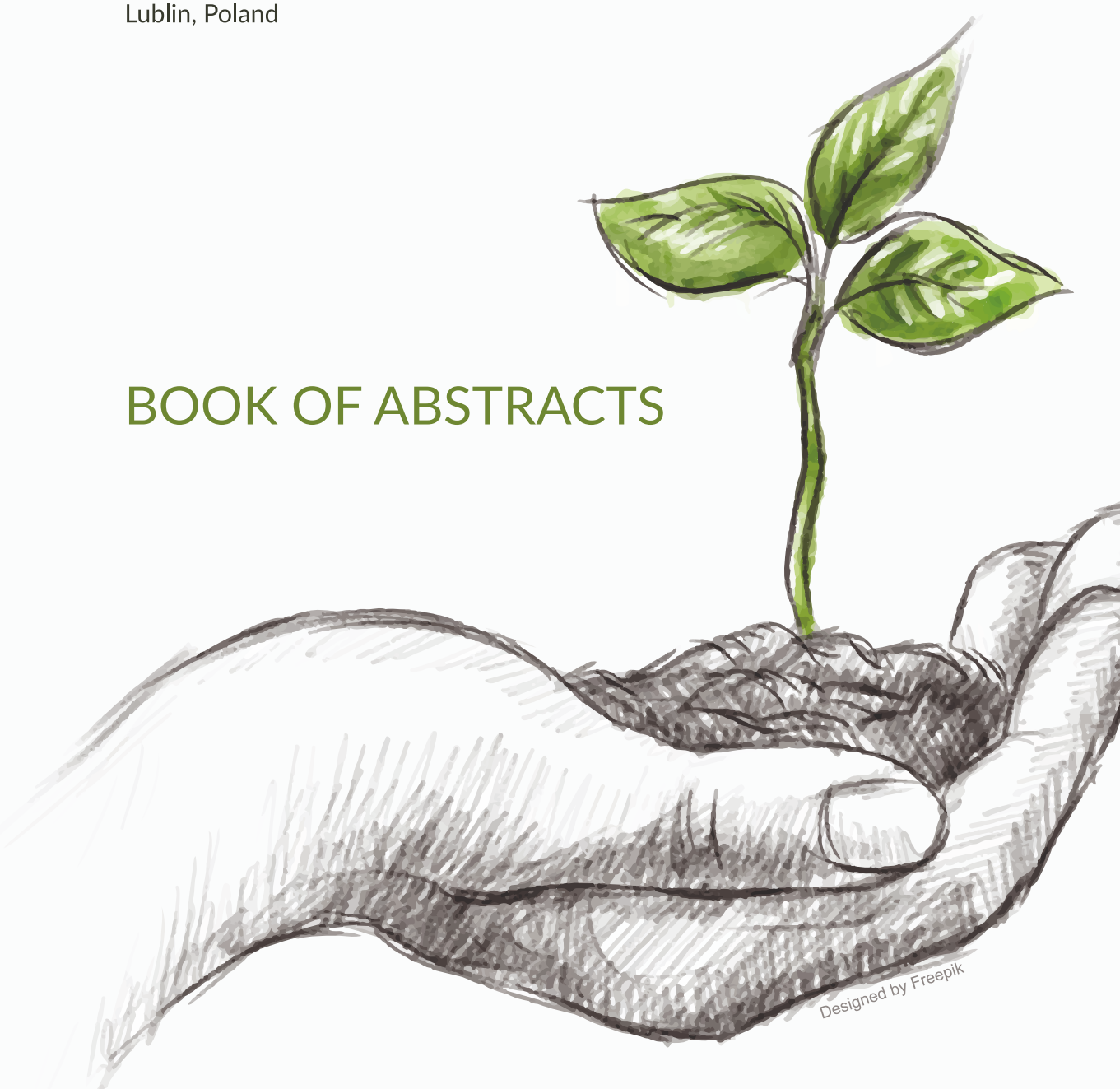
ICA 2018

12th International Conference on Agrophysics:
Soil, Plant & Climate

17th-19th September, 2018
Lublin, Poland



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CONFERENCE PROGRAMME

12th International Conference on Agrophysics: Soil, Plant & Climate

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ORAL PRESENTATIONS

Forest harvesting and climate and a public discourse

Vesala, T.[1], Bäck, J.[2]

[1] University of Helsinki, Institute for Atmospheric and Earth System Research/Physics, Faculty of Science, POBox 68, FI-00014, Finland, timo.vesala@helsinki.fi
[2] University of Helsinki, Institute for Atmospheric and Earth System Research/Forest Sciences, Faculty of Agriculture and Forestry, Finland, jaana.back@helsinki.fi

There exists a conflict between the latest knowledge and current policy on the use of forests as biomass in large scale energy production, and the tension between their role as both a carbon sink and a source of bioenergy. The conflict arises from the planned massive intensification of forest use as bioenergy, leading to increased harvests in the expense of carbon storage and sinks, and possibly even harvesting previously economically non-profitable stands with the help of government subsidies. This view has been based on the proposed carbon neutrality of forest biomass, however it is not accounting for e.g. the poor energy content of forest biomass in comparison to other energy sources, nor the climate relevant emissions from forest harvesting which last for decades after clear-cut. Therefore, the climate neutrality of forest-based bioenergy can be questioned. Other sources of renewable energy (solar, wind) have much shorter carbon payback times and appear to offer a more effective use of public funds than biomass.

In this presentation we also analyse the public dialogue on this issue. We have participated in several acts of writings, public discourses and seminars concerning the effects of forest utilization on climate and biodiversity (e.g. EASAC 2017; EURACTIV 2017). Writings include, among other things, long reports (multiple authors), newspaper columns and public letters (multiple authors). The comments and feedback we have obtained have varied greatly, depending on the perspective of the commenting persons and organisations. On the one hand, we have been acknowledged for participating in the important socio-economic debate, for bringing the scientific arguments to the discussion. On the other hand, our statements are blamed to be post-truth politics and representing green left values without scientific facts.

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EASAC (2017) Multi-functionality and sustainability in the European Union's forests. EASAC policy report 32, April 2017. ISBN: 978-3-8047-3728-0

EURACTIV (2017) Science-based forest policies urgently needed for effective climate action. www.euractiv.com/section/climate-environment/opinion/science-based-forest-policies-urgently-needed-for-effective-climate-action/

Rhizosphere links the above- and belowground processes

Kuzyakov, Y.

Agro-Technological Institute, RUDN University, 117198 Moscow, Russia

Soil volume affected by roots – the rhizosphere – is the most important microbial hotspot determining the processes, dynamics and cycling of carbon (C), nutrients, ballast elements, and fluxes of gases and water in terrestrial ecosystems. There is a very close connection between the photosynthesis of plants and various processes in soil and the localization of this connection is mainly in the rhizosphere. The time lag between the photoassimilation of CO_2 from the atmosphere and the release of this assimilated C by roots in the rhizosphere takes about 10-15 hours for grasses and few days for trees. This root-derived C creates the specific environment in the soil – with high C availability, low nutrient contents, very high activity of enzymes mobilizing nutrients from organic matter. Microorganisms in the rhizosphere have faster growth rates, higher mineralization potential, higher respiration, and various other activities. Consequently, rhizosphere is one of the most important hotspots of microbial activity in soil.

For better understanding of the rhizosphere, the results of various visualization approaches will be presented, including localization of C, pH changes, enzyme and microbial activities, water uptake etc. The size of the rhizosphere for various properties will be presented base on literature and own studies. Concluding, the broad range of root-microbial interactions in the rhizosphere is driven by the intensity of photoassimilation of plants and so, links the aboveground and belowground processes.

Fungal polysaccharides as a new sorbent

Nowak K.[1], Bieganowski A.[1], Wiater A.[2], Waśko A.[3]

[1] Zakład Biogeochemii Środowiska Przyrodniczego, Instytut Agrofizyki Polskiej Akademii Nauk, ul Doświadczalna 4, 20-090 Lublin, k.nowak@ipan.lublin.pl

[2] Zakład Mikrobiologii Przemysłowej Uniwersytet Marii Curie-Skłodowskiej w Lublinie , ul. Akademicka 19, 20-033 Lublin

[3] Wydział Nauk o Żywności i Biotechnologii, Katedra Biotechnologii, Mikrobiologii i Żywienia Człowieka, Uniwersytet Przyrodniczy w Lublinie, ul. Skromna 8, 20-704 Lublin, awasko1@tlen.pl

Fungi, including edible mushrooms, have the ability to accumulate various metallic elements, including heavy metals [1,2]. Their content depends on the degree of environmental pollution as well as on the mushroom species [3,4].

As a result of consumption of fungi there is a risk to human health, due to their toxicity and accumulation in the body. However, it is possible to use the potential of fungal materials as a sorbent of heavy metals to remove these pollutants from the environment.

The aim of the study was to determine the sorption capacity of fungal polysaccharides isolated from various species of fungi for heavy metals: nickel, cadmium, zinc and lead. In order to confirm the binding capacity of metals and an attempt to explain the mechanism of this process, additional analyzes (e.g. FTIR, NMR) were performed. The ability to remove heavy metals by *Boletus edulis* were 4.22, 7.99, 4.21, 8.52 mg/g for Ni^{2+}, Cd^{2+}, Zn^{2+} and Pb^{2+}, respectively. A feature of the tested mannoglucans are the low degree of crystallinity which can determinate good sorption capacity.

The fungal polysaccharides are probably components that are largely responsible for the binding of heavy metals. Satisfactory research results may be used for the commercialization of these fungal polymers in the form of a sorbent for the purification of waste waters contaminated with heavy metals.

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Organic farming affects soil physical properties – study results conducted in Poland and Japan

Fueki, N.[1], Lipiec, J.[2], Kuś, J.[3], Kotowska, U.[2], Nosalewicz, A.[2], Tanifuji, K.[4]

[1] Tokachi Agricultural Experiment Station, Hokkaido Research Organization, Shinsei, Memuro, Hokkaido 082–0081, Japan, fueki-nobuhiko@hro.or.jp

[2] Institute of Agrophysics, Polish Academy of Sciences, ul. Doświadczalna 4, 20–290 Lublin, Poland

[3] Institute of Soil Science and Plant Cultivation, ul. Czartoryskich 8, 24–100 Puławy, Poland

[4] Central Agricultural Experiment Station, Hokkaido Research Organization, Higashi 6 Kita 15, Naganuma, Hokkaido 069-1395, Japan

The objective of this study is to clarify the effects of organic farming on soil physical properties. For this study, we established experimental fields which consisted of both organic farming and conventional farming, in Poland (Puławy) and Japan (Tokachi region, Hokkaido). These results were as follows.

In terms of the experiments in Poland, the differences in infiltration and macropore between organically and conventionally managed soils (abbreviation: OR and CO, respectively) were measured. Soil columns at depths of 0–20cm (diameter: 21.5 cm) were also collected from the field to determine infiltration and macropore. The infiltration rate was 6–10 times higher in OR than in CO, owing to larger macropores in OR. The larger macropores in OR could be due to two factors as follows: Compost and clover–grass were applied only for organically managed field. Larger population of earthworms in organically managed field, which prefer applied organic matter (Pfiffner & Luka 2007) and dislike agrochemicals (Siegrist *et al.* 1998).

In terms of the experiments in Japan, the differences in bulk density, air-filled porosity, volumetric water content, solid rate, available water content and saturated hydraulic conductivity of soil were investigated. Higher air-filled porosity, lower volumetric water content and available water content were observed significantly in organically managed soil after several years since organic management started, than in conventionally managed soil. In organically managed soil, pronounced increase of weed roots were observed and this fact might be a cause of higher values of soil physical properties.

As the above description, similar change of soil physical condition under the effect of organic management could be observed in both of Poland and Japan, despite several environmental aspects are different among the two countries.

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Dynamics of minerals and nutrient imbalances in olive leaves under tillage and annual legume cover crops

Correia, C.[1], Martins, S.[1], Silva, E.[1], Brito, C.[1], Pinto, L.[1], Moutinho-Pereira, J.[1], Gonçalves, A.[1], Arrobas, M.[2], Rodrigues, M. A.[2]

[1] Centre for the Research and Technology of Agro-Environmental and Biological Sciences, University of Trás-os-Montes e Alto Douro, 5000-801 Vila Real, Portugal; ccorreia@utad.pt

[2] Mountain Research Centre – Polytechnic Institute of Bragança, Campus de Santa Apolónia, 5300-253 Bragança, Portugal

The concentration of minerals in leaves depends on phenology, crop yield, soil characteristics, environmental conditions and agronomic practices. This study was undertaken to compare the dynamics of minerals of olive rainfed trees under tillage (two per year) with trees in consociation with a mixture of 11 early season self-reseeding legumes. The results of leaf minerals concentrations, on both treatments, showed similar variation between sampling dates, with higher levels of N, P, K, B and Zn found in summer, at endocarp sclerification, and of Ca, Mg, Fe and Mn at winter resting period, resulting in statistically significant changes on nutrient ratios, with higher Ca, Mg, Fe and Mn-to-N and Ca:Mg and Fe:Mn ratios and lower K, P, B, Cu and Zn-to-N and K:Ca, K:Mg, Cu:Zn, Zn:Fe and Zn:Mn ratios during winter. Trees of plots managed with the cover crop had higher concentrations of N, Mg and Mn, in close association with leaf water status, photosynthetic activity and crop yield. Moreover, legumes plots presented significant higher Mg and Mn-to-N ratios and lower P, Fe and B-to-N ratios, as well lower K:Mg, Ca:Mg, Fe:Mn and Zn:Mn ratios on both dates, and lower K and Cu-to-N ratios during summer. Although only Cu values were higher than typical sufficient levels, important relative nutrient changes were found. Phosphorus and Mg-to-N ratios were above the optimal ratios for olive leaves, on both seasons, the Fe: N ratio was over during winter, the Mn:N ratio was higher under cover crop, the K:N ratio was lower at winter and Ca:N was below the reference levels during summer. These results highlighted that nutrient ratios can be more indicative than nutrient concentrations regarded as optimal for olive. It is important to standardise the procedures for leaf sampling and to define target values for nutrient ratios in different conditions, in order to detect and, if necessary, to correct nutrient imbalances.

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Soils response to the land use and soil climatic gradients at ecosystem scale

Alekseev, A.[1], Alekseeva, T.[1], Kalinin, P.[1], Hajnos, M.[2]

[1] Institute of Physicochemical and Biological Problems of Soil Science, Russian Academy of Sciences, Pushchino, Russia, alekseev@issp.serpukhov.psn.ru

[2] Institute of Agrophysics, Polish Academy of Science, Lublin, Poland

Soils as a part of Critical Zone are a product of multiple environmental factors that have varied over time including climate and anthropogenic impact. The quantifying and modeling the paleo and modern CZ is a central challenge for achieving a sustainable environment. Ecosystem in responses to land use change create feedbacks in soils and ecological processes. The complex investigation of three Luvic Phaezoem soils under secondary deciduous forest, grassland and cropland from Moscow region, Russia, were fulfilled with the main goal to study the state of solid phases of soils along global gradients of environmental change: land use and climate. The identification and quantification of such changes is needed as a part of understanding the relationship between climate, CO_2 emission, humidity, biological activity, soil carbon, surface redox, and plant nutrient cycling and lithology, mineralogy, biogeochemistry of bedrocks. Detailed study of mineralogy and chemistry (XRD, XRF), surface area, porosity, organic matter, carbon/microbial biomass, moisture content, monitoring of total soil respiration was performed. Land use change result in climate parameter on a smaller scale (soil climatic gradients) and formed feedback in weathering intensity and basic soil properties - organic matter, acidity, bulk density, WHC, surface properties and porosity, mineralogy and geochemical changes. In studied soils of subzone of deciduous forest, the decreasing of smectite in the upper parts of profiles and the increasing of illite and vermiculite contents takes place. Montmorillonite into vermiculite transformation, which took place only under the forest, can be attributed to rhizospheric effect, respiration; humic acids that caused the decreasing of pH, soil vermiculite may also derive from muscovite. The intensity of the given process and depth in soil profile is increasing as the following: forest soil < grassland < cropland. The redistribution of chemical elements between the different sub-fractions of silt and clay is in relationship to the land use. The maximum intensity of weathering and as results the redistribution of elements from silt fractions to the clay fraction is characteristic of cropland soil profile. The observed feedback of soils to local climatic gradients compared with results of investigation of Holocene paleosols in the frame of global climate change will be discussed.

Impact of Cu^{II} ions on herbicide mesotrione fate in contrasting soils

Alekseeva, T.[1], Besse-Hoggan, P.[2], Pinsky, D.[1]

[1] Institute of Physical Chemical and Biological Problems of Soil Science Russian Academy of Sciences, Pushchino, Moscow region, Russia, e-mail: alekseeva@issp.serpukhov.su

[2] Institut de Chimie de Clermont-Ferrand (ICCF), UMR CNRS 6296, Université Clermont Auvergne, France, e-mail : pascale.besse@uca.fr

Mesotrione, a member of the triketone family, is a recent selective herbicide used in maize culture. The aim of the present research was to estimate the effect of Cu^{II} ions on mesotrione adsorption, retention and biodegradation by *Bacillus megaterium Mes11* in soils. Four soils with contrasting properties have been chosen and their top 0-20 cm layers were investigated in detail: Chernozem, Luvisol, Red Soil and Vertisol. Mesotrione and its main metabolite AMBA adsorption experiments with soils polluted with Cu^{II} ions (2g/kg of dry soil) and Cu-free have been carried out using the batch equilibration technique with 1g /3 mL solid/liquid ratio with herbicides solution concentrations range from 10 - 1000 μM. The herbicide concentrations in equilibrium solution were quantified by HPLC. Isotherms of mesotrione and AMBA adsorption by all Cu - free soils are linear and all are well described by the Freundlich equation. Both herbicides are relatively weakly adsorbed by all soils. 53-92% of mesotrione and 56-70 % of AMBA were released after first desorption step. Red Soil demonstrates the largest adsorption capacity, Vertisol – the smallest. A statistical treatment of the data shows that adsorption parameters of mesotrione are best positively correlated with contents of free Fe-oxides. Best negative correlations were found with pH and total organic C content. Investigation of mesotrione and AMBA adsorption on Cu - polluted soils showed that the presence of Cu^{II} ions considerably modifies and increases the adsorption depending on soil, first of all with acid pH -Red Soil and Luvisol when mesotrione adsorption reaches 94 and 74 % respectively. Adsorption becomes almost irreversible (< 4 % of mesotrione desorbed). Presence of Cu^{II} ions also influences the bioavailability of mesotrione - the kinetics and the pathways of its biodegradation by *Bacillus megaterium Mes11*. The formation of Cu - mesotrione complexes most probably explains the observed phenomena (Le Person et al., 2016).

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Pore size distribution and adsorption properties of soils with different texture

Kercheva, M.[1], Sokołowska, Z.[2], Hajnos, M.[3]

[1] ISSAPPNP (Institute of Soil Science, Agrotechnology and Plant Protection "Nikola Poushkarov"), 7 Shosse Bankya str., Sofia 1080, Bulgaria, mkercheva@abv.bg

[2] Institute of Agrophysics (IA), Polish Academy of Science (PAS), Doświadczalna 4, 20-290 Lublin, Poland, sokolows@ipan.lublin.pl

[3] IA, PAS, Doświadczalna 4, 20-290 Lublin, Poland, m.hajnos@ipan.lublin.pl

The study quantifies the pore size distribution and adsorption properties of 30 soil horizons of 15 soil profiles from Bulgaria having different texture. Eleven soil textural classes of selected samples were identified according to FAO2006. The structure of soil porous space is characterized by indicators derived from the soil water retention curve, mercury intrusion porosimetry, nitrogen adsorption isotherms, and water vapor sorption. Statistical analyses were performed for grouping the soils according to the selected indicators and for testing pedotransfer functions.

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A soil quality index for the agricultural area under different level of anthropopressure

Klimkowicz-Pawlas, A., Ukalska-Jaruga, A., Smreczak, B.

Institute of Soil Science and Plant Cultivation – State Research Institute, Department of Soil Science Erosion and Land Protection, 8 Czartoryskich Str., 24-100 Puławy, Poland, e-mail: agnes@iung.pulawy.pl

Soil quality can be defined as the capacity of soil to function as a vital living system to sustain plant and animal productivity, promote environmental quality, and support human health and habitation. Different individual soil parameters or single indexes are utilized for evaluation of soil quality. Such approaches have many limitations, therefore the scientific attention is recently focused on derivation of complex indexes combining different soil properties. Several methods of soil quality evaluation have been developed, including soil card design and test kit, geostatistical methods and soil quality index methods.

The aim of the study was to determine a soil quality index (SQI) in agricultural soils as affected by different level of anthropopressure. The development of the SQI index included: selection of appropriate indicators for a minimum data set (MDS), score assignation for selected indicators and combining the indicator scores into the index.

The study was carried out in two agricultural regions located in the Silesian and Lublin Voivodeship with similar soil cover (predominance of Cambisols and Luvisols), but with different history and intensity of exposure to pollution. Soil samples collected from the surface layer (0-30 cm) were analyzed for physicochemical (e.i. texture, fractional composition of soil organic matter, pH), and biological (respiration, enzymatic activity, microbial biomass and nitrification) properties and the content of contaminants (PAHs and metals). The level of anthropopressure was assessed on the basis of pollutant emission indexes.

Statistical evaluation (PCA analysis) enabled the selection of indicators of significant importance for soil quality. The level of anthropopressure was an important factor influencing the soil quality; the higher SQI values (0.20-1.11) were determined for the area of low anthropopressure.

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About the influence of clay content to the distribution of soils into P status groups by AL, DL and MEGLICH 3 method

Toomsoo, A.[1], Jürgens, M.[1], Kõlli, R.[1], Kaart, T.[2], Kauer, K.[1], Tõnutare, T.[1]

[1] Estonian University of Life Sciences, Institute of Agricultural and Environmental Sciences, Kreutzwaldi str. 1, Tartu, 51006, Estonia, tonu.tonutare@gmail.com

[2] Estonian University of Life Sciences, Institute of Veterinary Medicine and Animal Sciences, Kreutzwaldi str. 1, Tartu, 51006, Estonia

Phosphorus is an essential element for plant growth. Therefore the content of phosphorus in soil has critical importance in modern high yield oriented agriculture. At the same time the high content of phosphorus in soil represents a risk for the environment due to leaching to groundwater, to rivers and lakes. Therefore the correct data about soil phosphorus content has very high importance for farmers as for environment health.

For determination of soil plant available phosphorus content many different methods have been developed in the world. Today in Europe more than 20 different methods are in use and each method has their own specific gradation.

The methods which were used in Estonia were Egner-Riehm or double-lactate (DL) and Egner-Riehm-Domingo or acetate-lactate (AL) method. Today the official method is Mehlich 3 (M3) method.

The determined soil phosphorus content depends besides of phosphorus also from several other factors as composition of extraction solution, soil pH, soil organic carbon content, content of carbonates and etc. The influence of these factors are already quite widely studied and reported. The sorption-desorption process of phosphates in soils is connected with soil texture. Therefore aim of our study was to investigate the role of clay content to the differences in distribution of soils to P status groups. In our work 140 soils from agricultural areas were analyzed for the content of phosphorus by AL, DL and M3 methods. Also the clay content, organic carbon content and pH was determined.

The results indicated the influence of clay content to the distribution of soils into P status classes. In group of soils with clay content below 10% the percentage of low P content soils is 1 – 4%. In the group of soils with higher clay content (10-21%) the part of low P content soils is 14%.

Laboratory measurement methods of splash erosion in micro scale

Ryżak, M.[1], Beczek M.[1], Mazur, R.[1], Sochan, A.[1], Korbiel T.,[2]
Lamorski K.[1], Bieganowski A.[1]

[1] Institute of Agrophysics PAS, Doświadczalna 4, 20-290 Lublin, Poland e-mail: m.ryzak@ipan.lublin.pl

[2] AGH University of Science and Technology, Department of Mechanics and Vibroacoustics, Krakow, Poland, e-mail: korbiel@imir.agh.edu.pl

Splash erosion can cause soil surface degradation. Preventing the negative effects of erosion requires a thorough understanding of the course of this phenomenon. The aim of the research conducted in our laboratory was to develop a new measurement methods for soil erosion and to apply the existing methods for quantitative description of splash erosion. Measurements were carried out in laboratory conditions using single drops of simulated precipitation.

The methods used in our research were based on optical microscopy, allowing the analysis of the surface, shape, and size of splashed particles (Ryżak and Bieganowski, 2012), high speed cameras allowing determination of the velocity of detached particles and their trajectory, dynamic force sensors, allowing the analysis of the impact force of a drop of water on the soil surface, microphones recording the noise generated during the water drop impact (Ryżak et al, 2016), and computed microtomography - to determine the crater depth and diameter after water drop impact (Beczek et al., 2018).

The above-mentioned methods allow the analysis of the splash phenomenon in its initial phase and make the measurement independent of the weight of collected soil (Ryżak and Bieganowski, 2012).

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Opportunities and current limits of omic approaches in soil microbial ecology

Renella, G.

University of Florence, Department of Agrifood Production and Environmental Sciences, Piazzale delle Cascine 18, 50142 – Florence, Italy, e-mail: giancarlo.renella@unifi.it

Molecular biology is long established discipline with ever developing methodologies targeting entire genomes, specific genes, gene transcription, proteins and metabolites. The application of omic techniques to the study of soil microbial communities and to the activity of soils microorganisms is the most challenging molecular biology field, owing to the high diversity of the microbial assemblages and the scarce annotation of environmental microbial species, and to the complexity of the physical environment and reactivity of the soil solid phases. Nevertheless, significant progresses have been made in the recent years to in analysis of soil genomes whereas the omic approaches aiming at analyzing other biological molecules such as messenger RNA (transcriptomics), proteins (proteomics), metabolites (metabolomics) still require the improvement of analytical techniques and new and imaginative approaches.

In this presentation, I present the current advances in both analytical techniques and the experimental approaches followed to characterize the diversity and the metabolic activity of the soil microbial communities. The results of genomic, transcriptomic, proteomic and volatilomic studies to characterize the microbial communities and a activities of bulk soil and rhizosphere are presented. In particular, possible causes of unsuccessful studies are critically discussed. Possible approaches for future research and the need of scientific based, rather than technology driven research are also illustrated and discussed.

Active role of AgroNanoGel on microbial biodiversity in the sandy soil at different water potential

Kuźniar, A.[1], Wolińska, A.[1], Widomski, M.K.[2], Stępniewska, Z.[1], Stępniewski, W.[2]

[1] The John Paul II Catholic University of Lublin, Department of Biochemistry and Environmental Chemistry, 1I Konstantynow str. 20-708 Lublin, Poland, agnieszka.kuzniar@kul.pl

[2] Lublin University of Technology, Faculty of Environmental Engineering, 40B Nadbystrzycka str. 20-618 Lublin, Poland

Active soil microorganisms require water availability to maintain their life functions (Tecon & Or, 2017). The effect of the soil water potential is on the architecture of the aqueous phase jointly shaped by the size and geometry of soil pore spaces, surface properties and by the prevailing soil water potential (Tecon & Or, 2017).

The aim of this study was to determine the microbial biodiversity changes related to different soil water potential in sandy soil enriched with AgroNanoGel (ARTAGRO), the preparation dedicated as a protector against water loss.

The two sieved fractions of sand (0.25-0.5 mm and 0.5-1.0 mm) were mixed in the two mass fractions (0.5% and 1%) of gel. The water retention characteristics of the prepared specimens were tested in the range from pF 0 to pF 4,2 (20°C, 70 days). Gravimetric water content was determined by the standard weight method after drying the sample in 105°C (ASTM C566-13). DNA contents were isolated with use of DNeasy PowerLyzer PowerSoil Kit (QIAGEN). Next the Generation Sequencing was performed by Genomed S.A. (Warsaw) in the MiSeq 2000 platform (Illumina Inc., San Diego, CA, USA)

The changes of the autochthonous microorganisms abundance resulted from the soil water potential values and AgroNanoGel addition were observed. *Proteobacteria* and *Firmicutes* seemed to be the most sensitive on water content loss as their abundance reached maximum level (60.11% and 20.76%, respectively) in pF 0 and decreased with higher pF values. Opposingly, the number of genus *Actinobacteria*, *Bacteroidetes* and *Verrucomocrobia* increased in the range of pF 2 – pF 4,2. It is possible to conclude that the addition of AgroNanoGel has a beneficial effect on selected microbial taxa and let them to survive under the water deficit conditions (for 70 days).

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Indication of root stress using phase shift measurement

Rajkai, K.[1], Vozáry, E.[2], and Cseresnyés, I.[1]

[1] Institute for Soil Sciences and Agricultural Chemistry, Centre for Agricultural Research, Hungarian Academy of Sciences, H-1022 Budapest, Herman Ottó út 15, Hungary

[2] Department of Physics and Control, Szent István University, H-1118 Budapest, Somlói út 14–16, Hungary

Single-frequency (1 kHz) measurement of impedance phase angle (F) in root–soil systems was used for monitoring plant responses to different environmental stresses. Potted wheat, soybean and maize plants were exposed to cadmium contamination, alkaline stress, drought, and weed competition. F was detected at regular time intervals between a ground/soil and a plant electrode during plant development. At the end of plants growth, root and shoot biomass were measured. Each type of stress significantly reduced both F, and the root and shoot dry mass, proportionally to the stress level. The decrease in F was attributed to various physicochemical changes in root cell membranes, the accelerated maturation of the exo- and endodermis, and altered root morphology.

These stress responses modified the dielectric properties of the root tissues, influencing the apoplast and symplast pathways of the electrical current inside the roots. 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 F. These results show that in pot experiments the measurement of the impedance phase angle in intact root systems is a potentially useful in situ method for detecting plant responses to environmental stresses affecting roots.

Crop response to combined action of drought and other abiotic stresses

Nosalewicz, A.[1], Siecińska, J.[1], Kondracka, K.[1], Vitkova J.[2], Šurda, P.[2]

[1] Institute of Agrophysics Polish Academy of Sciences, 20-290 Lublin, Poland, a.nosalewicz@ipan.lublin.pl

[2] Institute of Hydrology of the Slovak Academy of Sciences, Dúbravská cesta 9, 841 04 Bratislava, Slovak Republic

Soil drought is the major factor limiting crop yields worldwide. Water deficit alters plant growth and functioning at multiple levels including gene expression, biochemical metabolism and morphology. Unfavorable weather events used to occur multiple times during growing season increasing probability of crop exposure to simultaneous action of more than one abiotic stress. Heat and drought are the stresses that in field conditions often affects crops simultaneously. Co-occurrence of abiotic stresses is also highly probable for crops growing on acid soils that are the source of at least one persistent abiotic stress – aluminium toxicity. Strategies of plants response to combined stress may be different from that of two individual stresses. The aim of the study was to evaluate how drought perceived by plants can be altered by one additional co-stressor: high temperature (HT), aluminium toxicity (AL) or earlier exposure to drought. The analysis are based on results obtained during the experiments with controlled conditions during plant growth. Induced abiotic stresses were controlled in term of duration and intensity. To control water availability for plants the system for precise measurements and maintaining soil moisture was used. High temperature and drought stresses applied at flag leaf stage induced similar reduction of wheat photosynthesis, at the same time heat stress alone caused significant increase of transpiration. The reduction of photosynthesis rate due to combined action of heat and drought was stronger than a sum of the reduction of photosynthesis due to single stresses. This effect was caused by the increased evaporation that lowered soil water potential and increased temperature of leaves resulting from lower transpiration. The response of wheat to aluminium toxicity was strongly affected by specific resistance to Al. Aluminium reduced root length of sensitive wheat line (ES8) in comparison to tolerant (ET8) increasing sensitivity of the former to drought. At moderate drought significant differentiation of photosynthesis in response to growth conditions was observed only in sensitive line ES8. The overall impact of crops to drought as affected by combination of many abiotic stressors is difficult to predict as it depends on timing, duration, intensity and specie or cultivar resistance to the acting stresses. Still evaluation of the impact of these kind of interactions is of high importance due to its increasing impact on agricultural productivity. Comparison of the impact of single abiotic stresses and combined action of many adverse environmental factors may help in establishing complex interactions of the signalling pathways involved in plant response

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Petriella setifera – Intraspecific functional and genetic diversity

Pertile, G., Panek, J., Oszust, K., Siczek, A., Frąc, M.

Institute of Agrophysics, Polish Academy of Sciences, Lublin, Poland

Petriella setifera was isolated from industrial compost. In literature there are fragmentary information about this filamentous fungus. The aim of the study was the intraspecific genetic and functional diversity evaluation to understand the different functions and services of new isolated microorganisms inside the ecosystem. To know the intraspecific functional and genetic diversity, we used the BIOLOG and the AFLP fingerprinting analyses, respectively. The results showed significant diversity variability among the Petriella strains. As for the functional diversity, the BIOLOG analysis acknowledges that the analysed strains showed different patterns of the analysed carbon substrates divided them into two clusters with 51% and 62% similarity. On the other hand, the genetic diversity (analysed through the AFLP analysis) showed a clear separation of the strains into three clusters with 0%, 42%, and 54% similarity. The analysis revealed that *P. setifera* degraded substances involved in the degradation of hemicellulose, cellulose, and synthesis of lignin. These findings confirm the relevant role of the fungus in the ecosystem and its role in contribution to the carbon cycle. Furthermore, the study showed the utility to use these two methodologies (such as BIOLOG and AFLP analyses) to identify of intraspecific diversity of poorly investigated fungal species which is important for understanding their ecosystem functions.

Relevance of pectin nanostructure on strawberry fruit mechanical features - a case study under the AFM stylus

Posé, S.

Plant Biology Department, Plant Physiology Area, Faculty of Biological Sciences, University of Malaga, Spain

Atomic force microscopy (AFM) has been used to characterize the nanostructure of cell wall polysaccharides of strawberry fruits during the ripening and in functional lines with pectinases downregulated. This technique allows the imaging of individual polymers at high magnification with minimal sample preparation.

AFM studies show that pectin size, ramification and complexity is reduced during fruit ripening and in transgenic lines, and in most cases these changes correlate with softening in strawberry fruits. Globally, AFM could be a powerful tool to gain insights about the bases of textural fruit quality not only in strawberry, but also in other commercial crops where AFM is adding more evidences supporting the key role of pectins in fruit structure.

Water dynamics and cell wall polysaccharides assessment of apple viscoelastic mechanical properties

Lahaye, M.[1], Bouin, C.[1], Barbacci, A.[2], Le Gall, S.[1], Foucat, L.[1]

[1] INRA, BIA, rue de la Géraudière F-44316 Nantes Cedex, France, marc.lahaye@inra.fr

[2] INRA, LIPM, Chemin de Borde Rouge, F-31326 Castanet-Tolosan Cedex, France

Fleshy fruit texture is a challenging quality attribute to control for producer, consumer and food processor. It involves a combination of complex structural determinants at different scales leading to different descriptors in which viscoelastic mechanical properties play important roles. In an attempt to identify key components of fleshy fruit viscoelasticity, tissue structure and water status assessed by MRI together with cell wall chemistry were correlated with viscoelastic characteristics in contrasted apple varieties (Winisdorffer et al. 2015). To further this study, tissue structure, water status and cell wall chemistry were assessed in four apple varieties showing close but distinct viscoelastic properties. Water mobility and viscoelastic properties were assessed in fresh and plasmolyzed tissue to distinguish turgor from other tissue structural contributions. Water multi-exponential transverse relaxation (T_2) acquired by low-field NMR relaxometry was analysed by discrete (nonlinear least-squares fitting) and continuous (inverse Laplace transformation) methods to evaluate data processing on the resolution of short transverse relaxation time components. The results show that both methods of relaxation data processing discriminated similarly genotypes before and after plasmolysis. Although the sensitivity of T_2 relaxometry allowed distinguishing microstructures among genotypes even after cellular fluids were mixed and diffused in plasmolyzed tissues, no relaxation component correlated with apple viscoelasticiy. Among cell wall chemical features, only galactose and arabinose contents correlated with storage modulus (E') prior and after plasmolysis though the correlation signs were opposite. These results will be discussed with regard to the limits of NMR relaxometry in distinguishing water environments representative of cell compartments and to the potential key role of pectin RGI side chains in regulating apple texture.

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Field adjusted irrigation requirements of Highbush Blueberry (*Vaccinium corymbosum L.*) considering fruit developmental stage

Brandes, N.[1,2], Tsoulias, N.[1,3], Zude-Sasse, M.[1*]

[1] Leibniz Institute for Agricultural Engineering and Bioeconomy (ATB), Department for Horticultural Engineering, Max-Eyth-Allee 100, 14469 Potsdam, Germany

[2] Humboldt-Universität zu Berlin, Faculty of Life Sciences, Department of Crop and Animal Sciences, Lentzeallee 55/57, 14195 Berlin, Germany

[3] Agricultural University of Athens, Department of Natural Resource Management and Agricultural Engineering, Athens, Greece

The daily water balancing is crucial in water demanding crops such as blueberry even in the semi-humid climate of Brandenburg, Germany. The FAO standard equations need to be adjusted considering the soil properties and actual phenological stages of the plant. In the present study, the Geisenheim irrigation model was applied considering (i) soil texture, (ii) fruit developmental stage characterised by means of the fruit growth rate, and (iii) selective harvesting. The soil had a high percentage of organic substance leading to reduced evaporation and the need for adjusting the FAO equations considering the evaporation reduction coefficient (Kr). The fruit growth analysis was suitable for characterising the beginning of enhanced cell expansion and the adjusted timing of the crop coefficient (Kc). Furthermore, the Kc used at harvest requires consideration of the selective harvesting in blueberry and should be set at the end of harvest instead of beginning of harvest. The adjusted Kr and timing of Kc result in enhanced water use efficiency.

Distribution of arabinogalactan proteins (AGPs) in fruit cell wall

Leszczuk, A., Zdunek, A.

Institute of Agrophysics, Doświadczalna 4, 20-290 Lublin, a.leszczuk@ipan.lublin.pl; a.zdunek@ipan.lublin.pl

Arabinogalactan proteins (AGPs), subfamily of the HRGPs, are extracellular proteoglycans which are involved in plant growth and development (Showalter, 2001). Among other cell wall proteins, AGPs are characterized by a high proportion of sugar moiety, up to 90% of the total mass, heterogeneity of their protein backbone and carbohydrate chains, and presence of the C-terminal sequence GPI that anchors molecule to the outer leaflet of the plasma membrane (Tan et al., 2013).

The goal of this research was to create a pattern of the localization of AGPs in the cell wall of apple (*Malus x domestica*) fruit in different stages of physiological maturity and during postharvest storage. The arrangement of the AGP epitopes was analyzed using immunohistochemistry techniques with JIM13, JIM15, and MAC207 monoclonal antibodies (CCRC, University of Georgia, USA). The observations were carried out under a confocal laser scanning microscope (CLSM, Olympus BX51, Olympus Corporation, Japan). To confirm the immunofluorescence studies, experiments at the subcellular level were performed with the immunogold method using transmission electron microscopy (TEM, Zeiss EM900, Germany).

The AGP epitopes - βGlcA(1→3)-αGalA(1→2)Rha recognized by JIM13, JIM15, and MAC207 mAbs were found in the inner cell wall layer, in association with the plasma membrane. The specific distribution was disturbed in the fruit after postharvest storage. AGP epitopes were dispersed over the whole area of the cell wall, in the disintegrated plasma membrane, and in the cytoplasm compartments. The detailed images analysis showed that the occurrence of AGPs is correlated with the fruit microstructure changes during senescence process.

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NMR and texture measurements to characterize the evolution of apple microstructure during thermal treatment

Leca, A.[1], Clerjon, S.[2], Traore, A.[2], Bonny, J.M.[2], Renard, C.M.G.C.[1]

[1] UMR408 SQPOV, INRA PACA, 84000 Avignon, France, alexandre.leca@inra.fr

[2] AgroResonance, UR0370, INRA Clermont-Theix, 63122 Saint Genès Champanelle, France, sylvie.clerjon@inra.fr

Among the sensory aspects of fruit-based products, which are critical to consumer acceptance, texture is highly variable and depends mainly on the microstructure of the flesh. In apple, one of the most consumed and processed fruit, the evolution of microstructure during thermal treatment is not clearly explained, and non-destructive methods to follow it are scarce. However, high-resolution Nuclear Magnetic Resonance (NMR), by detecting water molecules mobility inside the tissue at sub-millimeter scale, enables a non-invasive detection of the vacuole state (Van As and van Duynhoven, 2013; Winisdorffer et al., 2015). The change in apple parenchyma texture due to thermal treatment was therefore studied by texture analysis (puncture test) and NMR (Multi-Slice Multi-Echo MRI and multi-exponential CPMG spectroscopy), as chosen from previous studies (Spyros 2016). Slices of apple fruit (*Malus domestica Borkh* cv. Golden Delicious) underwent different thermal treatments (raw, 45, 50, 53, 60°C) for 8 to 18 min depending on the target temperature. Control slices were cooked at 70°C, temperature at which the apple is fully cooked. The MRI T2 mapping showed 2 distinct groups: the "raw" group up to 50°C and the "cooked" group for temperatures higher than 53°C. This threshold temperature was confirmed by CPMG spectroscopy, detecting a sharp change in the T2 main fraction under and above 50°C. The firmness (load), estimated from the puncture tests, showed a clear separation between apples treated under 50°C and at 60°C, with an intermediary state for 53°C. This multiphysics and multiscale study thus provided valuable results improving knowledge on the effect of cooking on loss of texture of apple flesh.

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Fruit cuticle a lipo-polysaccharides assembly of polymers with unique properties

Philippe, G.[1], Girard, A.L.[1], Gaillard, C.[1], Petit, J.[2], Geneix, N.[1], Dalgalarrondo, M.[1], Lahaye, M.[1], Bres, C.[2], Mauxion, J.P.[2], Schreiber, L.[3], Sandt, C.[4] ,Rothan, C.[2], Marion, D.[1], Bakan, B.[1]

[1] Unité Biopolymères, Interactions, Assemblages, INRA, BP71627 44316 Nantes cedex 3-France

[2] Unité Biologie du fruit, UMR INRA-UVSB2-UB1, B.P. 81, 33883 Villenave d'Ornon Cedex-France

[3] Institute of Cellular and Molecular Botany, University of Bonn, Kirschallee 1, D-53115 Bonn, Germany

[4] SOLEIL Synchrotron, L'Orme des Merisiers - Saint Aubin - BP 48 91192 GIF-SUR-YVETTE CEDEX France

Cuticles are ubiquitous hydrophobic barriers covering the surface of aerial plant organs that fulfil multiple functions in plants. They control the non-stomatal water loss and permeation of gases and solutes, play also an essential role in the regulation of cell adhesion and are involved in the plant-pathogen interaction. Accordingly, there is a growing interest in the relationships between the structure and the biological functions of plant cuticles in the context of agro-food sustainability.

Plant cuticle is composed of a polymeric matrix, cutin (a polyester of glycerol, hydroxy and epoxy fatty acids) covered by waxes and closely associated to cell wall polysaccharides. The macromolecular structure of the cutin polyester was not fully resolved and the connection with the polysaccharides was almost unknown.

We have isolated a GDSL-motif lipase-acylhydrolase, CUS1, from tomato cuticle. CUS1, is specifically expressed in the exocarp. We showed that CUS1 is secreted in the extracellular apolastic cell wall compartment and that silencing of CUS1 induced fruit cuticle exhibiting drastic thickness reduction, modification in surface morphology and a decrease in resistance to desiccation. To further delineate the ester cross-linking of cutin and therefore, the activity of CUS1 *in planta*, an in situ benzyl etherification of the non-esterified hydroxyl groups of glycerol and hydroxy fatty acids was developed and applied to tomato CUS1 mutants. In mutants, midchain hydroxyl esterification of the dihydroxyhexadecanoic acid was specifically affected while both sn-1,3 and sn-2 positions of glycerol were impacted. These results confirm the role of CUS1 in the extracellular polymerisation of cutin and also showed that CUS1 transesterification involves, *in planta*, both primary and secondary hydroxyl groups of glycerol and fatty acids. Finally, microFTIRspectrometry was conducted on tomato fruit exocarp and revealed that the polysaccharides entrapped within the cutin polymer exhibit specific spectral signature.

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Molecular size of soluble pectins in apple fruits is not affected by heat processing into puree

Bürgy, A., Rolland-Sabaté, A., Leca, A., Le Bourvellec, C., Renard, C.M.G.C.

UMR408 Sécurité et Qualité des Produits d'Origine Végétale, INRA, Université Avignon, F-84000 Avignon, France, alexandra.burgy@inra.fr

Texture is an important quality attribute of processed fruits and vegetables. In purees, it is modulated by the pulp content, particle size distribution and viscosity of the continuous phase (Espinosa-Munoz et al., 2012). As changes in consistency are linked to alteration of cell wall (CW) structure, a better understanding of the cellular and molecular structure of raw and processed products is required in order to open new possibilities for innovative food products. This work aimed to better understand the effect of post-harvest storage and heat treatment on the structural and chemical composition of the CW in apple purees. After different storage times, *Malus domestica Borkh* cv Golden Smoothee apples were transformed into purees under simulation of an industrial process. The particle size distribution was analyzed and the polysaccharide composition of soluble and insoluble CW material were determined after preparation of alcohol insoluble residue. Furthermore, the molecular size distribution of soluble pectins was estimated using High Performance Size Exclusion Chromatography (HPSEC). Post-harvest storage increased cell separation, pectin solubilization and led to pectin depolymerization. In contrast, the heat treatment used in this study induced little modifications and pectic changes in purees depended on the post-harvest maturity (Colin-Henrion et al., 2009). Some pectins were solubilized during the processing into apple puree (Le Bourvellec et al., 2011) but their molecular size distribution was the same as that of water-soluble pectins in the apples. Consequently, they were not depolymerized during the heat treatment.

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The concentration affected aggregation and gelation in solution of sodium carbonate-soluble pectin extracted from pears

Koczańska, M., Cieśla, J., Gawkowska, D., Pieczywek, P., Cybulska, J., Zdunek, A.

Institute of Agrophysics, Polish Academy of Sciences, Doświadczalna 4, 20-290 Lublin, Poland, e-mail: a.zdunek@ipan.lublin.pl

Pectins are natural polysaccharides built mainly of galacturonic acid units. They are commonly used in food technology due to the gelling and stabilizing properties. However, the process of self-organization, aggregation and crosslinking of pectins molecules has been not precisely explained and described so far. The objective of this investigation was to evaluate the effect of concentration of sodium carbonate-soluble pectins which were extracted from pears on their macromolecules aggregation and gelation process in solution.

The diluted alkali soluble pectins (DASP) studied were obtained by means of sequential extraction (Cybulska et al., 2015) from pears (*Pyrus communis* L., cultivars 'Conference'). Samples were dialyzed and lyophilized. Three series of pectins solutions were prepared using the ultrapure water (MiliQ) and the salt aqueous solution (NaCl and $CaCl_2$) with the ionic strength of 30 mM. The polysaccharides concentration ranged from 0.0002 to 2%. The Fourier-transform infrared spectroscopy (FTIR), dynamic (DLS) and static light scattering (SLS), conductometry, potentiometry and rheological methods as well as atomic force microscopy (AFM) technique were used for the investigations of physical and physicochemical properties of samples.

The obtained results allowed to determine the role of ionic composition of dispersing medium and the content of pectins in the macromolecules aggregation and gelation process. Moreover, the pectins concentration at which the three-dimensional network of these polymer was formed.

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Correlation analysis of the selected relationships between physicochemical properties of apple juices

Kobus, Z.[1], Nadulski, R.[2], Rydzak, L.[2], Wilczyński, K.[2], Pecyna, A.[1], Santoro, F.[3]

[1] University of Life Sciences in Lublin, Department of Technology Fundamentals, Głęboka 28, 20-612 Lublin, zbigniew.kobus@up.lublin.pl, anna.pecyna@up.lublin.pl

[2] University of Life Sciences in Lublin, Department of Food Engineering and Machinery, Doświadczalna 44, 20-236 Lublin, rafal.nadulski@up.lublin.pl, leszek.rydzak@up.lublin.pl, kamilwilczynski100@wp.pl

[3] University of Bari Aldo Moro, Department of Agro-Environmental Science, Via Amendola, 165/A, 70126 Bari, francesco.santoro@uniba.it

The knowledge of physicochemical properties is necessary to assess the quality of fruit juices. Apples and their preserves are recognized as promoters of health because of their high content of bioactive compounds, such as polyphenols, pectins and organic acids (Włodarska et al., 2016). The research results suggest that some physicochemical properties may be strongly related to each other. For example Vieira et al., (2011) studying the antioxidant activity with the use of the DPPH reagent, noted a close correlation with the content of polyphenols for the skins and the flesh of apples.

The aim of the work was to analyse the correlation between the physicochemical properties of six different commercial apple juices produced in Poland.

The apple juices came from two different Polish companies. From each manufacturer three various juices were selected: two cloudy and clarified one produced as a mixture of different varieties. The following properties were evaluated: density, soluble solid content, viscosity, total phenolic contents and antioxidant activity.

The strong correlation between total phenolic content and antioxidant activity of apple juices was found. There was also a high interrelation between the density of juice and solid soluble content. However, no correlation was stated between the solid soluble content and the viscosity of the tested juices.

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Characterization of cellulose and nanocellulose isolated from fruit and vegetable pomaces

Szymańska-Chargot, M., Chylińska, M., Gdula, K., Pieczywek, P.M., Zdunek, A.

Institute of Agrophysics, Polish Academy of Sciences, Doswiadczalna 4, 20-290 Lublin, Poland, e-mail: m.szymanska@ipan.lublin.pl

The study presents the novel route of the fractioning process for the conversion of agro-industrial biomasses, such as pomaces, into useful feedstocks with a potential application in the fields of fuels, chemicals, and polymers. Pomaces from apple and carrot were treated sequentially with water, acidic solution, alkali solution, and oxidative reagent in order to obtain fractions reach in sugars, pectic polysaccharides, hemicellulose, cellulose, and lignin (Szymanska-Chargot et al. 2017). Pomaces were characterized by dry matter content, neutral detergent solubles, hemicellulose, cellulose, and lignin. The last fraction and residue was cellulose. Then nanocellulose in form of cellulose nanofibrils was prepared from isolated cellulose using ultrasound treatment. The cellulose and nanocellulose was characterized by crystallinity degree, microfibril diameter, and overall morphology. Isolated cellulose and nanocellulose had a very fine structure with relatively high crystalline index but small crystallites. Cellulose nanostructures have been recognized as possible biobased additive to enhanced bio-polymer performance, in terms of mechanical, thermal and barrier properties. The cellulose obtained from plant cell wall characterize with thinner microfibrils which can give better filler properties. Therefore the aim of study was to characterize cellulose and nanocellulose obtained from apple and carrot pomaces.

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Metallic ions and phenolic compounds: what distribution in apple tissue ?

Vidot, K.[1,2], Rivard, C.[3,4], Devaux, M-F.[1], Jamme, F.[3], Gaillard, C.[1], Siret, R.[2], Lahaye, M.[1]

[1] UR Biopolymères Interactions Assemblages, INRA, 44300 Nantes, France

[2] USC 1422 GRAPPE, INRA, Ecol e Supéri eure d'Agri cultures, SF R 4207 QUASAV, 55 rue Rabelais 49100 Angers, France

[3] Synchrotron SOLEIL, L'Orme des Merisiers, Sain t-Aubin, 91192 Gif-sur-Yvette Cedex, France

[4] UAR 1008 DPT CEPIA, INRA, 44300 Nantes, France

Among key quality components of fleshy fruits, metallic ions are linked to organoleptic characteristics and process ability but we known little on their precise contribution due to their low concentration and high diffusible behaviour. With regard to texture, potassium and calcium participate respectively, to tissue turgor pressure and cell wall polysaccharides cross-links, while transition metal cations (Fe, Mn, Zn or Cu) free and/or complexed in metalloproteins are involved in oxidation reactions, which disassemble the cell wall during fruit ripening. Transition metals recycled in vacuole are thought to participate in the condensed polyphenols structure and to the differentiation of phenolic compounds between fruit varieties impacting fruit taste, colour and nutritional characteristics. To better understand the relationships between the nature and distribution of metallic cations and phenolics on fleshy fruit quality, the distribution of these compounds has been investigated in apple. For that, original cryogenic methods were developed to limit ions and phenolics diffusion in apple tissue while observing them by laser scanning confocal microscopy using specific phenolics and ion fluorescent probes. Such cryoobservation methods were then adapted for synchrotron X-ray fluorescence imaging and deep-UV fluorescence imaging of two texture and phenolicscontrasted apples varieties at 3 ripening stages.

Results showed genetic and ripening dependent distribution and content of metallic ions and phenolics. Cations were mainly observed in the cell walls and cuticle. Calcium, iron and manganese presented a gradient distribution from the cuticle to the inner cortex, while potassium, aluminium, manganese and silicium were homogeneously distributed in the fruit tissue cell walls. Phenolics distribution differed mainly within the cuticle and epidermal cell layers. The distribution of these compounds will be discussed with regards to fruit ripening metabolism and possible consequences on fruit texture, colour or flavour elaboration.

The cross-linking process of sodium carbonate-soluble pectin from apples in the presence of strontium chloride

Gawkowska, D., Cieśla, J., Cybulska, J., Zdunek, A.

Institute of Agrophysics, Polish Academy of Sciences, Doświadczalna 4, 20-290 Lublin, Poland, e-mail: a.zdunek@ipan.lublin.pl

Pectins are polysaccharides which commonly occur in higher plants. Their main component is a galacturonic acid unit. The pectin structure affects their functions. Pectins, characterized by low degree of methylation, bind calcium ions according to "egg-box" model (Grant et al., 1973). These polysaccharides may also bind other divalent cations but the mechanism of this process has not been well evaluated yet.

Therefore, the aim of this research was to characterize the influence of strontium chloride on the cross-linking process of sodium carbonate-soluble pectin fraction (DASP fraction) extracted from apples. Pectin may be used to remove strontium radioisotopes from the human body. The DASP fraction was isolated as the result of sequential extraction according to the procedure by Cybulska et al. (2015) with some modifications. The studies were conducted in the wide range of strontium ions to galacturonic acid molar ratios (0-30).

The analysis of electrophoretic mobility, aggregation index and relative mean hydrodynamic diameter enabled the determination of concentration at which three-dimensional network was formed (gel point). The AFM images showed the changes of the DASP fraction structure with increasing molar ratio. The addition of strontium chloride to the DASP fraction solution caused the displacement of hydrogen ions and the formation of bonds between galacturonic acid units and strontium ions. Negative electrical charge, connected with the presence of carboxylate groups, was significantly neutralized. It can be concluded that the DASP fraction binds strontium ions.

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Multi-scale structural features of starches and starch products

Rolland-Sabaté, A.

UMR408 Sécurité et Qualité des Produits d'Origine Végétale, INRA, Université Avignon, F-84000 Avignon, France; * agnes.rolland-sabate@inra.fr

UR1268 Biopolymères Interactions Assemblages, INRA, F-44300 Nantes, France.

Starch is one of the most abundant biopolymers in nature present in the form of semi-crystalline granules in plants and tubers. Starches from cereals and tubers are widely employed over the world for nutrition and in industry for their functional properties. The macromolecular and structural characteristics of starches are linked to these properties, but this relation is not fully explained, in particular the effect of molecular size distributions and supramolecular structure on the final properties is not well known, probably because of the lack of adapted methods to probe structural properties. Developing new methods and analytical strategies to approach the molecular and structural properties of starches is then crucial. This talk will show that a combination of chromatographic, field flow fractionation and light scattering techniques allows the analysis of starch molecular properties (Rolland-Sabaté et al., 2011), when its supramolecular structure can be approached by means of new microscopic techniques (Rolland-Sabaté et al., 2017; Nessi et al., 2018). Through various examples on processed starches for nutritional, biomaterial or biomedical purposes, the molecular properties of native and extruded starches extracted from maize, wheat and tubers compared to other structural features such as granule morphology, crystallinity, thermal properties and enzyme susceptibility will be discussed.

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A comparative study between basket press and screw press in production of apple juice

Wilczyński, K.[1], Kobus, Z.[2], Nadulski, R.[3]

[1] University of Life Sciences, Department of Food Engineering and Machines, 20-280 Lublin, ul. Doświadczalna 44, Poland, kamilwilczynski100@wp.pl

[2] University of Life Sciences, Department of Technology Fundamentals, 20-612 Lublin, ul. Głęboka 28, Poland, zbigniew.kobus@up.lublin.pl

[3] University of Life Sciences, Department of Food Engineering and Machines, 20-280 Lublin, ul. Doświadczalna 44, Poland, rafal.nadulski@up.lublin.pl

Nowadays in Europe and in Poland, a decrease in the consumption of FC juices (from concentrate) and an increase in the consumption of NFC (not from concentrate) juices is observed. The cloudy juice (NFC) has a much higher content of bioactive compounds, fiber, mineral compounds as compared to the clarified one. An important aspect in the fruit processing is the selection of an appropriate pressing device to reduce the destructive impact of the production process on the quality of the apple juice. In the industry the following extractors are used: belt press, rack-and-frame press decanter, hydraulic press – basket press (Nadulski et al., 2016) and screw press (Bakhshabadi et al., 2018). The aim of study was to investigate the influence of construction solutions of presses on the yield and quality of apple juice. The tests were carried out on three apple varieties: Rubin, Mutsu and Jonaprince. The pressing was conducted using a laboratory basket press and a twin screw press. On the basis of studies it was found that for each of the varieties, the screw press was characterized by a higher pressing yield. The increases in the pressing yield of the press screw in comparison to the basket press were respectively: 10.15% for Jonaprince variety, 8.24% for Mutsu variety and 1.3% for Rubin variety. Juices obtained by the screw press for the Rubin and Jonaprince varieties had higher solid soluble content and density. Juices pressed on the screw press were of lower acidity and were of higher viscosity. Juices extracted by the screw press were characterized by a higher total phenolic content and showed higher scavenging ability of free radicals.

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Possible self-assembly mechanism of sodium carbonate-soluble fraction of pectin (DASP) studied with the atomic force microscopy and molecular dynamics

Pieczywek, P.M., Kozioł, A., Gawkowska, D., Zdunek, A.

Institute of Agrophysics, Polish Academy of Sciences, Doświadczalna 4, 20-290 Lublin, Poland

Cell walls of growing plants are extremely complex and sophisticated composite materials incorporating a dynamic assembly of polysaccharides, proteins, and phenolics. Among these, pectins are a family of biopolymeres – heteropolysaccharides – that constitute up to 60% of the plant cell wall. Recent discoveries showed that in fresh fruits and vegetables such as carrot, apples or pears, diluted alkali soluble fraction of pectin (DASP) form regular interlinked network on mica. This regular structure would have a great importance for cell wall integrity and therefore texture and firmness of the whole fruits and vegetables.

In this study we've made an attempt to characterize the molecular structure of the DASP fraction by means of AMF imaging and image analysis techniques coupled with molecular dynamics. The structure characterization involved acquisition of topological images of DASP deposited on mica. Pectin were isolated from apple fruit (*Malus Domestica*, cv. "Golden Delicious") cell walls during sequential extraction. Structural characteristics of DASP fraction were compared with prediction of molecular geometries obtained using the molecular dynamics. Several hypothetical configurations of DASP fraction polymer chains were tested with respect to their stability in water solutions, dimensions and shape characteristics as well as the chain stiffness.

Study showed that a possible candidate for the main constituent of the DASP fraction was a structure formed by the two adjacent HG chains in a parallel or anti-parallel configuration. Simulations of HG with an inclusion of a single unit of rhamnose in the middle of the chain showed that presence of 1,2-glycosidic bond have a crucial influence on the shape of the whole polymeric chain. This suggested that the small inclusions of rhamnose units into long chains of HG could be a possible explanation for the observed spatial distribution of the linear molecules on the AMF images. We hope that further studies with aid of the atomic force microscopy and molecular dynamics will give an answer which components of DASP fraction are responsible for self-assembly mechanism and what conditions are required for it to occur.

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Progress in modelling agricultural impacts of and adaptations to climate change

Rötter, R.P.[1], Koch, M.[1], Hoffmann, M.[1], Müller, C.[2]

[1] University of Göttingen, Department of Crop Sciences, Tropical Plant Production and Agricultural Systems Modelling (TROPAGS), Grisebachstr. 6, 37077 Göttingen, Germany; email: reimund.roetter@uni-goettingen.de

[2] Potsdam Institute for Climate Impact Research (PIK), Telegraphenberg A31, 14473 Potsdam, Germany; e-mail: cmueller@pik-potsdam.de

Systems modelling is a key tool to explore agricultural impacts of and adaptations to climate change. Here we report recent progress made especially referring to the agricultural systems research networks "Modelling European Agriculture with Climate Change for Food Security" (MACSUR) (Ewert et al., 2015) and the "Agricultural Model Intercomparison and Improvement Project" (AgMIP) (Rosenzweig et al., 2013), in particular, in modelling potential crop impacts from field to global using multi-model ensembles. We identify two main fields where further progress is necessary: a more mechanistic understanding of climate impacts and management options for adaptation and mitigation; and focusing on cropping systems and integrative multi-scale assessments instead of single season and crops, especially in complex tropical and neglected but important cropping systems. Stronger linking of experimentation with statistical and eco-physiological crop modelling (Rötter et al., 2018) could facilitate the necessary methodological advances.

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Adaptation of European cropping systems to climate change: Interrelations with mitigation and associated uncertainty

Ruiz-Ramos, M.

Universidad Politécnica de Madrid, Research Centre for the Management of Agricultural and Environmental Risks (CEIGRAM), Senda del Rey 13, ETSIAAB, 28040 Madrid, Spain, margarita.ruiz.ramos@upm.es

Within the context of agriculture and climate change, adaptation and mitigation communities have been traditionally worked independently. One main reason is that models able to simulate adaptation frequently are not calibrated for the most relevant variables for mitigation. In turn, models used in mitigation often use inaccurate descriptions of crop growth. Other reason is the different spatial and time scales involved. Up to date much more stress has been put on mitigation that on adaptation; however, there are many interactions between mitigation and adaptation that justify a more balance effort and a joint assessment. Examples are adaptation options with variable emission of greenhouse gases (Smith and Olesen, 2010), and mitigation strategies affecting yields (Sanz-Cobena et al, 2017). In some cases, adaptation and mitigation trade-offs are negative or conflicting, so selection of compatible practices from both points of view is required. Besides, both adaptation and mitigation share the challenge of uncertainty. In fact, mitigation and adaptation uncertainties are interdependent. Solutions are different for cases of low to moderate uncertainty and for high uncertainty situations, as illustrated by the assessment of the adaptation of crops under Mediterranean conditions (Ruiz-Ramos et al., 2018), which has been proven to be possible with high confidence. Neglecting the uncertainty or superficial analyses may result in maladaptation, and probably in ineffective mitigation. Some improvements in experimental and modelling fields are needed to avoid these, and to assure coherence between adaptation and mitigation objectives and progress.

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Impact of land use change on greenhouse gases emissions in peatland

Hatano, R.

Hokkaido University, Research Faculty of Agriculture, Sapporo 060-8589, Japan.
hatano@chem.agr.hokudai.ac.jp

Peatland has been generated at the rate of 100 to 200 kg C ha^{-1} yr^{-1} of organic matter accumulation for past 10,000 years due to lower microbial decomposition than plant production in wetland (Yu et al., 2010). World Peatland area is around 4.4 million km^2, which is only 3% of terrestrial area, but peatland contains around 600 Gt C, accounting for 25 % of total soil carbon. Natural wetland is a major source of CH_4 but not emit N_2O, But, peatland drained for agricultural use drastically changes the situation. This paper reviews the impact of peatland disturbance with land use change on greenhouse gases emissions (CO_2, CH_4 and N_2O).

Ground water level was most important controlling factor of CH_4 and N_2O emissions from peatland. Peat CH_4 emission increased at ground water level above -20 cm (Couwenberg et al., 2010). Increase of CH_4 emission with an increase of ground water level was lager in northern peatland than in tropical peatland. However, in tropical peatland, loss of natural vegetation increased CH_4 emission significantly due to loss of plant mediated oxygen supply in flooding (Adji et al., 2014). Peat N_2O and CO_2 emissions were characterized by using total 152 data (compiled by Mu et al., 2014; Takakai et al., 2006; Toma et al., 2011). Peat N_2O and CO_2 emissions increased at ground water level from -40 to -80 cm, especially in nitrogen fertilized tropical peatlands. In unfertilized fields, CO_2 emission was higher in tropical peatland than northern peatland, but N_2O emission was similar between tropical peatland and northern peatland. Drop of water lever and nitrogen fertilization in tropical peatland increased nitrogen mineralization remarkably, leading extremely large N_2O emission. Maintaining -20 to -40 cm of ground water level and appropriate amount of nitrogen fertilizer application are required for minimizing peat CH_4 and N_2O emissions in agricultural use of peatlands.

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Spatio-temporal properties of meteorological time series for Poland from NASA MERRA-2

Krzyszczak, J.[1], Gos, M.[1], Baranowski, P.[1], Kieliszek, A.[2], Siwek, K.[2]

[1]Institute of Agrophysics Polish Academy of Sciences, Department of Metrology and Modelling of Agrophysical Processes, Doświadczalna 4, 20-290 Lublin, Poland, j.krzyszczak@ipan.lublin.pl

[2]Maria Curie-Skłodowska University, Faculty of Earth Sciences and Spatial Management, Plac Marii Curie-Skłodowskiej 5, 20-031 Lublin, Poland

Time series of meteorological elements are applied for various statistical analyses to determine changes in climate dynamics or predict frequency and intensity of extreme weather events, but also serves as an input for retrospective analysis systems. One of such most developed systems is Modern Era Retrospective-Analysis for Research and Applications (MERRA), which combines observations distributed irregularly in space and time with an unchanging model and analysis system spanning the historical data record into a spatially complete gridded meteorological dataset (Rienecker *et al*., 2011). Evolving in time, the latest version (MERRA-2) contains both ground level, as well as airborne and even satellite measurements, including hyperspectral infrared imaging and microwave sensing.

The analyzed meteorological time series from NASA MERRA-2 spanned the period from 1980 to 2016 and came from a grid of 248 points covering uniformly the Poland territory. These data have been processed using the Multifractal Detrended Fluctuation Analysis (MF-DFA) method. The MF-DFA was used for meteorological quantities such as daily air temperature, wind speed, wind direction and atmospheric pressure. Main objective of this study was i) to check if, and to what extent, multifractality exists in the time series of meteorological variables from MERRA-2 data; ii) to compare the singularity spectra parameters for various grid points to find similarities/differences; iii) to find out whether the spatial patterns of multifractal properties can be connected with climatic conditions or a landform; iv) to derive spatial variability of singularity spectra parameters using geostatistical methods. The results show that MERRA-2 meteorological variables exhibit specific multifractal properties and spatial anisotropy.

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Reforestation techniques following windthrow vs the carbon exchange with the atmosphere

Ziemblińska, K.[1], Urbaniak, M.[1], Olejnik, J.[1,2]

[1] Department of Meteorology, Poznań University of Life Sciences, Piątkowska 94, 60-649 Poznań, Poland, klaudiaziem@wp.pl

[2] Department of Matter and Energy Fluxes, Global Change Research Centre, AS CR, v.v.i. Belidla 986/4a, 603 00 Brno, Czech Republic

Since forests play a major role as terrestrial carbon (C) sink, much effort has been put into investigating their C balance in regard to changing climatic conditions. As a consequence of these changes, the impact of various disturbances has recently received considerable attention. Even though wind is a major source of natural forest damages (Panferov et al. 2009), studies on the windthrows' impact on forest carbon balance remain scarce. Once tornado occurred in July 2012 in Trzebciny Forest District in northwest Poland, we thus took advantage of this extreme meteorological event. Carbon dioxide (CO_2) fluxes have been measured using the eddy covariance (EC) technique for four continuous years now, above two reforested Scots pine stands („Tlen I" and „Tlen II" sites). Our main objective was to determine whether and how two completely different reforestation techniques at windthrow areas impact net ecosystem production (NEP) of this pine forest ecosystem under similar meteorological and soil conditions. The two techniques were: (I) conventional: uprooted stumps pulled out and removed from the site followed by ploughing, and (II) non-conventional: all stumps left on the site to decompose with no ploughing. Our results indicate that both sites became significant carbon (C) sources after the windthrow (up to 575 g C m^{-2} y^{-1} in the first year). However, the Tlen I (conventional technique) lost over 30% less C than Tlen II during the 2015-2016 observation period. Furthermore, in contrast to existing knowledge, ploughing as done at Tlen I, did not substantially increase CO_2 emission, as compared to the Tlen II site, where only soil organic matter was locally ripped to the depth of 5-10 cm. So far then, the currently widely applied conventional reforestation technique in wind-disturbed Polish forest appeared to be more effective in decreasing C losses than a technique that leaves stumps to decompose and avoids ploughing.

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Biochar for environmental and agricultural applications – current state and future perspectives

Malińska, K.

Częstochowa University of Technology, Institute of Environmental Engineering, Brzeźnicka 60A, 42-200 Częstochowa, Poland, kmalinska@is.pcz.pl

Biochar is often defined as a solid, carbon rich material obtained through pyrolysis of various types of plant and animal biomass. In many respects, it is similar to charcoal that is used for combustion but differs in applications. In principle, biochar is used for a wide range of applications other than combustion. Those applications can include the use of biochar as a soil improver or a fertilizer, a sorbent for removal of organic and inorganic contaminants from water, wastewater, processing gases, etc., a supplementary material in composting and vermicomposting, a filler for plastic composites, a substrate for green roofs and hydroponics, and many more.

In recent years there is a significant interest in biochar and its properties. However, biochar is not a new material at all. It has been known for centuries, mostly as a soil improver. Now, biochar has been attracting a lot of attention and with the available technologies and analytical techniques biochar and its properties are being "rediscovered". Biochar shows very interesting properties such as beneficial chemical composition, presence of surface functional groups, increased microporosity and surface area that can play a crucial role in binding contaminants, retaining nutrients and water or fostering microorganisms. Depending on the feedstock and process parameters the properties of biochar can be designed to fit into a desired application.

The presentation provides an overview of current state of the art on biochar and addresses the following topics: (1) biochar definitions, (2) legal status and quality requirements, (3) feedstock types and requirements for production of biochar, (4) properties of biochar, (5) applications of biochar with special reference to environmental engineering and agriculture, (6) biochar as a soil improver or fertilizer, (7) potential threats related to biochar applications to soil, (8) future research, (9) challenges of bringing biochar into the market.

Structural characteristics of biochar-amended loamy sand soil

Kercheva, M.[1], Hajnos, M.[2], Sokołowska, Z.[3], Dimitrov, E.[4], Atanassova, I.[5], Benkova, M.[6], Mikova, A.[7], Skic, K.[8]

[1] ISSAPPNP (Institute of Soil Science, Agrotechnology and Plant Protection "Nikola Poushkarov"), 7 Shosse Bankya str., Sofia 1080, Bulgaria, mkercheva@abv.bg

[2] Institute of Agrophysics (IA), Polish Academy of Science (PAS), Doświadczalna 4, 20-290 Lublin, Poland, m.hajnos@ipan.lublin.pl

[3] IA, PAS, Doświadczalna 4, 20-290 Lublin, Poland, sokolows@ipan.lublin.pl

[4] ISSAPPNP, 7 Shosse Bankya str., Sofia 1080, Bulgaria, e.dimitrov7@gmail.com

[5] ISSAPPNP, 7 Shosse Bankya str., Sofia 1080, Bulgaria, i.d.atanassova@abv.bg

[6] ISSAPPNP, 7 Shosse Bankya str., Sofia 1080, Bulgaria, majaben@abv.bg

[7] ISSAPPNP, 7 Shosse Bankya str., Sofia 1080, Bulgaria, an15mi11@yahoo.com

[8] IA, PAS, Doświadczalna 4, 20-290 Lublin, Poland, kskic@ipan.lublin.pl

The effect of biochar of oak offcuts on structural characteristics of Sandy Loam Meadow-cinnamonic soil was assessed in a field experiment in Tsalapitsa, South Bulgaria. Soil structure was characterized by indicators related to solid phase (specific surface area, bulk density, soil aggregation and water stability of soil aggregates) and to soil porous space obtained by soil water retention curve, mercury intrusion porosimetry (MIP), and water vapor sorption. The biochar was applied at rate 300 $kg.da^{-1}$ in field plots with wheat and maize cultivation. The studied biochar material is hydrophilic, with high content of total organic carbon Corg=29.4%, relatively high cation exchange capacity (T8.2=10.3 $cmol.kg^{-1}$), and very high specific surface area (SpS=211 $m^2.g^{-1}$ for particles with size <1 mm, 297 $m^2.g^{-1}$ for particles 1-3 mm). The SpS as determined by B.E.T. method increased from 25 $m^2.g^{-1}$ in control variant to 31 $m^2.g^{-1}$ in biochar-amended variants. The relative change (24%) corresponds to the increase of organic carbon in the treated variants. Soil bulk density in all sample depth (0-5, 5-10 and 15-20 cm) decreased by 0.1 $g.cm^{-3}$ and the total porosity increased by 6% in treated variants under wheat planting. The relative changes of these parameters, 6% and +11% are of the same order as those obtained by MIP estimates for bulk density and porosity of the samples. The soil aggregation and water stability of soil aggregates of the studied soil is poor and the amended biochar had no effect on these characteristics. Significant increase of large pores is established by water retention data and MIP. The main maximum of pore size distribution registered by MIP in studied variants occurred at pore radii 80-120 μm. The volume of these large pores increased twice in 0-5 cm, and 53% in 15-20 cm soil layers of the ameliorated variants. The available water capacity increased from 10 to 13%.

Take a peek inside the earthworms behavior in biochar-amended soil. A review.

Kliszcz, A.

University of Agriculture in Krakow, Mickiewicz Av. 21, 31-120 Krakow, Poland
*angelika.kliszcz@student.urk.edu.pl

Earthworms provide a large number of environmental services in the field, including improving soil porosity, both linking soil aggregates and contributing to stabilize SOM fractions within their casts, and living together with microbial communities in the soil. Nonetheless, they are sensitive to harmful substances added to the soil's environment. On the other hand various types of thermally-converted biomass are producing in hope of enhancing the soil fertility and sequestrating C in agricultural areas, which are crucial for modern agriculture. The attempt was made to assess the earthworms behavior during penetrating the various biochar-amended soil. The results show that the biochar-derived soil amendments are not always friendly for mesofauna inhabiting agricultural areas.

Routine soil testing of agricultural land in Eastern Europe: perspectives of NIR/MIR/XRF sensor technology

van Erp, P.J.[1], Sarjant, S.[1]

[1] SoilCares Research, Nieuwe Kanaal 7C, 6709PA Wageningen, the Netherlands, peter.vanerp@soilcaresresearch.com

Routine soil testing is used to optimize farm activities towards optimal soil quality, optimal fertilization strategies, and sustainable farming systems. The soil testing methods used for this are laborious, expensive, time-consuming, and suffer from a high inner- and between-laboratory variation. Near Infra-Red (NIR), Mid Infra-Red (MIR), and X-ray fluorescence (XRF) sensor technology is an alternative for traditional soil testing; it is quick, precise, cheap, robust, and easy to use (Viscarro Rossel et al. 2016). But such a sensor-driven concept requires prediction models relating soil spectral characteristics to the results of traditional soil testing methods and hence detailed calibration studies are needed for this.

SoilCares has developed a new innovative concept for soil testing using NIR, MIR, and XRF. In 2015-2017 a calibration study was carried out in Ukraine, Poland, and Hungary. More than 2300 soil samples were collected from agricultural land and analyzed (both chemically and spectrally) at the SoilCares calibration laboratory in Wageningen. Based on the results, prediction models were developed using machine learning techniques. Moreover, a conversion study was carried out to find out relationships between SoilCares test values and local soil testing laboratories in Ukraine, Poland, and Hungary.

In this presentation we will discuss the results of the calibration study and the predictive value of the resulting prediction models. It will be shown that the prospective of using NIR/MIR/XRF sensor technology for most of the tested soil parameters are very good. The conversion study showed that SoilCares soil test values are related to test values of country specific soil testing methods. Based on these results, SoilCares has started a gradual roll out of their concept in Poland, Hungary, and Ukraine.

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Combined frequency and time domain electromagnetic simulations of a transmission mode soil moisture probe

Skierucha, W., Wilczek, A., Kafarski, M., Szypłowska, A.

Institute of Agrophysics PAS in Lublin, Doświadczalna 4, 20-290 Lublin, Poland,
w.skierucha@ipan.lublin.pl

The objective of the paper is to evaluate the performance of a profile probe working in transmission mode for monitoring dynamics of soil volumetric water content (VWC) in a soil profile. The applied software tools were 3D EM simulation (Keysight EMPro 3D EM Simulation Software) and electronic design software (Keysight Advanced Design System - ADS). The EMPro software package serves for finding electromagnetic interaction between the probe's surrounding material and the body of the probe. This interaction is described by the scattering matrix, especially its transmission parameter S_{21}, which is calculated using frequency domain Finite Element Method (FEM). Next, the S_{21} material parameter is used in the ADS software package as an element of the electric circuit. The ADS software calculates the travel time (t) of the electric pulse (narrow needle pulse) and the decrease its amplitude after covering the distance along the electrodes. These values depend on the dielectric permittivity (ε) of material surrounding the probe and its electrical conductivity (EC), which corresponds to soil salinity.

The presented combination of simulations can significantly shorten the time of developing a working prototype of the profile probe by optimizing its geometry and measurement circuitry, identification of sources of errors, testing resolution/accuracy and minimizing the cost of the measurement unit. Also, the applied electromagnetic simulations enable to make virtual calibrations VWC=f(t) for the tested geometries of the profile probe.

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The impact of variety on phytochemicals content and functional properties of tomato fruit

Jeż, M., Wiczkowski, W., Błaszczak, W.

Institute of Animal Reproduction and Food Research, Polish Academy of Sciences, Tuwima 10, 10-748 Olsztyn, Poland

Tomatoes are one of the most widely consumed vegetables around the world. Tomato fruits are a rich source of phytochemicals with widely documented health-promoting properties. Plant variety, cultivation and harvesting conditions or the applied technological processes can significantly affect the content and composition of phytochemicals in tomato fruit and tomato-based products (Vallverdu-Queralt et al., 2011).

We have, therefore, investigated the impact of tomato variety on the phytochemicals profile of tomato fruit obtained from four commercial tomato varieties (*Maliniak, Cerise, Black Price, Lima*) cultivated in Poland. The identification of polyphenols and carotenoids in the samples studied was carried using HPLC-MS/MS and HPLC-DAD, respectively. Since estimation of antioxidant properties is of a key significance to the nutritional quality of food, a combination of photochemiluminescence (PCL) and ferric reducing antioxidant power (FRAP) assays was used to determine the antioxidant and reducing capacity of the material analyzed.

Tomato extract of *var. Cerise* showed the highest polyphenols content (3.48 mg GAE/g dm) relative to the remaining samples. Alike, tomatoes *var.* Cerise reached the highest concentration of lutein, β-carotene and lycopene (total carotenoids content 20.53 mg/g dm). The extract from tomato *var. Maliniak* was least abundant in polyphenols (2.25 mg GAE/g dm) and total carotenoids (2.39 mg/g dm) content. Among all the samples studied, the extract from *var.* Maliniak did not contain quercetin, naringenin and lutein.

The antioxidant capacity of tomato extracts (PCL) ranged from 22.35 (*var. Maliniak*) to (*var. Cerise*) 47.46 µmol Trolox/g dm. Whereas, the highest reducing capacity was found for the extract of Lima tomatoes (34.26 µmol Trolox/g dm).

The results of this study indicated that tomato variety was a key determinant of the parameters studied, and due to that, it affected not only the product quality but also its nutritional value.

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Physical properties and texture of gluten-free snacks supplemented with selected fruits addition

Wójtowicz, A.[1], Mitrus, M.[1], Nowak, G.[1], Golian, M.[1], Żelizko, K.[1], Oniszczuk, A.[2], Kasprzak, K.[2], Widelska, G.[3], Oniszczuk, T.[1], Combrzyński, M.[1]

[1] University of Life Sciences in Lublin, Department of Thermal Technology and Food Process Engineering, Doświadczalna 44, 20-280 Lublin, agnieszka.wojtowicz@up.lublin.pl, marcin.mitrus@up.lublin.pl, nowak.gabriela49@gmail.com, martynapat1409@gmail.com, katarzyna.zelizko@gmail.com, tomasz.oniszczuk@up.lublin.pl, maciej.combrzynski@up.lublin.pl

[2] Medical University of Lublin, Department of Inorganic Chemistry, Chodźki 4a, 20-093 Lublin, aoniszczuk@o2.pl, kasprzak.kamila.k@o2.pl

[3] Medical University of Lublin, Chair and Department of Pharmacognosy with Medicinal Plant Unit, Chodźki 1, 20-093 Lublin, gabrielachodun@yahoo.com

Last several years there is observed increased consumption of snack foods due to development of new processing methods and raw materials used. Some of them can be classified as functional food according to the presence of health promoting ingredients with documented nutritional benefits. One of the useful technologies to achieve new types of functional snacks can be the extrusion-cooking. HTST extrusion-cooking allows to achieve modern snacks with increased nutritional value and specific quality characteristics relevant to consumers' needs, especially gluten-free products for celiac disease patients. The aim of this study was processing of ready-to-eat corn-based gluten-free snacks supplemented with selected fruits addition and evaluation of physical properties and texture of crisps. Black elderberry fruits, black chokeberry fruits and strawberries were dried and used in the experiments in amount of 5 to 20% as corn grits replacement. Directly expanded snacks were processed with single-screw extruder at screw speed 80 and 120 rpm and shaped with circular die (3 mm in diameter). Snacks were tested to evaluate the expansion ratio, bulk density, color profile in CIE-Lab scale as well as texture depend on processing conditions and additive type and level applied. The results showed various effects of fruit type and amount on physical properties and texture of supplemented gluten-free snacks. Increasing amount of fruits addition affected on significant decrease of expansion ratio and increase of bulk density of snacks. Decrease in lightness and increased red tint were observed according to red color of fruits used, but differences were observed depending on fruit type. Hardness of snacks suggested limitation of fruits addition up to 15% in the recipe, higher fruits levels increased hardness to unacceptable level. Various crew speed applied showed significant effect on expansion, bulk density and texture of tested snacks.

Discrete Element Method modelling of diametral compression of starch tablets

Horabik, J., Wiącek, J., Parafiniuk, P., Stasiak, M., Bańda, M., Molenda, M.

Institute of Agrophysics, Polish Academy of Sciences, Doświadczalna 4, 20-290 Lublin, Poland, e-mail: j.horabik@ipan.lublin.pl

Numerical simulations of compaction and the diametral compression test of potato starch were conducted to study the microscopic mechanisms of formation of tablets and the origins of their breakage strength. Simulations were performed with use of the EDEM software. The linear elastic-plastic constitutive contact model including adhesion was used in simulations as proposed by Luding [1]. Samples of 120 thousand of spherical particles with diameters normally distributed in a range from 10 to 72 μm (S.D. 15 μm) were compressed in a cylindrical die 2.5 mm in diameter. The components of the macroscopic stress tensor in the tablet were determined. The representative volume element used for calculation of the stress components was a cuboid 0.25×0.25×1 mm. The box was moved along horizontal x and vertical y directions, respectively, to obtain stress profiles along direction of loading (y) during diametral compression test and perpendicular (x).

After compaction and unloading of the tablet, the residual compressive forces remained in central part of the tablet and tensile forces in outer region. Distribution of the contact force (compressive and tensile) followed Laplace distribution (double exponential) with mean value close to zero. It means that the occurrence of the strong residual forces, compressive and tensile, decreased exponentially with the same rate with the magnitude of the force. During the diametral loading, the contact force distribution changed into asymmetric Laplace distribution with the mean value remaining close to zero. The occurrence of the tension force decreased exponentially with the magnitude of the force approximately threefold faster as compared to the compression force. The asymmetry of the force distribution was due to the limit of the tension force resulting from assumed value of the adhesion.

During initial stage of the diametral loading, the residual compressive stress in the central part of the tablet increased in all directions. A further loading resulted in an increase in the compressive stress in direction of loading (y), and a decrease in the compressive stress in x direction, with subsequent transformation into the tension. The tension stress was initiated in locations close to contact with loading plates similarly to behavior of elastoplastic materials [2]. The maximum tension stress moved along y direction towards the tablet center with an increase in deformation. The maximum tension stress arrived to the center in the case of the lower compressed samples (lower residual compressive stress) and stopped at $y/R \approx 0.4$ in the case of the higher compressed samples (higher residual compressive stress). In that case, the tension stress dip remained in the tablet center throughout entire deformation. Separation of two strongly localized compressive force chains along y direction was observed with an increase in the tablet deformation. Breakage occurred simultaneously along entire tablet's diameter.

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Thermal analysis of pure olive and mixed with sunflower oil

Vozárová, V., Petrović, A., Hlaváčová, Z.

Department of Physics, Slovak University of Agriculture in Nitra, Tr. A. Hlinku 2, 949 76 Nitra, Slovakia, e-mail: vlasta.vozarova@uniag.sk

Properties of food, including edible vegetable oils, and impact of temperature on the food properties are well described by many authors (Gunstone, 2002; Sahin & Sumnu, 2006; Figura & Teixeira, 2007 etc.). Study of thermal behaviour of food or food components is necessary for quality insurance in whole food chain.

The present work deals with study of thermal behaviour of pure olive oil and mixture of olive and sunflower oil. Monitoring of crystallisation and melting behaviour and enthalpy of transitions is provided by differential scanning calorimetry (DSC) (Wagner, 2013). Study of thermal decomposition of oil by thermogravimetric analysis (TGA) gives information on the content of volatile components e.g. water, on decomposition behaviour and the ash or filler content (Wagner, 2013).

Based on the results of DSC and TGA analysis temperature interval of oils thermal stability is defined, as well as comparison of crystallisation and melting behaviour including enthalpy of transitions of individual oil samples (pure olive oil and mixed with sunflower oil). It is concluded that the pour point of the mixtures is shifted in proportion to the percentage of added sunflower oil. Obtained results prove that application of DSC method is promising tool for detection of olive oil adulteration with sunflower oil (Chiavaro et al, 2009).

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Monitoring of gas cell coalescence during bread dough baking expansion

Miś, A., Nawrocka, A., Krekora, M., Niewiadomski, Z., Rusinek, R., Gancarz, M.

Institute of Agrophysics, Polish Academy of Sciences, Doświadczalna 4, 20-290 Lublin, Poland, e-mail: : a.mis@ipan.lublin.pl

The coalescence phenomenon consists in merging of two or more adjacent gas cells, resulting in the worsened homogeneity of the cellular structure of bread crumb. Monitoring of the coalescence rate was carried out performing simultaneous measurements of the dough volume, pressure, and viscosity. The obtained results showed that, during the baking expansion of chemically leavened wheat flour dough, the maximum growth rate of the gas cell radius determined from the ratio of pressure exerted by the expanded dough to its viscosity was approximately four-fold lower than that calculated from volume changes in the gas phase of the dough. Such a high discrepancy was interpreted as a result of the course of coalescence, and a formula for determination of its rate was developed (Miś et al., 2018).

The coalescence rate in the initial baking expansion phase had negative values, indicating nucleation of newly formed gas cells, which increased the number of gas cells even by 8%. The lower initial number of gas cells in dough intensified of the nucleation. In the next baking expansion phase, the coalescence rate started to exhibit positive values, reflecting dominance of the coalescence phenomenon over nucleation. The maximum coalescence rates indicate that, during the period of the most intensive dough expansion, the number of gas cells decreased by 2-3% within one second. At the end of the formation of bread crumb, the number of the gas cells declined by 55-67% in comparison with the initial value. Better quality flours contributes to decreasing both nucleation and coalescence rate. The developed method can be a useful tool for more profound exploration of the coalescence phenomenon at various stages of evolution of the cellular structure and its determinants, which may contribute to future development of more effective ways for improving the texture and sensory quality of bread crumb.

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Pre-treatment and bioconversion of agri/food residues into lactic acid

Venus, J.[1], Alexandri, M.[1]

[1] Leibniz Institute for Agricultural Engineering and Bioeconomy (ATB Potsdam), Dept. Bioengineering, Max-Eyth-Allee 100, 14469 Potsdam, Germany, jvenus@atb-potsdam.de

Introduction: Especially for biotechnological processes, in which the carbon of various substrates should be converted into microbial products, there is an increasing interest in the use of cheap raw materials, biogenic residues and wastes.

Aims: The goal is to develop a lactic acid fermentation process based on the substitution of expensive substrates and nutrients by cheaper materials from biomass due to their main proportion of the whole costs.

Materials and Methods: Many feedstocks cannot be used normally for fermentation directly because the fermentable sugars are bound in the structure especially as cellulose and several types of hemicelluloses. A pre-treatment of agricultural residues is required when enzymes are used for hydrolysis in an enzymatic approach. The pre-treatment in form of an acidic pre-digestion or physicochemical treatment (e. g. steam explosion) ensures that the recalcitrant structure is accessible to enzymes [Ravindran & Jaiswal, 2016].

Results: The viability of the production of lactic acid from several residues has been demonstrated from laboratory up to pilot scale including the entire value chain starting from the raw material and resulting with a polymer-grade product (LA). Pre-treatment methods are energy-intensive and the selection of an efficient method is crucial for the overall economy of a biotechnological process. As a result of the achievements so far the optimization of pre-treatment, hydrolysis, fermentation, and downstream processing steps in parallel together with the screening of other LA producing bacteria have been performed [Pleissner/Venus, 2014].

Conclusion: The entire processing chain has been implemented to generate marketable lactic acid of high enantiopurity and quality. Exploitation of L(+)- and D(-) lactic acid for the production of biopolymers is one of the recent applications. It is likely that one of the future trends in lactic acid production will end up in mixtures of different low-cost raw materials in order to avoid the use of expensive complex supplements [Koutinas et al., 2014].

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Energy potential of maize straw – case study for a polish biogas plant

Kozłowski, K.[1], Lewicki, A.[1], Czekała, W.[1], Chełkowski, D.[1], Cieślik, M.[2], Wójtowicz, A.[3], Kupryaniuk, K.[3]

[1] Poznan University of Life Sciences, Institute of Biosystems Engineering, Wojska Polskiego 50, 60-627 Poznan, e-mail: kamil.kozlowski@up.poznan.pl

[2] Poznan University of Life Sciences, Department of Biotechnology and Food Microbiology, Wojska Polskiego 48, 60-627 Poznan

[3] University of Life Sciences in Lublin, Department of Food Process Engineering, Skromna 8, 20-704 Lublin

The methods of green energy production include among others biogas production in methane fermentation process. One of the most commonly used substrate in biogas plant is maize silage, which application in mono-fermentation under Polish economic conditions causes fast bankruptcy. Unprofitability of the investments based on this material, enforces to seek for another, more economic favorable biomass sources i.e. maize straw.

The research aim was to define and compare energetic potential of maize straw and extruded maize straw used for biogas production and furthermore, the electricity and heat as well as heat production from direct combustion. The research tests were carried out at the Institute of Biosystems Engineering and Section of Wood Chemistry and Forest Products at the Poznan University of Life Sciences pursuant to adapted standards: DIN 38 414-S8, VDI 4630 and PN/G-04513. The experiments related to pressure pretreatment of maize straw were carried out in Department of Engineering Production at University of Life Sciences in Lublin.

The obtained results confirmed large energy potential of maize straw. It has been proved, that using an extrusion as a pretreatment before fermentation process, enables to increase biogas and methane production respectively by 7.50% and 8.51%. However, using an extruding machine in biogas plants in Poland is economically unjustified due to its high energy consumption.

Moreover, it has been shown, that using the maize straw in methane fermentation process enables to generate (in Poland) higher income then in case of using this material in direct combustion process.

The methane potential of selected plants cultivated for energy purposes, fertilized with biogas digestate

Witrożec, A., Matyka, M., Górnik, A., Strzemska-Markowska, E., Wolszczak, P., Woźniak, M., Rybicki, Ł.

Institute of Soil Science and Plant Cultivation-State Research Institute, Department of Systems and Economics of Crop Production, Czartoryskich 8 street., 24-100 Puławy, Poland, awitorozec@iung.pulawy.pl, mmatyka@iung.pulawy.pl

The interest in renewable energy sources has gained great importance in Europe due to the need to reduce fossil energy consumption and greenhouse gas emissions. One of the key targets proposed by the European Commission in energy and climate goals for 2030 is the share of renewable energy to reach at least 27 % by 2030. These objectives are seen as a step towards meeting the greenhouse gas emissions targets for 2050 put forward in the Roadmap for moving to a competitive low-carbon economy in 2050 (COM (2011) 112 final).

The field experiment was carried out the experimental farm in eastern Poland (51°27'53"N, 22° 3'52"E) in 2016. This research aimed to compare methane production from three different crops with three schemes of fertilization, including mineral and organic (digestate from biogas plant) fertilizers. Nitrogen fertilization was applied in the following schemes: N-1 only mineral, N-2 before sowing digestate and later mineral, N-3 only digestate. Each scheme included two dates, pre-sowing and during the cultivation. In cultivation trials, the effect of applying mineral and biogas digestate was evaluated by measuring the biomass yield in the first year of field experiment.

Methane production via anaerobic digestion form different substrates, was carried out for approximately one month for each sample, using Methane Potential (BMP) Assay. Analyses of three crops grown in eastern Poland for biogas production (triticale, sorghum, maize) showed varying performance regarding methane yield per hectare.

Replacing the mineral fertilizer with biogas digestate did not, with the exception of triticale, influence dry and green matter yields per hectare. The largest yields of biogas per hectare were from maize silage fertilized exclusively with mineral nitrogen. For sorghum (5835 Nm^3 $CH_4 \cdot ha^{-1}$) and triticale silage (3191 Nm^3 $CH_4 \cdot ha^{-1}$), the highest values were recorded from N-2, while for maize from N-1 (6980 Nm^3 $CH_4 \cdot ha^{-1}$).

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The effect of algal extracts on cucumbers growth in hydroponic system

Lewandowska, M.[1], Zabochnicka-Świątek, M. [1], Kocela, R.[1]

[1] Czestochowa University of Technology, Institute of Environmental Engineering, Brzeźnicka 60a, 42-200 Czestochowa, Poland; tel.: +48 34 3250917, fax: +48 34 3721304, mzabochnicka@is.pcz.czest.pl

Literature confirm wide application of algal extracts in agriculture as biofertilizers or plant protection products. However, not much information can be found on the use of algal extracts in hydroponic systems.

This study was carried out in order to examine possibility of using algal extracts (*Arthrospira* sp. and *Chlorella* sp.) as potential organic fertilizer for hydroponic growth of cucumber. The influence of *Arthrospira* sp. and *Chlorella* sp. extracts on cucumber germination, its biometric parameters and the physicochemical composition of plants was tested. Also, determination of the optimum concentration of algal extract was evaluated.

In the first stage of experiment cucumber seeds were subjected to 2 weeks germination test through soaking them in algal extracts: 2.5%, 10%, 25%, 50% and the results was measured by GP (germination percentage), FGP (final germination percentage) and MGT (mean germination time).

The hydroponic cultivation was carried out in a phytotron chamber under greenhouse conditions and lasted 90 days until first fruit buds appeared. The experiment was arranged in block of 50 pots filled with clay pebbles, consisted of 10 combinations and 5 replicates.

Plants were fertilized with 4 various concentrations of *Arthrospira* sp. and *Chlorella* sp. extracts: 2.5%, 10%, 25%, 50% in 10 days intervals, assessing their effect on the plants through entire experiment. The liquid extracts were obtained as a result of dilution of dry algal biomass with distilled water in ratio 1:10, and autoclaving the resulting mixture.

In the germination test, the best results of GP and FGP were obtained for plants soaked in 25% and 50% *Arthrospira* sp. extracts, and 25% for *Chlorella* sp. The shortest MGT was observed for 2.5% and 25% for *Arthrospira* sp. and *Chlorella* sp., respectively. For the main experiment, the highest growth of plants was obtained when using fertigation with 25% of *Chlorella* sp. extracts. Algal extracts can be successfully used as organic fertilizer in hydroponic growth of cucumbers and replace mineral based nourishments.

Use of Organic Wastes for Enhancing Food Security and Improving Environmental Quality

Shehzadi, S.[1], Shah, Z.[2], Mohammad, W.[3]

[1] Pakistan Institute of Nuclear Science and Technology, , Islamabad, Pakistan, email: sshehzadi11@hotmail.com

[2] Department of Soil & Environmental Sciences, The University of Agriculture, Peshawar, Pakistan. email: zahirshah@aup.edu.pk

[3] Nuclear Institute for Food and Agriculture (NIFA), Peshawar, Pakistan email:wisalyasir@hotmail.com

Land degradation, unbalanced crop nutrition, poor socio-economic conditions, global warming and climate change are the factors affecting the sustainability of agriculture and food security. The use of different organic wastes is an effective management strategy to improve soil fertility, crop productivity and environmental quality through enhanced soil C sequestration. A two year field study was aimed to assess the effect of four organic wastes viz., municipal solid waste (MSW), sugar industry waste (filter cake), crop residues and farm yard manure, alone or in combinations with NPK mineral fertilizers on soil properties (total soil organic carbon (SOC), soil microbial biomass C & N, heavy metals) and crop yields under irrigated wheat- maize cropping sequence. The research was conducted at the research farm of NIFA, Peshawar, Pakistan. The C: N ratio of the organic wastes ranged from 8.0 in the filter cake to 59.0 in the maize residues. Each waste was applied at 3 t C ha^{-1} alone or in combination with half or full recommended dose of NPK to each crop. The treatments were arranged in a Randomized Complete Block design with three replications. The results revealed that significantly higher effects of filter cake and MSW integrated with full NPK fertilizers were observed on total SOC, microbial biomass C & N and thus helped to mitigate C losses to atmosphere. On average, the highest increase in total SOC at 0-15cm was recorded by filter cake with 6.5 t ha^{-1} after wheat harvest and 7.7 t ha^{-1} after maize harvest. It was revealed that MSW added some heavy metals (Pb, Ni) to soil but that were well below the standard permissible limits. On average, highest grain yield (4800 kg ha^{-1}) of wheat was obtained with combined application of MSW and full NPK fertilizer, whereas, highest grain yield (4439 kg ha-1) of maize was received with filter cake plus full NPK. The integrated use of organic wastes with half NPK fertilizers reduced the cost of chemical fertilizers by about 50 %. These results suggested that targeted addition of organic wastes (MSW or filter cake) have the best potential for obtaining higher wheat/maize yields and sustainable soil fertility with limited environmental implications.

Detection of I_2/KI water solution entrance into aleurone layer during germination

Lev, J., Blahovec, J.

Czech University of Life Sciences Prague, Faculty of Engineering, Kamýcká 129,
165 00 Praha 6, Czech Republic, jlev@tf.czu.cz

The movement of water into dry seeds is a critical step in germination, preharvest sprouting and expression of dormancy (Rathjen et al., 2009). Rate of water uptake into seeds is a usual basis for determination of the three germination phases. The water uptake into seeds during their germination was investigated by many researchers who used various methods (e.g. magnetic resonance micro-imaging, near-infrared hyperspectral imaging and visualization with I_2/KI water solution (Lugol's iodine) (Kikuchi et al., 2006; Rathjen et al., 2009; Lancelot et al., 2017)).

We present a new method for detection of the I_2/KI water solution entrance into seed aleurone layer. Imbibition of seeds in I_2/KI water solution allowed water uptake visualization by the staining of cellular membranes and starch tissue. We found that a stained aleurone layer is possible recognize during germination via image analysis (without cutting). We focused on the moment when the water first enter the aleurone layer from scutellum. We found that the time is approximately 2 to 5 hours from the start of imbibition and it varies among varieties.

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Goethite and gibbsite aggregation in the polyacrylamide presence

Szewczuk-Karpisz, K., Skic, K., Boguta, P., Sokołowska, Z., Tomczyk, A., Cybulak, M.

Institute of Agrophysics, Polish Academy of Sciences, Doświadczalna 4, 20-290 Lublin, k.skic@ipan.lublin.pl

The flocculant usage is the way to prevent water erosion and improve soil structure. These macromolecular compounds make the soil more plastic, resistant to leaching and well-aggregated (Mclaughlin & Bartholomew, 2007).

The main aim of the study was to check the polyacrylamide (PAM) efficiency in goethite and gibbsite aggregation. The particle and aggregate size was measured using a differential centrifugal sedimentation method (CPS analyzer). In fig. 1 the light absorption dependence on the goethite particle size, with and without the polymer, is presented. The results obtained for gibbsite particles were analogous.

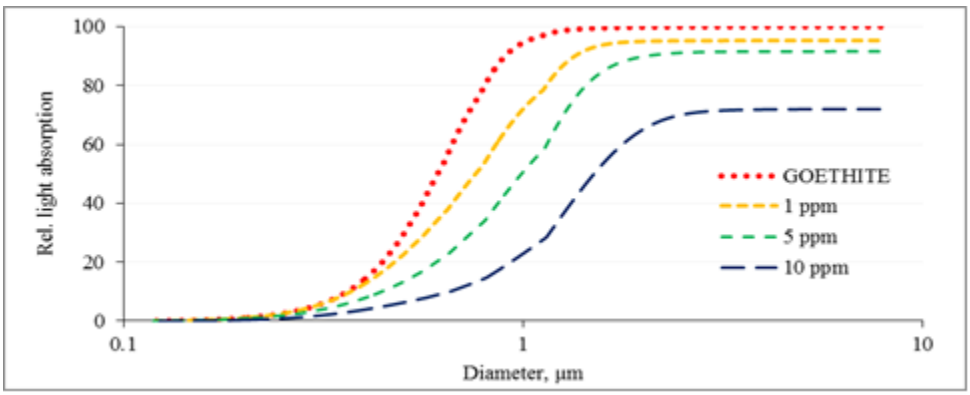

Fig. 1. The dependence of light absorption on the goethite particle diameter in the absence and presence of polyacrylamide (concentration of 1-10 ppm).

It was observed that the polyacrylamide addition contributes to the light absorbance reduction. It is connected with the aggregation of small particles. What is more, in the polymer presence the absorbance maximum is moved towards larger particle diameters. This is the evidence for formation of aggregates of a bigger size, as well as for the flocculating ability of polyacrylamide used relative to goethite and gibbsite.

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Soil salinity assessment with the use of dielectric spectrum at radio and microwave frequencies

Szypłowska, A.[1], Szerement, J.[1], Lewandowski, A.[2], Kafarski, M.[1,3], Wilczek, A.[1], Skierucha, W.[1]

[1] Institute of Agrophysics, Polish Academy of Sciences, Doświadczalna 4, 20-290 Lublin, Poland, a.szyplowska@ipan.lublin.pl

[2] Warsaw University of Technology, Institute of Electronic Systems, Nowowiejska 15/19, 00-665 Warsaw, Poland, a.lewandowski@elka.pw.edu.pl

[3] The State School of Higher Education in Chełm, Pocztowa 54, 22-100 Chełm, Poland

Excessive soil salinity is recognized as one of the most serious hazards to soil on a global scale, as it negatively impacts environment and agriculture. A reliable monitoring of soil salinity is necessary for management and mitigation of this threat.

Soil bulk electrical conductivity (EC_b) and electrical conductivity of soil pore-water (EC_w) are practical indicators of soil salinity (Rhoades et al., 1999). Since the direct measurement of EC_w is problematic, various models have been developed in order to obtain this quantity with the use of direct measurements of EC_b, soil moisture or soil dielectric permittivity.

The work presents an application of the salinity index model (Malicki & Walczak, 1999) with the use of soil dielectric permittivity spectra obtained in the 0.05-3 GHz frequency range measured by a coaxial transmission-line system (Lewandowski et al., 2017) for EC_w determination of samples of five mineral soils of various texture. The performance of the model was assessed for permittivity obtained at various frequencies. As a result, an optimal frequency range for soil salinity assessment was determined.

Acknowledgements

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Designing and open-ended probe with an antenna (OE-A) for the determination of soil moisture and salinity: computer simulations

Woszczyk, A., Kafarski, M., Wilczek, A., Skierucha, W.

Institute of Agrophysics, Polish Academy of Sciences, Doświadczalna 4, 20-290 Lublin, Poland,
a.woszczyk@ipan.lublin.pl, m.kafarski@ipan.lublin.pl, a.wilczek@ipan.lublin.pl, w.skierucha@ipan.lublin.pl

Growing shortage of fresh water enforces the necessity of its economical use. Reasonable use of water resources is required in every sector of the economy, including agriculture. The irrigation systems currently used generate significant losses of water, so there is a need to develop irrigation systems which minimise water losses and simultaneously satisfy individual plant requirements. To that end, it is vital to design sensors able to monitor soil moisture and salinity and automatically store the obtained data. We proposed a model of a simple open-ended probe with a prolonged central conductor in a form of an antenna for installation in a mobile unit. The open-ended probe with an antenna (OE-A) is characterized by bigger measurement volume than a classical coaxial open-ended probe (OE) making it applicable in agrophysics. However, the upper limit frequency of the OE-A is smaller than its classical counterpart [Kafarski et al., 2018]. Numerical simulations for different lengths of the central rod of the OE-A probe in various dielectric materials using Ansys HFSS software were performed in order to estimate its measurement frequency range. The length of the central rod was changed at 10 mm increments from 20 mm to 70 mm. The obtained S11 parameters enabled us to determine the dielectric spectrum of analyzed materials [Wagner et al., 2013] by dedicated MATLAB procedures. Our preliminary results contribute to the design of a mobile registration system of soil moisture and salinity and to the creation of the corresponding soil maps, ensuring effective and balanced irrigation and fertilization of field crops.

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Poster presentations

Effects of Vermicompost Application on Physiological and Merphological Triats of *Medicago rigidula* L. , *Medicago polymorpha* L. and *Onobrychis sativa* L.

Akhzari, A.

Associate Professor, Department of Watershed and Rangeland Management, Malayer University, Malayer, Iran, E-mail: akhzari@malayeru.ac.ir, d_akhzari@yahoo.com

The use of bio-fertilizers may due to heavy metals immobilization in the soil. This research has been conducted based on a factorial experiment in a completely randomized design with four replications in Malayer University. Pots contained a mixture of soil and different amounts (0 and 60% by weight) of vermicompost as bio fertilizer. Plants exposed to cadmium nitrate concentrations (0, 4 and 8 mmol per kg). The results showed that by increasing the concentration of cadmium root length and plant height significantly (P <0/05) decreased. The effect of Cadmium ion vermicompost fertilizer on root to shoot ratio was significant at the 5% level. The highest value of root to shoot ratio was 69 seen in Cd1V1 treatment. The maximum and minimum numerical value of total protein and survival capacity were seen Cd1V2 and Cd3V1 treatments. Translocation Factor (TF) significantly decreased by use of vermicompost fertilizer. The highest root concentration factor (RCF) of Cd was found in V1×Cd2 as compared to the other treatment levels. Generally, tolerance index (TI) values of all studied plants were significantly higher in the lower cadmium concentrations. Also compare the performance of three studied plants showed that *Medicago rigidula* compared to other species had higher survival capacity, tolerance, Translocation Factor, protein content and higher growth capacity in the presence of cadmium ion and fertilizer.

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Pre-sowing treatment with stationary magnetic fields on triticale (*X Triticosecale Wittmack*): effects on early growth stages

Álvarez, J.[1], Martínez, E.[2], Carbonell, MV.[3], Flórez, M.[4]

[1] Universidad Politécnica de Madrid, ETSIAAB, Av. Puerta de Hierro, 2 28040 Madrid, jose.alvarez.sanchez@upm.es

[2] Universidad Politécnica de Madrid, ETSIAAB, Av. Puerta de Hierro, 2 28040 Madrid, elvira.martinez@upm.es

[3] Universidad Politécnica de Madrid, ETSIAAB, Av. Puerta de Hierro, 2 28040 Madrid, victoria.carbonell@upm.es

[4] Universidad Politécnica de Madrid, ETSIAAB, Av. Puerta de Hierro, 2 28040 Madrid, mercedes.florez@upm.es

The objective of this study was to evaluate whether the static magnetic field induction has any impact on the initial growth of triticale seedlings. It may have an immediate effect on the agriculture practice, because of the possible faster growth of seedlings coming from treated seeds.

1100 seeds were exposed prior to sowing to either 125 or 250 mT magnetic field inductions generated by permanent ring magnets during different times (1,10 and 20 min, 1 and 24 hours). The experiment was carried out under laboratory conditions.

Growth was measured in terms of seedling length. All plants exposed to magnetic fields grew higher than control, although most significant differences were obtained for seeds exposed more than 1 hour. On the 6th day the greatest increases were obtained for P10 (24 hours treatment) 138.28±2.40 mm and P8 (20 min) 125.96±4.64 mm when compared with control (82.26±4.43 mm).

The use of electromagnetic stimulation-based methods may be a helpful way to improve seed growth, not only because of avoiding the emission of toxic gases or liquids and other hazardous materials, but of being an inexpensive method as well.

Tillage method assessment on soil biological properties under maize grown in latosolic red soils of southern China

Asenso, E.[1], Li, J.[1], Hu, L.[2], Issaka, F.[3], Tian, K.[1] L. Zhang, K.[1], Zhang, L.[1] Chen, H.[2]

[1] College of Water Conservancy and Civil Engineering, South China Agricultural University, Guangdong 510642, China, evansasenso@yahoo.com

[2] College of Engineering, South China Agricultural University, Guangdong 510642, China

[3] College of Natural Resource and Environment, South China Agricultural University, Guangdong 510642, China

Human activities have been a significant driver of environmental changes with tremendous consequence for soil biological activities. Based on the hypothesis that soil biological activities and maize yield components should be affected by different tillage methods, a field experiment was conducted to assess subsoiling (SS), two passes of rotary tillage (2RT), two passes of rotary tillage + subsoiling (2RTSS), and zero tillage (ZT) on biological activities and its effects on maize yield in latosolic red soil of southern China in 2016 and 2017. ZT treatment recorded the highest levels of bacterial and actinomycetes in 0-40 cm soil depth, whilst SS treatment increased the fungal count and also a higher concentration of soil urease, catalase and acid phosphatase in 0-40 cm soil depth respectively in both years. Also, maximum grain yield, dry matter, harvest index and 1000-grain weight were recorded under SS treatment. Overall, although ZT facilitated more bacteria and actinomycetes, soil with ZT had lower soil enzymatic activities, fungal count and maize yield components compared to SS treatment, and therefore SS treatment could be exploited as a strategy for soil health and productivity resulting in a sustainable agricultural system.

Changes in soil physical properties of a biochar amended soil

Barna, Gy.[1], Makó, A. [1], Skic, K.[2], Horel, Á.[1]

[1] Institute for Soil Science and Agricultural Chemistry, Centre for Agricultural Research, Hungarian Academy of Sciences, H-1022 Budapest, Herman Ottó út 15., Hungary; gyongyi.barna@rissac.hu

[2] Institute of Agrophysics, Polish Academy of Science, Doświadczalna 4, 20-290 Lublin, Poland, kskic@ipan.lublin.pl

In this study we investigated the soil physical and structural changes caused by woodchip biochar addition to silt loam soil. We predominantly studied the changes in particle size distribution, specific surface areas, bulk density, hydraulic conductivity, aggregate stability, aggregate size distribution, and water vapour adsorption. Our first results about surface area measurements are presented.

Soil samples were collected from a silt loam arable soil (eroded Alfisol) from the upper 28 cm. The soils were amended with different amount of biochar (control, with 0.5% BC, 2.5% BC, and 5.0% biochar, by weight). *Capsicum annuum* (green pepper) were planted in pots at a two to four leaf stage and sacrificial pots were disassembled at week 6, 10, and 12, during different phenological phases (plant growth, fruit development, harvesting). Experimentally measured adsorption isotherms were used to evaluate the specific surface area and the amount of adsorbed water vapour. Hygroscopic water content was measured according to Hungarian standard. BET-surface area of samples were determined by N_2 adsorption.

In overall, we found that biochar addition to the soil reduced the rate of hygroscopic water content. Biochar addition increased the BET-surface for all treatments compared to control measurements at the start of the experiment. Our study emphasizes that biochar has significant effects on the soil specific surface area, but these effects can be modified during the plant growth phases by the structure destructive processes of irrigation/precipitation, or by the structure improve efforts of mycorrhiza, hypha or roots.

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VIS-NIR spectroscopy of organic soils: soil properties prediction and classification

Debaene, G., Niedźwiecki, J., Smreczak B.

Institute of Soil Science and Plant Cultivation – State Research Institute, 8 Czartoryskich Str., gdebaene@iung.pulawy.pl

Visible and near-infrared (VIS-NIR) spectroscopy is a rapid, non-invasive and inexpensive technique for characterizing soils and can be used to analyze several constituents simultaneously. The method has proven to be a reliable tool for the prediction of several mineral soil properties at different scales (Stenberg et al., 2010; Debaene et al., 2014a). The method is also promising to classify mineral soils (Ben-Dor et al., 2008; Debaene et al., 2014b). However, very little is known about the potential of the method with organic soils (peat, muck, gyttja). In this paper, we are presenting preliminary results of the investigation of more than 300 soil samples that were scanned using a spectroadiometer (PSR-3500m Spectral Evolution, MA, USA) in the 350-2500nm range. The method seems suitable for the prediction of C_{tot}, N_{tot} or soil organic carbon (SOC) using partial least-square (PLS) regression with R^2 ranging from 0.7 and 0.8 and RMSE ranging from 2% to 5% for C and 0.2% to 0.4% for N. Classifying samples according to the level of organic matter degradation is possible. The spectra also clearly clustered samples according to the type of soil (peat, muck, gyttja, mineral soils with high SOC content).

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Biochar-added composts – properties and impact on soil characteristics

Dróżdż, D.[1], Kot, P.[2], Malińska, K.[3]

[1] Częstochowa University of Technology, Institute of Environmental Engineering, d.drozdz@is.pcz.pl*presenter

[2] Częstochowa University of Technology, Institute of Environmental Engineering, iis@is.pcz.pl

[3] Częstochowa University of Technology, Institute of Environmental Engineering, kmalinska@is.pcz.pl

The beneficial effects of biochar as a soil improver on soil properties and plant growth and yield have been demonstrated by numerous studies. However, it has been pointed out that the application of biochar to soil can cause some problems related to the increase in soil pH and the concentration of heavy metals. Also, it was observed that immobilization of nutrients for plants can occur - this, in turn can impair the nutrient uptake by plants (Rees et al., 2015; Xu et al., 2016). Therefore, this is recommended to use biochar in combination with composts of biochar-based composts as a relatively cost-efficient solution for improvement of soil fertility and remediation of contaminated soils. The overall goal of this study was to investigate the properties of composts obtained from sewage sludge and straw mixtures amended with different ratios of biochar and the impact of those composts on soil properties. The scope of the work included: (1) physical and chemical analysis of biochar-based composts, (2) preparation of soil combinations with selected amendments (biochar-based compost and biochar), (3) physical, chemical and phytotoxicity analysis of the investigated soil combinations. The obtained results showed that the composts obtained from composting of sewage sludge mixed with straw and amended with wood derived biochar can be used as soil improvers as they comply with the requirements for soil improvers. Soil amended with biochar-based composts demonstrated higher content of organic matter and organic carbon, and also higher values of pH and CE. The phytotoxicity test demonstrated that the addition of biochar-based composts was safe for plants.

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Potentials of nutrient recovery from fish pond sediments from fresh water systems in Poland

Dróżdż, D.[1], Malińska, K.[1], Mazurkiewicz, J.[2], Kacprzak, M.[1], Mrowiec, M.[1], Szczypiór, A.[1], Postawa, P.[3], Stachowiak, T.[3]

[1] Częstochowa University of Technology, Faculty of Infrastructure and Environment, Institute of Environmental Engineering, d.drozdz@is.pcz.pl*presenter

[2] Poznań University of Life Science, Institute of Biosystems Engineering

[3] Częstochowa University of Technology, Faculty of Mechanical Engineering and Computer Science, Department of Polymer Processing

In the last 40 years there has been a gradual increase in global production of fresh fish from aquaculture at the average rate of 8.8% annually (Haque et al., 2016). This increase in fish production results in the accumulation of fish pond sediments. These sediments lead to reduction of pond depth and space available for fish and also depletion of dissolved oxygen. Therefore, the removal of the sediment from fresh water ponds is crucial for pond maintenance, and thus economical fish production. Fish pond sediments are rich in nutrients and organic matter, and thus can demonstrate potential as fertilizers in crop production, nursery pot culture, etc. However, fish pond sediments contain compounds that undergo rapid degradation producing unpleasant odours. Therefore, they need to be managed and handled rapidly in the environmentally sound and sustainable manner. Promising technologies for converting fish pond sediments into fertilizers include composting and vermicomposting with the selection of appropriate type and rate of bulking agents (Kouba et al, 2018). There is little known about the management of fish pond sediments from fresh water ponds in Poland and the potentials for recovery of nutrients through bioconversion processes and the properties of fertilizers obtained from fish pond sediments. The overall goal of this study was to analyze (1) the current state and management practices of fish pond sediments generated in the existing aquaculture systems in Poland and (2) the potentials for recovery of nutrients through bioconversion processes to organic fertilizers.

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Kouba A., Lunda R., Hlaváč D., Kuklina I., Hamáčková J., Randák T., Kozák P., Koubová A., Buřič M. 2018. Vermicomposting of sludge from recirculating aquaculture system using Eisenia andrei: Technological feasibility and quality assessment of end-products. Journal of Cleaner Production 177, 665-673

Influence of electromagnetic stimulation of seeds on the photosynthetic indicators in *Medicago sativa* L. leaves in various stages of development

Dziwulska-Hunek, A.[1], Ćwintal, M.[2], Kornarzyńska-Gregorowicz, A.[1]

[1] University of Life Sciences, Department of Physics, Akademicka 13, 20-950 Lublin, Poland, agata.dziwulska-hunek@up.lublin.pl, agnieszka.kornarzyńska@up.lublin.pl

[2] University of Life Sciences, Department of Plant Production Technology and Commodity Science, Akademicka 15, 20-950 Lublin, Poland, marek.cwintal@up.lublin.pl

The paper explores the impact of electromagnetic stimulation of Ulstar alfalfa seeds on the quantum efficiency of the plants' photochemical reactions and the content of photosynthetic pigments in leaves. Before sowing, seeds were subjected to electromagnetic stimulation in the following configurations: control (C) - no stimulation; stimulation with He-Ne laser light with the wavelength of 632.8 nm and surface power density of 3 $mW \cdot cm^{-2}$ and exposition time of 1 minute (L1) and 5 minutes (L5); stimulation with alternating magnetic field with the induction of 30 mT and exposition time of 1 minute (P1) and 5 minutes (P5). In the respective years and stages of vegetation, both increase and decrease of photosynthetic efficiency, electron transport rate (ETR), and content of photosynthetic pigments was observed following electromagnetic stimulation. In terms of photosynthetic efficiency, the best results were observed for L1 and P5, respectively: 0.801 and 0.800. The significantly highest values in terms of chlorophyll a and b and carotenoid content were observed in 2014 at the onset of budding in the combination involving alternating magnetic field stimulation (P5), and were respectively: 30%, 28% and 73% relative to the control.

Assessment of the fungal communities of soil amended with spent mushroom substrate and chicken manure using comparative molecular approaches

Frąc, M., Pertile, G., Panek, J., Gryta, A., Oszust, K., Lipiec, J., Usowicz, B.

Institute of Agrophysics, Polish Academy of Sciences, Doświadczalna 4, 20-290 Lublin, Poland, * e-mail: m.frac@ipan.lublin.pl

The use of exogenous organic matter is recommended for sustainable agriculture rather than mineral fertilization. The use of spent mushroom substrate (SMS) and chicken manure (CM) is an environmentally friendly technique of soil quality management that also maintain soil organic matter content. Although, these types of organic amendments were extensively evaluated as a promising strategy to improve soil properties, there is a lack of information about fungal biodiversity abundance and structure in soils amended with spent mushroom substrate and chicken manure. In this study the responses of soil fungal microbiome to 20 years application of these organic amendments (SMS, CM) with including no amended control soil (C) were evaluated. To investigate the effects of organic amendments on soil fungal communities we used a combined qPCR, DGGE, t-RFLP and NGS approach.

The incorporation of SMS and CM caused increase of the fungal abundance. Sordariomycetes, Tremellomyceste and Mortierellomycotina were the most abundant classes in all soil treatments. However, Tremellomycetes and Pezizomycetes increased in soil amended with SMS, while Mortierellomycotina and Dothiomycetes in CM treatments. The abundance of operational taxonomic units (OTUs) of potential crop pathogens decreased in soil treated with SMS and CM. The results provide novel insight into the fungal community associated with soil organic amendments connected with the organic additives important in management of soil fungal microbiome, crop protection and productivity.

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Evaluation of the impact of the thresholding errors on X-ray CT imaging based estimation of saturated water conductivity

Gackiewicz, B., Lamorski, K., Sławiński, C.

Institute of Agrophysics, Polish Academy of Sciences, ul. Doświadczalna 4, 20-290 Lublin, Poland, b.gackiewicz@ipan.lublin.pl

X-ray computational tomography (CT), as a technique which allows for direct observation of the pore-space in soil cores, is gaining increasing popularity in soil studies. CT results are also useful for investigation of the soil transport processes e.g. estimation of the saturated water conductivity (SWC). All of the CT related soil studies rely on image analysis procedures which commonly start from thresholding step in which pore-space is distinguished from soil matrix. However, thresholding of soil CT images are prone to errors which leads to uncertainty in values of soil characteristics deduced from them e.g. total porosity, specific surface or simulated SWC.

The aim of the study is to compare simulated SWC, total porosity and specific surface values obtained from two thresholds estimated to evaluate impact of the thresholding errors. For this purpose four soil cores were scanned and 3D image of samples was thresholded using two different algorithms. Total porosity and specific surface were determined for binarized images. For the same images SWC was numerically estimated using Navier-Stokes equation based modelling. The study shows that erroneous thresholding step lead to uncertainty in determination of soil pore system characteristics and SWC estimation. The least relative error in the total porosity determination in our study was 15% and the maximum was 40%.

The results of the study demonstrate that errors related to thresholding may have huge impact on estimation of saturated hydraulic conductivity in soils easily reaching relative error 50% of SWC reference value. Even small shifts in the threshold level can cause huge change in SWC estimation. For instance threshold shift by 6.7% for one of samples analyzed in the study caused more than two-fold increase in the estimated value of saturated hydraulic conductivity.

Determination of the effects of different tillage systems on soil in terms of changes in dehydrogenases activity and readily dispersible clay and particulate organic matter contents

Gajda, A.M.[1], Czyż, E.A.[2], Furtak, K.M.[1]

[1] Institute of Soil Science and Plant Cultivation State Research Institute, Department of Agricultural Microbiology, Czartoryskich Street 8, 24-100 Puławy, Poland, e-mail: ag@pulawy.pl

[2] Rzeszów University, Department of Soil Science, Environmental Chemistry and Hydrology, Faculty of Biology, Zelwerowicz Street 8b, 35-601 Rzeszów, Poland, e-mail: ewac@ur.edu.pl

The good soil structure and soil quality depend on the content of organic matter and microbial activity in the soil, i.e. the friendly conditions for the development, abundance and species composition of the microbial communities and enzymatic activity. The development of microorganisms in the soil exert a great impact both its physical and chemical properties as well as fertilization and agrotechnical factors. The aim of the research was to determine changes of the activity of soil dehydrogenases and content of readily dispersible clay (RDC) and particulate organic matter fraction (POM) as the effects of various soil tillage systems. The research (2015-2017) was carried out on a long-term field experiment at ES of IUNG-PIB in Grabów (Mazowieckie Province, Poland). Winter wheat was grown in a reduced and traditional tillage system. Determinations of soil dehydrogenases activity was made according to the Polish Standard PN–EN ISO 23753–1, 2011 method. RDC content in soil was measured in ten replicates for each farming system separately using a HACH turbidimeter model 2100 (Czyż and Dexter 2015). POM content was quantified according to the method of Cambardella and Elliott (1992) in modification given in Gajda et al. (2001). Statistical analyses of the obtained results were made using the ANOVA method. Differences were considered as significant at $P \leq 0.05$. The obtained results showed that reduced tillage system influenced positively soil environment, which was reflected in the higher soil dehydrogenases activity, higher content of POM fraction and lower RDC content as compared with the values of these parameters obtained for soil under traditional tillage system.

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Changes in soil quality and metabolic microbial diversity in soil under different crop production systems

Gajda, A.M.[1], Czyż, E.A.[2], Furtak, K.M.[1]

[1] Institute of Soil Science and Plant Cultivation State Research Institute, Department of Agricultural Microbiology, Czartoryskich Street 8, 24-100 Puławy, Poland, e-mail: ag@pulawy.pl

[2] Rzeszów University, Department of Soil Science, Environmental Chemistry and Hydrology, Faculty of Biology, Zelwerowicz Street 8b, 35-601 Rzeszów, Poland, e-mail: ewac@ur.edu.pl

Microbial communities play an important role in agricultural soils due to their involvement in many soil processes as nutrients transformation and release, soil degradation control and many other soil functions in ecosystem. The effects of different farming systems on soil health and quality including microbial community traits have been revealed. The aim of the research was to determine changes of soil labile organic matter content, dehydrogenases activity and diversity of soil microbial communities as the effect of various crop production systems. The research (2016-2017) was carried out on a long-term field experiment at ES of IUNG-PIB in Osiny (Lubelskie Province, Poland). Winter wheat was grown in a organic and conventional crop production systems. POM content was quantified according to the method of Cambardella and Elliott (1992) in modification given in Gajda et al. (2001). Determination of soil dehydrogenases activity was made using the Polish Standard PN–EN ISO 23753–1, 2011 method. Microbial metabolic diversity was assessed using Biolog EcoPlate method. Statistical analyses of the obtained results were made using the ANOVA method and Statistica ver. 10.0 software (Stat. Soft Inc., Tulsa, OK, USA). Differences were considered as significant at $P \leq 0.05$. The results discovered that soil under organic crop production system showed higher soil dehydrogenases activity, higher content of POM fraction and higher microbial metabolic diversity as compared with conventional system. The organic crop production system much better maintained SOM and thus soil quality compared to conventional.

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Assessment of genetic and functional diversity of bacterial community in soils long-term contaminated with crude oil

Gałązka, A.[1], Grządziel, J.[1]

[1] The Institute of Soil Science and Plant Cultivation – State Research Institute, Department of Agricultural Microbiology, 24-100, Pulawy, Poland; e-mail: agalazka@iung.pulawy.pl;

The aim of the study was to evaluate functional and structural diversity of bacteria in soils long term contaminated with crude oil and also to identify the main groups of bacteria that could be indicators of changes in the soil under the influence of pollution. The significant differences of bacterial community structure between soils were obtained. The soils taken directly from oil wells were characterized by different composition of bacteria. The next generation sequencing technique (V3-V4 16S rRNA) was accompanied with the community level physiological profiling (CLPP) method in order to better understand knowledge of both genetic and functional structure of soils collected under several oil wells. The highest activity of carbon utilization patterns were observed in soils taken directly from oil wells. Also the highest biodiversity indexes were observed in these soils. The Alphaproteobacteria, Betaproteobacteria, Gammaproteobacteria were strongly correlated with biological activity in soils taken directly from oil wells. Also some family of Alphaproteobacteria were dominant in soil taken directly from oil wells: Bradyrhizobiaceae, Rhizobiaceae, Rhodobacteraceae, Acetobacteraceae, Hyphomicrobiaceae and Sphingomonadaceae. The study clearly proved that the long term contamination of soil may change bacterial community structure and their metabolic activity and help to develop completely different group of bacteria.

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Assessment of the metabolic diversity of microorganisms and glomalin contents as a soil environmental quality indicator

Gałązka, A.[1], Gawryjołek, K.[1]

[1] The Institute of Soil Science and Plant Cultivation – State Research Institute, Department of Agricultural Microbiology, 24-100, Pulawy, Poland; e-mail: agalazka@iung.pulawy.pl

Soil microbial community and their diversity under maize growth in different cultivation techniques were determined using Biolog EcoPlates and other microbial and biochemical methods used for the determination of soil properties (Gałązka & Grządziel, 2018). Comparisons of the patterns of substrate utilization and the diversity indexes showed differences in community composition of microorganisms related to different cultivation techniques and seasons (Gałązka et al, 2017a, 2017b). The soil samples collected in spring were characterized by statistically significant lower indexes of biological activity in comparison to the soil collected from the flowering stage of maize. The soils collected in spring from the plots with full tillage as the cultivation technique were showing similarly high biological activity as soils obtained from maize flowering season. The principal component of PCA analysis, showed the strong correlation between the parameters of soil quality and biodiversity indicators. Selected indicators of soil microbial diversity explained 71.51% of biological variability in soils. Based on the PCA analysis two major groups of soils have been indicated. The season was the main differentiating factor (spring and summer). The yield of grain was 22% higher in the rotation tillage system than of direct sowing tillage system.

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Germination energy and capacity of maize seeds following low-temperature short storage

Kluza, F., Domin, M., Góral, D., Kozłowicz, K., Blicharz-Kania, A.

University of Life Sciences in Lublin, Department of Biological Bases of Food and Feed Technologies, Doświadczalna 44, 20-280 Lublin, Poland, franciszek.kluza@up.lublin.pl, marek.domin@up.lublin.pl, dariusz.goral@up.lublin.pl, katarzyna.kozlowicz@up.lublin.pl, agata.kania@up.lublin.pl

The present researches have attempted to characterize the effect of low temperatures and moisture content of maize (*Zea mays* var. Kosmo 230, a commercial F1 hybrid) meant for sowing on its energy and capacity to germinate. Its germination capacity reached 98% and thousand seed weight 368.0 g. Seeds were moistened to varying degrees (15, 20, 25 or 30%), stored under various conditions and then their germination energy and capacity assessed. Moisture content was determined using the dryer method as per ICC standard. Appropriately moistened seeds were placed for 1, 3, 5, or 10 days at the temperature 0, -5, -10, -15, -20, or -25°C. Germination was conducted in eight batches according to the ISTA standard. Seeds were planted directly after being stored at the preset temperature. They were covered with a 0.5 cm layer of sand without compacting to ensure adequate air supply. Thus prepared, the samples were put in a room at the temperature ranging between 20°C and 30°C. The tests, carried out as per ISTA, concerning the examination of seeds for planting have not indicated any statistically significant effect of light on germination. The sowing material with 15% moisture content showed slightly declined germination ability when stored at -25 - -20°C for over three days, while the storage of seeds with a 25 and 30% moisture content at -5 – 0°C for 1 - 3 days had the effect of seed conditioning. Seedlings obtained from conditioned seeds grow more quickly and demonstrate nearly twice the size of other plants. . It was observed that warehousing and storage of grains with a lower as 15% moisture at temperatures up to -25°C do not significantly affect seed germination capacity and energy.

The assessment of soil respiration under willow, triticale and oilseed rape

Górnik, A., Matyka, M., Witorożec A.

Institute of Soil Science and Plant Cultivation – Stare Research Institute,Czartoryskich 8, 24-100 Puławy, agornik@iung.pulawy.pl

The subject of the carbon cycle in nature and the measurement of CO2 streams released between the soil and the atmosphere are gaining more and more importance (Canadell J.P. et al. 2004, Climate Change 2001). The states of the United Nations signed the United Nations Framework Convention in 1992 on the stabilization of Green House Gases content in the atmosphere. Due to the fact that it is necessary to reduce greenhouse gas emissions, Poland has committed itself to introducing a Climate Policy, one of the fundamental obligations of which is to conduct scientific research on the subject of climate change (Polityka Klimatyczna Polski 2003).

Different agroecosystems are characterized by the variability of respiration over time (Hendrix et al., 1988). Soil respiration have variabilities due to the different cropland management and can significantly affect on carbon cycle in the biosphere (Quan Zhang et al., 2013).

The experiment was carried out at the farm in Sadłowice (Lubelskie woivodeship) from april to september, one day a week. The measurement trial was conducted from dawn to dusk in years 2016 and 2017. The duration of carbon dioxide flux measurement was set at 3 minutes and has placed in 30 minutes intervals by using automated CO2 gas stations ACE.

Data analyzing shown high daily and seasonal variability of CO2 emission during soil respiration. It was found that willow crop has lower emission than triticale and rape crops: 30%; 38% respectively. High average daily gas exchange were noticed on 18th of April, in May and the turn of August and September. Low average daily gas exchange were noticed at 7th and 25th of July. From the 7th till 27th of September soil CO2 gas exchange has decreased.

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Simple, insensitive to environmental matrix interferences method of trace cadmium determination in natural water samples

Grabarczyk, M., Adamczyk, M.

Maria Curie-Sklodowska University, Chemical Faculty, Department of Analytical Chemistry and Instrumental Analysis, M. Curie-Sklodowskiej Sq. 3, 20-031 Lublin, Poland, mgrabarc@poczta.umcs.lublin.pl, marzena.adamczyk@poczta.umcs.lublin.pl

Cadmium is present in virtually all foods, but the concentrations vary to a great extent, depending on type of food and level of environmental contamination. Cadmium in environment is derived from both natural and anthropogenic sources. The most important anthropogenic sources of cadmium are smelters, burning fossil fuels such as coal or oil and incineration of municipal waste such as plastics and nickel-cadmium batteries. Therefore, it is necessary to monitor the environment for cadmium content.

Electrochemical methods such as anodic stripping voltammetry (ASV), have been used to direct measure the trace concentrations of metal ion in environmental water samples, such as rainwater, river water, and wastewater. The ASV technique is relatively simple, fast, and inexpensive. However, the limitations of this technique are due to interferences from organic matrix of environmental samples, such as surface active substances. In the literature data a number of ASV procedures for trace cadmium determination have been developed, however in most of them, the effect of surfactants has not been studied.

In this communication the proposition of the simple and insensitive to surface active substances ASV procedure of Cd(II) determination is given. In the proposed paper, first of all the impact of different surface active substances was precisely examined. In the case of interfering surfactants the simple and fast procedure of their elimination was proposed. For this purpose the adsorptive properties of Amberlite XAD resin was exploited. The resin was added directly to measuring cell, so the total measurement time did not extend. The developed procedure allows the determination of trace concentrations of cadmium in environmental samples containing even high concentrations of different kinds of surfactants. To prove the practical applicability of the proposed procedure it was successfully tested for the direct determination of cadmium in a real non-pretreated water samples collected from Eastern areas of Poland.

Simple, fast and cheap simultaneous quantification of Ga(III) and In(III) by adsorptive stripping voltammetry in environmental water samples

Grabarczyk, M., Adamczyk, M.

Maria Curie-Sklodowska University, Chemical Faculty, Department of Analytical Chemistry and Instrumental Analysis,, M. Curie-Sklodowskiej Sq. 3, 20-031 Lublin, Poland, mgrabarc@poczta.umcs.lublin.pl, marzena.adamczyk@poczta.umcs.lublin.pl

The need for procedures for simultaneous determination of gallium (Ga(III)) and indium (In(III)) in environmental samples stems from the fact that both elements are essential in high-technology industries, mainly semiconductor manufacture and electronic devices, in liquid crystal display screens (LCDs) used in computers, games, and CD/DVD players, flat panel displays and solar cells.

Simultaneous determination of Ga(III) and In(III) has risen considerable interest, and is commonly conducted by spectrometric methods, requiring expensive instruments. Voltammetric procedures can be an attractive alternative for simultaneous determining of Ga(III) and In(III), and therefore our research aimed at developing a simple and fast adsorptive stripping voltammetric (AdSV) procedure of simultaneous determination their concentrations. Important issue in voltammetric measurement is the choice of friendly for laboratory environment working electrode. We exploited in situ plated bismuth film electrode as fast and easily prepared working electrode for simultaneous determination of Ga(III) and In(III) by AdSV. On the basis of the measurements carried out, the optimal conditions for simultaneous determination were selected for obtaining sensitive and well-separated signals on the voltammogram simultaneously for the two elements. The results of the analysis of water samples collected from Eastern of Poland indicate promising applications of the used protocol.

Development of a technology of innovative microbiologically enriched mineral fertilizers – objective and general concepts of the project

Gryta, A., Frąc, M., Oszust, K., Pertile, G.

Institute of Agrophysics, Polish Academy of Sciences, Doświadczalna 4, 20-290 Lublin, a.gryta@ipan.lublin.pl

Development of agricultural production is closely linked with the need to comply with the principles of sustainable development, which combine production goals with environmental requirements. This kind of agricultural production, protecting soil and water resources, does not degrade the environment. Most agricultural soils in Poland and the EU are low in organic matter. In this context, it is vital to search for environmentally friendly methods of increasing the organic matter and humus content in agricultural soils, which will increase their biological activity, water content and sorption capacity, and improve the soil structure and gas exchange between the soil and atmosphere.

The aim of the project is to develop innovative microbiology enriched biofertilizers and to assess the effects of their use in crop production and in improving the bio-physico-chemical properties of arable and degraded soils. The task of Institute of Agrophysics, Polish Academy of Sciences is to study the influence of biofertilizers on microbiological, chemical and physical properties of degraded soils. The biofertilizers will be produced by combining selected mineral fertilizers with precisely characterized beneficial microorganisms with well-defined properties in the stimulation of the growth and yield performance of crop plants and improvement of the productivity of soils.

The project is expected to enable development of effective and safe biofertilizers for stimulating the growth and yield performance of crop plants and for improving the fertility and productivity of degraded soils. Development of the above technologies should contribute not only to the determination of the effects associated with the use of these biofertilizers but also to the development of rules for using in sustainable production of plants. An important aspects of the project is to determine the bio-physico-chemical parameters of degraded soils and to evaluate the influence of developed biofertilizers in reducing this phenomenon and improving the soils quality.

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Stimulatory impact of ash on sorghum plant physiological activity and development

Grzesik, M.[1], Janas, R.[1], Romanowska-Duda, Z.[2]

[1] Department of Nursery and Seed Research, Research Institute of Horticulture, Str. Konstytucji 3 Maja 1/3, 96-100 Skierniewice, Poland. Mieczyslaw.Grzesik@inhort.pl, Regina.Janas@inhort.pl

[2] Laboratory of Plant Ecophysiology, Faculty of Biology and Environmental Protection, University of Lodz, Str. Banacha 12/16, 92-237 Lodz, Poland, romano@biol.uni.lodz.pl;

The aim of research was to investigate the impact of the applied to soil ash, from burnt biomass of sorghum and Jerusalem artichoke, on *Sorghum bicolor* L. plant physiological activity and development, in order to see its suitability as fertilizer in the production of energy crops. The experiments were conducted both, in Phytotoxkit–plates in controlled conditions of vegetation rooms and outdoor in pots on container area. The commercial seeds of *Sorghum bicolor* L. were sown in Phytotoxkit-plates filled with substrate contained 0-100% of ash from burnt sorghum and Jerusalem artichoke plants or outside to pots filed with soil fertilized with these both ashes in doses of 0.6 - 4.8 t ha^{-1}. The seed germination dynamics and growth rate of roots was assessed on the base of daily measurements in Phytotoxkit-plates. During plant development in laboratory conditions and outdoor, the growth rate of shoots was periodically evaluated and the physiological activity was assessed by measuring index of chlorophyll content in leaves, gas exchange (net photosynthesis, transpiration, stomatal conductivity, intercellular CO2 content), enzyme activity (alkaline and acid phosphatase, RNase, total dehydrogenase) and at the end of growth – fresh and dry biomass.

The obtained results showed that the supplementation of soil with both studied ashes improved seed germination and plant development and thus they can be used, as fertilizers in sorghum cultivation. Although their effectiveness depends on ash properties, depending of burnt biomass, and their dosages. Ashes added to soil at the proper doses increased seed germination, health and growth rate of plant, fresh and dry biomass yield of roots and shoots, as well as gas exchange and enzyme activity in leaves, as compared to the control. In Phytotoxkit-plates the fastest growth was observed in substrate containing 2-5% of ash while outdoor in pots when soil were supplemented with dose of 2.4 t ha^{-1}.

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Investigating differences in fluid conductivity and effective porosity in organic liquid (DUNASOL 180/220)-soil and water-soil systems using soil physical indicators

Hernádi, H.[1], Barna, Gy.[2], Makó, A.[2]

[1] University of Pannonia, Georgikon Faculty, 8360 Keszthely, Deák F. str. 16. Hungary, e-mail: hhilduci@gmail.com

[2] Institute for Soil Science and Agricultural Chemistry, Centre for Agricultural Research, Hungarian Academy of Sciences, 1022 Budapest, Herman Ottó út 15. Hungary.

Flow and transport of nonaqueous phase liquids (NAPLs) in unsaturated porous media are generally simulated with models solving Richards equation. Water retention and saturated conductivity are primary input soil hydraulic properties of the simulation. These are commonly determined using parametric methods, fitting various hydraulic functions to measured data. NAPL retention and conductivity are generally calculated indirectly, using scaling methods (Leverett and Kozeny-Carman equation), from primary input properties - in view of fluid properties (viscosity, interfacial tension etc.), assuming ideal porosity.

Derivated normalized form of soil water retention (SWR) functions give opportunity to determine effective porosity (using Laplace-Young equation) and its dynamic changing (disaggregation, swelling-shrinking etc.). In our study a dataset was built from fluid retention (pressure plate apparatus; 0–150 kPa) and saturated fluid conductivity data (falling head method) determined with distilled water and a selected model NAPL, Dunasol 180/220, using 100 cm^3 samples (66 genetic horizon, 75% undisturbed). Dataset contains bulk density, percentage of clay, silt, sand, organic matter and carbonate content, occasionally BET-surface data, respectively. Statistical analysis (SPSS 20.0) was performed to investigate the relationships between soil basic and hydraulic properties, soil physical quality indicators (air capacity values, modal suction, slope at inflection point) and porosity using preliminary analysis methods. Classification regression tree was generated for predicting NAPL conductivity. Our results indicate the possible inaccuracy of scaling methods. All these hydraulic properties and soil physical indices were significantly different between soil-NAPL and soil-distilled water system. These differences were affected the amount and rate of the effective macro-, meso-, micro-, ultramicro-, and cryptopores.

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Three rod TDR probe for measurement of soil moisture distribution

Kafarski, M.[1,2], Wilczek, A.[1], Szypłowska, A.[1], Szerement, J.[1], Lewandowski, A.[3], , Skierucha, W.[1]

[1] Institute of Agrophysics, Polish Academy of Sciences, Doświadczalna 4, 20-290 Lublin, Poland, m.kafarski@ipan.lublin.pl

[2] The State School of Higher Education in Chełm, Pocztowa 54, 22-100 Chełm, Poland

[3] Warsaw University of Technology, Institute of Electronic Systems, Nowowiejska 15/19, 00-665 Warsaw, Poland, a.lewandowski@elka.pw.edu.pl

Soil moisture and its dynamic changes in the top layer of soil have fundamental importance for climatic, hydrological, biological and biogeochemical processes (Sheng et al., 2017). One of the most popular soil moisture measurement methods is the time-domain reflectometry (TDR) technique (Skierucha, 2000). Measurement of soil moisture distribution requires using several TDR probes (Ito et al., 2010) or insertion of one probe in different places of analyzed soil volume, which can be time-consuming and invasive to soil structure.

The work presents a novel three-rod TDR probe for the measurement of soil moisture gradient using single probe installation. The probe has electronically switched rods, it allows to determine the value and direction of soil moisture gradient during single probe insertion in the soil.

Electromagnetic simulations of the probe placed in materials with different moisture gradient were performed. Simulation results were compared with experimental results.

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Assimilable nutrient content correlation with physicochemical properties of soil

Tkaczyk, P.[1], Bednarek, W.[1], Dresler, S.[2], Krzyszczak, J.[3], Baranowski, P.[3], Kasperski, A.[3]

[1] Department of Agricultural and Environmental Chemistry, University of Life Sciences, Akademicka 15, 20-033 Lublin, Poland, przemyslaw.tkaczyk@up.lublin.pl

[2] Department of Plant Physiology, Institute of Biology and Biochemistry, Maria Curie-Skłodowska University, Akademicka 19, 20-033 Lublin, Poland

[3] Institute of Agrophysics Polish Academy of Sciences, Department of Metrology and Modelling of Agrophysical Processes, Doświadczalna 4, 20-290 Lublin, Poland

The levels of macro- and microelements in soils are subject to constant changes in time, depending on type of the plant cover, quantities of fertilizers used and soil management practices. Thus, the determination of the relationship between soil properties and the content of assimilable macro- and micronutrients is important from practical point of view. To assess the current pHKCl and the supply of basic macro- (P, K, Mg and S-SO_4) and microelements (B, Cu, Fe, Mn and Zn) for Polish soils, focusing on the soils of south-eastern Poland, an environmental studies for various mineral soils, mainly orchard soils and soils under cereal-root crops, were carried out. These studies have included the period of 2008-2014 and various land management practices and cultivars (Tkaczyk et al., 2017). The correlation between assimilable macro- and micronutrients and soil agronomic category, humus content and pH class were calculated. It occurred that soil reaction, humus content and level of macronutrients were positively correlated with the amount of colloidal clay and particles < 0.02 mm. Macronutrient contents were also positively correlated with soil pH and humus content for almost all agronomic categories. It was revealed that significant and positive correlation between the soil agronomic category and the content of manganese, iron and zinc exists. A significant and positive correlation between soil reaction and the content of manganese, iron and boron was also found. On the base on experimental data and derived correlations the models predicting the content of selected macro and microelements were created using multiple regression equations and soft-computing methods.

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The geometric mean of enzyme activities, soil microbial composition and plant growth after biochar application

Mierzwa-Hersztek, M.[1], Klimkowicz-Pawlas, A.[2], Gondek, K.[1], Chmiel, M.J.[3]

[1] University of Agriculture in Krakow, Department of Agricultural and Environmental Chemistry, al. Mickiewicza 21, 31-120 Krakow, Poland, email: monika6_mierzwa@wp.pl, rrgondek@cyf-kr.edu.pl

[2] Department of Soil Science Erosion and Land Protection, Institute of Soil Science and Plant Cultivation-State Research Institute, Czartoryskich 8, 24-100 Pulawy, Poland, email: agnes@iung.pulawy.pl

[3] Department of Microbiology, University of Agriculture in Krakow, al. Mickiewicza 24/28, 30-059 Krakow, Poland, email: maria.chmiel@urk.edu.pl

Soil microorganisms play a key role in many biochemical processes essential for the environment and ecological and production functions of soils, hence they are very important quality indicators (Ducey et al., 2015). The study aimed at evaluating the effect of 1% and 2% additions of wheat (WSB) and *Mishantus gigantus* (MSB) straw biochars (produced at 300ºC) on soil enzymatic activity (dehydrogenases, urease, acid phosphatase, alkaline phosphatase), microbial composition (bacteria, fungi, actinobacteria), and the perennial ryegrass biomass amount. The geometric mean of enzyme activities (GMea) was used as a soil quality index. Pot experiments were carried out on soil with a loamy sand texture. Application of 1% and 2% doses of WSB and MSB significantly increased C and N contents in soil. The 1% addition of MSB had the most beneficial effect on the number of bacteria and fungi (increase by 380% and 26%, respectively), and 1% of WSB on the number of actinomycetes (increase by 273%). The GMea showed an increase in the quality of soils amended with the higher dose of WSB and a lower dose of MSB. The GMea of enzyme activities could be considered as a suitable index to merge the values of various soil enzyme activities in a single numerical value sensitive to soil management practices. The highest perennial ryegrass yield was collected from treatments with 2% additions of both biochars.

Acknowledgements

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Responses of earthworms on compost from *Helianthus tuberosus L.* amended with biochar

Kliszcz, A.

University of Agriculture in Krakow, Mickiewicz Av. 21, 31-120 Krakow, Poland,
angelika.kliszcz@student.urk.edu.pl

Nowadays the one of the simply and fast method for assess the effects of presence of biochar in the soil is measuring the reaction of living part of underground world. The live beings, especially earthworms are tender for harmful substances in the soil. Their fragility is related to the indirectly uptake of nourishment in their alimentary canal, extremely high water-content of their bodies and sensitivity for toxic substances in the soil. On the other hand, many scientists argue that biochar mixed with compost accelerate the biological processes in the soil, especially the microbial part. However, larger organisms may have some troubles with penetrate the biochar-amended medium due to unfavorable conditions (i.e. pH).

In this research the modified Earthworm Avoidance Test as a tool for introductory evaluating the biochar's applicable feature was used and the influence of coniferous-derived biochar mixed with compost from Jerusalem artichoke (*Helianthus tuberosus* L.) on earthworms behavior was assessed.

The earthworms was sampled in 2018 from two-year compost from Jerusalem artichoke. Then 17 specimens were placed in each of the three two-compartment containers along the middle line, between the control side (compost blended with 25% (v/v) addition of sandy soil) and test medium (compost blended with 25% (v/v) addition of biochar). The vessels were incubated at 23,4 °C in laboratory conditions. After 48 hours the separator was inserted along the middle line and the number of animals and fresh weight of each specimen were counted. Due to ISO-17512 procedure the percentage of avoidance was calculated. The results were analyzed statistically using the Statistica. The chemical and physical properties of all materials used was determined.

The results show the strongly avoidance of earthworms (88,2%). However, the average fresh weight of earthworms was increased by 21% after two days of incubation.

Soil-specific drought sensitivity of Hungarian terroirs based on yield reactions of arable crops

Kocsis, M.[1], Dunai, A.[2], Mészáros, J.[3], Tóth, G.[1,4], Makó, A.[5]

[1] Department of Soil Science and Environmental Informatics, University of Pannonia, Georgikon Faculty, Keszthely, Hungary. H-8360, Deák Ferenc street 16.; e-mail: kocsis.mihaly@georgikon.hu

[2] Department of Plant Production and Land Use, University of Pannonia, Georgikon Faculty, Keszthely, Hungary, H-8360, Festetics street 7.; e-mail: dunai@georgikon.hu

[3] Department of Soil Mapping and Environmental Informatics, Institute for Soil Sciences and Agricultural Chemistry, Centre for Agricultural Research, Hungarian Academy of Sciences, Budapest, Hungary, H-1022, Herman Ottó út 15.; e-mail: meszaros.janos@agrar.mta.hu

[4] Department of Soil Science and Environmental Informatics, University of Pannonia, Georgikon Faculty, Keszthely, Hungary, H-8360, Deák Ferenc street 16.; e-mail: toth.gergely@georgikon.hu

[5] Department of Soil Physics and Water Management, Institute for Soil Sciences and Agricultural Chemistry, Centre for Agricultural Research, Hungarian Academy of Sciences, Budapest, Hungary, H-1022, Herman Ottó út 15.; e-mail: mako.andras@agrar.mta.hu

The hypothetical climate change and the stress influences caused by the much more frequently found meteorological extremities affect the fertility of soils in even more degree. During our soil-climate sensitivity researches, the expression of the drought sensitivity as a stress influence and evolved as a result of lack of precipitation in soil fertility was studied. During our work, effect of increasing droughts of last decades were investigated through the yield results of the three most important crops based on the area rate in the Hungarian sowing structure, winter wheat (*Triticum aestivum* L.), maize (*Zea mays* L.) and sunflower (*Helianthus annuus* L.), in relations of the natural geographical subregions and fertility of sites. For the examinations, the yield data National Pedological and Crop Production Database (NPCPD) were used. The database contains complex plot-level crop production and soil information for 5 years (1985–1989). The examination results prove the considerable drought sensitivity of that lands, where soil types with high sand or clay content can be found. The mainly exposed subregions for the effects of drought are e.g. Dorozsma-Majsa-sand ridge, Kerka-region, Dévaványa-plain etc., while less sensitive sites are e.g. Enying-ridge, Tolnai-Sárköz, Nógrád-basin etc.

Changes of soil respiration in natural ecosystems after biochar application

Kubaczyński, A.[1], Walkiewicz, A.[1], Brzezińska, M.[1], Bieganowski, A.[1], Usowicz, B.[2]

[1] Department of Natural Environment Biogeochmistry, Institute of Agrophysics, Polish Academy of Sciences, Doswiadczalna 4, 20-290 Lublin, Poland, a.kubaczynski@ipan.lublin.pl

[2] Department of Metrology and Modeling of Agrophysical Processes, Institute of Agrophysics, Polish Academy of Sciences, Doswiadczalna 4, 20-290 Lublin, Poland

Soil is one of the main components of terrestrial ecosystems. It is considered as a one of the largest sources of greenhouse gases (GHGs) on Earth. Currently, a lot of studies are focused on reducing excessive GHGs emission e.g. by improving properties of soil. Such possibilities are provided by the use of biochar as a soil additive (Kammann et al., 2017). Soil respiration is an important indicator of soil microbial activity, because CO2 emission from the soil can come from microorganisms even in 95% (Ryan & Law, 2005). It is especially important in natural ecosystems, because number and diversity of soil microrganisms is usually higher in soil without anthropopressure. These ecosystems are also more sensitive to external factors than agroecosystems (Li et al., 2018). Under laboratory conditions we tested how biochar application and soil moisture affect soil respiration in samples from natural ecosystems. Our study has shown that the effect of biochar depended on soil water status.

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Stimulation of methanogenesis in coal by microbial community enriched from gyttja

Szafranek-Nakonieczna, A.[1], Pytlak,A.[1], Kubaczyński, A.[2], Stępniewska, Z.[1]

[1] The John Paul II University of Lublin, Institute of Biotechnology, Konstantynów 1i, 20-708 Lublin, anna.szafranek@kul.pl

[2] Institute of Agrophysics, Polish Academy of Sciences, Doświadczalna 4, 20-290 Lublin, a.kubaczynski@ipan.lublin.pl

Dynamic climate change observed over the last decades is attributed to the increase in greenhouse gases concentration in the atmosphere. One of the main sources of both CO_2 and CH_4 is the mining industry. Unfortunately, in many countries (including Poland), coal is the basic source of energy. Greenhouse gases and other pollutants (e.g. dust, sulfur and nitrogen oxides) are released both at the stage of its exploitation and combustion. It is estimated that the mining sector is responsible for nearly 30% of the anthropogenic emissions of greenhouse gases. For years, alternative methods of using natural resources have been sought for allowing their effective use while limiting the adverse impact on the environment. One of the methods is the microbiological gasification of fossil carbons to CH_4. The subject of the presented study was to determine the possibility of methanogenesis stimulation in 9 coals (hard and brown) derived from various Polish coal basins by using microbial community isolated from (gyttja) found within peat soil profile. Microorganisms were propagated on the medium originally developed by Horn et al. (2003) with modifications including diversification of the available carbon sources (CO_2, tryptone, yeast extract and acetate). Three passages of microorganisms were made for each culture. Prior to coal inoculation, the microorganisms were centrifuged and rinsed with mineral medium to avoid the transfer of organic substrates. Control samples were prepared by addition of 2-bromoethanesulfonate (methanogenesis inhibitor). Incubations of bioaugmented coals were carried at temperature from 20 to 40°C. The best effects of stimulation up to 0,011 μM CH_4 g^{-1} $doba^{-1}$ were achieved using microorganisms grown on medium containing organic substrates derived from tryptone and yeast extract and headspace containing H_2:CO_2 (4:1). The results confirm that microbial communities derived from natural wetland ecosystems may be considered as a tool in the environmental biotechnology.

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Bioavailability of barium to plants in soils contaminated drill cuttings

Kujawska, J., Pawłowska, M.

Lublin University of Technology, Faculty of Environmental Engineering, Nadbystrzycka 40B Street, Lublin, Poland, j.kujawska@pollub.pl

Barium sulphate is the basic component of drilling fluids. Due to the constant search for new gas deposits, there is a fear that the bar will appear in the environment and may be exposed in various settings (Shock et al., 2007). In this study the bioavailability and toxicity of Ba in soils with addition drill cuttings was studied using test plant (Lamb et al., 2007). Barium concentration in contaminated solis determined by ICP-method were in the rage 100- 1000 ppm its depend from addition drill cuttings. Barite contaminated soils were shown to negative impact *Trifolium* L. relative to control soil. In *Trifolium* L. concentration Ba in soils with addition drill cuttings were both strongly related to shoot Ba, roof Ba and shoot biomass production. Calculated values of the bioconcentration factor (BCF) for barium showed a limitation of Ba accumulation in plants.

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Organic nitrogen concentration in soils and plants depending on their types, species, cultivars, plant organs, fertilizers and seasons

Kułek, B.

Horticultural and educational services Beata Kułek, Osiedle Przyjaźni 13/92, 61-687 Poznań, Poland, e-mail: B.Kulek@interia.eu

The aim of these studies was to determine the impact of soil type, plant species, cultivars, fertilizers and seasons on the concentration of organic nitrogen in dry mass of soils (Sapek & Sapek, 1997) and plants (Mroczkowski & Cygański, 1983) using spectrophotometric methods. The concentration of this nitrogen form was investigated from spring to autumn in various soil classes (III a, III b, IV a and IV b), species and cultivars of plants - in winter triticale 'Fredro' and 'Sorento', winter rape 'Mickey', winter triticale 'Leontino' with winter wheat 'Mewa' and in white mustard. The type of fertilizer and soil and plant organ had the greatest influence on the concentration of organic nitrogen, while that of species type and cultivar was slightly lower. The greatest organic nitrogen contents in soils and plants were detected after the use of granular urea with ammonium nitrate at the highest dose. The lowest amount of this nitrogen form was found in the soil where ammonium nitrate was applied, while the lowest amount was detected in plants cultivated in the soil fertilized with Polifoska 6. The greatest concentration of organic nitrogen was found in the soil with the highest nutrient contents and the lowest - in the soil with the lowest content of humus. A similar trend was found in the content of organic nitrogen in plants growing on the same soils. The largest accumulation of this nitrogen form was found in plant leaves, smaller - in their grains and the smallest - in the ears. The greatest amount of organic nitrogen was recorded in the leaves of winter triticale 'Fredro' and the lowest in cv. Sorento. The greatest concentration of organic nitrogen was detected in grains of winter triticale 'Leontino' with winter wheat 'Mewa', and the smallest - in winter triticale 'Sorento'. In flowers the highest organic nitrogen levels were recorded in white mustard, lower contents in the ears of winter triticale 'Fredro', and the lowest in the ears of 'Sorento'. The season of the year also had an influence on the amount of organic nitrogen in soils and plants, which was the largest in spring (when the greatest amount of fertilizers was used) and the lowest in summer.

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The activity of nitrate reductase in soils and plants depending on their types, species, cultivars, plant organs, fertilizers and seasons

Kułek, B.

Horticultural and educational services Beata Kułek, Osiedle Przyjaźni 13/92, 61-687 Poznań, Poland, e-mail: B.Kulek@interia.eu

The aim of these investigations was to determine the impact of soil type, plant species, cultivars, organs, fertilizers and seasons on nitrate reductase activity. The activity of the enzyme was tested from spring to autumn in different soil classes and plant species - in winter triticale 'Fredro' and 'Sorento', winter rape 'Mickey', winter triticale 'Leontino' with winter wheat 'Mewa', white mustard and in their various organs (leaves, ears and grains). It was determined with spectrophotometric methods in soils (Kandeler, 1996; Szajdak et al., 2010) and plants (Bandurska et al., 1994) in their dry mass. In soils and plants the activity of the enzyme depended most on the type of fertilizer, while the effect of its dose was much lesser. In soil it was the highest after applying Polifoska 6, the lowest after fertilizing it with ammonium nitrate, while in plants - after fertilization using ammonium nitrate with Polifoska 6 and Polifoska 6, respectively in the month of their application. The activity of the enzyme in plants was higher after fertilizing soil with Polifoska 6 and ammonium nitrate with a lower dose of nitrogen than after fertilization with ammonium nitrate and granular urea at a higher dose. The type of soil also had an influence on the activity of the enzyme. It was the highest in the soil with the highest humus content and the lowest in the soil with the fewest nutrients. The activity of this enzyme in plants depended most on the organ, slightly less on the species and the least on the cultivar. It was the highest in leaves of winter triticale 'Fredro' and the lowest in white mustard. It was high in ears of winter triticale 'Leontino' with winter wheat 'Mewa', and the lowest in winter triticale 'Sorento'. It was the lowest in cereal grains, the highest in winter triticale 'Leontino' with winter wheat 'Mewa' and the lowest in winter triticale 'Sorento'. The activity of nitrate reductase in the case of plants depended on the season of the year and it was the highest in spring and the lowest in autumn.

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The studies were conducted at the Institute for Agricultural and Forest Environment, Polish Academy of Sciences in Poznań, Poland within the framework of the NitroEurope Integrated Project No. 017841 "The nitrogen cycle and its influence on the European greenhouse gas balance", which was a part of the Sixth Framework Programme for Research and Technological Development of the European Union. The participation in the 12th International Conference on Agrophysics: Soil, Plant & Climate - the task financed within the framework of decision and agreement No. 602/P-DUNdem/2018 by funds of the Minister of Science and Higher Education intended for disseminating science and from resources of the company Horticultural and educational services Beata Kułek.

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Influence of physical properties of sugar beet seeds on the work quality planters

Findura, P.[1], Nozdrovický, L.[1], Malaga-Toboła, U.[2], Bajus, P.[1], Kwaśniewski, D.[2]

[1] Department of Machines and Production Biosystems, Faculty of Engineering, Slovak University of Agriculture in Nitra, Tr. A. Hlinku 2, 949 76 Nitra, Slovakia, pavol.findura@uniag.sk

[2] Institute of Agricultural Engineering and Informatics, University of Agriculture in Krakow, Balicka 116B, 30 149 Krakow, Poland, dariusz.kwasniewski@ur.krakow.pl

Biological, physical and technological properties of the sugar beet seed, tillage quality and quality of the seed placement to the soil have a predominant effect on the value and evenness of the sugar beet field emergency. During seeding the distance between two successive seeds in the row depends upon the technical parameters of the planter: type of seeding unit mounting to the frame, forward speed, design and the type of seeding mechanism drive (Jabro et al., 2010).

Measurements were realized in the laboratory and field conditions according to ISO 7256/1 Standard. Field experiments were conducted on loamy-sandy loamy soil where 30 % of soil aggregates were less than 0,01 mm and soil moisture was 19,4 % The experiments were conducted with using of the two types of sugar beet cultivars – Roxana (calibration 3,5-4,75 mm) and Flair (calibration 3,5-4,5 mm) The paper is focused on the comparison of the seeding quality of two type of sugar beet planters equipped with different seeding mechanism. First machine was drills with internal filling of gathering openings and second machine was based on vacuum principle.

Sugar beet planter equipped air under vacuum pressure system has caused bigger damage of the seeds during higher forward working speeds (5,4 %). In case planting mechanical system there was recorded the highest seed damage for working speeds 1,0 -1,5 $m.s^{-1.}$

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Formation of sugar beet harvest in modern conditions of heat and water availability of vegetation period

Lebedeva, M., Solovyov, A., Vagurin, I.

Belgorod State National Research University, 85, Pobedy St., Belgorod, 308015, Russia, vagurin@bsu.edu.ru

Evaluation of the impact of climate change on agricultural productivity is rather relevant for ensuring food security and substantiation of agrarian policy.

The conditions of heat and water availability of the vegetation period of sugar beet in the Belgorod oblast were studied. The source material was the data of meteorological and agrometeorological observations of the Belgorod center of Hydrometeorology and environmental monitoring at 6 stations in the region for the period from 1954 to 2017 and the calculated characteristics for assessing the agricultural productivity of climate.

It is revealed that the yield of sugar beet in the region currently depends on the climatic factor by 15%. The tendencies of sugar content dynamics in the conditions of Belgorod oblast in the connection with the observed climate changes during the reviewed period are determined. The factors that caused the corresponding changes were revealed by the method of the regression analysis. The conducted studies of trends of sugariness for 60-year period in the conditions of the Belgorod oblast showed its nonlinear dynamics

Significant influence on sugar content has a ratio of precipitation and the amount of air temperature in periods with temperatures above 15 and 20°C. Decrease of hydrothermal coefficient (HTC) contributes to the growth of sugar content, and its increase facilitates the decrease of sugar content. It should be noted that during periods of sugar content growth there is the general decrease in the yield of sugar beet in the region. However, the increased sugar content of beet in the relevant years «compensates» the decrease of the yield parameters. As a whole, there is a correlation between the dynamics of changes in sugar content of beet in the region with Brickner cycles. - in warm and dry periods, the sugar content increases, and in cold and wet is reduced.

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The role of weather conditions and agricultural technologies in the formation of the winter wheat crop in the southwest of the Central chernozem region of Russia

Solovyov, A., Lebedeva, M., Vagurin, I.

Belgorod State National Research University, 85, Pobedy St., Belgorod, 308015, Russia, vagurin@bsu.edu.ru

In the southwestern part of the Central chernozem region, the influence of agricultural technologies (predecessors, crop rotations, fertilizers and techniques of tillage) on the yield of winter wheat in changing weather conditions during the active vegetation period was studied.

The study was conducted on the fields of the Belgorod research Institute of agriculture in the multifactor experiment, which was disclosed in space and time.

The soil of the experimental site – postlithogenic accumulative-humus migration-micellar agrochernozem (typical chernozem) with content of humus in the arable layer 5.01-5.38%, 4.8-5.7 mg of mobile phosphorus, 9.2 -12.1 mg of exchange potassium per 100 g of soil, pH of salt extract 5.8-6.4.

The main factor (the rate of influence 60-75%) of winter wheat crop formation in the region is the value of the hydrothermal coefficient of active vegetation period. In adverse years, the role of weather conditions increases by 1.2 times. The positive effect of fertilizers in yield is expressed in favorable years and of pure steam in unfavorable ones. The role of soil cultivation techniques in the overall proportion of all factors is rather low.

There is the clear trend of worsening of hydrothermal conditions in the period of active vegetation of winter wheat in the region. In this regard, agricultural technologies that have positive impact on winter wheat crop are of particular importance. In unfavorable weather conditions, the influence of fallow on the yield of winter wheat is increased. Mineral fertilizer system is practically effective in the years different in weather conditions. Manure application in unfavorable years is twice efficient. Joint application of mineral fertilizers and manure provides the highest yield of winter wheat, and in unfavorable years the share of their participation increases by 1.3 times. Among the methods of basic tillage in the formation of the wheat crop in unfavorable years shallow tillage should be selected.

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Soil quality of organic hops plantation: visual examination

Frąc, M., Lipiec, J., Usowicz, B.

Institute of Agrophysics, Polish Academy of Sciences, Doświadczalna 4, 20-290 Lublin, Poland, * e-mail: j.lipiec@ipan.lublin.pl

In general, soil quality assessment requires analytical laboratory equipment, but this approaches need time to obtain the results. In some cases it is necessary to assess soil quality immediately. Therefore, to evaluate soil quality very quickly visual soil assessment approach was developed. Visual examination is made on the basis of easy qualitative indicators including mainly soil structure characteristics.

The aim of the study was to compare the influence of agricultural management practice (AMP) such as organic agriculture and conventional plant production system (Control) on soil quality status based on visual examination.

The case study site was located in Jastków in Poland (N 51.30203; E 22.42336). The research was made in 2016 on hops (*Humulus lupulus*) plantations in two crop production systems: organic (as AMP) and conventional (as Control). Organic hops plantation was set up in 2008. The representative fields were selected to the study. The evaluation of soil quality included: presence of a cultivation pan, soil colour, soil porosity, soil structure and consistency, soil aggregates stability, and biodiversity as an earthworms count. Additionally, pH and salinity were determined in situ in each plantation.

The results showed that tillage pan, soil colour and earthworms biodiversity were comparable between both assessed plantations, indicating good and in case of biodiversity moderate soil conditions. Soil in organic plantation had a good structure with a high porosity between and within aggregates, while control soil was characterized by moderate porosity. The results of soil slaking test indicated moderate aggregate stability in organic plantation, and poor – in conventional plantation.

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Biological diversity of wetlands in conditions of global warming and drainage melioration

Kirichenko-Babko, M.[1], Lagód, G.[2], Danko, Y.[3], Babko, R.[4]

[1] Schmalhausen Institute of Zoology, National Academy of Sciences of Ukraine, kirichenko14@ukr.net

[2] Lublin University of Technology, Faculty of Environmental Engineering, Poland, g.lagod@pollub.pl

[3] Sumy Makarenko State Pedagogical University, Ukraine yaroslavdanko@gmail.com

[4] Schmalhausen Institute of Zoology, National Academy of Sciences of Ukraine, rbabko@ukr.net

The changed water content and soil structure as a consequence of drainage melioration in the valleys of rivers and streams have led to the fact that some species have practically disappeared and some find refugia along the banks or in the valleys of a small tributary and streams. So our research has shown that in dry years up to 90% of the species composition of ground beetles accumulate in small depressions, at the bottom of drying floodplain lakes or oxbows. Drainage and fragmentation by dams not only changed the character and quality of the habitats of river valleys, but also excluded the most important factor from the annual cycle - the spring flood, whose role in the life of the valley populations remains underestimated. In light of the above, global warming can be seen as a verdict for the conservation of biodiversity in floodplains. An increase in the duration of dry periods will obviously lead to a reduction in the areas of refugia for hygrophilous species. Animals, although they are able to move actively, it is quite possible in the conditions of global warming will be practically deprived of refugia. Our studies of ground beetles which prefer wet habitats, showed that they actively migrate in the most suitable for them parts of floodplains or leave in the moist valleys of small rivers and streams. So 20 years ago, *Carabus granulatus* was distributed within the valleys of the 7 tributaries in which water flow continued throughout the growing season. However, by 2010 4 out of 7 inflows has dried up, and studies in 2016 showed that in the valleys of these tributaries the population of this species was not detected. *Carabus granulatus* practically disappeared, and beetles of the mesophilic and xerophilic group predominated now in the valleys of dried up streams.

Evaluation of soil texture determination using soil fraction data resulted from laser diffraction method

Makó, A.[1], Tóth, B.[1,2], Rajkai, K.[1], Szabó, J.[1], Bakacsi, Zs.[1], Labancz, V.[3], Hernádi, H.[2], Barna, Gy.[1]

[1] Institute for Soil Science and Agricultural Chemistry, Centre for Agricultural Research, Hungarian Academy of Sciences, 1022 Budapest, Herman O. út 15. Hungary, mako.andras@agrar.mta.hu

[2] University of Pannonia Georgikon Faculty, 8360 Keszthely, Deák F. u.16. Hungary

[3] Szent István University, Department of Soil Science and Agricultural Chemistry, 2100 Gödöllő, Páter K. u. 1. Hungary

There are intentions all around the world to harmonize soils' particle size distribution (PSD) data measured by the laser diffractometer method (LDM) and by traditional sedimentation techniques, e.g. sieving and pipette methods. Unfortunately, up to the applied methodology, PSDs of the sedimentation methods (due to different standards) are dissimilar and could be hardly harmonized with each other, as well. A need was arisen therefore to build up a database, containing PSD values measured by the sieving and pipette method according to the Hungarian standard (SPM-MSZ) and the LDM according to a widespread and widely used procedure. In our current publication the first results of statistical analysis of the new and growing PSD database are presented: 155 soil samples measured with SPM-MSZ and LDM (Malvern Mastersizer 2000, HydroG dispersion unit) were compared. Applying usual size limits at the LDM, clay fraction was highly under- and silt fraction was overestimated compared to the SPM-MSZ. Subsequently soil texture classes determined from the LDM measurements significantly differ from results of the SPM-MSZ. According to previous surveys and relating to each other the two datasets to optimising, the clay/silt boundary at LDM was changed. Comparing the results of SPM-MSZ to LDM, in case of clay and silt fractions the modified size limits gave higher similarities. Extension of upper size limit of clay fraction from 2 to 7 μm, and so change the lower size limit of silt fractions causes more easy comparability of SPM-MSZ and LDM. Texture classes were also found less dissimilar. The difference between the results of the two kind of PSD measurement methods could be further reduced knowing other routinely analysed soil parameters (e.g. pH(H_2O), organic carbon and calcium carbonate content) and constructing conversion equations, i.e. pedotransfer functions.

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Different response of ammonia oxidizing archaea and bacteria to soil properties and management

Malý, S., Čuhel, J., Obdržálková, E.

Central Institute for Supervising and Testing in Agriculture, Hroznová, 2, CZ-656 06, Brno, Czech Republic, stanislav.maly@ukzuz.cz

Ammonia-oxidizing bacteria (AOB) and archaea (AOA) represent model microorganisms in soil ecology and a shift in the status of their communities may serve as an indicator of changes of soil quality. The aim of this study was to evaluate how the structure of communities of AOA and AOB is determined by soil physico-chemical properties and soil management and to what extent is related to activity of these microorganisms.

Basic soil properties (pH, clay content, cation exchange capacity CEC) were measured in 24 samples taken from plots on arable land (17) and grasslands (7). Microbial ammonia-oxidizing activity was estimated as nitrite production in a buffered slurry (pH 7.2) containing ammonium sulfate as a substrate and sodium chlorate to inhibit oxidation of nitrite to nitrate. The structure of AOA and AOB was determined by means of terminal fragment length polymorphism (t-RFLP) of a part of amoA gene using two restriction enzymes (AluI, Csp6I). Cluster analysis was used for data evaluation.

In the case of AOA, soils were separated into two groups according to soil management. A larger group was further split to two clusters, the first one was characterised by significantly higher values of clay content, CEC, pH and ammonia-oxidizing activity. This finding may be explained by binding of ammonium ion from fertlisers on clay particles having higher CEC which may in turn result in creation of suitable conditions for AOA growth. Relationships between the community structure of AOB and studied soil characteristics was different. The main parameter explaining variability in data was pH, less acidic soils were characterised by higher rate of ammonia-oxidation. The group of soils with lower pH was further split according to soil management. The effect of clay content was not significant.

t-RFLP analyses showed that the structure of AOA and AOB communities responded in a different way on soil management and soil properties. AOA was influence mainly by soil management, AOB by pH.

Change in the weighted average diameter of the soil aggregates of chernozems under different cropping systems

Novykh, L., Pelehotse, E., Smirnova,L., Aolovyov, A.

Belgorod State University, Pobeda Street 85, Belgorod, 308015, Russia, novykh@bsu.edu.ru

The development of soil-protection agriculture with contour-meliorative organization of the territory is the base in the Belgorod oblast. In comparison with other Integral indicators of soil structure integral are of special interest. The aim of the study was to determine trends in the weighted average diameter of aggregates for soils functioning in zonal and landscape cropping systems.

The experimental site is located in the Belgorod oblast on the southern edge of the Central Russian Upland. It is used differentially: in the upper part of the slope up to 3□ steepness the tilling crop rotations are used, in the lower – steepness 3-5° – grain-grass crop rotation. Soils - clay-illuvial chernozems and hydrometamorphosed chernozems.

Field studies were conducted at intervals of 10 years. Determination of structural and aggregate composition was carried out by the method of Savvinov. According to the results, the weighted average diameter of the aggregates (WAD) and weighted average diameter of the water-stable aggregate (WADw) were calculated.

It is established that in the first period of selection of WAD units, on average for arable horizon on the slope of 1-3°, was 3.9 mm and did not differ for sites of different use. After 10 years, the tendency of its decline to 3.7-3.6 mm began to appear. Another picture was observed on the slope 3-5°: in both periods of study of the WAD of soil aggregates at the contour-reclamation organization of the territory is lower than for the zonal system. In the subsurface layer, the trends are similar, but the level of WAD, as expected, is higher: the average values of SVD are from 4.6 to 8.3 mm.

WADw in arable and sub-arable soil horizons on the slope of 1-3° with contour-meliorative organization of the territory is higher than in the zonal system: 0.6-1.1 mm against 0.5-0.9 mm. on the slope of 3-5° the picture is ambiguous, due to the greater diversity of soil cover, including due to increasing the secondary hydromorphism.

Thus, subsurface soil horizons have the low quality of structure due to the increase of the content of large fractions. The crops of herbs reduce the rates of WAD and increase WADw, which indicates the improvement of the quality of structure. However, 10 years is not enough to fully confirm this trend.

The results of the determination of the structural-aggregate composition are affected by weather conditions the time of sampling. Thus abnormally dry and hot weather in the summer-autumn period in the second term of sampling has led to the increase of blocks in the content in all variants of experiment.

Vulnerability of the structure of virgin and arable chernozems

Novykh, L., Solovyov, A., Smirnova, L., Novykh, I.

Belgorod State University, Pobeda Street 85, Belgorod, 308015, Russia, novykh@bsu.edu.ru

In the literature there are more than a dozen indicators used to characterize the structural state of the soil, but most of them are not widely used. To characterize the threat of destruction of certain fractions of the soil structure by water, the coefficient of the structure vulnerability (Kv) is used. We used Kv for the generalized characteristics of the soil fractions allocated at determination of the structural-aggregate composition.

Objects of research: virgin chernozems on the territory of the protected area «Yamskaya steppe» and arable chernozem near the border of the reserve. The sampling was carried out by triple replication. Determination of structural and aggregate composition and water stability of the structure was carried out by the method of Savvinov. The results were used to calculate the weighted average diameter (WAD) of aggregates and the weighted average diameter of water supply aggregates (WADw), on the basis of which the vulnerability factor of the structure was determined by the formula:

Kv = WAD / WADw

WAD for the virgin soil was 5.0-7.3 mm (average 6.0 mm), for arable land – 5.9-10.4 mm (average, 8.0 mm), which corresponds to the existing concepts of increasing of cloddiness in arable soils. WADw in virgin chernozem reached 0.3-2.0 mm (average 1.0 mm); in arable soil – 0,2-1,3 mm (on average, 0,8 mm).

Kv for virgin soil varied from 2.6 to 22.3 (average value – 8.5); for arable land – from 5.0 to 31.4 (average value – 15.0). The minimum Kv is marked in the surface horizon of virgin chernozem and at the depth of 40-50 cm in arable soil, and the maximum – in the parent rock.

It is determined that in the layer of 0-30 cm the average value of Kv in virgin chernozem is 3.1; in arable – 7.3 and it can be said without prejudice that the vulnerability of the structure of arable chernozem is significantly higher than virgin.

To assess the vulnerability of the structure, we propose to divide the whole set of obtained values of Kv into 3 groups:

1) Kv < 4-low risk of soil structure destruction by water;

2) 4 ≤ Kv ≤ 10-increased threat of destruction;

3) Kv > 10 – very high risk of destruction.

Thus, the use of the coefficient of the structure vulnerability allowed to clearly see the features of the transformation of the structural-aggregate state of the chernozem at plowing. We believe that the parameter has prospects of application, but additional study is required to develop the quantitative criteria for assessing the Kv.

Microbial functional diversity of soil inder Japanese knotweed (*Reynouria Japonica*)

Oszust, K.[1], Frąc, M.[1], Stefanowicz, A.M.[2]

[1] Institute of Agrophysics, Polish Academy of Sciences, Doświadczalna 4, 20-290 Lublin, Poland, koszust@ipan.lublin.pl, m.frac@ipan.lublin.pl

[2] W. Szafer Institute of Botany, Polish Academy of Sciences, Lubicz 46, 31-512 Kraków, Poland, a.stefanowicz@botany.pl

The presented research deals with soil microbial functional community composition under japanese knotweed (*Reynoutria japonica*), one of the most invasive and aggressive alien plant species (Murrell et al. 2011). Twenty five sites being near-monoculture stands of R. japonica (cover >90%) and neighboring patches of native plant communities (controls) were selected in riparian/fallow habitats. Soil samples were taken from organic and mineral horizons to a depth of approx. 20 cm in the case of R. japonica plots and only mineral horizon under native herbaceous vegetation. Microbial functional diversity of soil was evaluated following Biolog Eco Plates® analyses. The microbial response, regarded as overall respiration, in each microplate was expressed by biodiversity indices (Richness and Average Well Color Development). Mineral soil under invasive plant was characterized by slightly (but not significantly) lower microbial functional diversity comparing to both mineral control and invasive organic soils. Invasive organic soil was found to be richer in total C, N and other micro- and macroelements than mineral soil, which supported microbial performance.

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Cellulolytic enzymes of *Petriella setifera*

Panek, J., Pertile, G., Oszust, K., Siczek, A., Gryta, A., Frąc, M.

Institute of Agrophysics, Polish Academy of Sciences, Doświadczalna 4, 20-290 Lublin, Poland, * e-mail: j.panek@ipan.lublin.pl

The species of *Petriella setifera* belongs to the family Microascaceae, phylum Ascomycota. These fungi inhabit enriched soil and participate in wood decaying. Moreover, it was found on sessile oak, chir pine and red sage (Kwaśna, et al., 2005, Danon, et al., 2010, Qadri et al., 2013). *Petriella setifera* is commonly described as a wood rotting fungi - soft-rot fungi, which degrades cellulose and hemicellulose in wood with use of secreted cellulases. Despite that, *Petriella setifera* also possess the ability to degrade lignin and its synthesis products (Pertile, et al., 2018), which is characteristic of a brown rot fungi (Mathieu et al., 2013). These traits make this fungus and its enzymes an interesting objects of studies.

We isolated 5 strains of *Petriella setifera* from compost and identified them by sequencing D2LSU and ITS regions. We studied genes encoding three *Petriella setifera* cellulolytic enzymes: β-glucosidase (EC 3.2.1.21), endoglucanase (EC 3.2.1.4) and cellobiohydrolase (EC 3.2.1.91). Based on sequences of these genes obtained from five *Petriella setifera* isolates we performed in silico transcription and translation which allowed us to model 3D structures of studied enzymes and to analyze their molecular properties. Moreover we were able to find, that sequence of *Petriella setifera* cellobiohydrolase gene contains unique 73 base pair long, non-existent in other fungi, fragment. This region may present feature to development of genetic marker used to detect *Petriella setifera*.

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The influence of climate on the distribution of copper in the soil profile of southern chernozems (arid lithogenesis)

Petrova, L.

Institute of Geochemistry, Mineralogy and Ore Formations (IGMOF) National Academy of Sciences of Ukraine (NASU). 34, prosp. Palladina, 34, Kiev-142 , 03142, Ukraine, diamant775@mail.ru

The main problem of global warming is the displacement of the aridization boundary in the northern hemisphere to the north, which in turn leads to changes in the physical and chemical parameters of the zone of aeration and soil profile, respectively, it is reflected in the behavior of trace elements that are involved in the reactions of the catalysis and metabolic during vegetation of plants. Synthesis of nitrite reductase occurs with the participation of Cu and Mn. A prerequisite for Cu and Mn to participate in these biochemical reactions is that they should be in soluble or ion-exchange forms in the upper.

Purpose is Investigation of the forms of the copper presence in the soil profile of southern chernozems in the arid litogenesis of the southeast of Ukraine.

The experiment was conducted at depths of 0-10, 15, 20, 30, 50, 200 cm in the pits of eluvial landscapes in the soil profile of southern chernozems in the southeastern part of Ukraine. All selected samples were analyzed by semi-quantitative spectral method on 47 elements + Hg and F by atomic absorption method. The forms of presence of Cu, Hg, Zn, Pb, Cd were studied. Forms of the presence of metals in the soil profile were established by successive isolation of soil macrophases by chemical means, followed by an atomic absorption analysis. To conduct these works deployed analysis scheme was used.

Data from laboratory tests showed that metals, including Cu, are distributed in different ways on the soil profile, depending on the taxonomy of the geochemical landscape. Most metals, including Cu and Mn, are concentrated in the upper (A) soil horizons - 0-10-15 cm. The distribution of Cu in southern chernozem associated with eluvial landscapes in arid lithogenesis of southeast Ukraine has the following characteristic pattern: the depth of 0-10 cm - content (mg/kg) gross - 30-35, corresponding regional background; stable (insoluble) form - 25-30; organo-mineral form 2.5; acid-soluble form - 0,5; exchange-sorbed - 0,1, water-soluble 0,1 - 0,05 to a depth of 20 cm, there is a decrease in the weighting content and, accordingly, a stable form of finding Cu to 25 mg / kg, acid-soluble and organo-mineral remain virtually unchanged. From the depth of 20 cm ion-exchange and water-soluble forms sharply are diminished (practically to 0), there is a gradual increase of acid-soluble form to 1.0 - 1.5 mg / kg at a depth of 30 - 35 cm and a smooth increase to 2.5 mg / kg at depths of more than 1.5 m, indicating the processes of aridation of the zone of aeration, the organo-mineral form from a depth of 20 cm to 2 m smoothly reduced to 1-0.8.

Thus, plowing with depths of 25 cm and more deeply leads to the transport of chunks with sealed forms of trace elements, including copper, and water-soluble and ion-exchange forms fall below the depths of grain crops, which is a negative factor in germination of seeds and early vegetation of plants, to reproduction physico-chemical balance of the arable layer.

Conclusion. For land cultivation in arid latitudes and in latitudes with moderate climates in connection with global warming, it is very important to take into account the degree of aridity of the aeration zone and the soil profile, the geochemical processes occurring on the profile, as well as the synergy of soluble forms of trace elements in the arable layer for the balanced nutrition of plants at the beginning of the vegetation.

Optimize the settings of Mastersizer 3000 when measuring the particle-size distribution of soils

Ryżak, M.[1], Bieganowski, A.[1], Labancz, V.[2], Hernádi, H.[3], Barna, Gy.[4], Makó, A.[4]

[1] Institute of Agrophysics, Polish Academy of Sciences, Doswiadczalna 4, 20–290 Lublin, Poland

[2] Szent István University, Department of Soil Science and Agricultural Chemistry, 2100 Gödöllő, Páter K. u. 1, Hungary

[3] University of Pannonia Georgikon Faculty, 8360 Keszthely, Deák F. u.16, Hungary

[4] Institute for Soil Science and Agricultural Chemistry, Centre for Agricultural Research, Hungarian Academy of Sciences, 1022 Budapest, Herman O. út 15, Hungary, mako.andras@agrar.mta.hu

Laser diffraction method (LDM) is an up-to-date technique for measuring the particle-size distribution (PSD) of soils, but the introduction of an identical standard would greatly increase the reproducibility and comparability of the measurements. Preparation methods (breakdown of soil aggregates, dispersion of elementary particles) play an important role in this, but again no uniform standards have yet been composed.

Based on the experiences gained with Mastersizer 2000, LDM PSD methodological investigations were carried out using the Mastersizer 3000 with Hydro LV attachment (Malvern Ltd., UK). Heterogeneous soil sample set was tested, the samples were different in their structure, texture and basic soil properties.

By examining the reproducibility of measurement results and the model fitting error we were looking for the optimal setting of fitting models, pump and stirrer speed, measurement time, ultrasound application (time and power), chemical dispersing method and optical parameters (absorption and refractive index).

This paper presents the effect of selected methodological features on the LDM PSD results. It can be stated that both the optimum sample preparation method and the best instrument settings depend to a great extent on the physical and chemical properties of the soil to be measured and also depend on design of the measuring apparatus (even for two different devices of the same manufacturer).

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The effect of truncation of soil profiles on yields under conservation tillage in the loess area

Rejman J.[1], Rafalska-Przysucha A.[1], Jadczyszyn J.[2], Czyż E.[3]

[1] Institute of Agrophysics PAS, Doświadczalna 4, 20-290 Lublin, Poland
[2] Institute of Soil Science and Plant Cultivation, Czartoryskich 8, 24-100 Pulawy, Poland
[3] University of Rzeszów, Rejtana 16c, 35-959 Rzeszów, Poland

Conservation tillage is aimed to reduce soil erosion by water and increase water infiltration by leaving crop residue that covers at least 30% of soil surface. Remaining of plant residue creates better conditions for plant development and provides to the increase of soil organic carbon. The effectiveness of conservation tillage is weakly recognized in the areas of soils that were significantly transformed by processes of water erosion and moldboard tillage in the past. The purpose of studies was the evaluation of effects of soil erosion classes of Luvisol on yields under conservation tillage.

The studies were performed in the loess area of Grabowiec Heigths (Lublin Upland) after 8 years from implementation of conservation tillage (CT). The crop rotation included maize for grain, winter wheat and canola. Conservation tillage included strip-till in maize and canola, and direct drilling in wheat, remaining of crop residue, use of cover crops and subsurface application of fertilizers. Within the field of the area of 8.5 ha, the structure of soil profiles of Luvisol was determined on the basis of intact soil cores taken in 150 points located in the nodes of grid of 20 m and 40 m. According to the structure of profiles, the soils were classified as non-eroded, slightly, moderately, severely and very severely eroded, and depositional. Yields of grain were registered by system of harvest combine, and then were adjusted to the location of measurement points with ArcGIS.

Studies showed that soil cover of experimental field was largely transformed by water erosion and moldboard tillage in the past. Non-eroded, slightly, moderately, severely and very severely eroded, and depositional soils were represented by 20, 47, 14, 11, 9 and 49 cores, and mean soil thickness (Ap-BC) was 1.57, 0.88, 0.61, 0.38, 0.29 and 2.16 m, respectively. Mean yield of grain of maize was 8.79 (with CV=34%) in 2015, winter wheat - 8.92 (CV=15%) in 2016 and canola - 5.83 Mg/ha (CV=15%) in 2017. The yields were significantly differentiated according to the class of soil erosion. Yield of grain of maize on non-eroded soils was 9.7 Mg/ha, then significantly decreased on slightly eroded soils (by 24%), on moderately and severely eroded soils (by 33-35%), and on very severely eroded soils (by 49%). The yield of wheat on non-eroded soils was 9.4 Mg/ha, and was significantly smaller on severely and very severely eroded soils (by 20%). Canola was the least sensitive crop. The yield of canola on non-eroded soils was 6.25 Mg/ha, and the yield was significantly smaller on very severely eroded soils (by 18%). Generally, the yields of all crops were larger on slopes of N than S aspect. The very severely eroded soils were the exclusion, and yields were similar independently on the slope aspect. Limited accessibility of water to plants in the areas of severely and very severely eroded soils was identified as the main problem of arable land use under rain-fed conditions.

Summarizing, conservation tillage performed by 8 years limited the risk of water erosion, however CT was not able to balance the negative effect of truncation of soil profiles inherited by previous conventional tillage and water erosion on yields. The studies showed that maize was the most sensitive crop to the transformation of soil cover in the loess areas, however the exclusion of maize from crop rotation could largely limit the biological life in soils and provide to the decrease of positive effect of conservation tillage on accumulation of soil carbon.

Pedogeochemical barriers of heavy metals' migration

Savosko, V.M.

Kryvyi Rih State Pedagogical University, Gagarin Avenu, 54, Kryvyi Rih, Ukrane, 50086

Introduction. The objectives of this work are: (i) to consider the genesis of the «geochemical barriers» (ii) to invited a definition for «pedogeochemical barriers».
Materials and metods. The matiasl for this study was scientific publications that show the results of heavy metals' content and heavy metals'distribution in soils. The metods for this study was general scientific methods of research (analysis / synthesis, induction / deduction, generalization / analogy of abstraction / modeling).

Resalts. The geochemical barriers. As kwon, the modern concept of geochemical barriers was work out by A.I Perelman in 1961. At first time this concept had been used for: 1) ordering of the geochemical conditions at hypergenesis zone, 2) justification the concept of geochemical field; 3) mathematical modeling of geochemical processes, 4) effective mineral exploration. With the time, this concept has become successfully implemented in lithology, hydrogeology, soil science, geochemistry environment. Now, in the XXI century geochemical barriers used in the development of rehabilitation technology of contaminated lands and limit the spread of pollutants.

The ideas' invasion in soil science. At the beginning, the geochemical barriers's concept began to be used in soil science by V.A. Kovda (1972), A.A. Rode (1975), M.A. Glazovskaj (1988) works. With time, the number of researchers who used this idea in their works increased significantly. However, these researchers had misconceptions: 1) was performed a mechanical transfer this idea from geochemistry to soil science, 2) use this idea for environmental protection, 3) used of the geochemistry methodology and of the geochemistry classification schemes.

Pedogeochemical barriers. In our opinion, as for Soil Science the best analogue of "geochemical barriers" should recognize the term "pedogeochemical barriers". An essence pedogeochemical barrier is as follows. In hypergenesis zone the geochemical barriers act as "situational and contrast" phenomenon. In soil profile the pedogeochemical barriers act as "substation and reaction" phenomenon. We are supposed to that the soil profile is a multiaspect complex of pedogeochemical barriers. At that some of them can be localized within several soil horizons. At the same time, several such barriers can be located in one soil horizon. Therefore, in the refined form, a pedogeochemical barrier should be understood as part of the soil profile, where, as a result of the formation of special conditions for substitution-reaction interactions, the accumulation of certain chemical elements occurs.

Conclusions. The geochemist A.I. Perelman proposed and designed a "Geochemical Barriers"doctrine. This doctrine was used very effective and useful in geochemistry, geology, lithology, mineralogy, and in other contiguous sciences fields. At present, the ideas of this exercise are very important for a fundamental understanding of the biogeochemical functions of the pedosphere as the theoretical basis for preserving the biosphere and improving the soil in conditions of modern technogenesis. In our understanding, the pedogeochemical barrier is part of the soil profile, where, as a result of the formation of special conditions for substitution-reaction interactions, the accumulation of certain chemical elements occurs. In further studies it is expedient to consider: mechanisms of action, typology, parameters of pedogeochemical barriers, and also to analyze these parameters on the example of heavy metals in chernozems of ordinary and southern.

Plant specific effects on soil activity and microbial structure

Siczek, A., Frąc, M., Gryta, A.

Institute of Agrophysics, Polish Academy of Sciences, Doświadczalna 4, 20-290 Lublin, Poland, asiczek@ipan.lublin.pl

Plants control composition of microorganisms surrounding their roots by excretion of substances with signaling, nutritional, and antibiotic capabilities. Microorganisms subsequently stimulate or inhibit plant development and productivity.

The field study was conducted to assess the effects of two important for food and feed crops grown under the same soil and climatic conditions: faba bean (F) (*Vicia faba*), legume crops able to fix N and wheat (W) (*Triticum aestivum*), a widely cultivated cereal, on soil enzyme activities and microbial structure and their changes during the vegetative season. Soil activity was assessed by measurement of dehydrogenase, ß-glucosidase, protease, urease, cellulase, acid phosphomonoesterase and respiration activities. Abundance of ammonia-oxidizing archaea (AOA) was characterized by T-RFLP analysis of ammonia monooxygenase α-subunit (*amo*A) gene. The bacterial microbiome was analyzed using the next generation sequencing technique (NGS) based on 16S rRNA gene, using MiSeq platform (Illumina Inc., USA).

In most cases, the activities of dehydrogenase, protease, ß-glucosidase, urease and respiration were greater under F than W and opposite was for acid phosphomonoesterase activity. Archaeal amoA community profiles recorded the difference between both treatments in abundance of fragments, and specific fragments for wheat were noted. Based on a rare-cutter restriction enzyme (Csp6I), population of AOA showed greater diversity under wheat than under faba bean. In comparison with W, a higher number of bacteria of the order *Rhizobiales*, *Burkholderiales* and *Pseudomonadales* were noted in F, whereas *Bacillales* and *Actinomycetales* were more abundant in wheat than faba bean rhizosphere.

This study expands our knowledge of the ecological effects of faba bean and wheat on interactions between their rhizosphere and soil microorganisms.

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Changes in genetic diversity of soil microorganisms after pentachlorophenol contamination

Siczek., A.[1], Frąc, M.[1], Gryta A.[1], Kalembasa, S.[2], Kalembasa, D.[2]

[1] Institute of Agrophysics, Polish Academy of Sciences, Doświadczalna 4, 20-290 Lublin, Poland, e-mail: asiczek@ipan.lublin.pl (A. Siczek)

[2] Siedlce University of Natural Sciences and Humanities, Konarskiego 2, 08-110 Siedlce, Poland

Pentachlorophenol (PCP) has been used as a herbicide, insecticide and fungicide, as well as a wood preservative. It has a detrimental effect on the ecosystem, including human health. This study was conducted to determine the effect of pentachlorophenol on the genetic diversity of microorganisms in rhizosphere during faba bean growth.

The field experiment was performed on a Haplic Luvisol. Faba bean (*Vicia faba* L.) seeds before sowing were treated with PCP or not (Control). Rhizosphere soils were taken at phases: 4-5 leaves (T1), flowering (T2) and pod formation (T3). Abundance of ammonia-oxidizing archaea (AOA) was characterized by terminal restriction fragments length polymorphism (T-RFLP) and denaturing gradient gel electrophoresis (DGGE) analysis of ammonia monooxygenase α-subunit (*amo*A) gene.

The relationship between community structure and function was evaluated by the functional amoA gene. Archaeal amoA community profiles recorded one major fragments (253 bp) with abundances ranged from 79% to 89% depending on treatments in all soils (Alu I enzyme) and specific fragments were in both treatments. In soils with PCP we observed lower diversity of tested group of microorganisms comparing to the control. Digestion with enzyme Csp6I reveal high differences in T-RF profile between treatments and specific fragments were observed under PCP contaminated soil. Analysis of DGGE band profile revealed that the communities of AOA is represented by one main group (the most intensive band on the gel). It proves important role and stability of this species in soil, even if the environment conditions are changing. Results obtained from DGGE was very reproducible across the tested soils. In presented study, three dominant bands co-migrated in all of the soils irrespective of terms or PCP addition. Such observation suggests high stability degree of ammonia oxidizers in tested soils.

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The role of weather conditions and agricultural technologies in the formation of the winter wheat crop in the southwest of the Central chernozem region of Russia

Solovyov, A., Lebedeva, M., Vagurin, I.

Belgorod State National Research University, 85, Pobedy St., Belgorod, 308015, Russia, vagurin@bsu.edu.ru

In the southwestern part of the Central chernozem region, the influence of agricultural technologies (predecessors, crop rotations, fertilizers and techniques of tillage) on the yield of winter wheat in changing weather conditions during the active vegetation period was studied.

The study was conducted on the fields of the Belgorod research Institute of agriculture in the multifactor experiment, which was disclosed in space and time.

The soil of the experimental site – postlithogenic accumulative-humus migration-micellar agrochernozem (typical chernozem) with content of humus in the arable layer 5.01-5.38%, 4.8-5.7 mg of mobile phosphorus, 9.2 -12.1 mg of exchange potassium per 100 g of soil, pH of salt extract 5.8-6.4.

The main factor (the rate of influence 60-75%) of winter wheat crop formation in the region is the value of the hydrothermal coefficient of active vegetation period. In adverse years, the role of weather conditions increases by 1.2 times. The positive effect of fertilizers in yield is expressed in favorable years and of pure steam in unfavorable ones. The role of soil cultivation techniques in the overall proportion of all factors is rather low.

There is the clear trend of worsening of hydrothermal conditions in the period of active vegetation of winter wheat in the region. In this regard, agricultural technologies that have positive impact on winter wheat crop are of particular importance. In unfavorable weather conditions, the influence of fallow on the yield of winter wheat is increased. Mineral fertilizer system is practically effective in the years different in weather conditions. Manure application in unfavorable years is twice efficient. Joint application of mineral fertilizers and manure provides the highest yield of winter wheat, and in unfavorable years the share of their participation increases by 1.3 times. Among the methods of basic tillage in the formation of the wheat crop in unfavorable years shallow tillage should be selected.

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Formation of sugar beet harvest in modern conditions of heat and water availability of vegetation period

Lebedeva, M., Solovyov, A., Vagurin, I.

Belgorod State National Research University, 85, Pobedy St., Belgorod, 308015, Russia, vagurin@bsu.edu.ru

Evaluation of the impact of climate change on agricultural productivity is rather relevant for ensuring food security and substantiation of agrarian policy.

The conditions of heat and water availability of the vegetation period of sugar beet in the Belgorod oblast were studied. The source material was the data of meteorological and agrometeorological observations of the Belgorod center of Hydrometeorology and environmental monitoring at 6 stations in the region for the period from 1954 to 2017 and the calculated characteristics for assessing the agricultural productivity of climate.

It is revealed that the yield of sugar beet in the region currently depends on the climatic factor by 15%. The tendencies of sugar content dynamics in the conditions of Belgorod oblast in the connection with the observed climate changes during the reviewed period are determined. The factors that caused the corresponding changes were revealed by the method of the regression analysis. The conducted studies of trends of sugariness for 60-year period in the conditions of the Belgorod oblast showed its nonlinear dynamics

Significant influence on sugar content has a ratio of precipitation and the amount of air temperature in periods with temperatures above 15 and 20°C. Decrease of hydrothermal coefficient (HTC) contributes to the growth of sugar content, and its increase facilitates the decrease of sugar content. It should be noted that during periods of sugar content growth there is the general decrease in the yield of sugar beet in the region. However, the increased sugar content of beet in the relevant years «compensates» the decrease of the yield parameters. As a whole, there is a correlation between the dynamics of changes in sugar content of beet in the region with Brickner cycles. - in warm and dry periods, the sugar content increases, and in cold and wet is reduced.

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Effect of feedstock on biochar surface properties

Tomczyk, A.[1], Boguta, P.[1], Sokołowska, Z.[1], Cybulak, M.[1], Skic, K.[1], Szewczuk-Karpisz, K.[1], Kercheva, M.[2], Dimitrov, E.[2]

[1] Institute of Agrophysics, Polish Academy of Sciences, Doswiadczalna 4, 20-290 Lublin, Poland.

[2] Insitute of Soil Science Agrotechnology and Plant Protection "N.Poushkarov" Shosse Bankya 7, Sofia 1080 Bulgaria

On the basis of last research reports, it was found, that the kind of used biomass influences on physicochemical properties of biochar. These properties are of key importance in effectiveness of biochar as a soil amendment or a sorbent. Biochar as a sorbent can remove different pollution: heavy metals, antibiotics, pesticides etc. from groundwater, soil or water waste. Biochars used in experiment are: commercial product FLUID produced from wood waste by the company FLUID SA (Sędziszów, Poland), obtained from tobacco and from sweet corn cobs, which are produced by the "double-barrel" method (Deal et al., 2012).

The aim of the research was to investigate how the type of biomass affected surface properties of biochar. Analyses of biochars allowed assessing the effect of feedstock kind on values of variable surface charge and distribution of surface functional groups.

Tobacco biochar revealed significantly different results as compared to other biochars. The lowest values of surface charge were obtained for biochar originated from sweet corn cobs. High values of variable surface charge indicates greater amount of acidic surface groups. The distribution of surface functional groups demonstrated similar course in pH range from 3 to 10 with the clear pKapp. In the range of pH from 5 to 7 biochars have different the height of the peak. The biochar originated from tobacco has the highest peak. The above parameter of the biochars largely depended on feedstock kind. High value of variable surface charge and high content of surface functional groups indicate very good sorption properties of the studied biochars. On the basis of the obtained results, it was found that biochars from tobacco, wood waste and sweet corn cobs can be successfully used as sorbents for soil amendment.

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Impact of extraction time to results of soil phosphorus content determined by Mehlich 3 method

Tõnutare, T.[1], Raimo Kõlli, R.[1], Rinken, M.[1], Szajdak, L.[2] and Szczepanski, M.[2]

[1] Estonian University of Life Sciences, Chair of Soil Sciences, Kreutzwaldi 1, Tartu, Estonia, tonu.tonutare@gmail.com

[2] The Institute for Agricultural and Forest Environment of the Polish Academy of Sciences, ul. Bukowska 19, Poznan, Poland

Determination of soil plant available phosphorus (Pav) content is important for balancing agriculturally used soils fertility to support economic crop production and avoiding risk of pollution of environment. For determination of Pav content in soils several methods have been developed and are in use. In nine Baltic Sea states seven different methods of determination of soil Pav are in use today. All these methods are based on leaching of soil samples with extracting solution and following thereafter the determination of dissolved phosphorus in solution. Mainly the extraction of soil Pav is provided during specified period of time, which is sufficient for establihing equilibrium between phosphorus content in extract and on the soil particles surface. In the status of official method of determination of soil Pav in Estonia is Mehlich 3 method. Despite being an official method there are yet several discussions about the correctness of the results. We asume, that the extraction time of Mehlich 3 method is too short for establishing equilibrium between two phases and the correctness of analysis depends from exact tracking of duration of extraction.

The aim of this research was to establish the kinetic parameters of Pav extraction from different Estonian agricultural soils by M3 method. According to the results of soil Pav analysis by Mehlich 3 method we found, that extraction of Pav can be characterized by logarithmic equation (Fig. 1) and the equilibrium state between solid and solution phase P content can not be established before 30 minutes. Therefore all experiments which use Mehlich 3 method must very strictly follow the extraction time to avoid the risk of under- or overestimation of soil Pav content.

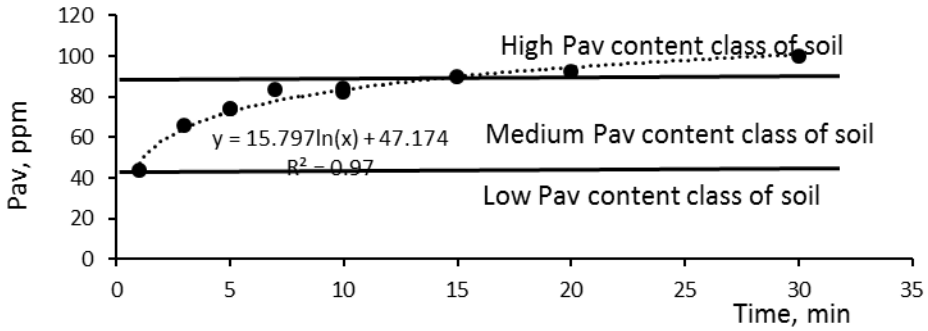

Figure 1. The kinetics of Pav extraction by Mehlich 3 method from soil to solution and distribution of soil into Pav status classes

Water infiltration and hydrophobicity of podzolic soils with ortstein under grassland and forest

Turski, M.[1], Lipiec, J.[1], Chodorowski, J.[2], Sokołowska, Z.[1]

[1] Institute of Agrophysics, Polish Academy of Sciences, Doświadczalna 4, 20-280 Lublin, Poland, sekretariat@ipan.lublin.pl

[2] Department of Soil Science and Soil Protection, Maria Curie-Skłodowska University, Kraśnicka 2cd, 20-718 Lublin, Poland, geograf@poczta.umcs.lublin.pl

Ortstein horizons (Bhsm) form by translocation of Al-humus complexes from A and E horizons and immobilization below in the soil profile where they cement sand grains (Bockheim, 2011). Ortstein is defined as a layer ≥ 25 mm thick and ≥50 % cemented. Soils with ortstein are used for forestry worldwide covering 2.2 million ha in the USA (in Poland - 100 000 ha). Due to its great cementation, and concentration of Al and Mn ions ortstein is considered as a barrier restricting plant roots growth and affecting the fluxes of water, heat and gas in soil (Lipiec et al. 2018). Presented study concentrated on cumulative infiltration and hydrophobicity of ortstein (Bhsm), overlying (E) and underlying (Bfe) horizons in two podzolic soils – under forest (FH) and grassland (GD).

To determine the cumulative infiltration of water (Q_w) and ethanol (Q_e) an apparatus consisting of a sponge connected with a graduated capillary tube filled with water/ethanol was used (Leeds-Harrison et al., 1994). The flow rate of liquid was taken as a measure of infiltration.

The results showed that water infiltration Q_w in both investigated profiles was considerably greater in E and Bfe in comparision with ortstein horizons (Bhsm). It was correlated with greater organic matter content in Bhsm than in E and Bfe. Also the hydrophobicity (calculated as Q_e/Q_w index) was many times greater in Bhsm than in horizons above and below.

Presented results clearly shows that ortstein horizons in the profile of podzols essentially affects its properties connected with water conductivity.

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Analysis of soil water content after biochar application in comparison with soil hydrolimits

Vitková, J., Šurda, P., Brezianská, K.

Institute of Hydrology, Slovak Academy of Sciences, Dúbravská cesta 9, 841 04 Bratislava, Slovakia, vitkova@uh.savba.sk

Our paper focused on an analysis of soil water content after biochar application in amount of 20 t/ha into silt-loam soil in comparison with soil hydrolimits wilting point (θ_{WP}) and field capacity (θ_{FC}). The biochar was applied at research area in Malanta (Slovakia) in 2014. Used biochar was produced from paper fiber sludge and grain husks. Results, presented in this paper, are from the year 2015, when maize (*Zea mays*) was sown. Soil moisture was monitored with 5TM sensors by Decagon Devices, which were installed in 5-10 cm depth below the surface during monitoring period from August to October 2015. The trend of soil water content was same at plot with biochar application, also at plot without biochar and was affected by precipitation events. Results were unexpected. They showed that soil water content was higher at plot without biochar application. We expected higher values of soil water content at plot with biochar application based on known biochar properties and previous studies (e.g. Basso et al., 2013). Soil water content was lower than soil hydrolimit θ_{WP} at both plots long time (about one month). This situation lasted about one week longer at plot with biochar application, but it was not exclusive because the soil water content was lower than θ_{WP} at the beginning of the monitored period (August 2015) as well as few days at the end of September 2015. Duration was longer at plot with biochar application too. The year 2015 was one of the hottest years in the history of measurements in Slovakia and high values of air temperature during summer months had also an impact on soil water content in top soil layer.

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Water deficit evolution in areas with viable irrigation systems from Romania

Calciu, I.C., Vizitiu, O.P.

National Research and Development Institute for Soil Science, Agro-chemistry and Environment – ICPA Bucharest, 61 Marasti Bvd., Bucharest 011464, Romania, e-mail: olga.vizitiu@icpa.ro

During the last decades, the drought phenomenon has expanded as a result of deforestation, destruction of forest protection belts etc., which took place on most of the land (agricultural and forestry). The areas that are potentially affected by desertification in Romania are mainly located in Dobrogea, Muntenia and southern Moldavia regions. In these areas the main viable irrigation systems are also located. The aim of this investigation was to evaluate the trends of climate aridity of areas where irrigation systems are present, based on meteorological parameters such as precipitations, potential evapotranspiration and water deficit as expressed as an average value of ratio between precipitation and potential evapotranspiration. The impact of climate changes on the elements that determine the water balance was made by comparing the annual precipitation and potential evapotranspiration values for the time periods of 1961-2000 and of 2001-2016, for communes where there is potential for crop irrigation. The average daily climate data for parameters for the two climatic series were spatially distributed across each administrative territorial unit, using the MARS methodology. The results showed that for time period of 2001-2016, the precipitations presented as mean values for all counties decreased down to 399 mm, and potential evapotranspiration increased up to 716 mm. Therefore, the water deficit expressed as an average value of the ratio between precipitation and potential evapotranspiration decreases from 0.594 to 0.557. In many areas where there is potential for crop irrigation the annual precipitation has decreased by 123 mm, the annual potential evapotranspiration has increased within the range of 24-35 mm, and the water deficit has increased in the range of 0.755 - 1.197 mm. There is a higher water deficit in the most areas of viable irrigation systems which require irrigation application, and the future trend is to increase the water deficit over time.

Evaluation of aridization risk in western part of Mures and Banat watersheds

Mocanu, V., Vizitiu, O.P., Calciu, I.C.

National Research and Development Institute for Soil Science, Agro-chemistry and Environment – ICPA Bucharest, 61 Marasti Bvd., Bucharest 011464, Romania, e-mail: olga.vizitiu@icpa.ro

In order to assess the risk of aridization in the area of Pecica, located in western part of the Mures watershed, and the Banat watershed, the following complex indicators were used: biophysical indicators, which define less favorable areas by assessing the constraints of land use in agriculture; MEDALUS Environmentally Sensitive Area to Desertification Index (ESAI), a comprehensive indicator for characterizing the susceptibility to desertification of agricultural ecosystems. Criteria related to soil which define the less favorable areas are as follows: drainage, soil texture and percentage of stones. The soil criteria were then integrated into a climatic criterion, namely soil water balance. The ESAI index was then used to evaluate the areas susceptible to aridization/desertification for identification of potential areas for irrigation as an mitigation method. This indicator is a complex one, based on the aggregation of soil, land, vegetation and management data. To calculate it was used a method of mediation of indicators calculated by assigning weights to a selection of parameters that characterize the topography, soil, climate, vegetation/land use and the intensity of agricultural management. Depending on the index values, the following classes on land degradation and desertification risk were defined: critical, fragile, potential. Using long-time series of climatic data the potential yield of winter wheat with the calculations of standard deviation for the western part of Mures watershed, which include the area of Pecica, and Banat region was estimated. The results obtained showed that most of the arable land is classified as fragile and critical. Within the Pecica town the ESAI index shows that more than 80 % of arable land is classified as critical. Also there is a high potential of this area for winter wheat production, the estimated crop yield being almost on the whole area more than 5.8 t/ha and 5,3 t/ha for Pecica respectively.

Application of nitrate ion-selective electrode based on ionic liquid and carbon nanotubes for determination of nitrate content in ground water and vegetables

Wardak, C., Lenik, J.

Maria Curie-Sklodowska University, Chemical Faculty, Department of Analytical Chemistry and Instrumental Analysis, M. Curie-Sklodowska Sq.3, 20-031 Lublin, Poland, cecylia.wardak@poczta.umcs.lublin.pl, j.lenik@poczta.umcs.lublin.pl

Nitrates are wide used in inorganic fertilizers, in production of explosives and for glass making. Nitrates also occur naturally in plants. They are present both surface waters and groundwater as a consequence of agricultural activity, from waste water treatment and from oxidation of nitrogenous waste products in human and animal excreta. High level of nitrate content in surface waters causes eutrophication of the natural waterbodies what leads to frog spit and devastation of local ecological systems. The main source of nitrate exposure for humans other than drinking water is food including vegetables, cured meat, fish and dairy products. The nitrate concentration in vegetables is depend on the use of fertilizers and growing conditions.

In presented research new nitrate-selective electrode with solid contact (SCISE) and its usefulness in monitoring of nitrate content in ground water and vegetables is described. SCISEs refer to a type of electrodes in which the internal reference electrode is in direct contact with the electroactive membrane and contains no internal solution. Such sensors can have various shapes, sizes, can work in any position and are simple and cheap in production. Proposed electrode was prepared by drop-casting of membrane cocktail on the surface of glassy carbon electrode. The composition of membrane mixture was 5% ionic liquid, 33 % polyvinyl chloride and 62% plasticizer. Before the application the membrane cocktail was doped with the multi-walled carbon nanotubes (MWCNTs) and sonicated in an ultrasonic bath for ca. 40 min. The obtained nitrate electrode was characterized by the good analytical parameters: theoretical characteristic slope, low detection limit, short response time as well as stable and reproducible potential. It was used for nitrate detection. Determination of nitrate was performed by application of direct potentiometry and standard addition methods. The obtained results were comparable with those obtained by reference method.

CO(II) ion-selective electrode based on ionic liquid for cobalt monitoring in natural environments

Wardak, C., Grabarczyk, M.

Maria Curie-Sklodowska University, Chemical Faculty, Department of Analytical Chemistry and Instrumental Analysis, M. Curie-Sklodowska Sq.3, 20-031 Lublin, Poland,
cecylia.wardak@poczta.umcs.lublin.pl, mgrabarc@poczta.umcs.lublin.pl

Many of trace elements play an important function in all organisms due to their functions in enzyme complexes. One of such element is cobalt which is component of vitamin B12 and enzymes such as carbonic anhydrases, alkaline phosphatases. They play important role in microorganisms involved in methanogenesis. It is known that deficiency of trace element such as cobalt may result in process instability and decreased biogas production. Therefore cobalt, nickel and other trace elements are added to bioreactors in order to create optimal conditions for the microorganisms present in the digester and improve the capacity of biogas plant. On the other hand supplementation with trace metals could lead to an increase of these metals released into the environment. Therefore continuous monitoring of supplemented elements in particular environmental component is necessary.

A quick, simple and cheap analytical method facilitate direct determination of many elements in its ionic form is potentiomery with ion-selective electrode (ISE). Obtainment of correct determination results requires the use of a sensor with an appropriate detection limit displaying selectivity towards interfering ions which may potentially occur in a tested sample. In this work preparation, properties and analytical application of Co(II) ion-selective electrode is presented. The ion selective membrane based on 2-amino-5(Hydroxy-1-naphthylazo)-1,3,4–thiadiazole was modified by various alkylmethylimidazolium ionic liquids with chlorides anions. Such membrane modification resulted in improvement of sensors performance by decrease of detection limit, increase of selectivity and shortening of response time. Moreover obtained electrode was characterized by stable and reproducible potential. The practical usefulness of the proposed Co-ISE was tested by its application for cobalt determination in real water samples. The water samples were collected from river, lake and well located near a biogas plant. The obtained results were comparable with those obtained by AdSV analysis.

Methane oxidation and production in cadmium contaminated soils

Wnuk, E., Walkiewicz, A., Bieganowski, A.

Institute of Agrophysics, Polish Academy of Sciences, Department of Natural Environment Biogeochemistry, Doświadczalna 4, 20-290 Lublin, Poland, e.wnuk@ipan.lublin.pl, a.walkiewicz@ipan.lublin.pl, a.bieganowski@ipan.lublin.pl

Soil ecosystem plays a key role in methane (CH4) budget. Depending on the oxygenation soil can oxidize (methanotrophy) or produce (methanogenesis) CH_4 - one of the important gases with about 20% participation in greenhouse effect. The rate of both processes depends on soil physical and chemical parameters which may be influenced by agriculture practices. One of the most important factor is heavy metal contamination, like cadmium (Cd), which is one of the most hazardous pollutant. Cd accumulation in arable soils may be a result of application of sewage sludge, phosphorus fertilizers, manure, or the type of soil parent rock.

The aim of the study was to examine the response of soil CH_4 processes on cadmium contamination. The research was conducted on three arable, mineral soils contaminated with two doses of Cd (the permissible dose in agriculture and its exceeding). The production and consumption of methane were determined using gas chromatography method controlled under laboratory conditions.

The results showed tolerance of methane production process in all tested soils to cadmium contamination with used doses. In the case of methanotrophy a slight delay or inhibition of process was observed in tested material.

Our experiment showed that despite of high Cd toxicity, the CH_4 processes in mineral soils were not strongly disturb by this heavy metal at used level acceptable in agriculture.

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Effect of neutralizing substances on content of selected trace elements in plants on soil contaminated with heating oil

Wyszkowski, M., Sivitskaya, V.

University of Warmia and Mazury in Olsztyn, Department of Environmental Chemistry, Plac Łódzki 4, 10-089 Olsztyn, Poland, miroslaw.wyszkowski@uwm.edu.pl

The objective of this study has been to determine the effect of neutralising substances (nitrogen, compost, bentonite, zeolite and calcium oxide) on the contents of cadmium, lead, chromium and manganese in plants on soil contaminated with heating oil (0, 5, 10, 15 and 20 g · kg^{-1} of soil). *Zea mays* L. was test plant. Plant samples for analysis were collected during harvesting of above-ground parts of maize in the intensive stem elongation phase. The content of the trace elements: cadmium, lead, chromium and manganese, were analyzed by the flame atomic absorption spectrophotometry (FAAS) on a SpectrAA240FS atomic absorption spectrophotometer.

The effects of increasing doses of heating oil and mitigating substances on the content of the tested elements in plants varied. In the series with no additives, the dependency between increasing doses of heating oil and cadmium content of plants was directed, yet the range of changes was relatively small. Under the influence of increasing doses of heating oil, the cadmium and manganese contents increased up to the dose of 10 oil · kg^{-1} of soil, lead up to 15 g of oil per kg of soil and chromium within the full range of its doses, as compared to the control object (with no heating oil). Higher doses of heating oil resulted in a decrease in cadmium, lead and manganese contents of maize. All substances had a significant effect on the trace element content of maize. A favourable and restricting effect on the content of most of them in the maize was only observed for cadmium and manganese, in contrast to lead and chromium. Calcium oxide, zeolite and bentonite had a stronger effect than compost and nitrogen on the contents of trace elements in this plant.

Assessment of nitrous oxide emissions from agricultural soils at local level in Poland

Wiśniewski, P.

University of Gdansk, Institute of Geography, Jana Bażyńskiego 4, 80-309 Gdańsk,
p.wisniewski@ug.edu.pl

According to the National Centre for Emissions Management, in 2016, N_2O emissions in Poland were estimated at 65,540 Mg (4.9% of total GHG emissions), 77.6% of which came from agriculture. Agricultural soils are mainly responsible for the share of N_2O emissions from this sector being so significant – they account for about 67% of the N_2O emissions. Agricultural N_2O emissions are currently being measured in two ways: direct emission measurement from a given source, and emission modeling from various sources on a global or regional scale. There are no reports showing research findings on N_2O emissions from agriculture at local levels. The study attempted to estimate the N_2O emission from agricultural soils and present its statistical analyses and spatial distribution for all Polish communes (LAU level 2). A simplified solution has been proposed which can be successfully applied using almost exclusively data available in public statistics. The annual N_2O emissions from agricultural soils in Polish communes range from 0.002 Mg N_2O-N to 437.77 Mg N_2O-N, and the cultivation of organic soils is its main source. The use of mineral and natural fertilisers, as well as indirect emissions from nitrogen leaching into groundwater and surface waters, are also significant. The highest GHG emissions related to agricultural land use are characteristic mainly for communes located in the northern and northeastern part of the country, where the share of organic soils is significant. The communes in southeastern Poland (the vicinity of Hrubieszów) also stand out, where the largest complex of agriculturally used Chernozems, in Poland, is located. In addition, in this area, there are lands of former State Agricultural Farm, on which the agricultural large-area management system is still maintained, which is conducive to GHG emission from cultivation. The results confirm the need to include GHG emissions from the use of agricultural soils and other agricultural sources in local low-carbon economy plans.

Influence of branch angle, temperature, and girdling on the quality of sweet cherry

Zude-Sasse, M., Ruppert, F., Stutz, R., Brandes, N., Richter, M.

Leibniz Institute for Agricultural Engineering and Bioeconomy (ATB), Max-Eyth-Allee 100, 14469 Potsdam, Germany

The fruit size and colour of sweet cherry is crucial for consumer acceptance and marketing. Thus, every measure in the production that can enhance the fruit size is of economic interest. In two cultivars of sweet cherry (*Prunus avium* L.) the angle of branches was adjusted to 45°, 90°, and 135°. Girdling was carried out as an alternative treatment. The branches were of equal age and number of leaves; the leaf/fruit ratio was adjusted for every branch in order to compare the effect of solely the formation treatments.

The growth rate of cherries was monitored throughout fruit development by means of an own mobile application for smart phone utilizing the camera of the smart phone to analyse the fruit size and calculate the growth rate. Additionally, the percentage of fruits according to size classes used in marketing was calculated. The data from the app were evaluated by means of manual recordings pointing to marginal measuring uncertainty, when considering the diameter, while the height of the fruit gave an increased error.

All cherries were harvested when the second peak of enhanced fruit growth rate was terminated, which was defined at growth rate reaching <0.2 mm/day. Each fruit was subjected to measurements of fresh mass, dry mass, L*a*b* colour (CM2600D, Konica-Minolta, Japan), anthocyanin content (Lambda 950, Perkin Elmer, USA) and refractometrical reading (DR 301-95, Krüss Optronic, Germany).

The results provide an improved insight in the quality potential achieved with the support of modern information and communication technology.

Comparison of possibilities of using maize silage and maize straw silage in 1 MW biogas plant

Chełkowski, D.[1], Czekała, W.[1], Kozłowski, K.[1], Cieślik, M.[2], Smurzyńska, A.[1]

[1] Poznań University of Life Sciences, Institute of Institute of Biosystem Engineering, Wojska Polskiego 50, 60-627 Poznań, wojciech@up.poznan.com

[2] Poznań University of Life Sciences, Department of Biotechnology and Food Microbiology, Wojska Polskiego 48, 60-637 Poznań

Maize (*Zea mays* L.) as one of many cereal crops have a great economic importance in many countries of the EU and in the world. An unquestionable advantage is its versatile use for fodder, food and industrial purposes. In Poland maize production amounted to 4.34 million Mg in 2016, which in comparison to 2015 gave a crop of 1,19 million Mg. In the case of corn harvest, post-harvest residues compose for 47-50% of the dry matter of whole plants. This value means that a large part of the maize yield is maize straw, which is widely available but it is not simply taken account in the anaerobic digestion process. With a relatively high dry matter , several technologies have been developed to correctly ensile maize straw. Volatile solids (VS) constituting about 90% of TS makes this substrate well suited for use in anaerobic digestion.

The aim of the study was to compare possibilities of using maize silage, maize straw silage in 1 MW biogas plant. The study assumes three variants: A – using 100% maize silage, B – using 100% maize straw silage, C – a mixture of previous variants in the 50/50 proportion. In comparison with the prevention of mineral substances deficiencies, the addition of slurry at the level of 30% of the inserted substrate.

Results of the experiments showed that the percentage difference in the biogas yield based on TS weight between maize silage and maize straw silage was about 12%. This admit of to observe that the use of maize straw in anaerobic digestion can be viable, especially that the lower price of the substrate can improve the economic balance of the biogas plant. A good practice in Polish biogas plants is the use of non-competitive substrates for the food industry and that is exactly how maize straw is.

Influence of chitosan addition on properties of nanocellulose composites obtained from carrot

Chylińska, M., Gdula, K., Pertile, G., Frąc, M., Zdunek, A., Szymańska-Chargot, M.

Institute of Agrophysics, Polish Academy of Sciences address, m.chylinska@ipan.lublin.pl

Cellulose nanostructures have been recognized as possible biobased additive to enhanced bio-polymer performance, in terms of mechanical, thermal and barrier properties. The cellulose obtained from fruit or vegetable plant cell wall characterizes with thinner microfibrils which can give better filler properties. Carrot pomace is composed of 28% cellulose, 2.1% pectin, 6.7% hemicellulose, and 17.5% lignin on a dry weight basis (Szymańska-Chargot et al., 2017).

Chitosan is the name for a family of derivatives of poly-N-acetyl-D-glucosamine (chitin), it is found in the exoskeletons of crustaceans such as crabs and shrimps (Morris et al., 2010). Chitosan has been studied for various applications because of its biocompatibility, biodegradability, antimicrobial activity and many others. Chitosan films have poor mechanical properties which limit its applications. Functional properties of chitosan based composites can be improved by reinforcement of nanosize cellulose.

The aim of this study was to obtain and characterize composites of chitosan and nanocellulose obtained from carrot wastes. The physicochemical properties of blends were characterized (FT-IR, Raman AFM, SEM, DSC). The mechanical properties in microscale (tensile tests, Deben UK) were considered. Also the antibacterial and antifungal activity of composites were studied.

Acknowledgements:

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Effect of starch type and processing conditions on mechanical properties of starch-based foams

Combrzyński, M.[1], Wójtowicz, A.[1], Oniszczuk, T.[1], Mitrus, M.[1], Matwijczuk, A.[2], Pawelczyk, P.[1], Mościcki, L.[1]

[1] University of Life Sciences in Lublin, Department of Thermal Technology and Food Process Engineering, Doświadczalna 44, 20-280 Lublin, maciej.combrzynski@up.lublin.pl, agnieszka.wojtowicz@up.lublin.pl, tomasz.oniszczuk@up.lublin.pl, marcin.mitrus@up.lublin.pl, paulinapawel94@gmail.com, leszek.moscicki@up.lublin.pl

[2] University of Life Sciences in Lublin, Department of Physics, Akademicka 13, 20-950 Lublin, arkadiusz.matwijczuk@up.lublin.pl

Potato starch and corn starch are popular types in processing of biopolymers as basic raw materials. Biopolymers can be produced with various methods. One of processing methods applicable to produce biopolymers can be the extrusion-cooking. According to several parameters and equipment configuration there is possible to achieve a wide variety of biopolymers based on starch. Loose fill foams are usually produced with application of polystyrene, but negative environmental effects of conventional plastics require to look for new environmentally friendly raw materials. The aim of the study was application of extrusion-cooking to prepare starch-based foams depend on the starch type and processing conditions applied. Starch foams were made using potato starch and corn starch under various screw speed of extruder during processing. Expanded foams were tested to evaluate the mechanical properties by cutting and compression tests. Universal testing machine Zwick Roell was used in the experiment and foams were tested for selected characteristics, as maximum cutting force, cutting force at break, elastic modulus, maximum compression force, compression force at break as well as work at compression and work at break. The results showed significant effect of processing conditions on compression properties of tested foams as well as cutting forces. Higher hardness of foams was observed if potato starch was used as basic raw material. Moreover, corn starch foams were more elastic in compression tests.

Selected properties of pellets and snacks supplemented with Moldavian dragonhead addition

Matysiak, A.[1], Combrzyński, M.[2], Wójtowicz, A.[2], Oniszczuk, T.[2]

[1] Pol-Foods Sp. z o.o., Kolejowa 1D, 19-335 Prostki, a_matysiak@pol-foods.com

[2] University of Life Sciences in Lublin, Department of Thermal Technology and Food Process Engineering, Doświadczalna 44, 20-280 Lublin, maciej.combrzynski@up.lublin.pl, agnieszka.wojtowicz@up.lublin.pl, tomasz.oniszczuk@up.lublin.pl

Various raw materials are used in the production of extrudates. The extrusion-cooking technique is widely used in the production of pellets and snacks. Multigrain snacks became very popular and these products are mainly made of maize, wheat, rice, barley, oats, quinoa, and other cereals. They are characterized by an increased content of fiber and protein and reduced salt content. Some additives, as fruits, vegetables, seeds, spices, herbs, vitamins and minerals or flavoring substances can be used as additives to increase the attractiveness of final products. Both the selection of raw materials and conditions of the technological processing have an impact on the quality characteristics of snack products. The main subject of the study was determination of selected characteristics of extruded pellets and fried snacks supplemented with *Dracocephalum moldavica* L. seeds applied in the recipe in amounts from 0.5 to 15% of basic raw materials composition. Snack pellets were made with a single screw extruder to the form of fluted sheets, cut for 3x3 cm pieces and dried. Pellets were expanded by hot oil frying to achieve RTE snacks. Several properties were evaluated, as expansion ratio, bulk density, color or texture, depending the level of additive applied. Addition of Moldavian dragonhead decreased lightness of pellets and fired snacks. Increased level of seeds decreased expansion ratio and bulk density but slightly increased hardness of tested snacks. Nevertheless, *Dracocephalum moldavica* could be an interesting food additive because of unique nutritional composition of dragonhead seeds.

Antimicrobial efficacy of mixtures of nanosilver and polyhydric alcohols against health-promoting bacteria

Czernel, G.[1], Waśko, A.[2], Gustaw, K.[2], Kamiński, D.[3], Matwijczuk, A.[1], Oniszczuk, T.[4], Matwijczuk, A.[1], Niemczynowicz, A.[5]

[1] University of Life Sciences in Lublin, Department of Physics, grzegorz.czernel@up.lublin.pl

[2] University of Life Sciences in Lublin, Department of Biotechnology, Microbiology and Human Nutrition

[3] Maria Curie-Sklodowska University, Lublin, Department of Chemistry

[4] University of Life Sciences in Lublin, Department of Food Process Engineering

[5] University of Warmia and Mazury, Department of Relativity Physics

Safe production and storage of food are associated with a number of challenges with respect to controlling microbiological hazards, and pathogens. Recently silver nanoparticles (AgNPs) have been used as antimicrobial agents for improving food safety especially in food packaging area. And on the other hand, some authors consider that the glycerol, and other polyalcohols are the best plasticizers used for the production of food packaging. The silver colloid was prepared by using the chemical reduction method according to the description of Lee and Meisel. The UV-vis spectra reveals the formation of AgNPs by showing a maximum absorption at wavelengths of 400nm. Average size estimated by spectroscopy studies was 20nm. Indirectly via AgNPs dissolution from antibacterial packaging their can induce alterations in the beneficial bacteria. Many of these beneficial bacteria have been used as probiotic dietary supplements to improve activities of digestion, metabolism, and the immune system. Here we have tested the antibacterial effects of binary mixtures of glycerol, xylitol, erythritol and mannitol with nanosilver on six species of health-promoting bacteria. The growth rate of each species of Bifidobacterium and Lactobacillus on media supplemented of AgNPs and polyalcohols was monitored by measuring optical density (OD 600) using a Bioscreen C instrument (LabSystem, Finland). Our results have revealed the silver nanoparticles inhibited growth of the Bifidobacterium and Lactobacillus species the same extent. Interestingly, the addition of polyalcohls protected bacterial cells from AgNPs activity. It may be speculated that polyalcohls interact through hydrogen bonds with lipid membrane in bacterial cells and change surface charge prevent attached nanopartiales to cell membrane.

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Silver nanoparticles surface functionalized with azole derivates – synthesis and spectroscopic studies

Czernel, G.[1], Matwijczuk, A.[1], Karcz, D.[2], Kamiński, D.[3], Waśko, A.[4], Gustaw, K.[4], Matwijczuk, A.[1], Gładyszewska, B.[1], Oniszczuk, T.[5]

[1] University of Life Sciences in Lublin, Department of Physics, grzegorz.czernel@up.lublin.pl

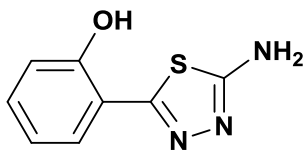
[2] Krakow Technical University, Faculty of Chemical Engineering and Technology (C1)

[3] Maria Curie-Sklodowska University, Lublin, Department of Chemistry

[4] University of Life Sciences in Lublin, Department of Biotechnology, Microbiology and Human Nutrition

[5] University of Life Sciences in Lublin, Department of Food Process Engineering

The use of silver and its ions as antimicrobial agents has been practiced for centuries. There are several ways by which the silver can be administered into the living cells, however its administration as silver nanoparticles (AgNPs) seems the most effective. The silver nanoparticles delivered into microbial organisms promote cells lysis, the process by which cells break down and ultimately die. Thiadiazole-derived compouns belong to the group of antimicrobial agents which currently are the most frequently used in agriculture. In the present study the synthesis of AgNPs and their functionalization with thiadiazole derivatives is described. Incorporation of thiadiazoles into AgNPs may effect in a synergistic effect coming from joint antimicrobial action of both silver and thiadiazole. The AgNPs were synthesized by reduction of a silver nitrate salt ($AgNO_3$, $1*10^{-3}$ M) with 1% (w/w) sodium citrate. The model thiadiazole, namely the 2-amino-5-(2-hydroxyphenyl)-1,3,4-thiadiazole (AHPT) was synthesized from salicylic acid and thiosemicarbazide in phosphorous oxychloride. The thiadiazole was added into the suspension of AgNPs and stirred at ambient temperature for 15 min.



Structure of 2-Amino-5-(2 hydoxyphenyl)-1,3,4-thiadiazole.

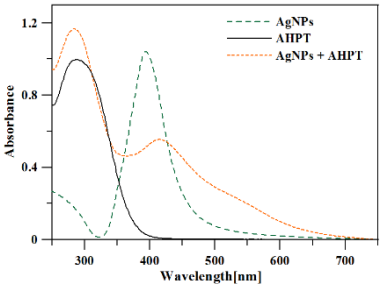


Fig. 1. Electronic absorbtion spectra to show the interaction between AgNPs and AHPT.

Addition of AHPT into the AgNPs resulted in colour change of the reaction mixture from green to pink. Also, a decrease in intensity of surface plasmon peak in the absorption spectrum was observed. Additionally, a new moderately broad band appeared in the region of 500-600 nm. The changes observed suggest the possible aggregation of silver nanoparticles, resulting from interaction with AHPT.

The changes of the properties of pasta during cooking and short-time storage

Biernacka, B.[1], Dziki, D.[1], Hassoon, W.H.[1,2], Różyło, R.[3], Polak, R.[1], Rudy, S.[1], Krzykowski, A.[1]

[1] University of Life Sciences, Department of Thermal Technology and Engineering Food Processing, Doświadczalna Street 44, 20-280 Lublin, Poland, e-mail: dariusz.dziki@up.lublin.pl

[2] College of Food Sciences, Department of Food Technology, Al-Qasim Green University, Babylon, Iraq, e-mail: waleedww27@yahoo.com

[3] University of Life Sciences in Lublin, Department of Food Engineering and Machines, Doświadczalna 44, Lublin 20-280, Poland, e-mail: renata.rozylo@up.lublin.pl

Pasta is one of the most popular corn products because of its ease of preparation, texture acceptability, low cost and long use-by date. The main objective of the present research was to determine the influence of the time of cooking and short-time storage of spaghetti on changes in the physical properties of these products, with particular emphasis on mechanical properties. For testing purposes, 8 samples of commercial spaghetti, produced with semolina and common wheat flour were used. The samples of spaghetti were cooked for optimum cooking time and overcooked. The following tests of pasta were performed: optimal cooking time, weight increase index, cooking loss, diameter before and after cooking and texture analysis (cutting test). Sensory evaluation of pasta was also performed. Moreover, immediately after cooking, the samples of spaghetti were cooled to room temperature and stored in polyethylene bags for one hour. For single samples of cooked spaghetti the following texture parameters were determined: cutting force and cutting work, namely pasta hardness and firmness, respectively.

The results showed that both weight increase index and cooking losses increases after pasta overcooking. From the other hand, the hardness and firmness of pasta decreased. Moreover, the short-time storage of pasta caused a significant decrease of cutting force and cutting work. The highest changes of these parameters were observed after 50 minutes of spaghetti storage. The sensory evaluation of pasta also confirmed the decrease of pasta firmness after storage. Importantly, we found that an increase of spaghetti diameter during pasta cooking could be a new indicator of pasta quality. The highest increase of pasta diameter was found for durum wheat pasta. The positive and significant correlation between pasta diameter and protein content was found, whereas the correlation between pasta diameter and cooking loss was negative.

Freeze-dried elderberry and chokeberry as natural colourants for gluten-free wafer sheets

Różyło, R.[1], Wójcik, M.[1], Dziki, D.[2], Biernacka, B.[2], Gawłowski, S.[1], Adam, Z.[1]

[1] University of Life Sciences in Lublin, Department of Food Engineering and Machines, Doświadczalna 44, Lublin 20-280, Poland, e-mail: renata.rozylo@up.lublin.pl

[2] University of Life Sciences in Lublin, Department of Thermal Technology and Food Process Engineering, Doświadczalna 44, Lublin 20-280, Poland, e-mail: dariusz.dziki@up.lublin.pl

Colour is an important indicator of food quality especially important for consumer preference. The freeze-dried elderberry and chokeberry were proposed as natural colourants for gluten-free wafers. Also the mechanical properties of wafers were determined and sensorial analysis was performed.

Freeze-dried fruit powders were characterized by various parameters of colour. The elderberry powder was significantly darker (Lightenss (L*) = 37.61) than chokeberry (L* = 41.01) and was characterized by considerably lower value of redness (a* = 4.21 and 12.32, respectively). Significant and favorable changes were noted in the colour of batter and wafer with an increased content of dried fruits form 1 to 5%. Gluten-free wafers with 5% addition of fruits were characterized by L*, a*, and yellowness (b*) values equal 35.73; 6.05; 3.24 and 39.74; 7.15; 5.05 for elderberry and chokeberry, respectively More acceptable wafer sheets were obtained with the addition of chokeberry than elderberry powder. Interestingly, the force of breaking wafer significantly increased with increasing in the content of elderberry and slightly decreased with chokeberry powder addition. The force of breaking wafers with elderberry was higher in comparison with chokeberry. Sensory evaluation showed that gluten-free wafer with 4-5% of chokeberry and elderberry was classified with high scores for appearance, taste and overall. Moreover, because of the observed tendency of wafer's batter to the delamination a new indicator of batter delamination was developed and it can be also proposed for other liquids.

In the conclusion freeze-dried elderberry and chokeberry powders used up to 4% can be natural colourants for gluten-free wafers which can be proposed as new functional product, making wafers more attractive (especially chokeberry) and in addition holding nutritional potential.

Drying kinetics, color changes and antioxidant activity of broccoli sprouts

Habza, E.[1], Hassoon, W.H.[1,2], Dziki, D.[1], Gawlik-Dziki, U.[3]

[1] University of Life Sciences, Department of Thermal Technology and Engineering Food Processing, Doświadczalna Street 44, 20-280 Lublin, Poland, e-mail: dariusz.dziki@up.lublin.pl

[2] College of Food Sciences, Department of Food Technology, Al-Qasim Green University, Babylon, Iraq, e-mail: waleedww27@yahoo.com

[3] University of Life Sciences in Lublin, Department of Biochemistry and Food Chemistry, University of Life Sciences, Skromna 8, 20-704 Lublin, e-mail: urszula.gawlik@up.lublin.pl

Broccoli (*Brassica oleracea* L. var. italica) is a cool-weather annual crop. This vegetable is interesting for consumers because of its healthy properties. Especially, the significant advantage of broccoli is its big impact in cancer medication. Especially sprouts of broccoli are the reach source of photochemicals. However, sprouts are highly perishable and thus have an inherently short shelf-life. The one of the method of sprouts preservation is drying.

The aim of the present work was to study the influence of the drying method and drying temperature on the process characteristics and physicochemical properties of broccoli sprouts. Broccoli seeds were sprouted in climatic chamber at temperature 20˚C and humidity 80% per 4 days. After this time the sprouts were hot-air dried at 40, 60 and 80°C. Moreover the sprouts were freeze-dried. Before this, the samples were frozen at -35°C. Freeze drying was carried out at 20°C. The mass of the material was recorded continuously during the drying process and the kinetic of the drying was studied. Moreover, the following physicochemical properties of sprouts were determined: colour coordinates, total phenolics content and antioxidant activity.

The results showed that the time of hot=air drying of broccoli sprouts decreased about three times with the increase of drying temperature from 40°C to 80°C. The longest drying time was found during freeze-drying of sprouts. The Page model was proposed for describing the drying kinetics of broccoli sprouts. The temperature of hot-air drying had little influence on colour coordinates of powdered sprouts. The highest lightness and the lowest redness were obtained for freeze-dried material. Interestingly, the temperature and the method of drying had little influence on the total phenolics content and antioxidant activity of broccoli sprouts.

Drying kinetics and physicochemical properties of hot-air and freze-dried haskap berries

Polak, R.[1], Rudy, S.[1], Krzykowski, A.[1], Hassoon, W. H.[1,2], Dziki, D.[1], Gawlik-Dziki, U.[3], Biernacka, B.[1]

[1] University of Life Sciences, Department of Thermal Technology and Engineering Food Processing, Doświadczalna Street 44, 20-280 Lublin, Poland, e-mail: dariusz.dziki@up.lublin.pl

[2] College of Food Sciences, Department of Food Technology, Al-Qasim Green University, Babylon, Iraq, e-mail: waleedww27@yahoo.com

[3] University of Life Sciences in Lublin, Department of Biochemistry and Food Chemistry, University of Life Sciences, Skromna 8, 20-704 Lublin, e-mail: urszula.gawlik@up.lublin.pl

Lonicera caerulea L. plant is bearing haskap berries, also called honeysuckle berries. The plant originates from northern Russia, China and Japan or in horticultural farms, plantations, and gardens in some European countries. This berries have a pleasant taste, a little similar to that of bilberry, blackcurrant, and blueberries, with some bitterness (Oszmiański & Kucharska, 2018). The high content of bioactive compounds such including anthocyanins in honeysuckle berries were reported in many studies.

The aim of the present work was to study the influence of the osmotic dehydration, drying method and drying temperature on the process characteristics and physicochemical properties of haskap berries. The mass of the material was recorded continuously during the drying process and the kinetic of the drying was studied. With a view to selecting the most appropriate equation for the description of the freeze-drying of cranberries, seven potential equations commonly mentioned in literature were examined. Moreover, the following physicochemical properties of dried berries were determined: colour coordinates, total phenolics content and antioxidant activity. The process of hot-air drying and freeze-drying was performed at 40°C, 60°C and 80°C.

The results showed that both osmotic dehydration and increase the drying temperature significantly decreased the time of drying. A few models were proposed for describing the drying kinetics of honeysuckle berries. The highest lightness and redness were obtained for freeze-dried berries at 60°C. Moreover, the temperature and the method of drying had significant influence on the total phenolics content and antioxidant activity of haskap berries.

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Some physical properties of value-added food

Hlaváčová, Z.[1], Petrović, A.[1], Vozárová, V.[1], Hlaváč, P.[1], Božiková, M.[1], Ivanišová, E.[2]

[1] Slovak University of Agriculture in Nitra, Department of Physics, Tr. A. Hlinku 2, 949 76 Nitra, Slovakia, zuzana.hlavacova@uniag.sk

[2] Slovak University of Agriculture in Nitra, Department of Storing and Processing of Plant Products, Tr. A. Hlinku 2, 949 76 Nitra, Slovakia, eva.ivanisova@uniag.sk

The development of new functional ingredients has the advantage that food manufacturers can add extra value to products the consumer is already familiar with. The main factors that have to be considered are the variations affecting the processing conditions, the sensory properties, and the nutritional value of the final product (Pasqualone et al., 2014, Hassan et al., 2012). The aim of this work was to characterize some physical properties of functional biscuits enriched with nettle (*Urtica dioica* L.), carrot (*Daucus carota sativus*) and fruit elderberry (*Sambucus ebulus* L.). Control biscuits, without the addition, were produced for comparison. A control sample of Linz biscuits was prepared from the following ingredients: wheat flour, vanilla, butter, water, egg, sugar, bicarbonate soda. Low-frequency electrical properties of biscuits were measured by an instrument GoodWill Instek LCR meter 821 at different frequencies from 0.1 kHz to 200 kHz using four-electrode (tetra polar) system. We found out that the samples with nettle and carrot have higher values of relative permittivity as control sample and sample with elderberries. We also measured the calorific value of biscuits by calorimeter IKA C5000. The highest value of calorific value has the sample with nettle and the lowest sample with elderberries.

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Identification of markers of rapid growth and winterhardiness of royal paulownia plants cultivated for biomass

Jacek, B.[1,2], Litwińczuk, W.[2]

[1] Doctoral Studies of the Institute of Soil Science and Plant Cultivation State Research Institute in Puławy and University of Rzeszów, jacekbeat@interia.pl

[2] University of Rzeszów, Faculty of Biology and Agriculture, Chair of Plant Physiology and Biotechnology, Ćwiklińskiej 2, 35-601 Rzeszów, Poland wlitw@ur.edu.pl

Royal paulownia (*Paulownia tomentosa* Steud.) is a deciduous tree native to central and western China (Rao et al., 1986). Due to fast growth and high biomass production paulownia is a promising species for energy purposes as well as wood production (Woods, 2008). Estimation of winterhardiness and biomass production of paulownia plants is important for breeding and planning its exploitation.

The aim of the presented study was to select markers useful for selection of valuable paulownia strains and specimens. Thirteen strains of royal paulownia of different origin were studied. The field experiment in randomized complete block design with three replications in south-east Poland (near Rzeszów) in June 2014 was established. Correlation analyzes among growth traits, winterhardiness and index of leaf greenness (SPAD) of paulownia plants were performed. Based on 3-year experiment results some valuable morphological and physiological markers were found. In particular, three traits: length of shoot, length of leaf petiole and SPAD were recommended. The length of strongest shoot and length of leaf petiole were significantly and positive correlated with diameter of the shoot base, number of shoots, fresh and dry weight of shoots, size of the leaf blade, fresh and dry weight of leaves and negatively correlated with number of dead plants. Similar relationships among the relative chlorophyll content and plant productivity were also found. Measurements of this traits are easy, quick and non-destructive. Thus such markers may be used for rapid estimation of specimens and strains in terms of biomass production and winterhardiness.

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Evaluation of growth and winterhardiness of royal paulownia strains cultivated for energy purposes in the third year of vegetation

Jacek, B.[1,2], Litwińczuk, W.[2]

[1] Doctoral Studies of the Institute of Soil Science and Plant Cultivation State Research Institute in Puławy and University of Rzeszów, jacekbeat@interia.pl

[2] University of Rzeszów, Faculty of Biology and Agriculture, Chair of Plant Physiology and Biotechnology, Ćwiklińskiej 2, 35-601 Rzeszów, Poland wlitw@ur.edu.pl

Paulownia is one of the fastest growing tree in the world (Icka et al., 2016). Due to the rapid growth rate the paulownia plantations for biomass production for energy purposes have been established in many European countries (Woods, 2008). In principle paulownia is unknown crop in Poland.

The aim of the presented study was to estimate of growth and winterhardiness of thirteen strains of royal paulownia in the third year of vegetation. The field experiment in randomized complete block design with three replications in June 2014 in Świlcza near Rzeszów was established. Information about the intensive plant growth and the rapid increase of biomass were confirmed. The biomass yield, both shoots and leaves, was high. After the third year of vegetation the total length of shoots of strongest strain was close to 3,5 m. The height of the longest shoot reached almost 2 m whereas diameter of the shoot base - exceeded 3 cm. The leaves of paulownia plants were impressive. Leaf width of strongest strains surpassed 40 cm. After the third year of vegetation the three strongest strain wintered better than other ones. Due to rapid growth and high biomass production the cultivation of paulownia plants can be valuable biomass source. It can be feasible to select the valuable genotypes well adapted to the polish climatic conditions.

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Effectiveness of pulsed radio frequency and led light on seed quality improvement of vegetable plant species

Janas, R.[1], Grzesik, M.[1], Górnik, K.[1], Romanowska-Duda, Z.[2]

[1] Department of Nursery and Seed Science, Research Institute of Horticulture, Konstytucji 3 Maja 1/3, Skierniewice, Poland, regina.janas@inhort.pl

[2] Laboratory of Plant Ecophysiology, Faculty of Biology and Environmental Protection, University of Lodz, Str. Banacha 12/16, 92-237 Lodz, Poland

The production of vegetable seeds under Polish climatic conditions is difficult and unstable due to the high sensitivity of these species to the weather during flowering and seed formation. High rainfalls in this period may lead to a lack of pollination and non-seeds forming and promote the development of infectious diseases, which cause a decrease in the quality and yield of seeds. Too high temperature during seeds germination can induce dormancy (thermoinhibition) inhibiting this process. Increasing competition on the local seed market, associated among others with the expansive influence of western seed companies, enforces the production and use of seeds of the best quality and health status, guaranteeing high yields and economic profitability of production. Therefore, the seeds are subjected to improvement of their quality, uniformity and speed of emergence and yield.

The aim of the study was to evaluate the effectiveness of selected physical methods of seed improvement in improving seed quality, health status and the possibilities of their implementation in organic and integrated seed production. Garden dill, carrot and red beetroot seeds were subjected to pulsed radio frequency and LED light treatments. The research was carried out in in vitro (laboratory) conditions, greenhouse and in vivo (experimental field of the Horticultural Institute in Skierniewice). Energy and percentage of seeds germination, their health status, dynamics of germination and physiological activity were evaluated. In order to assess the effectiveness of presowing seed treatments, biometric measurements of obtained plants, chlorophyll content in leaves and respiratory activity of plants (photosynthesis) were performed.

The obtain results indicate high protective efficiency of pulsed radio frequency treatment in respect of elimination of seed pathogens of tested vegetable species. Significant improvement of seed health status and improvement of their sowing value was obtained. The irradiation with LED light resulted in increased seed vigor and dynamics of germination as well as acceleration of plant emergence. To a lesser extent than pulsed radio frequencies, it affected the microflora of seeds.

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The use of physicochemical methods, FTIR spectroscopy and chemometric analysis to assess the quality of selected monofloral honeys

Kędzierska-Matysek, M.[1], Matwijczuk, A.P.[2], Niemczynowicz, A.[3], Matwijczuk, A.S.[2], Czernel, G.[2], Florek, M.[1], Wolanciuk, A.[1], Litwińczuk, A.[1], Skałecki, P.[1]

[1] University of Life Sciences in Lublin, Department of Commodity Science and Processing of Animal Raw Materials, monika.matysek@up.lublin.pl

[2] University of Life Sciences in Lublin, Department of Physics

[3] University of Warmia and Mazury, Department of Relativity Physics

Assessment of the quality of bee products is currently a very serious research problem. The methods available on the market can be used to determine the composition, structure and activity of individual components. Both simple and advanced methods can also be used to determine the origin and variety of honey and to confirm its authenticity. One of the methods used to assess honey quality is FTIR spectroscopy with chemometric analysis. Spectroscopic methods in combination with advanced methods of chemometric analysis enable comprehensive analysis of the quality of bee products. The aim of the study was to assess the quality of selected honeys. The research material consisted of 10 samples of monofloral honeys. The content of water and extract in the honey was determined with a refractometer, and free acidity and electrical conductivity using a pIONneer 65 meter. The content of 5-HMF was determined by the White method (Carry 300 Bio spectrophotometer). The physicochemical evaluation showed that the honey met the requirements specifying the acceptable limit for content of water and free acids as well as for conductivity and 5-HMF. FTIR measurements were made with a Varian 670-IR spectrometer. In the infrared spectra, marked differences were observed in the intensity of bands characteristic of –OH group vibrations. Bands with a maximum at approximately 3330 cm-1 (OH stretching) and with a maximum at about 1640 cm-1 (OH deformation) underwent significant shifts in all samples. These changes may on the one hand indicate variation in the water content of the honey samples, and on the other hand suggest a likely change in their consistency and initiation of the crystallization process. To conclude, it should be emphasized that FTIR analysis and chemometric analysis revealed differences in the most important spectroscopic regions, which may indicate variation not only in the composition of the samples, but also the quality of the products.

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Green synthesis of silver nanoparticles using aqueous honey solutions of various concentrations

Czernel, G.[1], Kędzierska-Matysek, M.[2], Matwijczuk, A.[1], Florek, M.[2], Terpiłowski, K.[3], Matwijczuk, A.[1], Rudaś, M.[4], Barłowska, J.[2], Litwińczuk, A.[2]

[1] University of Life Sciences in Lublin, Department of Physics

[2] University of Life Sciences in Lublin, Department of Commodity Science and Processing of Animal Raw Materials, monika.matysek@up.lublin.pl

[3] Maria Curie-Sklodowska University, Lublin, Department of Physical Chemistry – Interfacial Phenomena

[4] Central Laboratory of Agroecology, University of Life Sciences in Lublin

Silver nanoparticles (AgNP), due to their unique antimicrobial properties and low toxicity, are increasingly used in food production and storage. The most suitable method for the food industry, for reasons of food safety, is known as green synthesis. The aim of the study was to synthesize silver nanoparticles in aqueous solutions of honey with concentrations of 20%, 10% and 2% (m/m)% at two different temperatures, 35 and 70°C. The experimental material was organic fir honeydew honey. The concentration of the precursor (Ag+ ions) in each sample was 1×10-3M, the initial pH was 9.4 and the temperature was 35°C. In the case of the 2% concentration, a gradual colour change was observed in the solution immediately after the precursor was added, indicating the formation of nanoparticles. Registration of electron absorption spectra from the UV-Vis range after 15 min confirmed the formation of nanostructures. In the spectra obtained, a band was observed with a maximum at 415 nm, so that the size of the nanoparticles was estimated at about 15-40 nm. AgNP synthesis took place in an unusual way. The higher content of reducing substances contained in the 20% solution was expected to increase the reaction rate, but no formation of nanoparticles was observed for this concentration. At the 10% concentration, the reaction yield was very low, while at 2% synthesis began just after the precursor was added and proceeded at a fairly rapid rate. The study showed that the key factor for synthesis at higher concentrations of honey was the reaction temperature.

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An effect of pH on gelation of sodium carbonate-soluble pectin extracted from pears

Koczańska, M., Cieśla, J., Gawkowska, D., Pieczywek, P., Cybulska, J., Zdunek, A.

Institute of Agrophysics, Polish Academy of Sciences, Doświadczalna 4, 20-290 Lublin, Poland, e-mail: a.zdunek@ipan.lublin.pl

The gel formation by pectin is crucial for the application of these polysaccharides in the food industry (Thakur et al., 1997). The macromolecules of pectins in aqueous solution possess the negative electrical charge due to the dissociation of carboxylic groups. The change of acid/base character of dispersing medium may affect the electrostatic interaction between pectin molecules and the crosslinking process.

The aim of the study was to characterize the influence of pH on gelling process in solutions of diluted alkali soluble pectins (DASP) differing in ionic composition and polysaccharides content.

The pectins were sequentially extracted (Cybulska et al., 2015) from pears (*Pyrus communis* L., cultivars 'Conference'), dialyzed and lyophilized. The influence of pH (3 – 10 range) on properties of pectins dispersed in ultrapure water and the salt solutions (NaCl and CaCl2) with the ionic strength of 30 mM was tested. The investigations were performed using conductometry, Photon Correlation Spectroscopy (PCS), potentiometry and rheological techniques.

The analysis of changes in physical and physicochemical properties of pectins which were caused by the pH of dispersing medium allowed to more precisely define the role of hydrogen bonding in crosslinking process and determine the most favorable pH conditions for the gel formation.

Acknowledgments

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Ultrasound in wet biological materials subjected to drying

Kowalski, S. J.

Poznań University of Technology, Institute of Technology and Chemical Engineering, Department of Process Engineering, pl. Marii Skłodowskiej Curie 2, 60-965 Poznań, Poland

The aim of this article is to present the effect of external action of air-borne ultrasound (US) upon biological wet materials subjected to drying. The study allows to determine the drying effectiveness of such products like fruits and vegetables by convective drying with ultrasound enhancement. The vibration and heating effects induced by power ultrasound are considered. The mathematical model of drying is developed and validated experimentally using the data obtained from the experimental tests carried out on the hybrid dryer equipped with ultrasonic generator. The obtained results prove that the vibration effect induced by ultrasound has a great impact on the acceleration of mass transfer without significant elevation of product temperature, and thus on the drying efficiency with respect to energy utilization and the quality of dried products like fruits and vegetables.

Rearrangement of pectin distribution in *Helianthus annuus* (L.) roots in response to lead exposure

Leszczuk, A.[1], Chudzik, B.[2], Szczuka, E.[3], Zdunek, A.[1]

[1] Institute of Agrophysics, Doświadczalna 4, 20-290 Lublin, a.leszczuk@ipan.lublin.pl

[2] Department of Cell Biology, Maria Curie-Skłodowska University, Akademicka 19, 20-033 Lublin, ewa.szczuka@poczta.umcs.lublin.pl

[3] Department of Plant Anatomy and Cytology, Maria Curie-Skłodowska University, Akademicka 19, 4, 20-033 Lublin, bchudzik@poczta.umcs.lublin.pl

The detailed composition of the cell wall and the interactions between all components provide the right stiffness and determines its flexibility (Zdunek et al., 2014). The structure of the cell wall depends on the type of cell in particular organs and can be modified by environmental factors. The plant cell response to lead exposure is explained by remodelling of polysaccharides present in cell walls (Krzesłowska et al., 2016).

The aim of this study was to evaluate the effect of lead treatment on pectic polysaccharide occurrence in roots, especially on the distribution of homogalacturonan with low vs. high levels of methyl-esterification in the cells of the root cap, quiescent center, and elongation zone. The experiment was conducted using immunocytochemical technique with JIM5 and JIM7 monoclonal antibodies (CCRC, University of Georgia, USA). Also, the quantitative analysis of the galacturonic acid content and the level of ruthenium red binding were performed.

The obtained results indicate the effect of lead on arrangement of pectin in roots growing at different toxic ion concentrations. We found a correlation between the increasing lead concentration and the distribution of specific epitopes of methylated and un-esterified homogalacturonan. To sum up, lead exposure is a significant factor determining the structure and assembly of root cells.

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Influence of wood anisotropy on its mechanical properties in the scale effect aspect

Malaga-Toboła, U.[1], Łapka, M.[1], Findura, P.[2]

[1] Institute of Agricultural Engineering and Informatics, University of Agriculture in Krakow, Balicka 116B, 30 149 Krakow, Poland, Urszula.Malaga-Tobola@ur.krakow.pl

[2] Department of Machines and Production Biosystems, Faculty of Engineering, Slovak University of Agriculture in Nitra, Tr. A. Hlinku 2, 949 76 Nitra, Slovakia, pavol.findura@uniag.sk

Wood as a construction material is characterized by many advantages: low density, high strength and stiffness, low thermal and electrical conductivity and chemical durability. However, it is an anisotropic material that contains structural elements of varying stiffness and strength. When moisture increases, it is characterized by variability of mechanical properties and creep resulting from rheological properties. Therefore, it is important to know the mechanical properties of wood depending on its heterogeneity, the orientation of the sample in relation to the directions of anisotropy and its natural disadvantages (Manrique et al., 1994; Mishnaevsky and Qing, 2008).

The research material was obtained from lumber of the pine wood, which on the basis of the four-sided planing process was divided into 4 groups: A,B,C,D. The wood was subjected to strength tests specifying for appropriate groups of samples respectively: modulus of elasticity in static bending- group A-B, static bending strength- group A-B and compressive strength along fibers- group C-D. The influence of wood anisotropy on elasticity and strength properties of wood was demonstrated, which results from the variability of the wood element orientation and load direction in relation to the main directions of anisotropy.

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Impact of storage temperature and time on oil obtained from Moldavian dragonhead – spectroscopic and chemometric studies

Matwijczuk, A.[1], Oniszczuk, T.[1], Matwijczuk, A.[1], Gładyszewska, B.[1], Kocira, S.[1], Niemczynowicz, A.[2], Oniszczuk, A.[3], Wójtowicz, A.[1], Combrzyński, M.[1],

[1] University of Life Sciences in Lublin, Akademicka 13, 20-950 Lublin, Poland, arkadiusz.matwijczuk@up.lublin.pl, tomasz.oniszczuk@up.lublin.pl, alicja.matwijczuk@up.lublin.pl, agnieszka.wojtowicz@up.lublin.pl, maciej.combrzynski@up.lublin.pl, slawomir.kocira@up.lublin.pl bozena.gladyszewska@up.lublin.pl

[2] University of Warmia and Mazury, Słoneczna 54, PL-10-710 Olsztyn, Poland, aga.niemczynowicz@gmail.com

[3] Medical University of Lublin, Chodźki 4a, 20-093 Lublin, Poland, anna.oniszczuk@umlub.pl

Moldavian dragonhead (*Dracocephalum moldavica* L.) is a plant originating from Asia where it has been used for centuries in the production of essential oils. The plant is also valued by beekeepers, mainly due to its good honey output and ease of cultivation. Moldavian Dragonhead is relatively undemanding in terms of soil quality or nutrient availability, although it requires certain care in terms of maintaining correct soil moisture levels. The plant lives for only one year and does not reach excessive size, it favours moist and calcium-rich soils.

In our research we focused on analysing changes in the content of Moldavian dragonhead oil during a period of storage. To this end, we took advantage of FTIR infrared spectroscopy to determine the impact of storage time and temperature on the analysed oil samples. The origin of the key bands was verified against data available in literature, scarce though it may be with regard to this particular plant. Infrared band measurements were carried out at weekly intervals at the wavenumber range from 600 to 4000 cm-1, over a period of three months. In the subsequent part of the study, the method of chemometric analysis was used to process the results obtained from spectroscopic measurements, which allowed us to analyse even the tiniest spectral changes and attribute them to the respective changes in the content of the analysed samples. In order to classify the samples, the method of multivariate analysis was used (PCA, HCA and PSL regression).

To recapitulate, it can be concluded that oil pressed from Moldavian dragonhead is characterised by high durability and can be effectively used in the food industry due to its considerable health benefits.

Spectroscopy, content analysis and multivariate analysis in determining the impact of storage conditions on Moldavian dragonhead oil

Matwijczuk, A.[1], Oniszczuk, T.[1], Matwijczuk, A.[1], Chruściel, E.[1], Kocira, S.[1], Niemczynowicz, A.[2], Kocira, A.[1], Wójtowicz, A.[1], Combrzyński, M.[1]

[1] University of Life Sciences in Lublin, Akademicka 13, 20-950 Lublin, Poland, arkadiusz.matwijczuk@up.lublin.pl, tomasz.oniszczuk@up.lublin.pl, alicja.matwijczuk@up.lublin.pl, edyta.chrusciel@biotechnologia.lublin.pl, agnieszka.wojtowicz@up.lublin.pl, maciej.combrzynski@up.lublin.pl, slawomir.kocira@up.lublin.pl

[2] University of Warmia and Mazury, Słoneczna 54, PL-10-710 Olsztyn, Poland, aga.niemczynowicz@gmail.com

Moldavian dragonhead (*Dracocephalum moldavica* L.) is a plant with considerable health benefits and potential value as a food industry alternative. It is relatively undemanding in cultivation, does not require particularly fertile or nutrient-rich soils. In Asia, it is reatly valued by beekeepers due to its considerable honey output, although its main application is in the production of essential oils. At the same time, however, Moldavian dragonhead can be also be used in the production of cooking oil rich in essential fatty acids and vitamin E. As a food product it contributes to the organism's defences, particularly against circulatory system diseases and cancer.

Our research focused on analysing the impact of storage conditions on, among other elements, the content of fatty acids in oil pressed from Moldavian dragonhead. The study relied primarily on the use of FTIR spectroscopy. We analysed the shifts in the vibration of key bands and the origin of the same, as compared to data available in literature. All FTIR measurements were carried out in weekly intervals, in the range from 600 to 4000 cm-1, over a period of three months. Precise classification of the obtained samples was facilitated by employing a multivariate analysis (PCA, HCA and PSL). Furthermore, a chemometric analysis of the spectroscopic data was performed (after normalisation at a given wavenumber of the previously obtained spectra) to precisely assess the exact impact of storage conditions on the analysed oil samples.

It can be concluded that the application of the highly detailed spectroscopic and chemometric analyses, supplemented by a multivariate analysis and fatty acid content analysis, revealed that the studied samples of Moldavian dragonhead oil were characterised by high stability under a range of storage conditions. This observation supports the value of the plant, especially oil obtained therefrom, for the food industry, particularly given its additional benefit of easy cultivation.

Structural changes observed in the gluten network after bread supplementation with dietary fibre preparations as a result of dehydration process

Nawrocka, A. Miś, A., Krekora, M., Niewiadomski, Z., Gancarz, M., Rusinek, R.

Institute of Agrophysics, Polish Academy of Sciences, Doświadczalna 4, 20-290 Lublin, Poland, e-mail: a.nawrocka@ipan.lublin.pl

Nowadays, consumers demand dietary fibre-enriched bakery products of appropriate taste, texture and mouthfeel as a result of their growing awareness concerning the health benefits of consumption of this kind of products. Supplementation of a wheat bread with dietary fibre preparations considerably reduces its sensory quality. The quality is directly connected with the structure of gluten network. Addition of the dietary fibre preparations disturbs formation of gluten network characterized by adequate mechanical properties.

Four dietary fibre preparations (chokeberry, cranberry, cacao and carob) in the amount of 3%, 6% and 9% were used to supplement model bread dough. All dough samples were prepared in farinograph. Structural changes observed in the gluten network as a result of fibre supplementation were determined by using FT-IR and FT-Raman spectroscopies. Both techniques provide information about secondary structure of proteins (amide I and III bands), conformation of disulphide bridges, microenvironment of two aromatic amino acids – tyrosine (I(850)/I(830)) and tryptophan (I(760)) and water populations.

Analysis of the amide I and III bands showed presence of the aggregated structures such as aggregates, hydrogen bonded β-turns and β-sheets with intermolecular H-bonds. In the case of disulphide bridges, it was observed transformation of the g-g-g disulphide bridges into t-g-g and t-g-t bridges that are regarded as less energetically stable. Tyrosine and tryptophan residues participated in formation of H-bonds with other polypeptide chains and/or polysaccharides. Analysis of the water populations indicated that part of the water molecules interacted particularly with the fibre polysaccharides than gluten network.

The structural changes observed after supplementation of the dough with fibres indicated aggregation and/or abnormal folding of the gluten proteins which can be connected with partial dehydration of the gluten network.

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Assessment of accuracy of grape seasonal development model

Novikova, L.Y.[1], Naumova, L.G[2]

[1] N.I.Vavilov All-Russian Institute of Plant Genetic Resources; 42-44, B. Morskaya st., St. Petersburg, Russia, 190000; l.novikova@vir.nw.ru

[2] Research Institute of Viticulture and Winemaking named after Ya.I.Potapenko; 166, Baklanovsky av., Novocherkassk, Rostov region, Russia, 346421; LGnaumova@yandex.ru

Phenology of plants is most often predicted by the amounts of degree days (DD), for grapes above 10°C, but the accuracy of forecasts is insufficient, especially in conditions of climate change. We have created a model of grape plant condition dynamics (Novikova & Naumova, 2018). In model plant condition described by the temperature to which the plant is currently adapted (T_{in}). T_{in} is moving after air temperature (T_{out}) $\Delta T_{in} = q(T_{out} - T_{in})\Delta t$, where q is constant for variety and phenology phase. When the condition of the plant reaches a temperature minimum of budburst, then flowering, these phases begin. The duration of the period from flowering to ripening is constant for cultivar. We created a computer program SEASONS to simulate the dynamics with day step, and parameterize cultivars by finding the minimum mistake when calculating the parameters grid. The model was parameterized and verified on the base of long-term observations of 71 grape cultivars in Rostov region in 1981-2014, validated according data on 6 cultivars in 2015-2016. The aim of this study was to compare the prediction accuracy of our model and the DD method for the data 2015-2017.

For the 12 cultivars there were calculated SEASONS parameters and mean sum of DD during vegetation on the base of 1981-2014 observations. Mean prediction error of full ripening in 2015-2017 in our model was 8 days, at the base of DD was 14 days. The forecast error for duration of vegetation of our model was 4,0%. The obtained results indicate the suitability of the model SEASONS for forecasting and its advantages over the model DD.

Acknowledgements

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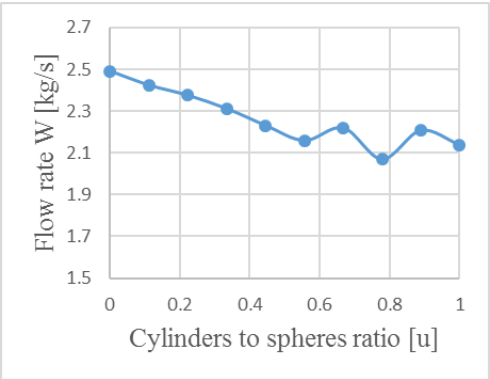
Outflow of mixtures of spheres and cylinders through horizontal orifices. Experimental and DEM simulations

Parafiniuk, P., Wiącek, J.,Horabik, J., Bańda, M., Stasiak, M., Molenda, M.

Institute of Agrophysics, Polish Academy of Sciences, Department of Physical Properties of Plant Materials, Doświadczalna 4, 20-290 Lublin, Poland, pparafiniuk@ipan.lublin.pl

The outflow of particles of various shapes from a model silo was tested experimentally and using the discrete element method (DEM). The silo was equipped with interchangeable discharge orifices of diameters D_0 from 5 to 15 cm and it was 40 cm in diameter and 50 cm high. The container was supported on three load cells that allowed to measure weight of particles and to calculate discharge rate. Outflow of spheres 15 mm in diameter d_p, 15 mm side cubes, cylinders 12 mm in diameter 20 (aspect ratio AR = 1.67) or 41 (AR = 3.4) mm long and their mixtures with varying proportion was tested.

We found that relationships between discharge rate and orifice diameter in all investigated cases were described by the Beverloo equation: $W = C\rho\sqrt{g}(D_0 - kd_p)^{5/2}$, where C and k are empirical constants, ρ is apparent density, g is gravitational acceleration. Discharge rate through 13 cm in diameter orifice of spheres – cylinders (AR = 1.67) mixture (see Figure) was found in a range from 2.5 kg/s (100% spheres) to approximately 2.1 kg/s (approximately 80% of cylinders). In a range to 60% portion of cylinders the curve was nearly linear, while above this fluctuations were observed.



DEM simulations of the performed laboratory testing were conducted in configuration reproducing conditions of sample formation and discharge for spheres and cylinders. Cylinders were substituted by clusters of spheres of equivalent AR.

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Estimation of soluble solids content of sour cherry fruits using NIR spectrometer

Takács, S.[1], Neményi, A.[1], Szuvandzsiev, P.[2], Daood, H.[3], Nagy, Z.[3], Korsós, M.[1], Helyes, L.[1], Pék, Z.[1]

[1] Institute of Horticulture, Szent István University, Páter K. út 1., H-2103 Gödöllő, Hungary, pek.zoltan@mkk.szie.hu*

[2] Univer Product ZRt., Szolnoki út 35., H-6000 Kecskemét, Hungary

[3] Regional Knowledge Center, Szent István University, Páter K. út 1., H-2103 Gödöllő, Hungary

Sour cherry (*Prunus cerasus* L.) is an important stone-fruit species, especially in European countries, like Poland Ukraine and Russia. It is one of the most intensively studied species, in terms of its antioxidant potential and health promoting effects. Soluble solids content (SSC) has a good correlation with its quality attributes. Currently the SSC is measured by destructive method which is time consuming. The goal of this research was to create a non-destructive method to estimate the soluble solids content of sour cherry fruits using a near infrared (NIR) spectrometer.

In a sour cherry plantation (Heves, Hungary) of 'Érdi bőtermő' cultivar on sandy soil at two different sites with different water capacity caused variation in the SSC of fruits. Fruits were collected in three different ripening stages, 96 samples in total from both sites. Reflectance of fruits were recorded in NIR spectral range (950-1650 nm) by Perten DA 7200 NIR analyser non-destructively. Digital refractometer was used for the determination of SSC (°Brix), which requires puree for the measurements (destructive method).

SSC values rose slightly during the ripening period in both sites. The better soil moisture content resulted in bigger fruit size and lower SSC. Partial least square regressions were carried out to perform models of prediction between spectral data and SSC. For a non-destructive SSC determination method, we had to calibrate a cross-validation model. Different statistical methods were tried for the calibration, so we could select the best fitted model. The accuracy of the predictions was discussed according to the correlation coefficient value (R), the root mean square error of calibration/cross-validation (RMSEC/CV). The calibration with the 96 samples resulted in an accurate model (R^2=0.87) for determining the SSC without destruction of fruits. This was achieved by standard normal variance transformation method that gave the least error, 0.7° Brix and 11 PCs factor.

Acknowledgements

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Effect of beet molasses supplementation on growth processes and composition of green algal biomass

Piasecka, A., Krzemińska, I., Tys, J.

Institute of Agrophysics, Polish Academy of Sciences, Doświadczalna 4, 20-290 Lublin, Poland, a.palcowska@ipan.lublin.pl

Algal cells are a source of many valuable metabolites and biologically active compounds. Algal cells are a source of protein, carbohydrates, and lipids, and the synthesis of the main cell components is dependent on e.g. the uptake and assimilation of two biogenic elements, i.e. carbon and nitrogen. The availability of these elements and their interrelationship play a key role in regulation of algal cellular metabolism (Procházková et al., 2014).

The aim of the study was to examine the potential of beet molasses application in cultures of unicellular selected green algal species and to identify and characterize the basic metabolic pathways induced by supplementation with molasses.

The effect of molasses supplementation was assessed with growth parameters and by determination of lipids, carbohydrates, proteins, and fatty acids.

Molasses has a different impact on the analyzed species, but yields a high final concentration of cellular biomass in all species. The addition of molasses does not increase accumulation of lipids in algal cells. The results show enhancement of protein synthesis in the cells caused by the molasses supplementation. The fatty acid profiles were dominated by acids containing from 16 to 18 carbon atoms in the carbon chain.

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Development of innovative *Lemnaceae* plants technologies with the use of Apol-Humus, a natural stimulator of

Piotrowski, K., Romanowska-Duda, Z.

University of Lodz, Faculty of Biology and Environmental Protection, Laboratory of Plant Ecophysiology, str. Banacha 12/16, 92-237 Lodz, Poland, zdzislawa.romanowska@biol.uni.lodz.pl

Energy crisis, chemical pollution, contamination and scarcity of clean water, lack of utilization of post-industrial waste are the biggest problems of the modern world. One of the solutions to the above issues may be aquatic plants of the genus *Lemnaceae* (Muradov et al., 2014). Multidirectional wide spectrum of macrophyte use (biofuel production, addition to animal feed, phytoremediation and bioindication properties), low costs of their breeding and rapid biomass growth create many new opportunities (Romanowska-Duda et al., 2016).

The experiments were carried out under laboratory conditions using *Lemna minor* L. macrophytes from in vitro cultures of the Laboratory of Plant Ecophysiology, Faculty of Biology, University of Lodz. Plant cultivation was carried out in a phytotron room at 24°C under 40W light on a standard "Z" medium (Zehender in Staub 1961) supplemented with various concentrations of Apol-Humus, a natural stimulator (Poli-Farm Ltd., Poland). During the research, the analysis of plant growth and physico-chemical parameters i.e. chlorophyll index content, net photosynthesis, transpiration, stomatal conductivity and CO2 concentration, fresh and dry mass was performed, as well as of significant parameters of the medium i.e. pH, temperature, chemical oxygen demand (COD).

The obtained results indicated that supplementation of the standard "Z" biostimulator with Apol-humus biostimulant was justified. The newly developed technology has a positive effect on the growth of *Lemnaceae macrophytes* and allows to obtain plants characterized by high physicochemical parameters as compared to the control series. Faster growth, high chlorophyll index, much more intensive gas exchange are most likely caused by fulvic and humic acids as well as chitosan polymers which are main components of Apol-humus. The analyzes carried out indicate the possibilities of using innovative technologies of aquaculture with multidirectional purposes.

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Cultivation of energy plants with the use of diatoms (bacillariophyceae) in the unusual conditions of a changing climate

Piotrowski, K., Romanowska-Duda, Z.

University of Lodz, Faculty of Biology and Environmental Protection, Laboratory of Plant Ecophysiology, str. Banacha 12/16, 92-237 Lodz, Poland, zdzislawa.romanowska@biol.uni.lodz.pl

The current agricultural practices in rural areas in Poland were based on full decision-making freedom which resulted in the unlimited use of chemical fertilizers and plant protection products. Huge negligence and problems caused by irresponsible agricultural policy have contributed to gross irreversible contamination of the natural environment. This situation prompted the European Union to implement numerous regulatory directives, especially in the field of crop production and agrotechnics. Sustainable farming based on organically grown plants with the limitation or elimination of chemical growth stimulants has become a priority for the current modern European economy.

The experiment was carried out on *Sida hermaphrodita* L., a popular energy plant cultivated from seeds in containers in the greenhouse and phytotron rooms. During the growing season the plants were watered, sprayed 4 times at three-week intervals using a mixture of *Navicula sp.* monocultures. Effectiveness of the bioinduced fertilizer was assessed on the basis of physicochemical parameters. The height and health of plants were analyzed, fresh and dry biomass, chlorophyll index content, gas exchange parameters were determined.

The obtained results confirmed the earlier hypothesis that diatoms which have a positive effect on the growth and development of *Sida hermaphrodita* L. may be a natural fertilizer. Simultaneous watering and spraying of plants was the most advantageous form of application. Ecological stimulators based on *Navicula sp.* monocultures can be an alternative to chemical fertilizers and plant protection products (Piotrowski et al., 2016). Biopreparations based on a mixture of diatoms being new-generation fertilizers are one of the most promising strategies in sustainable and integrated agriculture, both in Poland and in other European Union countries.

Acknowledgements

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Application of hyperspectral imaging to classify and monitor of fungal infected fruits

Siedliska, A., Baranowski, P.

Institute of Agrophysics of Polish Academy of Sciences, Doświadczalna 4, 20-290 Lublin, Poland
a.siedliska@ipan.lublin.pl

Spoilage fungi usually cause a lot of loss in all strawberry production areas: not only in the field, but also during storage, transit, and marketing of strawberry fruit, due to onset of severe rot as the fruits begin to ripen. Diseases in postharvest fruits and vegetables are mainly gray mold and anthracnose caused by Botrytis cinerea and Colletotrichum acutatum, respectively.

The traditional methods to detect fungal infection and mycotoxin contamination, like traditional microbiological and physicochemical techniques are expensive, time- and labor-consuming, require professional experience and have limited applicability since a limited amount of fruit batches can be tested at a time (Sanzani et al., 2016). Compared to the traditional chemically or physically destructive methods, hyperspectral imaging has the advantage of being non-invasive, chemical-free and has a reduced measuring time. Furthermore, more than one feature of interest can be measured at the same time. In recent time, this method was successfully used for detection of fungal infections in fruits like strawberries (Siedliska et al., 2018) and apples (Pieczywek et al., 2018).

The objective of this study was to determine the efficiency of visible and near infrared hyperspectral imaging technique to early detection of fungal infection caused by *Botrytis cinerea* and *Colletotrichum acutatum* in strawberry fruits.

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Tablets properties produced of starch straw mixtures

Stasiak, M., Molenda M., Górmińska, J.

Institute of Agrophysics PAS, Doświadczalna 4, 20-290 Lublin, mstasiak@ipan.lublin.pl

The objective of the project was to determine strength of possible construction material the press agglomerate of starch and ground straw. Tablets produced of potato starch PS (6, 12 and 18% of m.c.) and powdered wheat straw with 5, 10 and 20% addition of potato starch SPS (12 and 18% of m.c.) were tested. Uniaxial compression was performed in a cylindrical die, 10 mm in diameter and 70 mm high with deformation speed of 0.02mm/s. After compaction at four maximum pressures p of 38, 76, 114 and 152 MPa the strength of the tablets was measured in a material strength testing machine. The tablets were diametrically compressed between circular plate and stamp. During the experiments, the stamp was moving down with constant deformation rate v of 0.033 mm/s. The real time, force in N and displacement in mm of the moving stamp were recorded.

The breakage strength of agglomerates obtained for PS and SPS was increasing with consolidation stress. For consolidation stress of 152 MPa strength 0.7 MPa and 0.85 MPa was obtained adequately for PS and SPS. In the case of minimal consolidation stress zero strength of PS agglomerates was obtained, while this for SPS was about 0.15 MPa. This could be the reason of fibrous structure of powdered wheat which resulted in interlocking of particles. Tablet strength for SPS was four times higher than for PS. After 14 days of storage the strength of PS agglomerates increased, while the strength of SPS decreased. Increase in powders moisture content resulted in an increase of strength properties of PS tablets and decrease of strength of SPS tablets.

Characterization of the subsurface microstructure of apple fruit using contrast enhanced micro-CT

Wang, Z.[1], Van Beers, R.[2], Verboven, P.[3], Saeys, W.[4], Nicolai, B.[5]

[1] KU Leuven, MeBioS, Willem de Croylaan 42 - box 2428, Leuven, Belgium, zi.wang@kuleuven.be

[2] KU Leuven, MeBioS, Kasteelpark Arenberg 30-box 2456, Leuven, Belgium, robbe.vanbeers@kuleuven.be

[3] KU Leuven, MeBioS, Willem de Croylaan 42 - box 2428, Leuven, Belgium, pieter.verboven@kuleuven.be

[4] KU Leuven, MeBioS, Kasteelpark Arenberg 30 - box 2456, Leuven, Belgium, wouter.saeys@kuleuven.be

[5] KU Leuven, MeBioS, Willem de Croylaan 42 - box 2428, Leuven, Belgium, bart.nicolai@kuleuven.be

Understanding how fruits interact with their surrounding environment is necessary for evaluating perspective strategies for reducing losses in postharvest storage. The subsurface tissue is the main barrier for gas exchange and water loss. The 3D microstructure of this tissue has been difficult to quantify because of its dense nature. While nondestructive methods such as micro-computed tomography (CT) and optical coherence tomography (OCT) have been applied, full characterization of the 3D microstructure of the subsurface tissue remained impossible.

A new contrast enhanced micro-CT imaging technique was developed to nondestructively capture morphological data in 3D under the surface of apples fruits (*Malus domestica*). Cubic samples of apple subsurface tissues from Kanzi, Braeburn and Golden apple cultivars were excised and subjected to the new contrast enhancement protocol. The enhancement protocol consisted of agitated immersion of the excised apple pieces within a 10% cesium iodide contrast solution for approximately 2 hours. Following contrast incubation, excess contrast fluid was removed and samples were wrapped in parafilm to prevent sample dehydration and degradation. Micro CT scans were subsequently taken at a 60kV and 175uA, with capture time of 500ms and a voxel resolution of 2.5 micrometers. Reconstructed images were subject to image segmentation and analysis, and assessment of the enhanced micro-CT data revealed that cutin, epidermal, hypodermal and outer hypanthium cells and air spaces are clearly distinguishable from each other. Quantitative analysis included distributions of size, shape and volumetric density of cells and air spaces. Given that the captured datasets is in 3D, the value of such methodology and resulting data for downstream modelling studies is obvious.

Anti-inflammatory effect of Sunflower oil in Raw 264.7 macrophages

Watanapokasin, R.[1], Sriklung, K.[2]

[1] Srinakharinwirot University, Sukhumvit 23, Wattana District, Bangkok 10110, Thailand, ramidawa@yahoo.com

[2] Srinakharinwirot University, Sukhumvit 23, Wattana District, Bangkok 10110, Thailand, kanlayaneedd@gmail.com

Sunflower (*Helianthus annuus*) is a living annual plant in the family Asteraceae, In the past, sunflower oil was used as a traditional medicine as an anti-inflammatory and wound healing agent however research on molecular mechanisms of sunflower oil on anti-inflammatory activity was still unknown. Our work is focused on in-vitro anti-inflammatory activity of sunflower oil in Raw 264.7 macrophages using lipopolysaccharide (LPS) to induce cell changes. LPS-induced Raw 264.7 macrophages was incubated with various concentrations of sunflower oil for 24 hours to investigate cell viability by MTT assay then the non-toxic concentration will be determined. LPS-induced morphological changes was observed under electron microscopy. Nitrite accumulation in the culture medium was measured as an indicator of nitric oxide production based on the Griess reaction. The TNF-α and iNOS gene expression were normalized using β-actin as an internal control by the real-time quantitative RT-PCR system. The results showed no cytotoxic activity in Raw 264.7 macrophages by both 50 and 100 ug/ml sunflower oil. In addition, when Raw 264.7 macrophages were pretreated with sunflower oil for 2 hours prior to stimulation with LPS for 24 hours, the results showed that 100 µg/ml sunflower oil delayed cell damage and slightly increased cell morphological changes. Interestingly, 50% inhibition of nitric oxide formation, decreased TNF-α and iNOS mRNA levels were detected as compared to the untreated control. Further experiments on anti-inflammatory protein expressions and signaling pathway will be studied.

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Effect of extrusion-cooking conditions on pasting properties of extruded white and red bean seeds

Mitrus, M.,[1] Wójtowicz, A.[1], Kocira, S.,[2] Kasprzycka, A.,[3] Szparaga, A.,[4] Oniszczuk, T.,[1] Combrzyński, M.,[1] Kupryaniuk, K.,[1] Matwijczuk, A.[5]

[1] University of Life Sciences in Lublin, Department of Thermal Technology and Food Process Engineering, Doświadczalna 44, 20-280 Lublin, agnieszka.wojtowicz@up.lublin.pl, marcin.mitrus@up.lublin.pl, tomasz.oniszczuk@up.lublin.pl, maciej.combrzynski@up.lublin.pl, karol.kupryaniuk@o2.pl

[2] University of Life Sciences in Lublin, Department of Machinery Exploitation and Production Process Management, Głęboka 28, 20-400 Lublin, slawomir.kocira@up.lublin.pl

[3] Institute of Agrophysics PAS in Lublin, Department of Physical Properties of Plant Materials, Doświadczalna 4, 20-001 Lublin, a.kasprzycka@ipan.lublin.pl

[4] Koszalin University of Technology, Department of Agrobiotechnology, Racławicka 15-17, 75-620 Koszalin, agnieszkaplawgo@wp.pl

[5] University of Life Sciences in Lublin, Department of Physics, Akademicka 13, 20-950 Lublin, arkadiusz.matwijczuk@up.lublin.pl

Many bean varieties have been shown as nutritionally valuable due to high protein, vitamins and fibre content. However, bean consumption in Poland is low among other things due to some of antinutritional factors present in bean seeds. One possibility to deactivate these antinutritional substances is thermal treatment by micronization or extrusion-cooking. Various processing conditions can affect physicochemical characteristics of extruded materials. Pasting properties are useful to identify the intensity of thermal treatment during the extrusion-cooking. The objective was to study the effect of extrusion-cooking conditions on pasting properties of extruded white and red bean seeds. Extrusion-cooking was performed with Clextral twin screw extruder with a feed rate of 20 kg/h. Variable processing conditions as screw speed (300-700 rpm) and water level (0.8-2.4 l/h) were applied. White and red bean extrudates were ground to particle size below 0.5 mm and tested as 10% solutions with distilled water. Pasting properties were tested with Brabender Micro-Visco-AmyloGraph with heating rate at 7.5°C/min and test speed at 250 rpm. Pasting temperature (PT) (°C), initial viscosity (IV) (mPas), peak viscosity (PV) (mPas), final viscosity (FV) (mPas), setback (Set) (mPas) and breakdown (BD) (mPas) were evaluated. The results showed significant effect of extrusion-cooking on pasting properties compared to untreated materials. White and red bean extrudates were characterized by different pasting properties depending on the intensity of processing as a result of variable extrusion parameters (water level and screw speed).

Recent trends, challenges and opportunities of algal production

Zabochnicka-Świątek, M.[1], Krzywonos, M.[2], Kalaji, H.M.[3,4]

[1]Czestochowa University of Technology, Institute of Environmental Engineering, Brzeźnicka 60a, 42-200 Czestochowa, Poland, mzabochnicka@is.pcz.czest.pl

[2]Wrocław University of Economics, Department of Bioprocess Engineering, Komandorska 118/120, 53-345 Wrocław, Poland, malgorzata.krzywonos@ue.wroc.pl

[3]Institute of Technology and Life Sciences (ITP), Falenty, Al. Hrabska 3, 05-090 Raszyn, Poland

[4] White Hill Company, Żurawia 71/3 ,15-540 Białystok, Poland

Recently, algae production has become to be as one of the main interests of scientific community and various industries. The paper discusses the possibilities of reducing the CO_2 emissions due to the CO_2 capture by photosynthesizing algae Beside reducing of greenhouse effect and contributing to the decrease of the harmful substances amounts in the air, an attention has been paid to the possibility of using algae for wastewater treatment. A review of the potential ways of algal biomass utilization has been already done. Algae can be used for the production of biofuels, biopolymers, cosmetics, pharmaceuticals, dietary supplements, and also as feed for farm animals. The process of their breeding itself allows to reduce CO_2 pollution by the binding of this gas through algae cells during photosynthesis. Therefore, algae can be used to capture CO_2 from exhaust gases. In addition, the culture can be carried out using wastewater that can be purified by algae from biogenic compounds, heavy metals, etc. The increasing interest in the use of algal biomass for further applications may be forecasted in the coming years. It may be applied, for instance, in modern eco-construction, where algae can be used for household wastewater treatment, and the biomass will definitely be applied, e.g. as biofuel for buildings' heating.

Minimum and maximum air temperatures modelling with TBATS and SVM for various climatic localizations in Europe

Baranowski, P.[1], Gos, M.[1], Krzyszczak, J.[1], Murat, M.[2], Malinowska, I.[2]

[1] Institute of Agrophysics Polish Academy of Sciences, Department of Metrology and Modelling of Agrophysical Processes, Doświadczalna 4, 20-290 Lublin, Poland, p.baranow@ipan.lublin.pl

[2] Department of Mathematics, Lublin University of Technology, Nadbystrzycka 38a, 20-618 Lublin, Poland

Time series forecasting methods can be performed by analysis of long-term historical data (Murat et al., 2016, Murat et al., 2018). Such approach uses past patterns of meteorological time to derive future predictions. In recent years various methodologies were used for future predictions of meteorological time series including ARIMA, SARIMA, exponential smoothing and GARCH modeling or various soft computing methods. In general these methods try to study patterns in the past observations of a time series to develop an appropriate model which can predict future values.

In our study statistical modelling of air temperature time series was performed with TBATS and Support Vector Machine (SVM) to predict the minimum and maximum daily air temperatures. Long-term time series were used for six years predictions for various localizations in Europe, including Spain, Germany and Finland. For all the studied sites coupled TBATS/SVM models occurred to be effective in predicting air temperature courses, giving an improved precision (up to 25%) in forecasting of the seasonality and local temperature variations, compared to pure SVM or TBATS modelling. The precision of prediction of the maximum and minimum air temperatures strongly depended on the dynamics of the weather conditions, and varied for different climatic zones. For localizations with strong seasonality within the air temperature time series the prediction accuracy improved. It was also revealed that the especially for precipitation, the prediction accuracies of the coupled models depended localization. It was confirmed that proposed coupled modelling can be useful for missing-data imputation in the minimum and maximum air temperature time series.

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Comparison of meteorological time series derived from NASA MERRA-2 and synoptic stations

Gos, M.[1], Baranowski, P.[1], Krzyszczak, J.[1], Kieliszek, A.[2], Siwek, K.[2]

[1] Institute of Agrophysics Polish Academy of Sciences, Department of Metrology and Modelling of Agrophysical Processes, Doświadczalna 4, 20-290 Lublin, Poland, m.gos@ipan.lublin.pl

[2] Maria Curie-Skłodowska University, Faculty of Earth Sciences and Spatial Management, Plac Marii Curie-Skłodowskiej 5, 20-031 Lublin, Poland

Meteorological time series, both measured and coming from retrospective analysis, are frequently used as indicators of fluctuations in climate systems and for weather prediction. Ground long-term data from meteorological stations in Poland are scattered and not easily available. Also, the scaling of meteorological time series properties is not sufficiently acknowledged (Hoffman et al., 2017). However, there are high-resolution retrospective databases combining terrestrial and satellite measurements. A perspective source of meteorological data, combining terrestrial and satellite measurements, is MERRA - an improved Modern-Era Retrospective analysis for Research and Applications database (Rienecker et al., 2011). MERRA-2 (2015) is an improved version of MERRA (2008) and incorporates modern types of satellite observation and improved analysis methods.

The aim of the study was to compare properties of 10 years' time series (2007-2016) of air temperature, air pressure, wind speed and wind direction for Poland coming from MERRA-2 retrospective data base and ground observations from the database of Institute of Meteorology and Water Management (IMGW-PIB).

High correlation between MERRA-2 and ground time series was found, especially for the air-temperature, what was confirmed by the analysis of similarity measures including lock-step measures, feature-based measures, model-based measures, and elastic measures.

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Carbon dioxide emissions during wastewater treatment in the context of climate change

Jaromin-Gleń, K.[1], Babko, R.[2], Plaszecznik, V.[3], Danko, Y.[4], Łagód G. [5], Bieganowski, A.[1]

[1] Institute of Agrophysics, Polish Academy of Sciences, Doświadczalna 4 20-290 Lublin, k.jaromin-glen@ipan.lublin.pl; a.bieganowski@ipan.lublin.pl

[2] Schmalhausen Institute of Zoology, National Academy of Sciences of Ukraine, B. Khmelnytskogo 15, 01630 Kyiv, Ukraine, rbabko@kr.net

[3] Uzgorod National University, Narodna Square 3, 88000 Uzhhorod, Ukraine, volodymyr.pliashechnyk@uzhnu.edu.ua

[4] Sumy Makarenko State Pedagogical University, Romenska 87 40002 Sumy, Ukraine, yaroslavdanko@gmail.com

[5] Lublin University of Technology, Nadbystrzycka 40B, 20-618 Lublin, g.lagod@pollub.pl

Global climate change, currently occurring, has an obvious tendency to increase the average annual temperatures. Today, one of the obvious side effects of civilizational processes is a steady increase in the amount of waste, both solid and liquid. Utilization of the latter is carried out by wastewater treatment (WWT), the technology of which is constantly being improved. This improvement assumes optimization of biological processes of utilization, first of all, of organic substances. However, the utilization of organic matter is accompanied by the release of significant amounts of greenhouse gases (GHG)-CO_2 and CH_4. Considering that the only effective barrier against contamination of surface waters is the WWT technology, it can be assumed that the increase in the number and effectiveness of treatment plants in the future will be very significant. As an inevitable consequence the significance of the WWT plants as the sources of GHG will increase in the near future. Thus, it is important to model possible risks and form predictions associated with the effect of temperature changes on the amount of GHG emitted by treatment plants. Our studies under conditions of laboratory SBR yielded the following results. According to our data, the intensity of CO_2 release under SBR conditions depends linearly on temperature. If we assume that this dependence will persist at higher temperatures, then at 25°C the intensity of CO_2 emission will increase by 11% compared to the release at 20°C. If we rely on the literature data on the dependence of bacterial respiration on temperature, then on the basis of the Arrhenius formula we can expect a several times greater increase in the release of CO_2.

Urban Agriculture and Edible Landscape Development in Iranian Cites; Opportunities and Setbacks for Further Developments

Saeedi, I.

Senior Lecturer, Department of Landscape Engineering, Malayer University, Malayer, Iran, E-mail: Isaeedi@malayeru.ac.ir, Imansaeedi81@yahoo.com

The 21st century sustainable urbanism sets aims to reduce the ecological footprint of cities, merge more with natural environments and create sustainable food systems. Urban agriculture concept is a movement to make a transition toward more self-sustained cites. According to Urban agriculture principles, every open space, public or private landscapes, as well as some potential spaces for growing plants like roofs and walls, could be utilized for cultivation of fruits and vegetables. This utilization not only provides citizens with fresh and economical products but also enhances biodiversity, reduces damaging impacts on nature and a myriad of other constructive social, ecological and economic effects. Applying urban ecology could also provide a lot of unique opportunities in Iran due to its arid and semi-arid regions, climate change threats and its soaring population. So this research aims to consider the advantages and disadvantages of urban agriculture in Iranian cities. The Research method is descriptive consisting of two main stages; at first, with a concise literature review, the concept of urban agriculture has been introduced. In the second stage by describing Iranian cities structures, the possibilities and impediments of agricultural farming and edible landscapes have been enlightened. The result showed the application of this concept of urban farming will surely end up with a lot of economic, social and ecological advantages while some impediments like lots limitations can't be neglected.

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Bifilar electroseparator for removing selected inclusions from crushed rape seeds

Majcher, J.

Lublin University of Technology, Nadbystrzycka 38 A Str., 20-618 Lublin, Poland, Institute of Electrical Engineering and Electrotechnologie, j.majcher@pollub.pl

Food products derived from rape seeds must be of adequate purity and quality. The quality of products should be taken care of throughout the entire process, from seed harvesting to stacking store shelves. In order to obtain a high-quality final product, it is necessary to ensure the quality of the raw material, free of all kinds of contaminants. Therefore, it is important to separate individual impurities and obtain a homogeneous material. Often it is also necessary to separate seeds that are mechanically damaged. For this purpose, for example, a corona discharge can be used (Kovalyshyn et al., 2013).

The paper attempts to isolate undesirable fractions such as hull from rape seeds. As shown in (Szwed & Majcher 2010), electrical properties can be used as a separation criterion. To use this criterion, an electroseparator with a bifilar winding was constructed. The device in its construction has a rotating drum on which the bifilar winding is wound. This winding is supplied from a high voltage power supply and generates an nonhomogeneous electrostatic field. The separation of fragmented rape seeds involves the use of differences in the electrical properties of individual seed fractions. On the basis of properly selected parameters of electroseparation (such as the supply voltage, diameter of the winding or the speed of the rotating drum), it is possible to partially extract selected fractions from crushed rape seeds.

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Monitoring system of temperature and volatile organics compounds emissions during the bread production process

Gancarz, M., Rusinek R., Krekora M., Miś A., Niewiadomski Z., Nawrocka A.

Institute of Agrophysics, Polish Academy of Sciences, Doświadczalna 4, 20-290 Lublin, Poland, e-mail: m.gancarz@ipan.lublin.pl

The bread production process consists of three main stages: dough kneading, dough fermentation and baking. In each of these stages volatile organic compounds (VOCs) characteristic for each of them are produced, which affect the quality of the final product and its shelf-life. The evolved substances are responsible for the odours that are known as acid for acetaldehyde, butyrate for diacetyl, fat-popcorn for acetopyridine, sweet baking for acetyl pyridine, and baking for 2-ethyl-3-methylpyrazine (Ponzoni et al., 2008). The type and concentration of volatile substances change throughout the production and baking processes, which provide information on their courses. There are not known devices that would allow simultaneous monitoring of temperature and emission of VOCs in the process of kneading, fermentation and baking of bread. Nowadays, bread is often supplemented with fibres, bran, seeds that can affect the above-mentioned processes. For this reason, it is important to monitor these processes, particularly in terms of disruptions that are often occurring. Their control gives knowledge about the course of the process, which allows each time the best possible selection of parameters and obtaining the final product with the most desirable and desired properties. The aim of the research is to develop a control and measurement system for monitoring the process of kneading and baking bread. The system providing relevant data will allow for a thorough analysis of the course of processes during the production of bread.

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An application of a new method for generation of a smellprint identification of vocs during grain storage using agrinose

Rusinek R., Gancarz, M., Krekora M., Miś A., Niewiadomski Z., Nawrocka A.

Institute of Agrophysics, Polish Academy of Sciences, Doświadczalna 4, 20-290 Lublin, Poland, e-mail: m.gancarz@ipan.lublin.pl

Agrinose (Food Volatile Compound Analyser) is an electronic nose and has been designed and built in the Institute of Agrophysics, PAS, Poland. The device consists of eight metal-oxide semiconductor (MOS) sensors, which were selected with the following criteria: lower power consumption, a similar type and geometry of the sensors in the array, low susceptibility to humidity and temperature, and common use of the gas sensors tested in a similar measurement device. The sensors strongly respond to the presence of ketones, fatty acids, esters, and alcohols that can be expected in fungal metabolites in biomaterials.

Currently, creation of electronic smellprints of volatile compounds is based on a combination of the maximum response signals from a few or several dozen sensors, i.e. parameter (ΔR/R)max in the case of electrochemical sensors. The new three-parameter method for determination of the VOC type developed and filed for patent protection is based on adsorption and desorption phase sensorgrams obtained during measurements and establishment of three measurement points. The method includes the impregnation time (tIM), cleaning time (tCL) and maximum responses-(ΔR/R)max. An advantage of the new method is the possibility to generate three parameters during a single measurement of VOCs, which can describe an odour more precisely than the single-parameter ((ΔR/R)max) approach of the e-nose devices used currently.

An Agrinose was used for identification of loss of quality of rapeseed, barley, and wheat during a short period of storage after harvest. The results have shown a correlation between chemical methods for assessment of quality and the responses of electrochemical sensors. The investigations and analyses have demonstrated that the new three-parameter method for determination of volatile compounds describes the changes in VOCs more efficiently than the single-parameter approach based only on the maximum sensor response.

AFM study of strawberry pectin nanostructure and its relevance on fruit texture

Posé, S., Paniagua, C., Santiago-Doménech, N., Matas, A.J., Kirby, A.R., Gunning, A.P., Morris, V.J., Quesada, M.A., Mercado, J.A.

Atomic force microscopy (AFM) has been used to characterize the nanostructure of cell wall pectins during strawberry fruit growth and ripening, as well as in transgenic fruits with pectinase genes down-regulated. This technique allows the imaging of individual polymers at high magnification with minimal sample preparation.

AFM studies during fruit development show that pectin size, ramification and aggregation is reduced in ripe fruits. Additionally, transgenic lines with different pectinase genes downregulated (polygalacturonase, pectate lyase and B-galactosidase) also show a more complex pectin nanostructure, including longer chains, higher branching degree and larger presence of aggregates. In all those cases the higher pectin complexity at nanoscale correlates with a reduced softening in strawberry fruits at macroscale level.

Globally, our results support the key role of pectins in fruit structure and highlights the use of AFM as a powerful tool to gain insights about the bases of textural fruit quality not only in strawberry, but also in other commercial crops.

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Changing rainfall patterns of clay minerals and soils under the influence of humic acid

Kurochkina, G. N.[1], Pinsky, D.L.[1], Hajnos, M.[2]

[1]Federal state budgetary institution of science Institute of physico-chemical and biological problems of soil science, Russian Academy of Sciences, 142290, Russia, Pushchino, Moscow region, Institutskaya str., 2, colloid41@ rambler.ru

[2]Institut of Agrophysics Polish Academy of Sciences, 20236, Poland, Lublin, ica@ipan.lublin.pl

In this paper, the influence of humic acid on me was established- the formation mechanism of adsorption layers and their influence on aggregate stability and stabilization of suspensions of individual soil mines (quartz sand, kaolinite, montmorillonite, palygorskite) and soils (gray forest, Chernozem, as well as fractions of gray forest soil). At the molecular and supramolecular level, we studied the adsorption and education primary mineral organic compounds on the surface of mineral and organomineral matrices. In experiments to determine the volume of sludge, according to mercury porometry, electron-microscopic studies have shown that the stability of the suspensions increases with increase in concentration of humic acids depending on the type of the crystal structure of minerals, the soil type and its components. It is shown that the surface modification of minerals and soils adsorbed humic acid has a different effect on porosity, average radii, surface area and volume of pore space in the direction of increasing and decreasing sizes. At the same time, it leads to a significant change in the differential pore volume and a more uniform pore distribution.

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