assessing vegetation changes and land use dynamics in the Middle East: implications for sustainable development

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The Middle East region has witnessed notable changes in vegetation coverage and land use patterns over the past few decades. Understanding these changes is crucial for sustainable city development planning and environmental policymaking. In this presentation two key aspects are analyzed: the impact of anthropogenic factors on vegetation dynamics, and urbanisation effect on heat island occurrence.

The Normalized Difference Vegetation Index (NDVI) derived from Moderate Resolution Imaging Spectroradiometer (MODIS) data was used to assess vegetation changes. The results indicate a significant increase in vegetation coverage across the Middle East during the 2001–2019, particularly in Egypt and Turkey. This increase can be attributed to factors such as dam construction and agricultural practices utilizing groundwater and desalinated seawater.

Additionally, the study examines the dynamics of land use/land cover (LU/LC) and land surface temperature (LST) in the metropolitan city of Mashhad, Iran, from 1990 to 2019, using Landsat satellite imagery. The study employs the Markov chain model to predict future LU/LC and LST for 2030, providing insights into the long-term dynamics of these parameters. The analysis reveals varying patterns of LU/LC, including built-up land, vegetated land, and bare land, which influence the distribution of LST in the city. Specifically, the presence of built-up and bare land areas positively correlates with higher LST, while vegetated land areas show a negative correlation.

These findings have significant implications for sustainable city development planning and environmental policymaking. They emphasize the importance of considering governmental policies, such as dam construction and urban expansion management, to promote vegetation growth and mitigate UHI effects in the Middle East. By understanding and addressing these factors, countries like Egypt, Saudi Arabia, Qatar, Kuwait, Iran, and Turkey can work towards fostering environmental sustainability in their respective regions.

The impact of crop rotation, mono-cropping and farming intensity on phenolic compounds and antiradical activity of winter rye (*Secale cereale* L.)

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Plant and soil health depend on crop rotation. However, less is known about the impact of crop rotation systems on plant metabolic response. The aim of the study was to evaluate the contents of phenolic compounds and their interaction with antiradical activity in winter rye (*Secale cereale* L.) in four crop rotations, arranged since 1967: 1) Intensive (winter rye with winter rapeseed as a catch crop and NPK fertilizers (CRint); 2) Winter rye monoculture without fertilizers and herbicides (MonoF0H0); 3) Winter rye monoculture with fertilizers and herbicides (MonoF1H1); 4) Three-year crop rotation with winter rye, fertilizers and herbicides (CR3y). The total phenolic content (TPC) and DPPH (2,2-diphenyl-1-picrylhydrazyl) free radical scavenging activity in leaves and roots of rye at the head emergency stage (BBCH 57-59) were determined. There were strong positive correlations between TPC and antiradical activity in leaves (r=0.909) and roots (r=0.837). In leaves, a significantly (P<0.05) higher TPC was found in MonoF0H0 compared to MonoF1H1, CRint and CR3y (about 11%,18%, and 30%, respectively). A similar trend was found in DPPH radical scavenging activity; however, there were no significant differences in MonoF0H0 and MonoF1H1. Contrary, in roots, the highest TPC and DPPH scavenging activity was found in the CR3y crop rotation system, while the significantly lower contents (about 1.6-fold and 1.8-fold, respectively) were measured in the CRint system. In addition, the TPC of rye roots in CR3y did not significantly differ from the MonoF1H1 system. Further, the rye roots in MonoF1H1 and MonoF0H0 systems demonstrated a similar ability to scavenge DPPH free radicals. The data showed that the accumulation of phenolic compounds and antiradical activity varies among winter rye leaves and roots and depends on the crop rotation. More detailed studies are needed to understand the metabolic responses of individual plant parts in response to different crop rotations.

Influence of thermal and hydrothermal treatment on selected rheological properties of wheat bread flour fortified with baking enzymes

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With the growing market demand for clean label products, heat treatment appears to be the most effective approach to wheat-based food processing. Dry and hydrothermal heat treatment is effective in modifying the physical, rheological, technological and functional properties or storage stability of wheat flour and other milled products. In addition to the reduction of microorganisms, the beneficial functions of heat treatment include improving the taste, texture and color of the product. Another method of modifying the properties of flour are enzymes commonly used in baking industry. In the literature, there are test results confirming a positive effect of cellulase and xylanase on non-starch polysaccharides present mainly in the outer layers of cereal grains. In this study, type 750 bread flour, characterized by a high content of non-starch polysaccharides, was fortified with cellulase and xylanase enzymes and then subjected to dry and hydrothermal heat treatment. Treatment-induced rheological differences were tested in the diluted flour suspension and in the dough matrix by rheological analyses.

Dry heat treatment caused a less significant effect on the protein complex of the tested flour. The addition of enzymes allowed to improve the rheological properties, extending the dough development time, maintaining baking strength, and thus improving the quality of gluten proteins. The hydrothermal treatment increased the viscosity of both the flour suspension and the dough matrix, also improving the stability of the flour, however, the use of steam in the process negatively affected the protein structure, which was manifested by the difficulty in producing a sufficiently stretchy and elastic dough in the rheological analysis.

These results can be helpful in the production of flour products with specific technological and functional properties.

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The influence of vegetable processing waste from bell pepper and tomato on the baking characteristics of wheat flour and the quality of wheat bread

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One of the key challenges in the agri-food industry today is the management of substantial quantities of by-products generated during various stages of food production. Utilizing by-products from fruit and vegetable processing by incorporating them into food production is one strategy. By-products can offer valuable sources of diverse nutrients, contributing significantly to both the enhancement of bakery product appeal and the reduction of food waste.

The aim of this study was to investigate the impact of incorporating vegetable processing waste from tomatoes (TP) and bell peppers (PB) at concentrations of up to 12% on dough characteristics and bread quality. The research involved analyzing the chemical composition of raw materials and the farinographic properties of wheat flour, both independently and in blends with TP and PB. Bread quality assessment included parameters such as bread yield, volume, baking loss, porosity, crumb moisture, and the chemical composition of the bread. Furthermore, evaluations were conducted on crumb color, texture (TPA), and sensory attributes through organoleptic assessment.

The addition of TP and PB increased water absorption, dough development, and softening, while reducing stability time. However, it did not significantly affect bread quality parameters (baking yield, loss, volume, and crumb porosity). Crumb hardness, chewiness, and cohesiveness remained unchanged within supplemented levels up to 9%. TP and PB also notably impacted the bread crumb color, intensifying redness and yellowness. Fortifying with TP and PB up to 9% yielded baking results comparable to 100% wheat bread. TP and PB supplementation led to changes in nutrient content, particularly dietary fiber, without significantly altering the bread's caloric value. Sensory evaluation indicated a decrease in aroma and taste when PB exceeded 9%, and a similar effect on taste when TP exceeded 9%. In conclusion, incorporating TP and PB up to 9% can enhance the nutritional profile while maintaining bread quality.

Effect of the addition of sea buckthorn (*Hippophae rhamnoides*) leaves on the physicochemical properties and quality of pasta

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Pasta is one of the most popular cereal product and can be an ideal food matrix for introducing substances with high health-promoting potential. A valuable source of dietary fiber, minerals, protein, fat and antioxidants are sea buckthorn (*Hippophae rhamnoides*) leaves.

The purpose of this study was to evaluate the effect of the addition of dried and powdered sea buckthorn leaves on the dough consistency and physicochemical properties of pasta. As part of the study, samples were prepared in which durum semolina was replaced by the addition of sea buckthorn leaves at 0 (control sample), 4, 8, 12 and 16%. Farinographic parameters of the mixtures of semolina with sea buckthorn leaves were studied, including determination of water absorption, dough development time, dough stability, softening degree. Under semi-technical laboratory conditions, pasta was produced from the prepared mixtures and evaluated for physicochemical properties.

The study showed that the addition of sea buckthorn leaves to semolina had a positive effect on dough consistency. The sample enriched with 8% addition of sea buckthorn leaves was characterized by more than twice as long dough development time (25.12 vs. 10.4), more than twice as long dough stability time (28.57 vs. 12.49) and significantly ($p<0.05$) lower degree of softening in comparison with the control sample. Pasta enriched with sea buckthorn leaves were at the same time characterized by a higher content of dietary fiber, fat, ash and a slightly higher ($p<0.05$) protein content. At the same time, it was observed that the addition of sea buckthorn leaves determined lower weight gain and higher dry matter loss during pasta cooking.

In summary, substitution of semolina with sea buckthorn leaves at a level of up to 8% makes it possible to increase the nutritional value of pasta while maintaining its acceptable cooking quality.

How can the application of green manure in maize cultivation influence the abundance of functional genes involved in the N and C cycle?

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In the last decade the European Community has been trying to guide and encourage the use of natural agricultural treatments to reduce the production of greenhouse gases by agriculture. In recent years there has been talk of the use of organic amendments, especially green manure. Green manure is an agricultural practice in which crops are buried. The positive aspects of this practice are the increase of nitrogen and phosphorus, organic matter, and slowdown of soil erosion leading to soil conservation (Astier M. et al 2006). Carbon and nitrogen input from crops used in green manure can influence soil microbiological activity, nutrient availability and SOM turnover (Li T. et al 2019). To observe whether the application of the green manure can influence the availability and important biogeochemical cycles (i.e. C and N), we quantified the presence in soil samples of several functional genes belonging to the C and N cycle. The purpose of this work is to be able to understand whether the supply of nutrients by the plants used in the green manure practice can positively influence the microbial activity and lead to an enrichment of nitrogen and carbon, increasing fertility of the soil.

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Microgreens-microbiomes interactions – beneficial bacterial strains isolation and identification using molecular markers with Sanger sequencing method

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Distributed agriculture, including urban farming representing agricultural activities within an urban setting, may increase the accessibility to safer and more nutritious foods, as well as may contribute to build community resilience, which is the adaptability, as an alternative solution to urban food insecurity since food is one of the basic human needs. Therefore, in order to strengthen food security in Europe and over the world it is necessary to looking for alternative solutions, including the ground-breaking nature based on innovative research.

In order to understand microgreens-microbiomes interactions important for shelf-life and quality and to achieve sustainable microgreens farming, it is necessary to treat microgreens as metaorganism: holobionts with its associated microbiome. The first and crucial steps towards enhanced sustainability lie in the recognition if microgreens interact with, and foster, a healthy microbiome, as well as with microbial inoculants. As beneficial bacteria can be used as inoculum in healthy plant production, the task concerning charactarization of microorganisms started from the isolation and identification of beneficial microbes. We used pickled cucumbers and powder milk as a source of beneficial bacterial strains and we identified them with the molecular markers using Sanger sequencing. We isolated in total 19 bacterial strains, which were cultivated on the agar medium and then DNA from pure strains were isolated and two type of molecular markers were used for identification. The bacterial strains were belonged to *Bacillus* genus and some of them were identified as *B. subtilis*. Selected strains will be characterised with metabolic and molecular tools and will be used as inoculum for microgreens cultivation.

The overall approach of the project is based on transdisciplinary, integrative and innovative research methodology. In order to achieve the aim of the project including increasing microgreens quality by new approaches and assays, that requires basic research concerning explanations of microbiome-microgreens interactions.

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Application of non-destructive sorting techniques for pepper (Capsicum annuum L.) using VOCs parameter

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Peppers come in many varieties and depending on their capsaicin content, peppers are classified as hot or sweet in terms of cooking and food properties. The quality of fresh pepper primarily depends on consumer acceptance, which is determined by spiciness, aroma and color. To classify sweet peppers from hot, sorting must be unique and accurate. To minimize errors during sorting, an electronic nose equipped with 9 metal oxide sensors was used. In this study, Padron pepper was evaluated. To perform the tests, they were first evaluated by the electronic nose because it is a non-destructive method and does not harm the samples, then the samples were prepared to obtain the amount of capsaicin. The output data from the e - nose was analyzed by SVM and ANN methods. Then the samples were evaluated for the determination of capsaicin by HPLC-ES/MS method. According to the obtained results, the amount of capsaicin in sweet peppers was less than 2.5 µg/g FW1 and in hot peppers it was around 10 µg/g FW1. Also, in classification ANN and SVM methods, the accuracy of both classification methods was determined to be 100%. According to the obtained results, the use of e-nose in combination with machine learning modeling can be a cost-effective and fast approach for sorting peppers. This method can be considered and investigated as a reliable way to separate sweet peppers from hot ones with the help of the odor parameter.

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How to identify roast defects in coffee beans based on the volatile compound profile?

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The aim of the study was to detect and identify volatile compounds in coffee obtained in defect roast processes versus standard roasting and to determine the type and strength of correlations between roast defects and the volatile compound profile in roasted coffee beans. To achieve this goal, the process of coffee bean roasting was set to produce an underdeveloped coffee defect, an overdeveloped coffee defect, and defectless coffee. The "Typica" variety of Arabica coffee beans was used in the study. The study material originated from a plantation located at an altitude of 1400-2000 m a.s.l. in Huehuetenango Department, Guatemala. The analyses were carried out with the use of gas chromatography/mass spectrometry (GC-MS) and an electronic nose. The study revealed a correlation between the identified groups of volatile compounds and the coffee roasting parameters: time to the first crack, drying time, and the mean temperatures of coffee beans and heating air. The electronic nose helped to identify roast defects.

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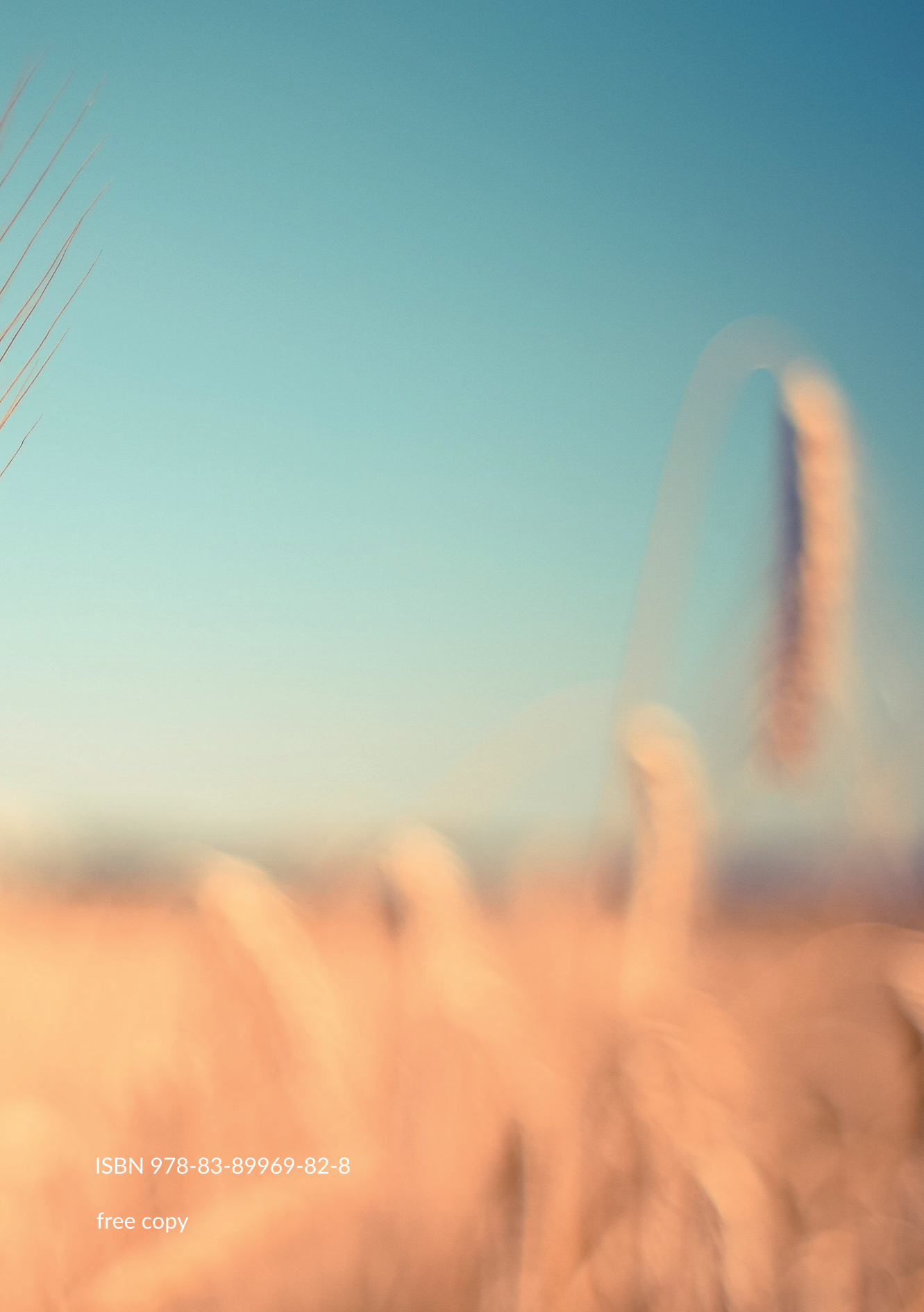

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