BSE 12th International Conference
Biosystems Engineering
May 5-7, 2021 in Tartu, Estonia

BOOK OF ABSTRACTS

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Book of Abstracts. 12th International Conference on Biosystems Engineering 2021
Editors: Olt, J., Kikas, T., Meneses, L.
http://bse.emu.ee

ISBN 978-9949-698-91-2 (pdf)

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I AGRICULTURAL ENGINEERING

Experimental research into uniformity in spreading mineral fertilizers with fertilizer spreader disc with tilted axis

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Abstract. Improving the efficiency in the work process of mineral fertilizer dressing is a topical problem in today's agricultural industry. The authors have developed a design of the fertilizer spreading tool with a tilted axis and carried out field experiment investigations on it. It has been established by the results of the investigations that the non-uniformity in the spreading of mineral fertilizers along the line of their departure from the fertilizer spreading tool with a tilted axis is most strongly affected by the disc rotation frequency. The obtained results provide for selecting the optimum parameters and modes of operation for the tool under consideration in the situation, when it is installed in fertilizer placing machines. Also, it has been established that increasing the spreading disc rotation frequency in such a tool from 600 to 800 rpm results in the growth of the effective range of mineral fertilizer spreading along the placing line at a level of 10.5 m. Increasing the disc's angle of inclination to the horizontal plane to 20º results in the rise of the effective fertilizer spreading range at a level of the 48th tray (24 m) inclusive as well as the increase of the distance between the tool and the tray that contains the maximum share of the spread fertilizers (5.1%) to 24 trays (12 m). At a constant rotation frequency of the disc in the tilted-axis fertilizer spreading tool, in all its kinematic modes of operation, an increase in the angle of its disc's inclination to the horizontal plane results in the rise of the indices representing the distribution of the mineral fertilizers over the trays along the line of their placing. The width of the mineral fertilizer spreading can be controlled by adjusting the rotation frequency of the disc in the tilted-axis fertilizer spreading tool, when it is set at an angle to the horizontal plane, similar to how it is done in state-of-the-art fertilizer placing machines with horizontally positioned discs in their centrifugal spreading tools. The rotation frequency of the disc in the tilted-axis fertilizer spreading tool has the most significant effect on the coefficient of variation incidental to the distribution of the mineral fertilizers along the line of their placing.

Key words: disc, inclination, mineral fertilizer, uniformity, spreading tool.

Research into geometric parameters of digging shares used for lifting sugar beet roots from soil with assistance of vibration

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Abstract. One of the important conditions in securing the high quality, when performing the work process of vibrational root lifting, is to avoid damaging the roots. It is obvious that the greatest probability of damaging and even breaking the lifted root arises, when the tool interacts with the root body during their first contact and in the time of the root passing in the throat between the operating shares. The aim of the study is to substantiate the rational design length for the working throat of the vibrational root lifter in its interaction with the sugar beet root while lifting the latter from the soil. As a result of the completed research, the minimum permissible tool oscillation frequencies have been determined for the specific values of the lifter's translational velocity and the working throat rear part length, at which the event of the vibrational lifting tool gripping the root will occur at least one time. For example, when the length of the lifter's working throat rear part is equal to 0.1 m and the oscillation frequency is equal to ν = 20.3 Hz, the satisfactory quality of the vibrational root lifting process is ensured, when the velocity of the translational motion performed by the vibrational lifter stays within the range of 1.3-2.55 m s^{-1}. In order to ensure the good quality of the vibrational root lifting process at the lifter's translational velocity equal to V = 2.0 m s^{-1} and the frequency of its tool's oscillations equal to ν = 10 Hz, it is necessary that the length of the lifter's working throat rear part is equal to 0.2 m, at a tool oscillation frequency of 6.7 Hz – 0.3 m. As a result of the completed numerical calculations, the permissible values have been determined for the tool oscillation frequency, which can be recommended for the translational velocities within the range of 1.3-2.2 m s^{-1}, taking into account the limitation set for the tool oscillation frequency by the pre-condition of the guaranteed gripping of each root by the digging shares.

Key words: amplitude, frequency, oscillation, sugar beet root, vibrational lifting tool.

Evaluation of potato storage in terms of energy consumption and CO_2 production

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Abstract: In storage of potatoes, it is necessary to perform various energy-intensive tasks, including ventilation, which has to respond based on the amount of substances released from the tubers, including carbon dioxide (CO2). The tested potato variety was stored in equally large warehouse boxes in all variants of the trial. In operational trials, total energy consumption was monitored not only during storage, but also during loading and unloading of tubers from storage. The rate of CO2 production was affected by a large number of factors, including air temperature and tubers. The research was also focused on monitoring the changes in the ambient conditions of potato storage before and after modifications to the warehouse. The energy consumption was measured with the use of electricity meters and climate sensors, before and after the insulation of the ceilings and the walls using sprayed polyurethane foam in 3-5 cm thickness. Thermal transmission through the construction was also measured. Three different types of fan drives (a fan with EC drive, an original fan equipped with frequency converter and a control with the original fan). Comparing the consumption of the existing electric fan motor, the annual electricity savings when using an EC motor were 880 kWh and when using an electric motor with a frequency converter they were 690 kWh per storage season.

Key words: tuber quality, potato storage, energy consumption, carbon dioxide, air storage temperature, air storage humidity, thermal permeability.

ACKNOWLEDGEMENTS: The authors gratefully acknowledge the financial support of The Ministry of Agriculture of the Czech Republic, grant number RO0618.

Evaluation of passive cooling system in plywood enclosure for agricultural robot prototype

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Abstract: The use of autonomous robots in agriculture has been increasing rapidly in recent years, but is hampered by the complexity of data recording and processing. The prototyping process involves many changes to the housing design during development. Using laser cutting to make a housing is more convenient, faster and cheaper than milling or casting if only one body needs to be made. To speed up the production of autonomous robot prototypes, the body was made of birch plywood using laser-cut parts. The study analyses the efficiency of passive cooling to make sure that birch wood plywood is suitable for the production of a robotic body for outdoor use in agriculture. Under laboratory conditions, temperature measurements were made inside and outside the housing to determine how the heat released by the electronic components dissipates into the environment. An exponential model with a static coefficient and a time constant can be used to determine the recommended operating time at different ambient temperatures when the allowable operating temperature of the component is known. Air flow and heat transfer simulations were performed to represent heat dissipation. Birch plywood can be used for the production of prototype enclosures for agricultural robots, but the design must provide technological solutions for heat dissipation to prevent overheating of electronic components.

Key words: cooling system, heat transfer, modelling, thermal management.

ACKNOWLEDGEMENTS: This research is funded by the Latvian Council of Science, Funding Number: lzp-2018/1-0482.

An investigation into the state of agricultural lands under water erosion conditions

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Abstract. Protecting agricultural land from erosion continues to be the most important task within the overall issue of the protection and rational use of land resources. That is why it is necessary to comprehensively study patterns of development in the erosion processes, and to assess the specific nature and features of their impact upon soil and vegetation, water resources, and landscapes in various natural conditions. The work is based on the results of many years of experimental research on problems that are related to soil erosion, and on the accumulation of slope sediments in catchments and in the valleys of small rivers, based on the use of landscape geography, soil morphology, and cartography methods of research. The research methodology that is included the collection covers the analysis of cartographic and experimental materials on the geo-ecological situation regarding an formation and manifestation of spatial and temporal erosion processes in the territory, and, the carrying out of research work which cover the soil washout and erosion processes in key areas of agricultural landscapes. The methodology also includes, the process of conducting a determination of the influence of natural and anthropogenic factors on the intensity of erosion processes, and the cameral processing of results that have been obtained in the field, all of which characterise the erosion and hydrology situation in the basins of small rivers. The paper presents the latest levels of research on the spatial and temporal variability of the features of erosion processes, depending upon their mechanisms of functioning, the complexity of the territory's geomorphological landscape conditions, and the intensity of anthropogenic load on the catchment areas of small rivers. The management of the migration of biogenic elements in agricultural landscapes can be improved if, on the one hand, the share of cultivated land is reduced and, on the other hand, the area of meadow land and small forest plots is increased, which significantly serve to slow down the flow of erosion products, including biogenic elements, into the hydrosphere. It has been established that, with an increase in the share of arable land, the removal of biogenic elements with runoff increases in direct proportion. Therefore, with up to 50% of the territory being cultivated, nitrogen removal was seven times higher - and phosphorus two times higher - than with the same territory under 20% of cultivation. With 80% cultivation, nitrogen removal increases two times and phosphorus and potassium removal increases four times when compared to 40-50% cultivation of the same territory in the catchments.

Key words: agricultural landscape, catchment, environmental monitoring, runoff, soil erosion.

Linear compression behaviour of oil palm empty fruit bunches

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Abstract: The study describes the mechanical behaviour of oil palm empty fruit bunches (EFB) as a promising product for pyrolysis production. The EFB samples mixture of moisture content 6.3 ± 0.3 (% d.b.) were grouped into different fraction sizes of 10, 20, 40 and 100 mm. The initial pressing height of each fraction size was measured at 60 mm and compressed at a maximum force of 4500 N and speed of 10 mm min^{-1} to obtain the force-deformation dependencies using the universal compression machine and pressing vessel of diameter 60 mm with a plunger. Deformation, deformation energy, volume energy and strain were calculated. While deformation decreased with fraction sizes, deformation energy increased. The deformation energies at fraction sizes from 10 mm to 100 mm indicated energy savings of approximately 23 %. The optimal fraction size in relation to energy efficiency was observed at 10 mm. The tangent model accurately described the mechanical behaviour of the EFB samples mixture. The results provide useful information for the design of optimal technology for processing EFB for energy purposes.

Keywords: mechanical behaviour, mathematical model, energy requirement, biomass material, pyrolysis production.

ACKNOWLEDGEMENT: The study was supported by the Internal Grant of Faculty of Engineering, Czech University of Life Sciences Prague: IGA 2019: 31130/1312/3119.

Strategic planning of grass forage production in North-West Russia

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Abstract. Energy and nutritional value of harvested forage rely heavily on grass vegetative phase and harvesting time. The study aimed to identify rational forage harvesting options in terms of harvesting time. The data for modelling were taken from the literature based on the results of many years' research. The mathematical models of variation of grass mass and quality depending on days after emergence were created. The possible options of two-step harvesting of forage grass (cocksfoot, *Dactylis glomerata*) were considered using mathematical methods of nonlinear programming: (1) obtaining maximum hay mass with maximum feed units from specified area of 400 ha and maximum forage yield at full flowering of 15.0 t ha-1; and (2) identifying the harvesting timing and area to obtain the required amount of hay (2500 t) with a target nutrient content (1200 feed units). Problem 1 solution was Harvesting 1 scheduled for the 45th day after emergence at full earing on 170 ha; Harvesting 2 scheduled for the 69th day after emergence at full flowering on 230 ha. In this case, 2,066.5 t of hay with 947 feed units would be obtained. Problem 2 solution was Harvesting 1 scheduled for the 43th day after emergence at middle earing on 250 ha; Harvesting 2 scheduled for the 65th day after emergence at early flowering on 156 ha. The created models can be effectively applied for forage harvesting in any grassland area required and in any regions.

Key words: cereal grass, forage harvesting, forage quality, modelling, non-linear programming, strategy, yes-no decision.

II AGRICULTURAL ECONOMICS

Joint Business-to-Business recovery management: the moderating role of locus of failure

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Abstract: Agricultural machinery manufacturers and services providers increasingly experience failure in core products and service deliveries. Despite the importance of recovery management in context, scant research exists on studying recovery management, collaborative recovery activities, and the impact of joint recovery management on post-recovery relationship quality. More pressing is the lack of research on the impact of relationship quality on the customer's intention of future co-recovery activities. Using an experimental design with data from 30 agronomy machinery and equipment manufacturers and service providers in Iran, we investigate how customers' perception of relationship quality is influenced by the interplay of locus of failure and supplier recovery tactics (non-co-creation of recovery vs co-creation of recovery). The results reveal the locus of failure, interacts with the supplier recovery tactics to impact the customers' perceptions of relationship quality. Finally, all three dimensions of relationship quality (satisfaction, trust, and commitment) positively impact the customers' intention for future co-recovery activities.

Keywords: business-to-business, co-creation, joint recovery management, locus of failure, relationship quality, agronomy machinery, agronomy services.

The Role of Producer Organizations in Development of the Latvian Fruit and Vegetables Sector and the EU

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Abstract. Cooperation works as a tool for stable and sustainable economic development, facilitating human well-being and development of economy. It reflects cohesion of the sector and interest in facilitation of the common development of the sector. At the EU level, an increasing attention is paid to cooperation and its role in promotion of competitiveness of the fruit and vegetables sector. The aim of the research is to evaluate the contribution of producer organizations to the development of the fruit and vegetable sector and achievement of the objectives of the EU's Common Agricultural Policy. Based on the national and international planning documents, available statistical data and the results of conducted questionnaires, a general overview of the activities of fruit and vegetable producer organizations in Latvia and their achieved results in reaching the objectives of the EU's common organization of the market in agricultural products was provided. Several proposals were developed to strengthen the activities of fruit and vegetable producer organizations, to facilitate the competitiveness of the sector, as well as to implement the Common Agricultural Policy of the EU. The results obtained during the research can help the institutions involved in the establishment and implementation of the Common Agricultural Policy of the EU to better develop and improve the policy in the sector.

Key words: cooperation, fruit and vegetables sector, EU Common Agricultural Policy, Latvia, producer organizations.

Artificial Intelligence Use for Agri-Circular Economy: An Analysis of Possible Areas of Application, Potential Benefits and Challenges

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Abstract. The last three decades have witnessed an astronomical development and applications of artificial intelligence in various sectors of our economy. Artificial intelligence has transformed governance, commerce, education and many other aspects of our lives. It has led to increased efficiency and improved productivity. Similarly, the circular economy concept has been gaining global attention as an approach to implementing sustainability at the micro, meso, and macro levels. The goal of this study was to evaluate possible areas of application of artificial intelligence in fostering successful implementation of circular economy in the agri-food sector, the benefits, potential challenges and how the challenges can be surmounted. The study involved an intensive literature survey and an ethnographic analysis based on over twenty years working knowledge and understanding of the agri-industrial sector. Results of the analysis revealed immense opportunities for artificial intelligence (AI) application in data gathering, process monitoring, and biosystems optimization at various points along the agri-industry value chain. Identified areas of AI applications include agri-resource/residuals' gathering, transportation, processing, grading, and marketing. Integration of artificial intelligence in the implementation circular economy in the agri-industry will drastically enhance the attainment of global agri-industrial environmental, social and economic sustainability.

Key words: Agri-circular economy, Agri-industry, Artificial intelligence, Bioenergy, Bio-based materials, Biosystems optimization, Circular economy, Sustainable development.

Attitudes of a group of young Polish consumers towards selected features of dairy products

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Abstract. Consumer opinion surveys include key elements of improving the food market and assessing consumers' approaches to current issues related to access to high-quality food. In the survey, which aimed to find out the opinions of young Polish consumers about dairy products, the focus was on issues related to the assessment of selected features of dairy products and their packaging, evaluation of regional products and innovations in dairy production. The methodology for assessing the significance of the features of dairy products and their packaging was based on the proposed feature significance index (FSI). In the carried out research, young respondents pointed to the importance of taste and quality of dairy products, and indicated the small role of packaging, determining the choice of products concerned. The ease of product identification based on packaging has gained the greatest importance among the assessed packaging features. Over two-thirds of respondents indicated that they did not pay attention to the biodegradability of dairy product packaging. When asked about regional dairy products, respondents paid most attention to their value resulting from natural methods of production without preservatives, and least to freshness. In the opinion of young consumers, access to regional products increases the certainty of using raw materials from a given region and facilitates the development of local agricultural business. A small percentage of young respondents showed knowledge of the idea of dairy production "from grass to glass", which would indicate insufficient interest in innovative solutions in the dairy sector.

Key words: biodegradation, consumer preferences, dairy products, packaging, regional products, young consumers.

ACKNOWLEDGEMENTS: We would like to thank all the respondents who took part in the survey, took the time to complete the survey and share their opinions and knowledge about dairy production.

Marginal Abatement Cost Curve for an Ammonia Reduction Measure in Agriculture: the Case of Latvia

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Abstract. With the production of grain and livestock–derived agricultural commodities increasing, the agricultural sector has become one of the main sources of ammonia (NH_3) emissions in Latvia. In 2018, the agricultural sector contributed to 83% of the total NH_3 emissions originated in Latvia (15.46 kt) (LIIR, 2020). The EU has already put in place measures to control NH_3 emissions. This includes the EU target of reducing ammonia emissions by 21% by 2030 and sets out emission reduction commitments for Latvia. Considering Latvia's indicative emission reduction target, the NH_3 emission reductions need to be achieved by 2030 (Directive 2016/2284) so that the emissions do not exceed the 2005 level (11.33 kt). Implementing no mitigation measures, Latvia has projected agricultural sector NH_3 emissions to be 32.4% higher than those in 2005, and therefore the mitigation of the NH_3 emissions from agriculture is important. The research aims to estimate cost-effective NH_3 emission reduction measures in agriculture in Latvia. The results of the research represent a marginal abatement cost curve (MACC) analysis. The calculations carried out allowed us to group the measures according to their priorities: measures that are cost-effective and with high potential for reduction of NH_3; measures that are cost-effective but with low NH_3 emission reduction potential; measures that are not cost-effective but with high potential for reduction of NH_3; measures that are not cost-effective and with low potential for reduction of NH_3. The estimated cumulative (total) reduction of NH_3 emissions in Latvian agriculture by 2030, with the implementation of the measures analysed, is equal to 20.08 kt.

Key words: ammonia, emissions, measures, mitigation, cost efficiency.

ACKNOWLEDGEMENTS: Adjustment of Latvian agricultural greenhouse gas and ammonia emissions as well as CO_2 removal (arable land and grassland) reduction cost curves (MACC) for use in agricultural, environmental and climate policy formation. Project subsidy decision No: 10.9.1-11/18/929-e.

Modelling the Multiplier Effect of a Local Food System

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Abstract. Revitalisation of rural communities, benefits for local farmers and environment are expected outcomes of local food initiatives which are emerging as an opposition to the adverse social and economic effects of globalization. Local food networks diversify the rural economy, promote greater economic independence and local potential, improve the area's image and reduce GHG emissions. The purchase of local food increases incomes of both the community and local producers, as well as increases employment and related multiplier effects at the local level, for example, increased value of new production, import substitution, increased incomes, and created additional jobs. Revitalisation of rural communities, benefits for local farmers and environment are expected outcomes of local food initiatives which are emerging as an opposition to the adverse social and economic effects of globalization It has been revealed that much of current research on local and regional food networks lacks a strong theoretical grounding and quantitative rigor; however, community development practitioners and planners need objective and research-based information for food system design and implementation in order to produce community or regional wellbeing. The aim of the paper is to develop the concept of an integrated assessment model of local food systems based on the analysis of the literature, which would provide a basis for empirical analysis. The analysis model contains dimensions of sustainable development, allowing us to assess not only direct effects (income, reduced greenhouse gas emissions etc.) but also indirect ones (economic, social and environmental resilience of local communities).

Key words: conceptual model, local food system, sustainable food systems.

ACKNOWLEDGEMENTS: The paper is based on the results of research project No. LZP-2020/2-0409 "Resilient and sustainable rural communities: the multiplier effect of the local food system" supported by the Ministry of Education and Science of the Republic of Latvia and the Latvian Council of Science.

Evaluation of bioresources validation

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Abstract: A major worldwide problem is the degradation of energy sources and the wide amount of waste products from industries, households, or from any other human activities. But what if both problems can be solved by one solution? Extensive data show that validation of bioresources increases the production of the value-added product. The assessment is based on a scenario approach. A vast literature review was performed, to investigate the alternative application pathways for various types of non-primary bioresources. Multicriteria analysis is considered as the current gold standard technique for bioresources valorisation and is proved for two cases. Firstly, we present tests that evaluate the performance of different pre-treatment methods in order to extract fibre from Hogweed biomass. Secondly, we assess the resilience of our approach using Multi-criteria analysis for brewers' spent grain to find out the best value-added product. The results demonstrate the adequacy of the method for Hogweed biomass and brewers' spent grain valorisation.

Keywords: Bioeconomy, Biorefinery, Bioresources, Industrial by-products, Multi-criteria Analysis, Valorisation pathways.

ACKNOWLEDGEMENTS: This work was supported by the Latvian Council of Science, project "Bioresources Value Model (BVM)", grant No. lzp-2018/1-0426. Completing any type of work required strong support from several persons. I would like to thank and convey my sincere gratitude to my academic supervisor Professor Dagnija Blumberga for her kind direction and proper guidance, Lauma Zihare for help me to improvise the structure of my work, and my university (Riga Technical University) to give me such a priceless opportunity.

Economic assessment of use of pulses in diets for captive red deer

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Abstract: The quality of compound feeds used in livestock diets could be enhanced by means of domestically produced pulses. Nevertheless, there are available few research studies that would allow us to identify the economic efficiency of livestock diets with pulses and the digestibility of protein by livestock for deer farming. Accordingly, the present research aims to identify the economic efficiency of diets supplemented with domestically produced pulses – faba beans, peas and lupine beans – for captive deer. The research conducted a feeding experiment on captive deer (*Cervus elaphus*) kept in fenced areas to identify the economic efficiency of diets supplemented with three legume species: peas (variety 'Vitra'), faba beans (variety 'Fuego') and narrow-leaved lupin seeds (variety 'Boregine'). Deer productivity was assessed by live weight, live weight gain, feed intake and protein efficiency ratio during the experimental period, as well as feed cost per live weight gain unit. The research found that feeding deer diets containing peas, faba beans and lupine beans as protein-rich feedstuffs was economically advantageous – at the same cost of feed, deer productivity increased and per-unit production costs decreased. Live weight gains during the experimental period were 1.02% higher in group 2 (pea diet), 1.78% higher in group 3 (faba bean diet) and 2.91% higher in group 4 (lupine diet) than in the control group. During the experimental period, the highest protein efficiency ratio was found in group 4 fed a diet containing lupine beans – a unit of protein fed (1 kg) yielded the highest weight gain or 0.43 kg. Feed costs per kg of live weight gain were the lowest in group 4 (2.32 EUR kg^{-1}), 2.48 EUR kg^{-1} in group 3 and 2.70 EUR kg^{-1} in group 2, which was 20.56%, 14.81% and 7.39%, respectively, lower than those in the control group.

Key words: deer farming, feed cost, pulses, legumes, economic efficiency, animal science.

ACKNOWLEDGEMENTS: The research received funding from the ERDF Post-doctoral Research Support Programme (project No.1.1.1.2/16/I/001) Research application "Assessment of the Bioeconomic Efficiency of Use of Legumes for Feed" (No.1.1.1.2./VIAA/1/16/181).

Gross margin comparison of cultivation of different legume species in the organic farming system

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Abstract. In order to identify the most suitable varieties for organic farming, the Institute of Agricultural Resources and Economics in 2018 started study four legume species. The independent variables of the study were the legume genotypes: faba bean (*Vicia faba L.*, cv. 'Isabell', 'Lielplatone', 'Laura', 'Boxer '), field pea (*Pisum sativum* L, cv. 'Astronaute', 'Bruno', 'Rebekka', 'Zaiga'), narrow lupine (*Lupinus angustifolius* L., cv. 'Sonet', 'Probor', 'Derliai', 'Haags Blau'), and soya (*Glycine max* L., cv. 'Annucha', 'Sculptor', 'Augusta'). The soil types of the experimental organic field were sod–podzolic, sandy loam, and loamy sand. At the start of the study the organic substance concentration was 15–18 mg kg^{-1}, pH $_{KCl}$ was 5.3–5.98, the concentration of plant– available phosphorus (P_20_5) was 133.2–182.9 mg kg^{-1}, and the concentration of potassium (K_2O) – 69.2–109.7 mg kg^{-1}. Green manure (buckwheat) was a pre–crop, incorporated in autumn. For the comparison of economic indicators, the gross coverage calculation was used, which based on the difference obtained by subtracting variable costs from the valuation of gross output. All variable costs and revenues were included in the gross margin calculation without value added tax. The study indicated large differences in yields between genotypes. From the economic point of view, the most suitable cultivars for cultivation according to the organic farming method were: field beans – 'Isabell' and 'Lielplatone' with average gross cover (GC), 505.40 and 504.60 EUR, respectively, field peas – 'Bruno' (GC 379.60 EUR) , narrow-leaved lupin – 'Derliai' (GC 647.70 EUR), soybeans – 'Sculptor' (GC 204.40 EUR). Among the legume species studied, lupine showed the highest economic performance, among the genotypes – cultivar 'Derliai' (α=0.05).

Key words: gross margin, legume cultivars, organic farming.

ACKNOWLEDGEMENTS: The research 'Economic comparison of cultivation of different legume species in the organic farming system was conducted within the EAFRD project *'Demonstration of legumes, including non-traditional species and varieties in Latvia under the conditions of organic farming'* (LAD240118/P4).

III BIOENERGY

Effect of ink removal on bioethanol yields from waste banknote paper

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Abstract: Although banknote paper has been used during centuries, there are few studies about its end-of-life handling options. The treatment solutions that are currently available in the market are neither sustainable nor attractive. The presence of residues such as ink, heavy metals, microbial load, and other inhibitory factors such as humidity resistance, make the treatment of waste banknote paper very limited. As waste banknote paper is mainly buried or burned, the banking industry is searching for more environmentally attractive solutions to manage these residues. This study investigates the potential of waste banknote paper for bioethanol production. For this, acid and alkaline pretreatment methods (H_2SO_4 and NaOH, respectively) were used to open its crystalline structure and to make the cellulose available for the subsequent step (enzymatic hydrolysis). The results of this study show that deinked samples that were pretreated with H_2SO_4 and combined H_2SO_4 and ultrasonic, have a weight loss between 11% and 18%, and that its reduced sugar concentration that varies between 5.07 g/L and 8.72 g/L. Overall, the glucose yields of deinked samples were 0% to 13% lower than the glucose yields of blank samples. A correlation was reported between glucose yields and weight loss percentage ($r=0.800$, $p \leq 0.01$). For deinked samples that were pretreated with NaOH and combined NaOH and ultrasonic, the weight loss varies between 2.5%-7.3% and the glucose yields between 1.5g/L and 4.7g/L. The ethanol yields of deinked remained between 18g/L and 36g/L, while the fermentation efficiency varied between 38% and 80%. These results demonstrate that deinked samples have better glucose and ethanol yields, when compared with samples with ink. Due to its composition (high amounts of alpha cellulose), waste banknote paper is a suitable feedstock for bioethanol production.

Keywords: biorefinery; circular economy; fermentation; lignocellulose; pretreatment; zero-waste.

ACKNOWLEDGMENTS: We gratefully acknowledge the financial support of the Doctoral School of Energy and Geotechnology III, supported by the European Union, European Regional Development Fund (Estonian University of Life Sciences ASTRA project “Value-chain based bio-economy”).

Life cycle inventory of processing one tonne of oil palm fresh fruit bunch

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Abstract: Large-Scale producers of palm oil in Nigeria make use of palm kernel shell and mesocarp fibre and sometimes empty fruit bunch for heat and power generation needed in the mills. Small-scale processors, which include smallholder and semi-mechanised processors in Nigeria rely on diesel power while making little use of the biomass generated in the mills. The study was on gate-to-gate life cycle inventory of the large-scale, smallholder and semi-mechanised processors of oil palm fresh fruit bunch in Nigeria. The functional unit is one tonne of processed fresh fruit bunch. The inputs include diesel, water, fresh fruit bunch solid biomass while the outputs include crude palm oil, palm kernel and all emissions to the environment. Carbon dioxide and dinitrogen oxide (N2O) emissions in the smallholder mills were 47% and 73% more than in the large-scale mills, respectively. The semi-mechanised mills produced 73% more N2O than the large-scale mills. However, 73% more methane emissions were produced in Large-Scale mills than in smallholder and semi-mechanised mills. Further analysis is needed to compare the environmental impacts of these mills.

Key words: life cycle assessment, empty fruit bunch, mesocarp fibre, palm kernel shell.

ACKNOWLEDGMENTS: The authors gratefully acknowledge the financial support of Alexander von Humboldt Foundation.

Laboratory analyses for assessing the potential for biogas production of various agricultural residues in Greece

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Abstract: Greece produces significant amounts of agricultural and livestock waste. For the needs of this study, Greece was divided into a Northern and a Southern part and relevant proposals were made for residues that can be used for energy production, through anaerobic digestion. For Northern Greece, this study concluded that the most abundant residues and potential substrates for anaerobic digestion valorisation are those of maize, inedible vegetables (including greenhouse vegetables), cattle manure, as well as the residues of beer and wine industry. For Southern Greece, the corresponding substrates are those of maize, inedible vegetables, sheep/goat manure and residues of wine, tomato, orange and olive processing, respectively. Based on the physicochemical characterization of individual feedstocks, corn silage, tomato husks, watermelon, malt, cattle manure, orange, and olive processing residues (olive pomace) were considered as most suitable feedstocks for anaerobic digestion. Biochemical Methane Potential (BMP) assays for Northern Greece were also performed, testing the most abundant and appropriate residues for anaerobic digestion (of this area), namely corn silage, cattle manure and malt, in order to define their BMP yield as well as their prospective optimum mixtures. It was concluded that the BMP of the mono-substrates is in accordance with literature, while there were no statistically significant differences in the methane yield of all tested mixtures. The residual biomass originating from the three main categories of the agricultural sector (crop residues, agro-industrial residues, and animal manure) in Northern Greece can be efficiently valorised via anaerobic co-digestion, without observing, though, any synergistic effects on methane production.

Key words: agricultural residues, anaerobic digestion, biogas, BMP assays, Greece, residue characterization.

ACKNOWLEDGEMENTS: This article has derived and financed from project SYNAGRON a joint RT&D project under Greece – China Call for Proposals launched under the auspices of the Ministry of Science and Technology (MOST) of the People's Republic of China and the Ministry of Development & Investments / General Secretariat of Research and Technology (GSRT) of the Hellenic Republic. *Greece: Funded under European Regional Development Fund (ERDF) and National Resources (GSRT). China: Funded under Ministry of Science and Technology of the People's Republic of China.*

Algae processing for energy production: development of waste pyrolysis technology

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Abstract: Waste processing accordingly to waste-to-energy concept remains a major challenge to deal with growing amounts of different waste types. The aim of the study is to expand the knowledge base for biomass waste thermochemical processing into syngas and biochar on example of algae waste treatment. In accordance to this concept, waste pyrolysis technology is further advanced by evaluating, studying and adapting the most technologically and economically feasible approach and by developing a pilot scale facility with the aim to demonstrate its potential to offer the industry an innovative solution for solid waste processing. The study includes theoretical background for thermal recovery of organic waste, with application of specifics of algae waste (beach wrack). Algae waste thermochemical processing and gas analysis are tested both for process of torrefied material and with full ash content characterisation. Additional algae waste proximate/ultimate analysis were done. The synthesis gas produced by the pyrolysis process contain 30 – 60 % CH_4, 5 – 12 % H_2, 20 – 40 % CO (remaining CO_2, N_2) and thus can be used for heating purposes. The another algae waste pyrolysis product - biochar is enriched with mineral components thus increasing its application potential in agriculture, however in can be used also for energy production purposes. Thermal analytics of beach wreck undertaken on different type of samples to be common for the Baltic Sea area and projections on application of gasification technology for upscale at municipality level is analysed with a view to application for municipality larger amount material.

Key words: algae waste, biomass waste, biochar, gasification, syngas.

ACKNOWLEDGEMENTS: Research is supported by ERDF project Nr.1.1.1.1/19/A/013 “Innovation of the waste-to-energy concept for the low-carbon economy: Development of novel carbon capture technology for thermochemical processing of municipal solid waste (Carbon Capture and Storage from Waste - CCSW)”.

Investigation of changes in biogas quality and digestate composition using manure and fat

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Abstract: Livestock processing companies have been producing large amounts of fat by-products for many years and encountering a challenge to utilize it. So far, burning technology was the most popular and easiest way to get rid of organic by-products because it is cheap. On the other hand, burning off of that kind matter creates new environment contamination with nitrogen oxides and solid parts. That problem drives us to find an environment-friendly technology which allows recycling of any biodegradable matter, the livestock fat by-products as well. The latest studies show that fat can be utilized through the digestion process and that allows to use it for biogas production. Our research has been conducted on anaerobic digestion of cow slurry and poultry manure using livestock fat by-products as substrate supplement. Anaerobic digestion opportunities and challenges associated with these substrates and supplement are identified by analysis of factors that affect anaerobic digestion process, biogas yield, methane concentration in the biogas and the digestate composition. Two "Umwelt- und Ingenieurtechnik" BTP-2 biogas pilot plants (laboratory reactors) were employed for digestion process – one for cow slurry and second for poultry manure substrate. Both reactors were fed manually once a day. At the first stage, only the manure substrate was used. At the further stages, the fat was added to each reactor. The daily biogas yield was counted at the reactor control system and the average daily composition of biogas measured with Awite AwiFlex biogas analyzer. Results showed that addition of 7 g (it is 1 % from daily cow manure substrate weight) of f t to cow slurry increased the biogas yield by 59 vol. % and the methane concentration by 1.6 vol %, while the same amount (it is 1.75 % from daily poultry manure substrate weight) of fat added to poultry manure increased the biogas yield by vol. 29 % and the methane concentration by 1.6 vol. %. The addition of fat to cow manure substrate significantly increases that manure value and makes it more attractive for biogas production. However, there are several drawbacks associated with fat usage, which includes sludge floatation, scum and pellet formation. Our study shows that the fat can be used for a significant increase of the biogas yield and the methane concentration in biogas produced. We could suggest choosing the anaerobic digestion technology as the environment-friendly technology for fat by-product utilization.

Key words: biogas, cow slurry, poultry manure, fat, biomethane, methane concentration.

Implications of Fungal Biomass Production from Sidestreams on the Economy of First Generation Ethanol Plants

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Abstract: Contribution of side products to the process economy is crucial in dry-grind ethanol plants. Increasing the value of co-products not only contributes to the profitability of the facility but also to the robustness of the process towards fluctuations of raw material cost and capability to compete within the fuel market. Dried distillers grains with solubles (DDGS) is the common co-product in conventional bioethanol plants through evaporation and drying of sidestreams following ethanol separation through distillation. These sidestreams can alternatively be converted by edible filamentous fungi into a higher value co-product in comparison to that of DDGS. In this research work, the techno-economic analysis of a bioethanol plant with integration of filamentous fungi cultivation was studied considering the various end applications of fungal biomass in different feed and food markets. In the sensitivity analysis, capacity change and price change of grain, ethanol, fungal biomass as animal feed (i.e. for pig and fish feeding) and human food were analyzed. The effect of using a different filamentous fungi strain leading to lower ethanol and higher biomass production on the process economy was also investigated. Fungi integration by following human food market application resulted in 5.56 times higher NPV (net present value) after 20 years in comparison to the conventional bioethanol plant. The integrated process using the high-performance fungi towards biomass production and targeting human food market was the most resistant process to grain price fluctuations. This integrated process makes it possible to compete in the fuel market with lower ethanol prices while providing alternative sources for an increasing demand on food and feed proteins.

Key words: bioethanol process, techno-economic analysis, filamentous fungi, feed, food.

ACKNOWLEDGMENTS: This study was supported by the Swedish Agency for Economic and Regional Growth (Tillväxtverket) through a European Regional Development Fund.

Carbon balance of biogas production from maize in Latvian conditions

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Abstract: Production of biogas using bioresources of agricultural origin plays an important role in Europe's energy transition to sustainability. However, many substrates have been denounced in the last years as a result of differences of opinion on its impact on the environment, while finding new resources for renewable energy is a global issue. The aim of the study is to use a carbon balance method to evaluate the real impact on the atmosphere by carrying out a carbon balance to objectively quantify naturally or anthropogenically added or removed carbon dioxide from the atmosphere. This study uses Latvian data to determine the environmental impact of biogas production depending on the choice of substrate, in this case from specially grown maize silage. GHG emissions from specially grown maize use and cultivation (including the use of diesel fuel, crop residue and nitrogen fertilizer incorporation, photosynthesis), biogas production leaks, as well as digestate emissions (including digestate emissions and also saved nitrogen emissions by the use of digestate) are taken into account when compiling the carbon balance of maize. The results showed that biogas production from specially grown maize can save 1.86 kgCO_2eq emissions per 1 m^3 of produced biogas.

Key words: agriculture, bioenergy, biofuels, multicriteria analysis, sustainability.

ACKNOWLEDGEMENTS: This research is funded by the Ministry of Economics of the Republic of Latvia, project "Sustainable and renewable transport policy formulation in Latvia", project No. VPP-EM-2018/AER_2_0003.

Production of xylitol on undetoxified corn cob hydrolysates by *Pachysolen tannophilus* and *Pichia kudriavzevii*

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Abstract: Xylitol is a natural polyol that has wide applications in the food and pharmaceutical industries. However, its large-scale production through chemical means is expensive and not environmentally friendly. Utilization of cheap and renewable substrates like corn cobs (CC), and the reduction of processing steps can help improve the economic outlook of xylitol production. In this study, undetoxified acid hydrolysate of CC was explored for fermentative production of xylitol using selected filamentous fungi and yeasts. Xylitol amount produced on CC hydrolysate was similar to that obtained on xylose substrate, with the yeasts *Pachysolen tannophilus* and *Pichia kudriavzevii* having significantly higher production than the filamentous fungi. Optimal levels of individual parameters for xylitol production were pH 5.0, 96 h and 72 h fermentation time, substrate concentration of 15% and 20%, and 1.5 mL and 2.5 mL of inoculum size for *P. tannophilus* and *P. kudriavzevii* respectively. Supplementation with 1.5% methanol under combined optimal parameters increased xylitol production by 31% and 18.6% compared to non-supplemented conditions for *P. tannophilus* and *P. kudriavzevii* respectively. These findings demonstrate the robustness of these yeast strains for the sustainable and cost-effective production of xylitol from waste CC.

Keywords: corn cob hydrolysate, *Pachysolen tannophilus*, *Pichia kudriavzevii*, xylose, xylitol production.

Development of the Digital Matchmaking Platform for international cooperation in the biogas sector

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Abstract: The demand for sustainable, renewable and clean energy sources has been increasing in the past decade in order to combat global warming by reducing greenhouse gas emissions. Biogas has proven to be a versatile energy carrier which can be used for heating purposes, power and fuel. Having acknowledged the high potential for the use of biogas energy and having researched the demand and supply markets, the Digital Global Biogas Cooperation (DiBiCoo) project aims to link European biogas and biomethane technology providers with emerging and developing markets. To achieve this goal the development and application of innovative digital support tools is necessary - a digital matchmaking platform (DMP) with bi-directional partnership architecture. DMP can be used as means to build trust-based business relationships, share information on available European technologies and serve as an additional marketing option for EU and non-EU companies and industries. This article presents the developed platform prototype and demonstrates its basic functionality and the development process. Basic business and functional requirements were defined and then refined into functional, user-interface and performance requirements for implementation. User requirements were defined using user centred design approach in collaboration with potential platform end-users, considering their specific needs. During the development process Agile methodology was used. In the future digital platform functionality will be extended based on discussions and feedback of the stakeholders and end-users during local workshops and other events, where the DiBiCoo platform will be presented.

Key words: DiBiCoo, biogas, international cooperation, matchmaking, IT platform.

ACKNOWLEDGMENTS: The authors would like to thank the European Commission and the INEA for the support of the DiBiCoo project. DiBiCoo has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 857804. This paper reflects only the author's view and neither INEA nor the Commission are responsible for any use that may be made of the information it contains.

Packing materials for biotrickling filters used in biogas upgrading – biomethanation

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Abstract: One of the promising methods of biogas upgrading is biological methanation (biomethanation). During biomethanation process hydrogenotrophic microorganisms use carbon dioxide from biogas and added hydrogen to generate biomethane. Application of biotrickling filter reactors is one of the prospective biotechnologies for methanation where hydrogenotrophic methanogens are immobilized over a material that is used in reactor. Packing materials for biomethanation are critical in terms of hydrogenotrophic methanogens immobilization on the surface of packing material. It acts as support for biofilm growth. Therefore, characteristics of filter material are important parameters that influence the growth of microorganisms and methane production. Factors, such as optimal specific surface area and porosity are important to sustain growth and activity of microorganisms. Optimal particle size and capability to mechanically resist compaction ensures avoiding high pressure drop. Optimal particle size also ensures uniform gas flow as gases distribute through the packing material. This review paper summarizes and compare the characteristics of different packing materials important for biomethanation through ex-situ biotrickling filter reactor systems.

Key words: biogas upgrading; biomethanation; biotrickling filter; biofilm; packing materials.

Hydrothermal carbonization of chemical and biological pulp mill sludges

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Abstract: A modern pulp mill generates a variety of different by-products and waste streams. In addition to internal recycling, some of these can be sold, refined, or used on-site for energy production. However, some, such as chemical (primary) and biological (secondary) sludges produced in wastewater treatment, cannot be reused or disposed easily, mainly due to their high moisture contents and poor drying characteristics. The tightening legislations regarding waste disposal as well as the growing need to increase the process efficiencies of pulp mills act as driving forces to find environmentally friendly and energy-efficient techniques for pulp mill sludge treatment. This study summarizes the current methods for pulp mill sludge handling and evaluates the potential of hydrothermal carbonization (HTC), a conversion process through which wet organic substrates can be transformed into a carbonaceous material (hydrochar). Depending on process parameters such as temperature, the material's structure is modified, enabling hydrochar use in energy, soil conditioning and adsorption applications. The chemical and biological sludges were hydrothermally carbonized at 180, 200, 220 and 240 °C for 3 hours. The hydrochar and liquid products' main physical and chemical properties as well as elemental composition were analyzed. Their potential applications were also evaluated. The effective treatment of sludges from the pulp industry with HTC could transform the energy demanding waste into a value-added source of materials.

Key words: Thermochemical process, sludge treatment, waste biomass.

ACKNOWLEDGEMENTS: Authors highly appreciated the support from Jussi Saari for his help with the English language improvement and gratefully acknowledge the assistance of Jordan Banks in the HTC experiments.

Use of principal component analysis to evaluate thermal properties and combustibility of coffee-pine wood briquettes

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Abstract: The coffee production chain is a potential source of residual biomass inherent to the high productivity that can contribute to the generation of value-added products. The residues from the coffee sector are typically disposed to landfill without treatment causing potential environmental inconveniences. Briquetting presents an alternative process to produce a uniform fuel with high energy density. Briquettes facilitates easy transportation, enables better handling and storage of biomass residues. Properties such as low equilibrium moisture content, high energy density and compressive strength were reported for different coffee-pine wood briquettes treatments. Moreover, understanding of the thermal properties of the briquettes during combustion is crucial to evaluate their final application. This research is the first study that investigates the combustibility properties and kinetic parameters of the thermal decomposition of briquettes from coffee-pine wood using differential and integral thermal analysis under non-isothermal conditions. Multivariate analysis of the collected parameters through principal components analysis (PCA), was implemented to reduce the dimensionality of the data. The desired profile in the combustibility is directly related to high temperatures and long burning times, thus, the tested briquettes displayed a significant combustibility potential, reporting peak temperatures and burnout times around 600 °C and 27 minutes, respectively. Activation energy kinetic parameter in the range of 12-42 $kJ \cdot mol^{-1}$ and average reactivity of 0.14-0.22 min^{-1}, were also found. The results revealed the not thermally hard material to degrade when compared to biomasses typically used for combustion.

Key words: briquette, chemometrics, combustion rate, reactivity, solid biofuels.

ACKNOWLEDGEMENTS: This work was kindly supported by the Brazilian Research Foundation CAPES (Coordenação de aperfeiçoamento de pessoal de nivel superior).

Analysis of characteristics of solid biomass fuel used for energy production

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Abstract: Solid biomass fuel such as wood chips and logging residues makes currently the largest share of biomass fuels used for heat generation in district heating plants and provided by variety of suppliers. Ash and moisture contents, as well as calorific value of this fuel may vary considerably depending on composition of the fuel, its preparation technology and storage conditions, as well as seasonality. Knowing the variability of these characteristics is important for at least 2 main reasons. First, it is important in setting the prices of fuel and heat supplied to its consumers, in reconciling balances of produced heat and consumed fuel and eventually for evaluation of the volumes of ash and other harmful emissions. Second, in practice, there is the need for periodic check of biomass supply batch to heat producers, when the characteristics must be examined by taking samples from each lot submitted for analysis. Consequently, the paper provides the results of summarizing the main characteristics of solid biomass fuel, such as moisture and ash content, calorific value, experimentally tested for significant range of samples from two production objects and rather wide time periods between 2018 and 2020, During the period under review (2017-2020), it was found that the moisture content of the fuel varied from 35 %to 45%, the calorific value from 18,400 to 19600 kJ/kg, and the ash content from 0.5% to 4.5%. The calculated relative expanded uncertainty of the moister content measurement was 2,1 %, of calorific value - ± 1,5% and of ash – 1,0%. and measurement uncertainties of those results.

Keywords: solid biomass fuel, wood chips, moisture content, calorific value, ash content, pooled standard deviation.

Cultivation of single cell protein (*Methylophilus methylotrophus*) for the production of carbon-reducing animal feed

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Abstract: Worldwide population growth has led to an increase in the consumption of and demand for food products. In order to satisfy this demand, global meat production has increased from 71 million tonnes in 1961 to 341 million tonnes in 2018. However, intensive livestock practices associated with the production of animal feed incur high costs, are unsustainable and pose negative environmental impacts. Therefore, great attention has been paid to protein animal feed substitutes, such as C$\bar{p}$rute, a low-cost, high-quality single cell protein (SCP) product with a low-carbon footprint. This non-photosynthetic SCP can be used as an animal feed replacement and as a protein supplement in livestock and aquaculture industries. During C$\bar{p}$rute production, methanol is used as a carbon and energy source for the cultivation of the methylotroph *Methylophilus methylotrophus*, with a high carbon conversion efficiency. The SCP produced has a net protein value that is 13% and 35% higher than that of fishmeal and soybean meal, respectively. The cost of C$\bar{p}$rute is 20% lower than that of fishmeal and 40% lower than the price of soybean meal, while its CO_2 emissions are 48% lower than for example, the CO_2 emissions from soybean production. When produced at a larger scale, SCP reduces GHG emissions and prevents deforestation, since large amounts of land are required for animal feed production. As 77% of the land devoted to agriculture is used for animal feed and forage, replacing plant-based protein with SCP will contribute to the protection or restoration of land, forests and ecosystems directly related to the production of meat and animal feed. This project investigates different refining strategies for the fermentation of *M. methylotrophus* in order to improve C$\bar{p}$rute yields and quality. The results of this study will be used to plan the scale-up process and the commercialization of C$\bar{p}$rute.
Keywords: animal feed replacement, carbon-reducing feed, C$\bar{p}$rute, protein supplement.

Effect of hydrothermal carbonization and torrefaction on spent coffee grounds

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Abstract: Coffee is one of the most tradable commodities worldwide with the current global consumption of over 10 billion kilograms of coffee beans annually. At the same time, a significant amount of solid residues, which are known as spent coffee grounds (SCG), is generated during instant coffee manufacturing and coffee brewing. Those residues have a high potential in various applications, yet they remain mostly unutilized. The current work presents the experimental comparison of two pretreatment technologies – hydrothermal carbonization (HTC) and torrefaction – for converting SCG into a valuable char. The results showed that low-temperature torrefaction (<250 °C) has a negligible effect on feedstock properties due to initial pre-processing of coffee beans. However, the energy conversion efficiency of torrefaction at higher temperatures is comparable with that of HTC. The average energy yields for high-temperature torrefaction (>250 °C) and HTC were on the level of 88%. Devolatilization and depolymerization reactions reduce oxygen and increase carbon contents during both processes: chars after torrefaction at 300 °C and HTC at 240 °C had 23-28% more carbon and 43-46% less oxygen than the feedstock. Both pretreatment methods led to a comparable increase in energy density: the highest HHV of 31.03 MJ kg^{-1} for torrefaction at 300 °C and 32.33 MJ kg^{-1} for HTC at 240 °C, which is similar to HHV of anthracite. The results showed that both processes can be effectively used to convert SCG into energy-dense char, even though HTC led to slightly higher energy densification rates.

Keywords: biomass pretreatment, hydrothermal carbonization, torrefaction, spent coffee grounds.

ACKNOWLEDGEMENTS: Authors highly appreciated the help of Toni Väkiparta, D.Sc., in making SEM images of the samples. Special thanks to Jussi Saari, D.Sc., for his valuable input of the coffee feedstock for the current experiments.

Recovering industrial wastes in (semi)-biocomposites

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Abstract: A Circular Economy focuses on rational and effective utilization of various industrial wastes. The surplus of wood biomass wastes results from the processing of logs in forestry and wood shavings, sawdust, chips, wood dust, etc. in wood mechanical processing. The main use of wood wastes as a fuel is not rational for the bioeconomy and the environment. The reuse and recycling of synthetic polymer wastes formed by plastic packaging and construction is very important, because their burning is accompanied by carbon dioxide formation that leads to climate changes. At the same time, the rational use of industrial waste leads to saving energy and raw materials, reducing environmental pollution and risk factors for public health. Wood-plastic composites (WPC) are a young generation of (semi)-biocomposites with rapidly growing usage in the world. The drawback of WPC is bad compatibility of a wood matrix with polyolefins in the blends that appears in the poor adhesion at the wood/polymer interface. To overcome this challenge, the wood matrix is chemically modified. The aim of the work is to study the effect of the treatment of milled birch wood shavings, obtained from furniture processing, with a low concentration of sodium hydroxide solution at the middle temperature on the mechanical properties and wettability of WPC based on recycled polypropylene without and in the presence of a compatibizator. It was shown that, with applying 0.5% NaOH solution at a temperature of 60oC, the chemical composition of the wood changed, namely, hemicelluloses amount decreased, the relative content of celluloses increased, but lignin content changed slightly. The cleavage of the ester bonds in the wood matrix led to the increase in the content of phenolic hydroxyl and carboxyl groups and favoured the availability of the wood matrix for interaction with recycled polypropylene. The WPC samples were prepared using a twin-screw extruder and a moulding machine at a temperature of 175°C and an injection moulding pressure of 45-50 MPa. The content of milled shaving microparticles' (< 100 μm) in the composites varied from 10% to 50 %. A comparison of the mechanical properties (tensile, bending) of the obtained WPC samples filled with the alkali treated wood microparticles showed a pronounced improvement in the mechanical properties and a decrease in their hydrophilicity in comparison with the WPC samples filled with the untreated wood. However, the hydrophobicity of the WPC samples with the treated wood filler was not high. For decreasing the water wettability, maleic anhydride grafted polypropylene wax Licocene PP MA 7452 as a compatibilizer was added to the composite blends. Its usage allowed to increase the contact angels, to diminish the water sorption and the heterogeneity of the obtained WPC samples as well as to improve the processing technology.

Key words: Recovering industrial wastes, Semi-biocomposites, Wood shavings, Alkali treatment, Recycled polypropylene, Compatibilizer.

ACKNOWLEDGMENTS: The authors gratefully acknowledge the financial support from the National Research Programme (ResProd) and the Biogrant (1/2019-2020).

Perspectives for biogas generation from manure on the farms in the Leningrad Region of the Russian Federation

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Abstract: The interest in biogas in the Leningrad Region is consistently growing. Biogas can replace fossil fuels in different applications and reduce greenhouse gas emissions. The study aimed to demonstrate the perspectives for its generation from livestock waste and further farm application. The farm energy audits identified the pattern of fuel and energy consumption. Computational and statistical methods were applied to estimate the biogas generation. First, the study considered a cattle farm with 1800 head and manure output of 43,300 t $year^{-1}$. According to calculations, the farm can fully meet its own needs for electricity or motor fuel by converting the manure into biogas. Meanwhile, the fuel use of biogas can reduce pollutant emissions by almost 30% against conventional fuel. Secondly, the study estimated the biogas production potential from the farm organic waste in the whole Leningrad Region with the total cattle stock of 165,000 head, pig stock of 184,000 head, and poultry stock of 29 180, 000 head, producing about 8 million t $year^{-1}$ of animal/poultry manure. According to calculations, the livestock waste processing will yield up to 500 million m^3 of biogas. This is enough to fully cover the energy inputs of the farms in this region. However, the payback period for biogas plants is above eight years. The positive aspects of biogas application are introducing biogas in the farm energy balance as an energy resource; reducing the hazardous emissions owing to the improved processing of organic farm waste; obtaining high-quality fertilisers to consequently increase crop yields.

Key words: biogas, electrical power, manure, motor fuel.

ACKNOWLEDGEMENTS: A part of this work was performed within the framework of KS1675 project "Russian-Finnish Bioeconomy Competence Centre – BioCom" of the "South-East Finland – Russia Cross-Border Cooperation (CBC) Programme 2014–2020".

Measurability of quality in fermentation process of rice wine by IoT in the field of industry 4.0

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Abstract: The article inquiries into the issue of automation of the rice wine fermentation process in the field of industry 4.0. Fermentation is the process of converting D-glucose into ethanol along with oxidation of reduced coenzymes (fermentation). This is known as ethanol fermentation, which takes place anaerobically in the presence of yeast. The fermentation is being improved by automation (sensors, etc.). The main aim is to develop an experimental automation environment in industry 4.0 for the process of rice wine fermentation. During the rice wine fermentation process, variety of measurable attributes are created which affect the quality of the resulting product. They can be monitored with the help of automation elements (pH, temperature, humidity etc.). In case of an experimental environment development, it is therefore important to select appropriately the sensory that can record the measurable attributes. At the same time, the sensory must be at a level of reliability that guarantee their sufficient use in the mentioned experimental environment for the rice wine fermentation. The result is that, if the right environment is chosen, the quality of the fermented wine will improve.

Key words: rice wine, fermentation, industry 4.0, IoT, automation.

ACKNOWLEDGEMENTS: It is a project supported by the CULS IGA TF "The University Internal Grant Agency" (2020:31150/1312/3105 and 31170/1312/3116).

Comparison of physical composition of municipal solid waste in Czech municipalities and their potential in separation

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Abstract: Czech Republic has been moving from landfill–based waste system toward resource–based waste management system with an increasing rate of recyclable waste in the last years (38.6% of recycling by material and 11.7% of energy recovery in 2018). However, landfill is still a popular way of mixed municipal solid waste (MMSW) disposal due to the low tax. In the Czech Republic, MMSW is collected from households by door–to–door system or recovery operations (Household Waste Recycling Centre) and only should consists of everyday items, which are further non–recyclable and non–reusable. However, a significant amount of recyclable waste can still be found in MMSW. Therefore, a good knowledge of the physical composition of MMSW is required to define strategy plans and improve waste management in municipalities. This work is aimed at comparing the physical composition of MMSW in the Czech Republic with small municipalities up to 2,999 inhabitants and big municipalities from 3,000 inhabitants to recognize the share of recyclable and non–recyclable waste in MSW and designate the potential of separation at source. Composition of MMSW was determined by a physical evaluation of waste collected from households in target municipalities which consists in a detailed manual sorting of waste into 13 specific groups according to their types, and weighting by a scale. We found that the real proportion of MMSW that could no longer be reused or recycled was much less than the amount disposed of in the municipal waste bins. A large part of MMSW consisted of organic waste together with food waste. This type of waste is especially useful when people turn it into compost to prevent the production of waste and it returns the nutrients back to the soil, closing the circle. The rate of recyclable waste was also high in many municipalities covered by our analyses, which indicated a lower rate of separation and reflected an insufficient sorting system in municipality and insufficient education of inhabitants. On the other hand, it points to the larger space of separation potential in households. In conclusion the evaluation emphasizes the improper proportion of MMSW in Czech municipalities. A lot of waste can be recycled but once it is thrown into black bins as MMSW, there is no chance that it will be reused/recycled. It therefore calls for measures to improve sorting at source, which will benefit municipal authorities in term of increasing recycle rates in order to comply with regulations and make a profit. We found the analysis of the physical composition of MMSW as a fundamental method for municipalities to verify the separation rate at the source, and it is recommended to conduct this analysis regularly and monitor developments.

Key words: physical analysis, waste composition, municipal solid waste, separation at source, Czech Republic.

ACKNOWLEDGEMENTS: Special thanks to the Institut Cirkulární Ekonomiky, z. ú. for collaborating and providing data for this study. This research was supported by the Internal Grant Agency of Faculty of Engineering, Czech University of Life Sciences Prague, Grant No. 2020:31180/1312/3108.

IV ERGONOMICS

Development of farm safety culture in Finland

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Abstract: The aim of the project was to develop tools for occupational safety culture on farms in Finland. The project gathered information on the means of developing an occupational safety culture on farms. In addition, statistics on the causes of accidents at work and occupational diseases in different age groups of farmers were examined. The project promotes the capacity of agricultural entrepreneurs to identify and systematically reduce occupational safety risks. According to the results, urgency, negligence or fatigue are often risk factors for farm accidents at work. Farmers have also said that work is often done even ill. The highest number of accidents at work on farms in Finland occurs in animal care work. Furthermore, the proportion of machinery accidents at farm work has increased in years 2009-2018. Knowledge and experience are important factors in the use of machines. In years 2014–2017 accidents at work increased relatively in all farmer age groups, but it was particularly strong in the younger age groups. Accidents in those under 40 increased by almost 20% during this period. This was partly due to a change in technologies and largening farm volumes, but also the changes in insurance system, which lowered the threshold for reporting an accident. It is assumed that many risk factors on the farm can be influenced by the determined construction of a good occupational safety culture. A farm occupational safety culture refers to practices that are related to the safe performance of work. It involves the beliefs, perceptions and attitudes of the people working on the farm about how work is done safely and what a safe work environment is like. A good occupational safety culture maintains and nurtures safe working practices and understands their importance. The main influencing factors in the farm work environment are changes in the work environment, crisis situations and stressors in the work environment, such as difficult conditions. Current influences on an individual's safety behavior include individuals' attitudes, works strain, new technologies, and the increase in automation technology. It is important that young farmers get enough training for good management of occupational safety culture. Providing education, training and information are needed but also older farmer behavior and attitudes showing younger farmers, what good occupational safety culture means on a farm. The first step is just to take safety seriously. Research on development of farm safety culture in Finland was funded by Farmers' Social Insurance Institution of Finland (Mela) and is connected to the work of Safety Culture and Risk Management in Agriculture (Sacurima) COST Action CA 16123.

New device for air disinfection with a shielded UV radiation and ozone

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Abstract: Indoor air disinfection has become particularly relevant recently because of the Covid-19 pandemics. A shielded device for air and surface disinfection with UV radiation and ozone has been developed. It contains 28 low intensity (11 W) UV lamps (254 nm) in a specially designed three-dimensional grid to provide a large flow cross-sectional area and long path for the air particles to be irradiated. The device can be used in medical institutions, veterinary clinics, manufacturing plants, public premises, poultry, and livestock farms. It does not generate air-ions and ozone concentrations do not exceed the allowed 8-hour average values. The large number of UV lamps and powerful fans ensure air disinfection in large rooms in a relatively short time (400 $m^3 h^{-1}$). Simultaneously, the floor surface under the appliance is disinfected. Disinfection efficiency tests demonstrated 99,9999% reduction for *Escherichia coli*, *Staphylococcus aureus* and Pseudomonas phage Φ6 aerosols within a single transfer through the system (10 seconds of treatment). The housing of the device protects from direct UV radiation; therefore, people can be in the room during the operation of the device.

Key words: air ions, disinfection, ozone, prototype, UV radiation.

ACKNOWLEDGEMENTS: This research was funded by the Ministry of Education and Science, Republic of Latvia, National Research Programme ‘for Covid-19 mitigation’ Project ‘Integration of reliable technologies for protection against Covid-19 in healthcare and high-risk areas’ Project No. VPP-COVID-2020/1-0004. We thank Mr. Ralfs Vevers and Ms. Jelena Dzjubenko for technical assistance in efficacy tests.

Promoting Farmer occupational safety and health (OSH) services through Extension

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Abstract: Strategies for improving OSH in European agriculture are urgently required given the high level of reported injuries and ill health in the sector. The agriculture sector in Europe is enormous in scale and diverse in production systems. A dispersed labour force is deployed in the sector, predominantly using family labour, which is self-employed. Accordingly, a large proportion of the agricultural workforce is outside the scope of EU directives on occupational safety and health (OSH).The aim of this paper is to examine the role and engagement of the discipline of agricultural extension in promoting OSH in agriculture and consider methodologies that this discipline can use most effectively to gain OSH adoption. The paper compares regulatory and extension approaches to consider their respective roles in promoting OSH in agriculture. EU developments related to extension and OSH are then outlined. Regarding extension engagement, findings of a survey among extension and OSH professionals throughout Europe found that OSH is considered an important topic and worthwhile for inclusion in extension but it indicates that currently the level of extension programming is limited. Irish data on OSH extension methodologies indicates that advisors consider that a range of extension approaches are available to motivate farmers on OSH adoption with TV victim testimonials, on-farm social learning discussion groups and on-farm demonstrations having the highest preferences. Data presented indicates that Irish farmers expressed good satisfaction ratings with OSH extension relevance to their farms. Overall, the study advocates giving more consideration of the role of extension in promoting agricultural OSH.

Key words: agriculture, ergonomics, extension, regulation.

ACKNOWLEDGEMENTS: Completion of the pan–European Survey component of this study was supported by a Research Grant from the Irish Government, Department of Agriculture, Food and the Marine. The second author (MF) received a Teagasc Masters Scholarship. The authors acknowledge the valuable input of participating farmers, advisors and both EU COST Action SACURIMA and EUFRAS meeting participants.

V LIVESTOCK ENGINEERING

Approach to a classification of construction typologies of pig facilities: case study Antioquia – Colombia

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Abstract: Pig facilities foro confined production in tropical countries such as Colombia does not specify, in the present moment a typological classification that allows researchers to carry out evaluations related to animal comfort and environmental impacts according to the type of accommodation. To achieve the objective of this research were developed a survey to a panel of experts, a decision sensitivity analysis and the *hierarchical analytical method AHP*. Parameters that allowed to describe the concept of a technified pig farm were obteined, where the most relevant were: biosecurity measures, measurement of zootechnical parameters, training for workers and legal fulfilment. Additionally, ranges were defined to establish the production size in small, medium and large according to the number of animals. The results obtained per group were: 1) breeding small (50-200), medium (201-1,000) and large (1,001-5,000); 2) growth small (60–200), medium (201 - 800) and large (801 - 5000); and 3) finishing stage small (50-500), medium (501-1,000) and large (2,001-5,000). A total of 948 typological combinations were initially determined. Finally, the construction characteristics with the greatest technical and operational feasibility were prioritized for each group achieving 36 typologies that can represent the typological pig facilities not only in the state of Antioquia but also in many others states in Colombia.

Key words: Tropical country, natural ventilation, swine production, animal comfort.

ACKNOWLEDGEMENTS: This report is a result of a collaboration between The National University of Colombia Faculty of Agricultural Sciences and the Laboratory of Bioclimatic Applied to Agroindustry of the National University of Colombia.

Ecological footprint of beef consumption in the state of Rio de Janeiro - Brazil

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Abstract. The beef production chain can cause considerable impacts on the environment depending on how it is carried out. The need to discuss the impact of the consumption of this food in a country whose production base is mainly agricultural and livestock is relevant in view of the environmental degradation and scarcity of resources. In this work, the ecological footprint of beef consumption was evaluated using the state of Rio de Janeiro as a case study. Data were collected such as population, productive capacity, annual consumption, cattle weight, grazing equivalence factor. Calculations of livestock density, consumption per capita, productivity, number of oxen, area per capita, and total area required were also carried out. The value found for Total Ecological Footprint was 1,117,995.22 gha and for Ecological Footprint per capita was 0.065 gha. It was found that the ecological footprint per capita is higher than the area destined for each inhabitant of the State which is 0.019 ha. It can be inferred that the consumption of beef as it is currently carried out harms the ecosystem in which production is inserted.

Key words: Livestock, Sustainability, Indicator.

Effect of replacement of coated barley grain with hulless barley in diet on growth, carcass and meat quality traits of fattening pigs

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Abstract: A amount of experimental pigs were 40 crossbred pigs (Yorkshire ×Landrace). The initial body weight of pigs were average 27.0 kg. The goal of research was to assess the effect of replacement of coated barley grain with hulless barley in diet on pig growth, carcass and pork quality indices. Experimental groups of pigs on the holding were conducted according to age and sex. For trial group of pigs, a compound feed with hulless barley (38.9-45.4%) was prepared, for the control with coated barley (39.3-43.3%). The feed recipes made according the pigs age. The other feed ingredients were not changed and were wheat, soybean meal and oil, premivit, and from 20 till 70 kg liveweight also fish meal. Diets were formulated with the same of metabolizable energy and crude protein content. During the study the live weight of pigs was monitored and the feed consumption was counted. At the end of the study all pigs slaughtered, determined carcasses traits and took samples of loin muscle for chemical analyses. The results showed that pig fattening indices (daily liveweight gain were in control pig group 0.686 ± 0.183 and trial 0.716 ± 0.174) did not differ significantly between groups (P> 0.05), although its were slightly lower in the control group pigs by 4.37%. Feed consumption for live weight gain in both groups ranged from 3.14 to 3.25 kg. Carcasses scores showed significant differences in lean meat and chops (P <0.05). There were also differences in the backfat thickness. The thickness of backfat was 2.62 mm less in the control pig group, which indicates that when feeding coated barley to fattening pigs, the carcasses have a higher proportion of lean meat (62.1 ± 0.7%). Pigs were slaughtered reaching a live weight of 110 to 114 kg. The meat yield 71.7% and moisture level (70.2-75.2%), as well as protein (22.3-22.9%) indicators showed that fattening pigs are sold at the optimal age. In conclusion, results from this study suggest that feeding hulless barley to fattening pigs results in higher live weight gain. Carcass indicators showed a significantly higher proportion of lean meat and weight of chops when pigs eating coated barley. Chemical composition of pork in groups without significant differences.

Key words: hulless barley, fattening pigs, growth performance

ACKNOWLEDGEMENTS: Publication and dissemination of research results were carried out due to the support for EIP groups cooperation project “New technologies and economically viable solutions for the production of local feed for pig production: cultivation of non-genetically modified soybeans and new barley varieties in Latvia” No. 18-00-A01612-000015.

Reduction of ammonia emissions by applying probiotics on litter in a commercial breeding poultry house

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Abstract: Agricultural sectors account for a part of total ammonia emissions, including poultry. This is especially true in breeding poultry houses, where birds live on litter for several months. The purpose of the research was to reduce ammonia emission and to improve birds living environment. The study was performed in two breeding poultry houses: the test house (ProLG) and the control house (ConLG). The study starts when young breeding birds (Ross 308) are housed at 19 weeks of age until the birds are eradicated at 60 weeks of age. At the test house the probiotic mixture in a powder form was manually spread 10g / m^2 before the birds were placed, and it was spread manually once a week on litter and over manure pits throughout the lifetime 5g / m^2 of probiotic mixture. The amount of ammonia in ProLG and ConLG houses was measured in the fifth week after the start of the study and afterwards every four weeks at the same 6 points each time and the condition of the litter was assessed on a 5-point scale. As the age of the poultry increases, the number of measurements also increases. Electricity consumption was calculated every month for the test housing and for the control housing. The trial is still ongoing, initial results showed that amount of ammonia has decreased compared to the control house, indicating that the probiotics can be used efficiently to reduce ammonia in the manure of the birds and improving the microclimate in poultry houses, but subsequent results did not give the expected results - the efficacy of probiotics had not been yet approved.

Key words: Ammonia, *Lactobacillus farcimins*, *Lactobacillus rhamnosus*, manure, poultry.

ACKNOWLEDGEMENTS: We would like to thank Lilita Bojare, Amanda Vavilova, Edite Zvilna and Artis Latkovskis for the work done in the research.

The impact of ventilation type on the heat load of dairy cows

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Abstrac: t Heat load in cattle causes deterioration of health and reduced production of milk. Therefore, it is necessary to protect cows by appropriate passive and active means and monitor the air quality in barns. Based on several indicators of environmental quality, is possible to make a more comprehensive assessment of the microclimate and more precise conclusions. This study, was monitoring the values of air temperature, relative humidity, and air velocity in two barns with the same volume and layout with floor dimensions of 26.6 m × 62.1 m. In barn 1, roof ridge of which had underwent only partial reconstruction, there were installed fourteen basket fans with a total fan performance $Q(1)_{fans}$ = 218,400 m^3 h^{-1}. In barn 2, there were twelve panel fans with a total fan performance $Q(2)_{fans}$ = 289,320 m^3 h^{-1}. The resulting THI, HLI and ETIC values were compared in relation to each other and in relation to the recommended values.
Despite the operating ventilation technology and enlargement of wall openings, the above-limit values of climatic characteristics were observed in both barns during tropical days. There were no differences between the barns ($p>0,05$), in barn 1: THI(1) = 83.10 ± 0.51; HLI(1) = 85.62 ± 1.42; ETIC(1) = 27.24 ± 0.31, and in barn 2: THI(2) = 83.12 ± 0.34; HLI(2) = 85.77 ± 1.50; ETIC(2) = 27.29 ± 0.28, however, there were found significant differences in values of temperature indices obtained in the detailed measurements at points arranged perpendicularly, as well as parallelly, to the direction of air velocity in the animal zone ($p<0,05$).

Key words: air flow speed, cattle, heat load index, temperature – humidity index

ACKNOWLEDGEMENTS: This publication was supported by the Operational Programme Integrated Infrastructure within the project: Sustainable smart farming systems taking into account the future challenges 313011W112, cofinanced by the European Regional Development Fund.

Comparative effect of different amount of inulin and synbiotic on growth performance and blood characteristics 12 weeks old calves

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Abstract: The study was focused on assessment of the effect of prebiotic inulin (from Jerusalem artichoke (JA) powder it contain ~50% of inulin) and mixed with probiotic preparation call symbiotic thereof on growth performance and blood parameters of milk calf. In total, 70 milk calves (50+/-5 kg; 23+/-5 d.old) were used in a 57-d experiment. The seven dietary treatments consisted of the control diet (CoG); diet CoG supplemented with different amount of prebiotics (PreG6; PreG12; PreG24; accordingly 6g, 12 or 24g of JA) and three different amount of synbiotics (SynG6; SynG12; SynG24; accordingly inulin and probiotic 0.25g Enterococcus faecium (2*109 CFU g-1). Throughout the study prebiotic (PreG) and synbiotic (SynG) groups calf average daily gain (ADG) was increased ($p<0.01$) than CoG, the end of study the highest ADG reached PreG12 than SynG12 and it was ($p<0.01$) compare with CoG. At the end of te study PreG6 and SynG6;12 hematocrit was higher ($p<0.05$), but PreG12;24 and SynG24 ($p<0.01$) than CoG. Hemoglobin PreG and SynG12;24 was higher($p<0.01$) compare with CoG. WBC was lower ($p<0.05$) PreG24, but there were no differences between synbiotic groups (SynG) compare CoG. PLT was ($p<0.01$) higher PreG and SynG supplemented groups than CoG. Total protein PreG12; SynG6;12 ($p<0.01$) higher compare CoG. Glucose PreG6;12 is lower ($p<0.05$) than CoG. In conclusion, 12g and 24g of JA powder and the same amount JA powder mixed with probiotic Enterococcus faecium can improve the 4 to 12 weeks old calf performance and health status. However, new synbiotic didn't improve inulin action.

Keywords: calf, inulin, *Enterococcus faecium*, growth, blood.

ACKNOWLEDGMENTS: This research was supported by the National Research Program Agricultural Resources for Sustainable Production of Qualitative and Healthy Foods in Latvia (AgroBioRes) (2014 – 2017).
The ethical concerns of this study, animal protection and wellbeing were reviewed by Latvia University of Life Sciences and Technologies conducted LL Animal Welfare and Protection Ethics Council. Permission for this study was granted (Nr DZLAEP-2017/2).

Growth performance and production of rumen gases in calves supplemented with prebiotic inulin or a novel synbiotic (inulin and yeast)

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Abstract: Different feed additives can lower emissions, improve animal productivity. The aim was to evaluate the effect of two feed additives (prebiotic inulin and synbiotic inulin and *Saccharomyces cerevisiae* strain 1026) on the performance and GHG production of crossbreed Friesian calves. Fifteen calves were assigned into three groups: PreG – prebiotic (6 g inulin) group; SynG – synbiotic (6 g inulin and 5 g *S.cerevisiae* strain 1026) group, CoG – control group. The weight of calves, the amount of produced methane, carbon dioxide in the rumen was determined on day 1, 28, 56. On day 56th, three calves from each group were slaughtered, the meat samples were analyzed for some chemical parameters. The incidence of main methane producing microorganisms was determined in rumen fluid samples and feces. Prebiotic and synbiotic significantly increased daily weight gain. Cholesterol (mg 100 g^{-1}) in meat sample in the CoG was significantly higher than in PreG. The synbiotic showed the lowest amount of produced methane and carbon dioxide in rumen (mg m^{-3}). The occurrence of total prokaryotes in rumen fluid was at higher PCR cycle in SynG than in PreG, the occurrence of total methanogens was at higher PCR cycle in PreG than in SynG. Supplementation of prebiotic and synbiotic has a significant effect on weight gain; synbiotic decreases the amount of GHG in rumen. Prebiotic inulin reduces the level of cholesterol in meat. No convincing results were found about the feed additives and incidence of total prokaryotes, methanogens and several methanogen species in rumen fluid and feces.

Key words: calves, greenhouse gases, inulin, meat quality, yeast *Saccharomyces cerevisiae*.

ACKNOWLEDGEMENTS: Supported by the National Research Programme Agricultural Resources for Sustainable Production of Qualitative and Healthy Foods in Latvia (AgroBioRes) (2014 – 2018).

Trend of cow herd size in Baltic states

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Abstract. The article analyses trend of cow herd size from 2000 to 2019 in four Baltic states: Estonia, Latvia, Lithuania and Poland. It has been stated that during this period of time the average size of cow herds has increased 3-4 times, except in Estonia, where it has increased 8 times. Nevertheless, the number of cows in the herds is different in individual countries. In the herds with up to 5 cows in Estonia there are about 2% of cows, but in the other Baltic states it is 10-18% of the total number of cows. In turn, in the herds with 50 or more cows, what corresponds to implementation of modern milk production technologies and machinery, in Latvia and Lithuania there are about 50% of cows, in Poland 30%, but in Estonia 90% of the total number of cows in the country. It has influenced the specific labour intensity of the people working in milk production. In Estonia, this indicator in 2019 was about 100 man-h per cow per year, but in the other Baltic states it was 300-350 man-h calculating per cow per year. Still, with robotization and automation of all basic work operations the specific labour intensity in milk production can be decreased to 30-50 man-h calculating per cow per year. Therefore, there are still great development possibilities in all Baltic countries.

Key words: cow, dairy farm, modernization, labour intensity, herd size.

Thermal comfort assessment in a typological non-isolated maternity pig sheds with different types of farrowing systems

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Abstract: Swine facilities in tropical climates, especially the maternity, have worked with typological systems that have been little studied to determine the influence of the type of farrowing on microenvironmental conditions and its effect on both the sows and the piglets' physiological parameters. Therefore, the aim of the research was evaluate the thermal environment (Temperature Humidity Index - THI and Radiant Thermal Load - RTL) and its influence on some physiological parameters (respiratory frequency - RF and rectal temperature - TRectal) in the sows and piglets in two different types of farrowing systems (Traditional and Slatted), in a typological swine facility located in tropical climates in Colombia. The findings showed that in the two systems, both for sows and piglets, the type of farrowing system did not generate significant differences in the physiological responses RF and TRectal. Also, the RTL did not show significant differences in the two types of farrowing system at the piglets and the sows' level, without exceeding the maximum allowed levels. Temperature-Humidity Index was above the threshold during all experimental time, being slightly higher at the piglets' level with Slatted systems. These results show that the type of floor has little impact on the conditions of animal thermal comfort at the sows and piglets' level. However, variables like low-temperature, low radiant energy exchange, and high humidity, which were found mainly at the piglets' level, could have the highest incidence for not achieving a suitable microenvironment. This means that almost all Colombian pig farming facilities require a redesign of their farrowing system to guarantee better thermal conditions for both piglets and sows.

Key words: comfort Index, farrowing systems, swine facility, tropical country.

ACKNOWLEDGEMENTS: The authors would like to thank the Universidad Nacional de Colombia, Faculty of Agricultural Sciences "Bioclimatica Aplicado a la Agroindustria" Lab, and San Pablo Swine Experimental Farm in Medellín Campus, and Lavras Federal University – Brazil.

A perspective of the Portuguese consumer awareness, beliefs and preferences towards piglet castration methods and its implications on the meat quality

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Abstract: Neutering male piglets by surgical procedures without anaesthesia, with analgesia and/or anaesthesia and, recently, immunological-chemical castration are practices to avoid unwanted or aggressive sexual behaviour, and to prevent the development of meat boar taint. This exploratory study aims to investigate Portuguese consumer's awareness, beliefs and attitudes in issues like boar taint, piglet's castration and pork meat quality, observing possible demographic trends. It is also intended to identify clusters of consumers with similar attitudes, crossing them with demographic data to verify the existence of patterns in Portugal related to these issues. To attain this objective, a consumer's survey was performed through an online questionnaire open for 30 days. A total of 158 respondents completed the survey. Almost a half (46%) of respondents stated their unknowledge about boar taint. Surgical castration and its effects are topics with which older consumers with a rural background are more familiar with, while immunological-chemical castration is still unknown to most consumers: 65% of consumers said they were not aware of this method, and 75% did not know whether it is an effective method for eliminating boar taint. Hierarchical clustering followed by K-means analysis segmented consumers into three clusters characterized according to their opinions, mainly divided by ethical and chemical-free orientations and by a more conservative meat quality and flavour-oriented attitudes, generally independent of prevailing demographics. In general, there were no defined opinions about the subjects under study, due mainly to the lack of information or knowledge. Nevertheless, cluster classification revealed differences in consumer's opinions, especially regarding the reasons for castration and the pain inflicted, about meat quality and the willingness to buy pork from entire males or to pay more for this type of product.

Key words: boar taint, consumer perception, entire male pigs, immunocastration, surgical castration.

ACKNOWLEDGEMENTS: This work is a result of the project TECH - Technology, Environment, Creativity and Health, Norte-01-0145-FEDER-000043, supported by Norte Portugal Regional Operational Program (NORTE 2020), under the PORTUGAL 2020 Partnership Agreement, through the European Regional Development Fund (ERDF). To UIDB/05937/2020 and UIDP/05937/2020 – Centre for Research and Development in Agrifood Systems and Sustainability (CISAS) – funded by national funds, through FCT – Fundação para a Ciência e a Tecnologia.

Effect of dietary crude protein concentration on milk productivity traits in early lactation dairy cows

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Abstract: The evaluation and control of nitrogen balance at the farm and its relation to milk productivity traits are becoming essential in dairy farming. Increasing in milk productivity farmers tend to increase protein content in feed. The research complied into three (A, B, C) dairy cow groups (8 cows in each group) with LB and HM breed's cows in the early lactation period divided into three phases (I, II, III) from 10 till 30 lactation days and lasting to 90 lactation days. Each group cows were feeders with total mixed ration (TMR) with different CP content (approx. 17.0%; 16.0%; 15.0% accordingly). The amount of feed consumed by each cow were recorded and feed samples collected during the study. Feed samples were analysed for CP and other feed quality descriptive traits. Milk yield (kg d^{-1}) and milk samples were collected at day 21 of each phase for analysis. Milk samples were analysed for fat (%), total protein (%), casein (%), and urea content (mg dL^{-1}). The statistical analyses were conducted using ANOVA and descriptive parameters. To evaluate the feed CP conversion efficiency estimated part of that in the yield of milk protein for each cow and on average for the study group in each study phase. The conversion efficiencies of feed CP in milk were ranged from 28.5% to 40.7% in study phase I, and from 33.0% to 39.9% in phase II, and the differences were statistically significant. In phase III, the range from 30.4% to 36.3% were not statistically significant.
The objective of this study was to evaluation of feed protein conversion efficiency for dairy cows in the early lactation phase and define the optimal crude protein (CP) content in the feed.

Key words: milk yield, milk total protein, milk urea, feed crude protein.

ACKNOWLEDGEMENTS: Research was conducted with support from Latvia Ministry of Agriculture project No S349, agreement No 19-00-SOINV05-000024.

Nutritive characterization of Musa *spp* and its effects on *in vitro* Rumen fermentation characteristics

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Abstract: This research aims to study the effect of nutritive value of *Musa spp* on animal feed. Residues of banana culture, leaves and stems, could be used as a fibre source for animal feeding, especially in Banana producing areas, such as Macaronesia Archipelagos, avoiding wastes and supplementing periods of scarcity of food.
Musa spp were collected and dried at 65ºC in an oven with controlled air circulation. The pseudostems were divided in three different portions and chemical composition, *in vitro* digestibility, and *in vitro* gas production were determined. Regarding dry matter results, they were low (16.54% in leaves and 6.54% DM% in pseudostem), crude protein raging 11.25 DM% in leaves and 7.25% in pseudostem. Concerning fiber values, NDF is higher in leaves (70.07 DM %) than in pseudostems (52.11 DM %) and ADL is higher in leaves (9.90 DM %) comparing with pseudostems (6.21 DM %). *In vitro* DM digestibility is low, (24.42% in leaves and 42.69% in pseudostem), corroborating the NDF values. Cumulative gas production was recorded at 4, 8, 12, 24, 48, 72, and 96 h of incubation. The results showed that the gas production in leaves was lower (11.36 ml 200 mg^{-1}DM) when compared to pseudostem (23.81 ml 200 mg^{-1}DM), being so in accordance with the digestibility results.
The current study suggested that this by-product can be used in animal feed, however, it will be necessary to carry out tests to improve its nutritional value, namely with NaOH and/or with Urea, being a promising strategy for improving ruminant feed efficiency.

Keywords: Animal Science**,** *In vitro* digestibility, Gas production, *Musa spp*, Ruminants.

ACKNOWLEDGEMENTS: This work has been funded by INV2MAC Project (*Potencial aprovechamiento de biomasa generada a partir de especies vegetales invasoras de la Macaronesia para uso industrial*, **MAC2/4.6a/229)**, has been approved in the first call of the territorial cooperation programme MAC towards FEDER funds and the Regional Directorate of Science and Technology of the Azorean Regional Secretariat for the Sea, Science and Technology.The authors also express their appreciation to IITAA (Institute of Investigation Agrarian for support of this research from FCT project ref: **UIDB/00153/2020** and the permission to use their research facilities.

Analysis of environmental conditions and management in a compost-bedded pack barn with tunnel ventilation

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Abstract: The housing system based on compost-bedded pack for dairy cows is spreading rapidly in Brazil. Completely open buildings without curtains and simple roofs are usually provided. However, in the last years some new completely closed barns have been realized. This study aims to analyse one of these closed barns, located in the State of Minas Gerais. The two main sides of the facility are provided with polyethylene curtains of blue colour and five deflectors. The barn is equipped with an evaporative adiabatic cooling system, associated with the tunnel-style ventilation, realized with exhaust fans, continuously operating 24 hours a day. 85 lactating Holstein cows were housed in the barn during the trials carried out in the winter season 2019. Microclimatic data were collected continuously. Air speed, illuminance and bedding temperature were measured during the farm visits. Pack moisture was calculated. The results state the importance of bedding management and climatic conditions inside the barn. It emerges that the cows housed in this kind of closed barn, with forced ventilation, are in good thermal conditions, which are fairly constant. The average illumination of the barn can be considered acceptable (55.06 lx), even if some areas of the barn present values below the minimum ones reported in literature. The bedding temperature varies between a maximum of 36.33°C and a minimum of 25.44°C with an average of 31.26°C. The values of bedding moisture are between a maximum of 64.36% and a minimum of 60.81% with an average of 62.48%.

Key words: compost bedded-pack barns, dairy housing, tunnel ventilation, ventilation systems.

ACKNOWLEDGEMENTS: The authors are thankful to the Federal University of Viçosa for this opportunity. This work was carried out with the support of CNPq, National Council for Scientific and Technological Development – Brazil.

Behavioural patterns of cows housed in two different typologies of compost-bedded pack barns

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Abstract: The compost-bedded pack barn (CBP) is an innovative housing technique which has the improvement of animal welfare as main objective. A comparative study of the behaviour of Holstein-Friesian dairy cows housed in two different compost-bedded pack barns located in the State of Minas Gerais (Brazil) was carried out during the winter season. One barn (CBP A) is closed and applies a wind tunnel ventilation (negative pressure). A second barn (CBP B) is open with natural ventilation, without curtains on the sides, and has fans placed in the resting area. Infrared video cameras were installed in the two barns to allow continuous and simultaneous monitoring of cows' behaviour. Air temperature and relative humidity inside the barns were monitored continuously and Temperature-Humidity Index was consequently calculated. The results show that the cows housed in the closed barn, with forced ventilation (CBP A), were in good thermal conditions, which were fairly constant, while in the open barn (CBP B) the internal microclimatic conditions were more subject to outside climatic conditions. A close relationship was found between the trend of air temperature and relative humidity inside the facilities and the behaviour of the cows. The number of cows at rest, in CBP B, decreased as the THI value rose. In CBP A, the behaviour of the cows in relation to THI was much more constant.

Key words: animal behaviour, compost bedded-pack barns, dairy housing, environmental conditions.

ACKNOWLEDGEMENTS: The authors are thankful to the Federal University of Viçosa for this opportunity. This work was carried out with the support of CNPq, National Council for Scientific and Technological Development – Brazil.

VI PRECISION AGRICULTURE

Characterization of red raspberry (*Rubus idaeus* L.) for their physicochemical and morphological properties

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Abstract: Different raspberry cultivars are grown in Latvia suitable both for fresh market and for processing. Fresh local red raspberry is available for consumers from July to October. Information about the physical, chemical, and morphology properties of raspberry fruit is essential for understanding the behavior of the product during the postharvest operations such as harvesting, transporting, sorting, grading, packaging and storage. Knowledge of the physicochemical properties of red raspberries is essential because variations in the levels of these properties may exist between cultivars. New varieties of plants were used to describe and compare the fruit quality of red raspberry cultivars: 'Daiga', 'Shahrazada', 'Norna' and 'Polana' grown in Zemgales region of Latvia. The samples were collected from farm 'Pluģi' the full stage of ripening. The current research aimed to investigate and determine the chemical composition (total phenolic content (TPC), total flavonoid content (TFC), titratable acidity (TAc), total soluble solids content of raspberry fruits, the physical parameter pH, and color. Presented morphological parameters of fruit included their weight, receptacle length (Rl), receptacle width (Rw), fruit length (Fl), fruit width (Fw), weight of fruit (M), number of seeds. Research results showed significant differences in all chemical and physical characteristics as well as in morphology properties *($P < 0.05$)* between cultivars.

Key words: raspberry, *Rubus idaeus* L, physicochemical, physical and morphological properties.

Phosphate solubilization potential of indigenous rhizosphere fungi and shelf-life studies of their biofertilizer formulations

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Abstract: The continuous use of synthetic chemicals in the formulation of agricultural fertilizers and their accumulation in the soil have resulted in wide ranging deleterious effects, leading to a shift in focus to more environmentally-friendly soil improvements, including biofertilizers. This study aimed at isolating fungi from the soil and assessing their potential phosphate solubilizing ability. Soil from the rhizosphere of four plants were collected and plated on Pikovskaya (PVK) agar to isolate and screen for fungi capable of solubilizing phosphorus. Seven fungi were isolated and three with the highest phosphate solubilizing ability were selected. Furthermore, these isolates were grown in Pikovskaya broth, with varying substrates and growth conditions to optimize the amounts of phosphate solubilized. Biofertilizers were formulated using charcoal and sawdust as carriers. Shelf-life of the biofertilizers was assessed for sixteen weeks. The results revealed that *Aspergillus niger*, *Aspergillus flavus* and *Aspergillus fumigatus* had the highest solubilization indices of 1.72, 0.95 and 1.01 on PVK agar respectively. Highest amounts of soluble phosphate by *A. niger*, *A. flavus* and *A. fumigatus* were 149, 111 and 125 mg/L on day 5 of fermentation. This rose to 548.93 mg/L on day 11 (*A. niger*); 379.28 mg/L on day 9 (*A. flavus*) and 429.72 mg/l on day 9 (*A. fumigatus*). Biofertilizers formulated using *A. fumigatus* had longest shelf–life at 16 weeks, while that formulated from *A. niger* had the shortest shelf-life at 6 weeks. These results confirmed the potential of the indigenous fungi as biofertilizers for improving soil fertility.

Keywords: *Aspergillus,* biofertilizer, phosphate-solubilizing-fungi, phosphate soil fertility, solubilizing efficiency.

Hybridspecific nutrient interactions and their role in maize yield quality

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Abstract: Different fertilisation levels can be used according to the intensity of the cultivation technology, with the goal of producing more with better quality. The interactions among all the essential nutrients, the different ways of antagonisms and synergisms can weaken or strengthen the physiological processes of the plants, affecting significantly the efficiency of the production. Analysis of variance showed that the effect of different nitrogen fertilisation levels was significant on grain yield, protein, oil and moisture content. Significant differences were measured between the different maize genotypes in grain yield, protein and starch content. In the experiment all essential nutrient concentrations were measured. Among them, the important nutrient ratios of macro- and micronutrients for the physiological development of maize were calculated and evaluated according to its scale of influence in yield formation. It can be concluded that different nitrogen fertilisation levels affected significantly the essential nutrient ratios of the vegetative and generative plant parts of three maize hybrids in the growth period. Correlation between K:Mg ratio of leaves and grain yield was significant in all three hybrids, marking it as an important parameter for future research. Analysing the optimal nutrient ratios related to the yield quality and their interaction with the fertilisation practices can give certain recommendations to the farmers to implement hybrid- and site-specific nutrient management systems, reducing the environmental impact of the over-fertilisation.

Keywords: correlation, maize, nutrient ratios, stoichiometry, yield quality

ACKNOWLEDGEMENTS: Project no. TKP2020-IKA-04 has been implemented with the support provided from the National Research, Development and Innovation Fund of Hungary, financed under the 2020-4.1.1-TKP2020 funding scheme, and supported by the EFOP-3.6.3-VEKOP-16-2017-00008. project.

Potential of Multivariate analyses of X-Ray fluorescence spectra for characterisation of the microchemical composition of plant materials

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Abstract: This work describes a method for the rapid element analysis of plant material using ED-XRF in conjunction with chemometrics. An effective analyses method is developed by measuring certified reference materials (CRM) of plant materials (algae, cabbage, lichen) covering major chemical elements with ED-XRF, to overcome the matrix effect. All samples have been measured additionally by ICP-MS. The ICP-MS analysis was used for missing information on the concentration of some elements in certificated standards. ICP-MS with CRM was used to determine sample related element sensitivity for microelements for ED-XRF analyses.
Instead of each element concentration calculation, the ED-XRF spectral patterns were used for Multivariate principal component analyses by SIMCA strategy. The model allows quickly analyse samples for similarity and differentiate them based on a little difference in spectral pattern, which correspondence to a minor difference in element concentration pattern. Samples with specific chemical composition could be easily spotted for in-depth analysis.The proposed strategy for plant material sample chemical composition screening allows the quick method to improve laboratory work efficiency, reduce unnecessary analysis and rapid method for control reliability of results of more complex chemical methods, such as ICP-MS.

Key words: chemometrics, ED-XRF, ICP-MS, multivariate analysis, plants, screening analysis, SIMCA.

ACKNOWLEDGEMENTS: The research received funding from the ERAF Post-doctoral Research Support Program project Nr. 1.1.1.2/16/I/001 Research application “Development of screening methods by innovative spectroscopy techniques and chemometrics in the research of herbal medicine,” Nr. 1.1.1.2/VIAA/2/18/273. This project has received funding from the European Union’s Horizon 2020 research and innovation programme under the grant agreement No 857287.

Evaluation of carbon, nitrogen, and oxygen isotope ratio measurement data for characterization of organically and conventionally cultivated spring barley (*Hordeum vulgare* L.) grain

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Abstract: With the growing interest of public in the consumed food quality, the organic produce has been steadily gaining important place in the everyday menus of our society. The growing demand has boosted the organic farming and we have also seen the difference of prices between the organic products and their conventional counterparts. For the public it is important to have security, that the 'organic' labelled food has really been growing according to the good practices of organic farming and have not received any chemical pesticides, herbicides, and synthetic fertilizers. Stable isotope ratios of crops from different crop management systems can help answering these questions, as these values depend on the growing conditions, fertilizers used etc. In this study 10 barley grain samples from conventional and organic crop management systems have been studied. The carbon, nitrogen and oxygen isotope ratios have been determined and the element content in the samples has been calculated. For discrimination between conventional and organic grain principal component analysis has been carried out. The PCA showed that it is possible to discriminate between conventionally and organically grown barley, based on the $\delta^{15}N$ and $\delta^{18}O$ values. Also, it has been concluded that the total element content of carbon and nitrogen in barley grains does not correlate with the stable isotope ratios and cannot help with discriminating of these samples.

Key words: barley, organic farming, grain, principal component analysis, stable isotopes, stable isotope ratio mass spectrometry.

Variation of chickpea nodulation in a Mediterranean agroecosystem: relationship with soil characteristics and thresholds for significant contribution to plant growth

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Abstract: This study was designed to investigate the influence of some environmental constraints on chickpea (*Cicer arietinum* L.) growth and nodulation in a reference agroecosystem. This multi-local field experiment, realized in the agroecosystem of Chlef in northern Algeria, involved 24 sites where the local well-adapted genotype Ain temouchent is grown. Determination of soil properties allowed the identification of three clusters of sites. Plant biomass (SDW) varied significantly among sites from 6.7 to 39.4 g SDW plant^{-1} and was highly correlated with nodule biomass (NDW). The slope of the regression function between NDW and SDW, defined as the efficiency in use of the rhizobial symbiosis (EURS) inside clusters ranged from 67 to 200 g SDW g^{-1} NDW. Analysis of the EURS highlighted the existence of a low nodulation threshold of 0.1g NDW plant^{-1} below which the contribution of nodulation to the host plant growth was not significant and a high threshold above which the nodule biomass increase was not linked with an increase in shoot biomass. Thus, the significant regression of shoot growth as a function of nodulation ranged from 0.10 to 0.35 g NDW plant^{-1} ($R^2 = 0.54$, $P < 0.001$). Moreover, nodule biomass was positively correlated with soil Olsen-P, more particularly in cluster A ($R^2 = 0.50$, $P < 0.05$) and B (R2 = 0.61, $P < 0.01$). This approach proved to be a rapid and efficient way to identify the major factors affecting nodulation in order to develop strategies to optimize nodule contribution to chickpea growth and yield.

Key words: Chickpea; Efficiency in use of the rhizobial symbiosis; Nodulation; Phosphorus; Plant-soil interaction; Symbiotic nitrogen fixation.

ACKNOWLEDGEMENTS: The authors thank the company semence du Chéliff for their technical support of this work. The authors also thank the local authorities and chickpea growers for their participation in the multilocal trial realized in this study.

Delineation of catchment area for the lake Kisezers for environmental sustainability

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Abstract: The previous extensive research on catchment area delineation in Latvia was carried out in the late 20th century. Anthropogenic impacts combine with climate change over time might lead to changes in the hydrological network of rivers, hydrological regime, surrounding terrain, depths of lakes and rivers, groundwater levels, and soil moisture conditions. In addition, new and precise geospatial data has become widely available and can be used for multiple purposes including delineation of catchment areas. This research aims to understand what differences can be changing conditions cause and how we can manage a catchment area in favor of all. Lake Kisezers was selected as the study site because of the location and wide range of research data availability. The lake catchment area covers multiple rivers, urban and rural territories, forests, high and low terrains. In the catchment area of Lake Kisezers many hydrologic monitoring stations with continuous data are situated. In the research area, we can study how those factors interact with the possibility to perform a catchment area delineation. The study aims to develop a methodology for the delineation of a catchment area. The methodology includes the processing and analysis of LiDAR data, on-field height measurement data, bathymetric data, hydrological data. A combination of all data results in multi-purpose 3D raster data for catchment area delineation. The final result of this study is the catchment area for Lake Kisezers . The research results are high-definition and can be used to understand locations of floodplains, territories with malfunctioning drainage systems. The repetition of this study requires extensive knowledge of cartography, experience in working with terrain and bathymetry data, wide-range of GIS knowledge. The research was performed using computer software such as QGIS and GRASS GIS. The application of the methodology used in this study can serve as an example for delineation and analysis of a catchment area for other lakes and rivers.

Key words: Catchment area, GRASS GIS, LiDAR, QGIS.

Influences of soil tillage, fertilization and plant density on maize yield

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Abstract: The aim of the presented research is to compare the effects of different tillage methods, plant density and N fertilization treatments on the amount of maize yield. The two year experiment was carried out at the Látókép Experimental Area of the University of Debrecen, Hungary in 2018 and 2019, in a moderately warm and dry production area, on deep humus layered chernozem soil. The managements were of monoculture maize under winter ploughing to a depth of 0.3 m, strip tillage to a depth of 0.3 m and ripping to a depth of 0.45 m. Three levels of nitrogen as 0, 80, 160kg N ha^{-1} and two of the plant density as 60.000 and 80.000 plants ha^{-1} were evaluated. Based on the results, significant effects of the different nitrogen fertilization levels and the different soil treatments were measured among the yields. Maize grain yield and yield-related traits were significantly affected by nitrogen doses and plant densities. Throughout both years the results indicated that the most favourable nitrogen dose, plant density and soil tillage were 160kg N ha^{-1} and 60,000 plants ha^{-1} with ripping as soil tillage system for maize grown. On average, the use of reduced tillage techniques with 180 kg N ha^{-1} and with the plant density of 60,000 plants ha^{-1} provided the highest amount of yield. Analysing the tillage methods and nitrogen doses related to the amount of yield can provide recommendations to the farmers for optimal nutrient management.

Key words: fertilization, plant density, tillage, maize yield.

Examinations of the impact of tillage, fertilization and crop year on the starch content of maize

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Abstract. The use of maize, both as main and by-product, is extremely versatile and diverse. The highest amount of carbohydrate within maize is found in the form of starch (C6H10O5)x. In terms of industrial starch, maize is the most important raw material. Fodder maize is primarily an energy source due to its high starch content, and its protein and oil content are less important. It was found that starch and protein content, which are negatively correlated with each other, are significantly affected by fertilizer doses. The experiment is located in the Hajdúság Loess Plateau, its soil is loess-based deep humus layered calcareous chernozem. The following treatments were applied in the scope of the polyfactorial experiment: Tillage: T1= winter ploughing, T2= strip tillage, T3= ripping. Crop years: 2017, 2018 and 2019. Fertilization treatments: N 0 kg/ha P2O5 0 kg/ha K2O 0 kg/ha (control); N 80kg/ha P2O5 60 kg/ha K2O 90 kg/ha and N 160 kg/ha P2O5 60 kg/ha K2O 90kg/ha. Analysis of the nutritional component was carried out by means of a Foss Infratec TM 1241 Grain Analyser.
In terms of fertilization treatments, the highest (64.42%) maize starch content was measured for the control treatment, while the lowest starch content was recorded in the case of the 160 kg Nha treatment (62.62%). The analysis of the crop year effect showed that 2018 was the most favourable year for the maize starch content of the examined samples (65.76%). Of the studied years, the lowest starch content was measured in 2017 (61.78%).

Key words: starch content, starch yield, fertilization, crop year, tillage.
ACKNOWLEDGEMENTS: Project no. TKP2020-IKA-04 has been implemented with the support provided from the National Research, Development and Innovation Fund of Hungary, and has been financed by the 2020-4.1.1-TKP2020 funding scheme and the EFOP-3.6.3-VEKOP-16-2017-00008 project.

Evaluation of soil properties, irrigation and solid waste application levels on Cu and Zn uptake by industrial hemp

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Abstract: A three-year experiment was performed to study the alteration of copper and zinc levels in industrial hemp grown in different soils using elevated sewage slurry solid waste applications. Two soil samples, an acidic and an alkaline one, with different soil properties, such as percentage of $CaCO_3$ and cation exchange capacity values, were used. Three treatments of waste solid with provided elevated concentrations of Cu and Zn were combined with two irrigation levels. The application of high doses of the solid residue as well as high irrigation level lead to an increase of the mobility of metals in hemp leaves in acidic soil in contrast to alkaline. On the contrary, in alkaline soil along with a reduced irrigation level, there is a decrease in the mobility of Cu and therefore its accumulation in the roots or stems was observed. Concluding, hemp seem to be a promising plant remediator, after the application of the proper irrigation level and taking into account the physico-chemical soil properties of moderately contaminated (with copper and zinc) soils.

Key words: Heavy metals, *Cannabis sativa*, sewage sludge, phytoremediation.

Examination of the stress state of maize by means of stomatal conductance measurement

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Abstract: The present study focuses primarily on how maize responds to stress caused by the reduction of soil moisture and high temperature. The experiments were performed in Hungary, on calcareous chernozem soil in 2019 and 2020, with the involvement of the Fornad (FAO 420) hybrid. In addition to the non-fertilized treatment, the doses of 60 and 120 kg N ha^{-1} applied as spring basic fertilizer were followed by two doses of top-dressing in V6 and V12 phenophases, the amount was +30 and +30 kg N ha^{-1}. As the phenological phases progressed, stomatal conductance showed a decreasing tendency in both years, with the rate of decrease for the R1 phase being 43.9% and 32.1% ($P < 0.001$; $P < 0.01$). The highest stomatal conductance occurred in the V6 phenophase, in the non-fertilized (589 mmol/m^{2-s}) treatment in 2019, and in the $V6_{150}$ kg N ha^{-1} (476 mmol/m^{2-s}) treatment in 2020. The less favourable physical condition of the plants was recorded in the R1 phenological phase in 2019 (183 mmol/m^{2-s}) in the A_{60} treatment, and in 2020 (208 mmol/m^{2-s}) in the A_{120} kg N ha^{-1} treatment. The correlation between stomatal conductance and yield was close and moderate in both years. The V12 phenological stage would have been adequate for the application of irrigation water (2019 and 2020), as the stomata began to close after that due to the decrease in the water supply available to them. All this supports the finding that the detection of water stress can be realized by measuring stomatal conductance.

Keywords: maize, stomatal conductance, drought stress.

ACKNOWLEDGEMENTS: "Supported by the UNKP-20-3 New National Excellence Program Of The Ministry For Innovation And Technology From The Source Of The National Research, Development And Innovation Fund. Project no. TKP2020-IKA-04 has been implemented with the support provided from the National Research, Development and Innovation Fund of Hungary, and has been financed by the 2020-4.1.1-TKP2020 funding scheme and the EFOP-3.6.3-VEKOP-16-2017-00008 project."

Production of CO_2 concentrations in different ways of biowaste treatment

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Abstract: The aim of this study was to analyse the production of CO_2 concentrations in relation to the composting technology used. Three loose piles of bio-waste (V1, V2, V3) were created with the same volume. V1 reference pile was without any treatment. The biological preparation containing probiotic bacteria was added to the pile V2. The pile V3 was treated once a week by turning and watering. The degassing shafts were installed in each pile and the Multigas Monitor 1312 gas analyser with the Multipoint Sampler 1309 were used to measure of gas concentrations during the degradation process. Continuous 24-hour measurements of carbon dioxide concentrations from each pile were performed in the first, fourth, and seventh week of the degradation process to compare the amount of concentrations between piles in those weeks. Pfeuffer GT 1 needle thermometer was used to measure compost temperature. Determination of compost moisture, pH and C/N nutrient ratio was performed in a certified laboratory. Statistical analysis of significant differences in MATLAB environment was used to process the obtained data. The measurement showed that the amount of gas concentrations gradually increased during the process. In the first week, the production of CO_2 concentrations from the monitored piles did not differ significantly ($P < 0.05$), the mean values were 1,071.86 mg m^{-3} ± 57.66 (V1); 1,052.98 mg m^{-3} ± 28.12 (V2) and 1,053.94 mg m^{-3} ± 27.37 (V3). The values of pH were found 7.31 (V1), 7.54 (V2) and 7.54 (V3) and a nutrient ratio C/N were 32.23/1 (V1), 32.17/1 (V2), 32.18/1 (V3) from the samples of material taken at week 1st from each pile. In the fourth week, statistically significantly higher gas concentrations were recorded from the V3 pile than from the pile of V1 and V2 ($P < 0.05$). The mean CO_2 concentrations were 4,498.80 mg m^{-3} ± 394.56 (V1); 4,651.96 mg m^{-3} ± 452.32 (V2) and 12,757.06 mg m^{-3} ± 1,673.52 (V3). In the seventh week it was statistically proven that from the V3 pile significantly higher concentrations of gas ($P < 0.05$) were recorded. The mean CO_2 values were 5 times higher from the V3 pile than from V1 and 4 times higher than the V2 pile; specifically 6,642.41 mg m^{-3} ± 902.4 (V1); 8,359.11 mg m^{-3} ± 1092.93 (V2) and 33,554.94 mg m^{-3} ± 2,619.42 (V3). At the week 7th, optimal values of the pH 7.88 (V1), 7.96 (V2) and 7.92 (V3) were found and the nutrient ratio decreased to 22.53/1 (V1), 23.58/1 (V2), 22.25/1 (V3). It has been shown that turning and watering affected the temperature of the compost, the loss of carbon but also the resulting amount of product.

Keywords: composting technology, carbon dioxide in compost, compost properties, environmental impacts, compost moisture.

ACKNOWLEDGMENTS: This publication was supported by the Operational Program Integrated Infrastructure within the project: Demand-driven research for the sustainable and inovative food, Drive4SIFood 313011V336, cofinanced by the European Regional Development Fund.

Effect of fertilization on growth of lingonberry (*Vaccinium vitis-idaea* L.)

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Abstract: Today, most of the global berry crop of *Vaccinium vitis-idaea* L. is obtained from wild berries. In recent years, however, their cultivation has become slightly more widespread, especially as demand has increased. As the commercial production of lingonberries is a completely new fruit-growing sector in Latvia, research on mineral nutrition, development of the crop production system and proper fertilizer management is critically important. The objective of this study was to elucidate the effect of different fertilizer rates on the nutrient status of lingonberry plant tissues and plant growth performance. Field experiments with the lingonberry variety 'Runo Bielawskie' were carried out during the 2019 and 2020 cropping season. Experimental plantations were established on an excavated peat bog in Latvia. Lingonberry plants received 4 different levels of complex and foliar fertilizers. Leaf analyses and soil (peat) testing were used as diagnostics tools to reveal nutrient (N, P, K, Ca, Mg, S, Fe, Mn, Zn, Cu, Mo, B), soil pH and EC status. In general, plant growth characteristics were significantly affected by different levels of fertilizer. The results showed that the highest fertilizer rates resulted in a larger shrub diameter, the highest total number of rhizomes and shoots of a mother plant.

Key words: plant and soil analysis, nutrient status, excavated peat bog.

ACKNOWLEDGEMENTS: The financial support provided by the European Rural Development Fund for project „Development of methodology for propagation and cultivation of lingonberry (Vaccinium vitis-idaea) varieties", Nr:18-00-A01620-000011 is acknowledged.

Crop Growth and Health Monitoring, Phenotyping, and Weed Detection with Multispectral Drone Images at the Estonian Crop Research Institute

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Abstract: Crop growth and health monitoring is time consuming, particularly for breeding trials, and recorded phenotypic data varies between observers. Weed detection and severity rating is also time consuming and may be inconsistent between observers. The Estonian Crop Research Institute (ETKI) is testing multispectral drone imagery for crop growth and health monitoring, phenotyping, and weed detection. A DJI Phantom4 RTK (P4) drone with built in RGB camera and a MicaSense RedEdge MX multispectral camera is used to image field plots. The goal of crop growth monitoring is to assist breeders in identifying varieties displaying desirable traits such as early heading in wheat. Crop health monitoring can also assist breeders in identification of crops with desirable traits such as disease resistance or drought tolerance. Vegetation indices, including NDVI, LAI, EVI, CWSI, etc., are calculated at the plot level. The vegetation indices will be evaluated by the breeders to determine which are most beneficial for detecting each trait for each crop. The goal of weed detection is to reduce herbicide use by accurate detection of weeds and the severity of the infestation. Multiple methods for weed detection are being tested including 1) color differentiation, 2) row pattern recognition, and 3) plant feature detection. The objective of this poster is to give an overview of ETKI's use of multispectral drone imagery for phenotyping breeding plots and detecting weeds in fields.

Key words: multispectral imagery, drone, phenotyping, plant breeding, weed detection.

Activation effect of β-alanine and chitosan derivative on *A. glycyphyllos* and *A. membranaceus* seed germination and seedling growth and development

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Abstract: Agricultural cultivation of astragalus is fraught with a number of difficulties caused by both certain requirements for climatic conditions and individual characteristics of plants of this genus. In this study, carboxyalkylated derivative of chitosan was first proposed to use for improvement of astragalus propagation. Effects of N-(2-carboxyethyl)chitosan on in vitro A. glycyphyllos and A. membranaceus seed germination and seedling growth and development in comparing with β-alanine and chitosan acetate were detected. Carboxyethylation of chitosan leads to an increase in hydrophilic properties of the molecule, which enhances a penetration of nutrients inside the plant owing to improved solvating effect and bioadhesive activity. Seed germination assay were performed on Murashige-Skoog growth medium with or without tested compounds. N-2-Carboxyethylated derivative of chitosan was found to demonstrate active stimulating effect on the plant growth and development, contrary to the effect of acetate chitosan, but not to cause an activating effect on seed germination, while β-alanine does.

Key words: agricultural benefits, bioactivity, functional derivatives, morphological measurements, plant grow regulators, polysaccharides, statistical Friedman test, stimulating effect.

ACKNOWLEDGEMENTS: This work was supported by the basic themes of the Russian Academy of Sciences (state registration no. AAAA-A19-119011790132-7) and Botanical garden UB RAS task. Physicochemical studies were carried out using the equipment of the Center for Joint Use ‘Spectroscopy and Analysis of Organic Compounds’ at the Postovsky Institute of Organic Synthesis UB RAS. The work was also supported by the Ministry of Science and Higher Education of the Russian Federation (task no. AAAA-A20-120061990010-7).

The effect of cultivation technology on the plant development of organically grown garlic

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Abstract: The new technological solutions for the hardneck garlic production were tested to prevent the influence of unfavourable soil and climatic conditions on the rooting, sprouting and wintering ability of hardneck garlic – factors that affect significantly the hardneck garlic production in Latvia. Field studies were carried out at the experimental field of the organic farm, located at the Koknese district, Latvia, during the seasons of 2018/2019 and 2019/2020, on sandy loam soil using hardneck garlic cultivar `Lyubasha` and local clones. Two variants of garlic growing were compared – traditional planting in the autumn in the field as control, and planting in the trays as an innovative solution. Results indicated that low temperature treatment (below +7 ºC) for the period of at least 50 days initiates cloves primordia development. The using of trays is effective technology to prevent unfavourable agroecological conditions on the field in the case if controlled conditions are available and technically feasible in the farm.

Key words: *Allium sativum* var. *ophioscorodon* (Link) Döll, bulb, clove, stalk development.

ACKNOWLEDGEMENTS: The research was conducted in the framework of the project on the modernization of winter garlic cultivation to ensure guaranteed yield in the organic production system. The authors gratefully acknowledge the financial support of ERDF and Ministry of Agriculture of Latvia, grant number 18-00-A01620-000014.

Leaf nutrient status of tomatoes in coconut coir medium – differences in varieties, impact on yield and quality

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Abstract: Coconut coir as an alternative to rockwool is increasingly used as a growing medium for soilless hydroponic greenhouse production of tomatoes. However, little is known about the nutrient status of tomatoes in coconut coir, especially under intensive production conditions. The aim of this study was to investigate the nutrient status of different tomato varieties (orange plum 'Organza F1', red cherry 'Daltary RZ F1', red large fruit-sized 'Securitas RZ F1' and pink large fruit-sized 'Fujimaru F1') under industrial greenhouse production, using coconut coir as a substrate to reveal nutrient imbalances, their impact on tomato yield and quality, as well as variety differences. Essential nutrient and chlorophyll content in SPAD values was detected for the youngest fully developed leaves and the old still vital leaves twice per month from April to August 2020. The total yield, marketable and non-marketable yield was regularly determined. During the crop cycle, the content of most nutrients corresponded to the standard range for tomatoes. However, some imbalances were found: all varieties were characterized by low Zn and high S levels in both young and old leaves, as well as by high concentrations of Mn in older leaves. The obtained results also identified several differences between the varieties. Thus, cherry tomatoes 'Daltary' had significantly higher N, K, Fe and Zn in leaves compared to other tomato varieties. The lowest N, Fe and Cu were determined for large fruit-sized 'Securitas'. The impact of variety, nutrient status and microclimate conditions were discussed in relation to tomato fruit yield and quality.

Key words: different-age leaves, different colour and fruit-size varieties, natural lighting, *Solanum lycopersicum*, SPAD indices.

ACKNOWLEDGEMENTS: The financial support provided by the European Agricultural Fund for Rural Development for project 'Determining of optimum growing conditions for vegetables, using hydroponics growing method with an artificial and day light', No 18-00-A01612-000017, are acknowledged.

Development of an algorithm for canopy measurements with terrestrial LiDAR to implement precision spraying in vineyards

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Abstract: To improve precision spraying, some variable might be used to make variable rate application. One feature that can be measured to characterise spatial variability is the volume of the canopy. In the vine growing, the volume measurements are based on non-destructive detection techniques that use ultrasonic sensors that punctually assess small portions of the canopy. As an alternative, the LiDAR sensors can also be profitably used for this purpose. Generally, they require complex and laborious procedures of canopy characteristics computing through post-processing points cloud reconstruction. This work aimed to simplify the processes of point cloud reconstruction. To solve this problem, the developing and testing an automated calculation algorithm was carried out through the use of a tractor-coupled with terrestrial LiDAR and GNSS technology. Data were collected on several vines located in two vineyards with different row spacing. In order to evaluate the algorithm's good functioning in canopy volume extraction, the LiDAR-based volume was compared with two manual measurements of canopy volume (Tree Row Volume and Point Net Cloud). The results showed good correlations between manual and LiDAR measures for total canopy volumes (R^2 = 0.67 and 0.56). Instead for partial canopy volume, determination coefficients of 0.74 were reached. In conclusion, although the LiDAR-base algorithm works in automatic mode, the canopy volumes approximation is acceptable. However, the algorithm makes easy and quicky the canopy volume measurements and data processing to optimise differentiated spraying strategies and canopy management techniques achievable at variable-rate.

Keywords: Canopy management technique, Canopy volume, Site-specific data, Variable rate technique, Viticulture.

ACKNOWLEDGEMENTS: Tuscany Region's public funding supported this work through the “Kattivo” Project (PSR 2014-2020-PIF 43/2015). The authors are grateful to the wine-farm Tenuta Gretole, Ruffino (Castellina in Chianti) and Società Agricola San Felice (Castelnuovo Berardenga) for the help during the field tests.

Detection of sour and sweet cherry viruses in Ukraine

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Abstract: One of the main obstacles on the way to successful cultivation of orchards and planting material of sour and sweet cherry is infection with viral pathogens. They can adversely affect yields, reduce plant resistance to abiotic factors and cause losses in the nursery. Therefore, it is important to determine the spread of viruses in plantations and the selection of virus-free plants for the establishment of nuclear stock collections. In order to study phytovirological state of the orchards, tests for the presence of five viral pathogens were performed: Tomato black ring nepovirus (TBRV), Cherry leaf roll nepovirus (CLRV), Apple chlorotic leaf spot virus (ACLSV), Petunia asteroid mosaic tombusvirus (PeAMV), Plum pox virus (PPV). The level of infection with these pathogens reaches 19.2% for sour cherry, 5.8% – for sweet cherry, and 7.4% – for rootstocks. PPV prevailed in sour cherry material – 7%, in sweet cherry material – ACLSV (3.6%), while the rootstock samples were most infected by PeAMV – 5.6%. Until now, this virus has not been reported in Ukraine. TBRV and ACLSV viruses have been known in other crops so far, while not yet been detected in sour and sweet cherry. It was determined that PPV isolates (Mahaleb 1, Mahaleb 2) which were detected in sour cherry, belong to strain D.

Keywords: ELISA, TBRV, CLRV, ACLSV, PeAMV, PPV, phylogenetic.

Influence of tillage intensity on the spatial variability of soil water content

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Abstract: The water content of the soil can vary greatly on agricultural land. Apart from the obvious factors that influence soil water variability, such as differences in topography and precipitation, variations in soil properties and soil management practises can also have a significant impact. During the 2020 soybean growing season, we conducted continuous measurements of soil water content in silty-clayey-loamy textured soils in a 20-year-old long-term field trial with different tillage practises (Biotechnical Faculty, University of Ljubljana). The measurements were carried out in soybean cultivation from June to October 2020 on a small area of 24 m × 12 m with two contrasting tillage practises, no-tillage (NT) and conventional tillage with a mouldboard plough (CT). For each tillage practise five spatially balanced survey points were defined. For each point we analysed soil texture, organic matter content and water retention properties of the soil at two depths of interest, 10 cm and 20 cm. Before installing the sensors, we collected undisturbed soil samples for soil-specific calibration. At each measurement point we installed capacitive soil moisture sensors at both depths. The measurements were performed automatically and transferred to a cloud service at half-hourly intervals. For the data analysis we used calibrated values and calculated daily averages of water content. We found that the practise of NT leads to an accumulation of organic matter in the upper soil layer (10 cm) and to improved water retention, which was also confirmed by time series of soil water measurements. In the lower soil layer (20 cm) differences in water content are not so obvious. The spatial variability of the measurements was greater at CT than at NT. We can speculate that this is due to the disturbances in the soil structure caused by tillage and the resulting micro-compaction of the soil by machine transport.

Key words: spatial variability, soil characteristics, soil water content, water retention, tillage practices.

ACKNOWLEDGMENTS: The authors gratefully acknowledge Slovenian Research Agency (ARRS) with ARRS Grant for PhD student Urša Pečan.

Does the sowing time affect yield and quality of field beans in the Baltic region?

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Abstract: As field beans (*Vicia faba* L.) need a lot of moisture to germinate, growers believe that they should be sown as early as possible in the spring. Field trial was carried out at the LLU RSF "Pēterlauki", from 2018 till 2020. Following factors were researched: A) sowing time (early, medium and late), B) variety ('Laura', 'Boxer', 'Isabell'), C) sowing rate (30, 40, 50 germinable seeds m^{-2}), D) fungicide application (without and with application of fungicide at the GS 61–65). Adverse meteorological conditions for faba bean growing were observed in 2018. Similarly, spring and early summer of 2019 was hot and dry, but later conditions improved. The best year for bean yield formation was 2020, when temperature and precipitation was moderate. The highest average three year been yield was obtained sowing beans at the medium sowing time, yield of equal value was obtained sowing beans it early sowing time. Fungicide application increased average three year yield significantly ($p = 0.007$), but influence of variety and sowing rate on average three year yield was insignificant; the only tendency observed was that the variety 'Boxer' yielded slightly more on average, and that the sowing rate 50 germinable seeds m^{-2} ensured a yield increase. Average three-year values of crude protein content, thousand seed weight, and volume weight were affected by sowing time significantly ($p < 0.001$). Trial year, variety and fungicide application affected all quality parameters significantly ($p < 0.05$), but the effect of sowing rate was insignificant ($p > 0.05$).

Key words: *Vicia faba* spp. *minor*, sowing time, variety, sowing rate, fungicide application.

ACKNOWLEDGEMENTS: Research was supported by the SusCrop – ERA-NET project LegumeGap: "Increasing productivity and sustainability of European plant protein production by closing the grain legume yield gap", and by the RSF "Pēterlauki" of LLU.

The ecological adaptation of new spring canola varieties in different environmental conditions

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Abstract: The study of phenotypic plasticity and stability, according to which the potential of new spring canola varieties adaptability for agroecological technology of spring canola growing in the strategy of intensification of plant production is actual. The new canola varieties, which were included in the State register of plant varieties suitable for dissemination in Ukraine was studied. Field studies were carried out in 2018-2019 on the testing sites of the Ukrainian Institute for Plant Variety Examination in Forest and Forest Steppe zones of Ukraine. The phenotypic plasticity and stability analysis for yield, 1000 seeds weight, protein and oil content were carried out according to the Eberhart and Russell approach. As results of this study, it was determined that for yield Cleopatra and SAOKER CL varieties are considered as stable. CEBRA CL and Lavina varieties are characterized stability of 1000 seeds weight during studied years. According to the Wricke's ecovalence deviation and standard deviation Lavina, Lakritz and CEBRA CL varieties consider as intensive type varieties for yield; for 1000 seeds weight - Cleopatra and SAOKER CL varieties. According to standard deviation for protein and oil content CEBRA CL and SAOKER CL varieties are considered as highly adapted. Cleopatra, Lavina and Lakritz are stable for protein content. For oil content CEBRA CL and SAOKER CL varieties are considered as stable. For protein content CEBRA CL and SAOKER CL varieties are intensive. Thus, spring canola varieties, which are intensive for studied characteristics, respond positively to an improvement of growing conditions.

Keywords: phenotypic plasticity, stability, spring canola, intensive and extensive varieties, yield, quality seed traits.

The efficiency of nitrogen stabilizer at different soil temperatures on the health condition of maize (*Zea mays* L.)

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Abstract: Nitrogen (N) stabilizer containing nitrapyrin inhibitor is responsible for slowing the activity of *Nitrosomonas* sp. bacteria down which oxidize ammonium to nitrite ions, thus, N-loss resulting from nitrate leaching can be reduced. Although prior studies have shown its effectiveness in the pre-sowing application in maize, considering that it disturbs the activity of *Nitrosomonas* bacteria which is the most intense between 25°C and 30°C, soil temperature may significantly influence the efficiency of nitrapyrin. Besides, nitrapyrin aims to enhance N-use efficiency in high N-demanding plants, such as maize, that demands N at the most during stalk elongation, which lays down the reason for its subsequent application. This study focuses on the efficiency of nitrapyrin at different soil temperatures and its health impacts on maize. In a laboratory test, 10°C, 15°C, 20°C, and 25°C temperature soils were treated with nitrapyrin and change of nitrate content was monitored to observe the nitrification dynamic. Results show that as the soil temperature elevated, the inhibition efficiency increased. In a field experiment with maize, nitrapyrin was applied in 13°C and 25°C temperature soil. Results suggest the later treatment enhanced N-use efficiency, as during the high N-demanding growth stage, more N-forms were available in the soil. This resulted in significantly higher relative chlorophyll concentration in the leaves and laboratory leaf analysis confirmed the prevention of N deficiency. Results of further measurements on parameters indicating biomass production such as root mass, stalk diameter, ear size, 1,000-kernel weight indicate that the nitrapyrin application should be timed later.

Keywords: maize, nitrapyrin, nitrogen, nitrogen stabilizer, *Nitrosomonas*, soil temperature.

ACKNOWLEDGEMENTS: The publication is supported by the EFOP-3.6.3-VEKOP-16-2017-00008 project. The project is co-financed by the European Union and the European Social Fund. Project no. TKP2020-IKA-04 has been implemented with the support provided from the National Research, Development and Innovation Fund of Hungary, financed under the 2020-4.1.1-TKP2020 funding scheme. The research was supported and financed by the Kerpely Kálmán Doctoral School (University of Debrecen). The authors thank the Institute of Plant Protection (University of Debrecen) for use of land and resources for the field experiment.

Winter wheat leaf blotch development depending on fungicide treatment scheme under different nitrogen levels

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Abstract: Tan spot (caused by *Pyrenophora tritici-repentis*) and Septoria leaf blotch (caused by *Zymoseptoria tritici*) are the most widespread winter wheat leaf diseases in Latvia. The aim of the present research was to clarify the development of leaf blotches on winter wheat depending on fungicide treatment schemes under four nitrogen rates. A two-factorial trial was conducted at the Research and Study farm "Pēterlauki" (Latvia) of Latvia University of Life Sciences and Technologies. For this study, data from the 2018/2019 and 2019/2020 growing seasons was used. Four schemes of fungicide application and an untreated variant, as well as four nitrogen rates (N120, N150, N180, and N210 kg ha^{-1}) were used. The total disease impact during the vegetation period was estimated by calculating the area under the disease progress curve (AUDPC). The severity of leaf blotches in winter wheat leaves differed significantly during both vegetation seasons. Tan spot was the dominant disease in 2019. The development of tan spot was reduced by fungicide treatment; however, only in 2019, the influence of fungicide was significant. Nitrogen fertilizer rate had no significant effect on the development of tan spot. Septoria leaf blotch was the dominant disease in 2020, and its development was decreased by fungicides. Nitrogen fertilizer rate had no significant effect on the development of Septoria leaf blotch.

Key words: winter wheat, *Pyrenophora tritici-repentis*, *Zymoseptoria tritici*, values of AUDPC, control.

ACKNOWLEDGEMENTS: The research was supported by the EIP-Agri project "The development of the decision-making support system for restriction of the diseases, affecting leaves and ears of winter wheat".

Product-oriented production of industrial hemp according to climatic conditions

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Abstract: Cultivation area of industrial hemp in Europe has increased since 2012. It is expected that in future its production will increase, because European Union (EU) policy focuses more on the 'green deal' goals. Research into the effects of climate conditions (temperature and rainfall) on growth is important to select the best industrial hemp varieties for hemp products. The objective of the research is to develop a method for identification of industrial hemp varieties depending on climatic conditions in order to obtain products with the highest added value.Four industrial hemp varieties were used for the research: 'Purini' (Latvia), 'Bialobrzeskie' (Poland), 'USO -31' (France-Ukraine), 'Finola' (Finland). Field trials were carried out in Eastern Latvia in 2010, 2011, 2012, 2013, 2019. Climatic indicators were recorded during the vegetation period from April to September. Yields of seeds, fiber, shivs and total biomass were determined during the research. Factor analysis method was used to determine the impact of temperature and rainfall on the yield of seeds, fibers and shivs.

Key words: hemp growth, industrial hemp, climate conditions.

ACKNOWLEDGEMENTS: Rural Support Service project "Innovative solutions for the treatment and processing of industrial hemp". No. 18-00-A01612-000026.

Matrix quality variability of oilseed radish (*Raphanus sativus* L. var. *oleiformis* Pers.) and features of its formation in technologically different construction of its agrophytocenosis

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Abstract: Overview of the formation of matrix variability of oilseed radish seeds at two levels: within a single pod and within the generative part of the plant, given the presence of vertical layering in the placement of fruit elements. The peculiarities of formation of variation component of morphological parameters of seeds from different zones of inflorescence were estimated, basing on their electrical scanning for oilseed radish agrophytoconosises of different technological construction and sowing rate against the background of four options of mineral nutrition (without fertilizer to the level 90 kg ha^{-1} with an equal interval of 30 kg ha^{-1} of the primary material)). The results of the value of matrix variability in morphological and weight characteristics were grounded on the basis of the analysis of the structure of selected seed fractions and their intra-group variation. The main features of formation of morphometric variability of seeds from different zones of inflorescence depending on different technological construction were formulated.

Keywords: heterospermy, matrix variability, morphological parameters of seeds, oilseed radish, seed fractions, separation variability.

A global perspective of herbicide-resistant weeds and management options

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Abstract: In crop lands around the globe, various interventions for weed suppression are used and among them are chemicals which are widely recommended for weed control. This paper will try to bring forth ideas that can be integrated into the development of herbicide resistance. In most instances, researchers devote more time in defining herbicide resistance, this will therefore shift the attention towards comprehensive investigations of the resistance development in weeds. Weed experts in collaboration with plant biologists can work in synergy to develop better approach and sound innovation aimed at addressing herbicides resistance challenges. Chemical herbicides have been known to affect weed fitness, ecosystem and the diversity of their community changes over a period of time in response to both herbicides and other intervention strategies imposed on them. Regular application of the herbicides with same active ingredients and site of action repeatedly and intensively have the potential to swiftly result in population that is more tolerant, and difficult to suppress, this will ultimately result in weed community that is herbicide resistant, particularly in absence of using herbicides with different modes of action. Therefore, there is need for concerted efforts and more work to be done by both weed experts and evolutionary biologists towards an improvement and broader knowledge with regard to resistant development in plants. This collaboration is cardinal in offering innovative and tangible solutions to the herbicide resistance challenges being faced by the world.

Key words: Weed Fitness, Herbicide Resistance, Selection, Mode of Action, Diversity.

A closer look at analyzing drought stress pot experiment spectrometric data using Bayesian statistics

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Abstract: In their oilseed rape hyperspectral imaging study, Żelazny and Lukáš (2020) highlighted the high performance of the RGI vegetation index to discern between the watering treatments of the plants. The index response was apparent not only in terms of its mean values, but also the standard deviations. An assessment of the latter would have been be challenging using the traditional frequentist statistical approach, but it is readily attainable within the Bayesian framework. This contribution dissects the Bayesian linear model that was employed for the RGI index evaluation. A detailed computational replication of the analysis using the "brms" and "tidybayes" R packages is presented with a commentary. Additional merits of the Bayesian statistics are mentioned as an invitation for agronomy researchers to adopt this approach in their work.

Key words: statistical reform, water deprivation, imaging spectroscopy.

ACKNOWLEDGMENTS: The author gratefully acknowledges the financial support of the Ministry of Agriculture of the Czech Republic, grant number MZE-RO0418 (institutional support).

VII RENEWABLE ENERGY

Ecological footprint of beef consumption in the state of Rio de Janeiro - Brazil

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Abstract: The beef production chain can cause considerable impacts on the environment depending on how it is carried out. The need to discuss the impact of the consumption of this food in a country whose production base is mainly agricultural and livestock is relevant in view of the environmental degradation and scarcity of resources. In this work, the ecological footprint of beef consumption was evaluated using the state of Rio de Janeiro as a case study. Data were collected such as population, productive capacity, annual consumption, cattle weight, grazing equivalence factor. Calculations of livestock density, consumption per capita, productivity, number of oxen, area per capita, and total area required were also carried out. The value found for Total Ecological Footprint was 1,117,995.22 gha and for Ecological Footprint per capita was 0.065 gha. It was found that the ecological footprint per capita is higher than the area destined for each inhabitant of the State which is 0.019 ha. It can be inferred that the consumption of beef as it is currently carried out harms the ecosystem in which production is inserted.

Key words: Livestock, Sustainability, Indicator.

The influence of selected installation factors to the energy balance of photovoltaic system

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Abstract: Energy balance of the photovoltaic system is affected by many external and internal factors. In this article the effect of tilt and azimuth angle changes of the photovoltaic system energy production is analysed, because these parameters have significant influence on the amount of solar radiation which hits on the photovoltaic panel surface and this also affects on the amount of the energy absorbed by the surface of the photovoltaic modules. The main aim was identification of the optimal position of photovoltaic system installation in the central European region. The experimental apparatus had two setups, the first for identification of the tilt angle changes in the range (0°-90°). The second setup was focused on the detection of the azimuth angle effect to the energy production. The azimuth angle was different from -90° (East) to 90° (West). The annual measurement results were statistically processed, there was applied group method of data analysis and then the characteristic values for every month were extracted. The numerical results are presented as graphical dependencies which characterize time relations between the tilt angle respectively the azimuth angle and the energy produced by the photovoltaic system. Obtained dependencies are presented as two-dimensional and three-dimensional graphical relations and they are described by regression equations with relatively high coefficients of determinations. On the three-dimensional relation was applied polynomial approximation of the second degree. Final mathematical model equations allow simple prediction of the photovoltaic system energy production in the real operating conditions. Presented model equations can be used for the design, dimensioning and the operation optimization of the photovoltaic system in the central European region.

Key words: azimuth angle, energy production, solar energy, tilt angle, time relation, solar energy.

ACKNOWLEDGEMENTS: This publication was funded by the Cultural and Educational Grant Agency KEGA Project No 026SPU-4/2020 and by the Operational Program Integrated Infrastructure within the project: Demand-driven research for the sustainable and innovative food, Drive4SIFood 313011V336, cofinanced by the European Regional Development Fund.

Community/Shared Solar Power Option: A Pathway to Sustainable Rural Electrification in Nigeria

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Abstract: Nigerian governments at all levels have been making a concerted effort to extend electricity supply to the rural areas. Among the several efforts by various governments are formulation of rural electrification policies, creation of agencies for the administration of rural electrification projects, installation of diesel power generators, and development of public-private partnership strategies in solving rural power supply problems. While significant progress has been made, several rural communities are yet to have access to electricity supply. Rugged terrain and limited financial resources are among the constraints to extension off-grid to the rural areas. However, electricity supply, being one of the drivers of economic development and social well-being, is a problem that has to be tackled head-on. The current climate change concern and many other environmental issues of our time necessitate finding a sustainable solution to the problem. Consequently the goal of this study was to examine the potentials of community solar power option as a sustainable rural electrification approach in Nigeria. It was also aimed at identifying potential hick-ups in its lifecycle management and what could be done to ameliorate the challenges that may arise. Moreover, it was to determine the suitable configuration for efficient and sustainable community solar power management in Nigeria. The study methodology involved intensive literature survey, historical data collection and case studies on rural electrification in Nigeria as well as examples of community solar projects in Nigeria. Preliminary results revealed that community solar power would be a sustainable approach to rural electrification in Nigeria if a number of conditions are satisfied. Some of the conditions to be satisfied include devolving the lifecycle management of a community solar system to a participative/collaborative committee of municipal and other stakeholders representatives, and incorporating community capacity building in the plan. Such capacity building should cover areas of operation, repairs, component fabrication and management. Other conditions are government, corporate and municipalities collaboration in funding such projects from scratch till after one or two years of operation, and incorporation of monitoring and intervention strategies for continuous power supply and further improvement.

Key words: Community solar, Lifecycle management, Renewable energy, Rural electrification, Shared solar, Sustainable energy.

Distribution Grid Stability – Influence of Synchronous Machines

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Abstract: This paper showsthe influence of grid frequency oscillations on synchronous machines coupled to masses withlarge moments of inertia. It solves the maximum permissible value of a moment of inertia on the shaft of a synchronous machine in respect to oscillation of grid frequency. Grid frequency variation causes a load angle swinging on the synchronous machines connected to the grid.This effect is particularly significant in microgrids.

Key words: angle swinging, grid frequency oscillations, electromechanical system, inertial masses microgrids.

Operation of the Photovoltaic System in Prague and Data Evaluation

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Abstract: The on-grid photovoltaic system was installed at the Faculty of Engineering in 2015. The monitoring system developed in our laboratory monitors data and can also detect failure and type of failure. The evaluation of the data shows that the amount of electricity produced slightly exceeds the expected values predicted by the internationally used internet application PVGIS. The effect of the aging of PV panels has so far had a minimal effect on the electricity produced. Immediate output power is affected by multiple parameters. Higher temperatures reduce the efficiency of energy conversion, so in summer the instantaneous power may be lower even at higher radiation intensity and smaller angle of incidence.

Key words: solar energy conversion, photovoltaic generators, Solar panels, data monitoring.

ACKNOWLEDGEMENTS: The work was supported by the internal research project of the Faculty of Engineering IGA 2021.

Building performance analysis of a dairy factory in South Iraq: appraisal of a local bio-based envelope

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Abstract: Buildings have a relevant impact on the environment, and building materials cause environmental impacts during all life cycle stages: production, utilization, management and demolition. The global request for more efficient buildings with less environmental impacts has grown during the last years. Among various technologies, thermal insulation has proven to be helpful in reducing emissions by increasing energy conservation. This paper intends to show how the Building Performance Analysis (BPA) supports the decision-making process in many areas where common insulation materials are not available and there is a general reluctance to use local natural materials. A building located in the city of Al Chubaish in Dhi Qar Province in Iraq is examined as a case study. The construction is designed for processing buffalo milk. It was built in the first decade of the century, during the Iraqi conflict, using only the materials available at that time, most of which, concrete bricks, mortar and plaster. Currently, this dairy factory is a very inefficient structure in terms of energy saving. But because its elementary form, it is a perfect example to investigate how a simple exterior wall insulation can improve building performance in extreme environmental conditions. Accordingly, two different models have been created. One is the replica of the real building without any upgrading. The second instead presents a thermal insulation realized with reed bio-based material locally available. Through advanced simulation engines and building performance analysis data integrated into Autodesk Revit, each model has been tested to identify significant improvements in terms of energy savings in this particular stressed background.

Key words: Building performance analysis (BPA), reeds, bio-based thermal insulation, Iraqi Marshlands.

ACKNOWLEDGEMENTS: This work was supported by the Italian Agency for Development Cooperation (AICS) under the project Enhancement of the production and processing chain of water-buffalo milk in South Iraq, AID 011772/01/4.

VIII NANOCOMPOSITES AND NANOMATERIALS

Comparative analysis of the use of biostimulants on the main types of soil

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Abstract: A plant requires certain physiological conditions for normal and productive development. The determining vital factor is the nutritional status of the soil and the environment. At present, the biologization of agriculture is becoming increasingly important. The use of biostimulants is one of the rapidly developing areas in the world practice of crop production and, in the cultivation of agricultural crops, contributes to the production of environmentally friendly products and the improvement of the environment.Such substances can be metal nanoparticles, as well as preparations with a high level of biogenicity, nutritional value and physiology,they are used to improve the growth and development of plants, as well as to activate soil-microbiological processes, which is a liquid-phase biological product (LPBP). The purpose of this work is to identify the effectiveness of the use of a liquid-phase biological product and cobalt nanoparticles in pre-sowing seed treatment against the background of a minimum dose of organic fertilizers, the effect on the productivity and quality indicators of green mass when growing a grass mixture with over-sowing oats on three main types of soil: sod-podzolic, gray forest and black soil.Used cobalt nanoparticles have the following characteristics 40-60 nm, phase composition - Co - 100%. A suspension of nanoparticles was obtained by dispersing with ultrasound in an aqueous solution. LPBP is a dark brown liquid with a specific odor, pH = 6.5 - 7.5, contains N, C, P, K, Ca, Mg, tryptophan, microorganisms. Cobalt nanopowder in solution contained 0.01 g per hectare seeding rate; LPBP concentration was 1%. The seeds were soaked 30 min before sowing in double distilled water (control), in a suspension of nanoparticles and LPBP.The research was carried out according to generally accepted methods. Presowing seed treatment in combination with organic fertilizers in minimal doses provided an increase in yield on soddy-podzolic soil - by 5.69 - 21.71%, gray forest soil - 2.64 - 7.50%, black soil - 9.18 - 18.28%, while no decrease in nutritional value was observed: metabolizable energy, feed units, digestible protein. It is noted that the use of cobalt nanoparticles leads to an increase in the carotene content.

Keywords: cobalt nanoparticles, liquid-phase biological product, grass mixture, oats, sod-podzolic soil, gray forest soil, chernozem.

Effect of Pre-seed and Foliar Treatment with Nano-Particle Solutions on Seedling Development of Tiger Nut (*Cyperus Esculentus* L.) Plants

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Abstract: Micronutrients are part of enzymes and play an important role in plant germination. Purpose of our study was to establish the effect of pre-seed treatment of chufa tubers with metal nanoparticles on the growth of the root system and seedlings in the early stages of development. Laboratory tests were performed on seed of tiger nut cultivar Pharaoh. Experiment involved two methods of treatment: pre-sowing treatment of seeds with nano-particles solutions of manganese, zinc, copper and iron with a concentration of 60 ppm and re-application of these solutions after seedling emergence. The weight of seedlings and roots was determined at 3rd and 10th days after emergence in treated and untreated variants. Pre-sowing treatment of chufa tubers with all forms of micronutrients significantly increased the weight of the plant (excluding the weight of seeds), and the most effective were treatments with copper and iron. Treatment with copper colloidal solution increases in root weight at 3rd day on 156 % compared to control without treatment and this dynamic stayed at 10th day. Most affective treatment is iron colloidal solution. This treatment gives +99 % of root weight at 3rd day and 194 % at 10th day after germination compared to control in same time. Colloidal forms of manganese, copper and iron also significantly increased the weight of the shoot. Increase in the mass of roots, shoots and plants is observed in plants with foliar fertilizing, but a few variants have an insignificant difference or inhibit the assimilation processes of plants. Pre-sowing treatment with zinc citrate at 60 ppm decreased root and shoot weight in chufa.

Key words: citrate, chufa, colloidal, copper, iron, manganese, solution, zinc.

Thermo mechanical vibration of single wall carbon nanotube partially embedded into soil medium

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Abstract: Single wall carbon nanotube is one of the promising forms of carbon nanocomposite. Due to its high strength and stiffness, carbon nanotube is potentially used in various nanoscale structures. In this paper, dynamic behaviour of single wall carbon nanotube partially embedded into elastic soil medium is modelled by the Euler-Bernoulli beam theory and nonlocal theory of elasticity. Analytical solution technique is employed to solve these governing differential equations of nanotube. Analysing the effects of temperature, nonlocal parameter, coefficients of elastic medium on dynamic behaviour of nanotube are our main concern. The results reveal that the effects of temperature, nonlocal parameter and coefficients of elastic medium are very significant on the natural frequency of nanotube.

Key words: carbon nanotube, partially embedded, elastic soil medium, temperature effect, exact solution technique.

Nanopreparations in technologies of plants growing

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Abstract: The use of engineered nanomaterials in sustainable agriculture has demonstrated a completely new way of food production that can potentially overcome uncertainty in the agricultural sector with limited available resources. Nanoparticle engineering is one of the latest technological innovations which demonstrate unique target characteristics. During 2013 - 2020, research on the directions and effectiveness of nanopreparations in plant growing: nutrient source, activation of photosynthesis, immunocorrectors, stimulators of seed germination, plant growth and development, multivalent drugs for increasing plant resistance to stress was conducted. Monoparticles, nanoparticle combinations, and chelate complex of nano fertilizers on crops of soybean were tested. Field research was conducted in a stationary field experiment of the Plant Science Department of the National University of Life and Environmental Sciences of Ukraine. The soil of the stationary experiment is typical chernozem. In research was used soybean *(Glycine max (L.) Merr*.) of early-ripening variety Horol. Over the years of research, weather conditions varied, but were within the typical for zone of research. Average monthly temperatures were close or higher the perennial average indicators. The purpose of the research is to find out the influence of pre-sowing seed treatment and fertilizing of crops by nano-preparations Avatar (microfertilizer of carboxylates of natural acids), Iodis-concentrate (immunomodulator - stimulator of growth processes), and Super Micro Plus (nanochelate fertilizer) on leaf formation - rate, the activity of symbiotic nitrogen fixation and yield of soybean variety Horol. Nanopreparations were used for pre-sowing seed treatment and fertilizing - spraying during the growing season in several doses. The use of nanopreparations, as seed treatment in combination with inoculation and as fertilizer, intensified formation of the leaf surface area, symbiotic apparatus activity of soybean plants. The introduction of nanofertilizers complex in the top-dressing helped to increase yields and change the functional quality of crop products which indicates their unconditional effectiveness. Soybean yield significantly depended on weather conditions, varying from 1.23 to 3.48 t ha^{-1}depending on the weather conditions and the combination of seed inoculation and nanofertilizer. Soybean yield under favourable weather conditions in 2016, depending on the use of preparation combination ranged from 2.27 to 3.48 t ha^{-1}.As a result of the research, it was found that the use of nanopreparations Avatar, Jodis-concentrate and Super Micro Plus for seed treatment and fertilizing intensified leaf surface formation and symbiotic apparatus activity of soybean plants. The obtained results confirm that application of nanofertilizers complex Jodis-concentrate, Avatar and nano chelate fertilizer Super Micro Plus in the soybean fertilizing helped to increase the yield, which testifies to their unconditional effectiveness. The highest efficiency of nanofertilizers was shown by inoculation and seed treatment by Avatar and fertilizing by Avatar + nano chelate fertilizer Super Micro Plus, providing the formation of 52.4 thousand m^2/ha of leaf surface area of soybean varieties Horol, 69.7 pcs/plant of root nodules, 785 mg/plant of their weight and yield at the level of 2.79 t ha^{-1}an average of five years.

Key words: nano fertilizers, forms of fertilizers, soybean, yields.

The productivity of spring barley when using cobalt nanoparticles and liquid-phase biological product

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Abstract: The purpose of this study is to study the effect of growth activators on the yield and quality of spring barley products. For the most complete disclosure of the potential yield of spring barley against the background of the application of minimal doses of organic fertilizers, cobalt nanoparticles were used, as well as a liquid-phase biological product (LPBP) in various combinations (NPCo, Compost, Compost + NPCo, Compost+ LPBP 1%, Compost+ LPBP 2%, Compost+ LPBP 1%+ NPCo, Compost+ LPBP 2%+ NPCo). The size of cobalt nanoparticles was 40–60 nm, the phase composition - Co - 100%. A suspension of nanoparticles was obtained by dispersing with ultrasound in an aqueous solution in accordance with the requirements of the technical technical conditions. LPBP is a dark brown liquid with a specific odor, pH = 6.5–7.5, contains N, C, P, K, Ca, Mg, tryptophan, microorganisms. Cobalt nanopowder in solution contained 0.01 g per hectare seeding rate (20 mg l^{-1}), LPBP concentration was 1% and 2%. Compost was used as an organic fertilizer; it consisted of 90% of cattle manure and 10% of poultry manure at a dose of 20 t ha^{-1}. The seeds were soaked 30 minutes before sowing in double distilled water, in a suspension of nanoparticles and LPBP in accordance with the experimental options. The analysis of the results of the research showed that the studied preparations have a stimulating effect, contribute to an increase in resistance to suboptimal weather conditions, an increase in productivity and product quality. It was noted that the best indicators were obtained with joint pre-sowing treatment of seed material by cobalt nanoparticles with 1% solution of a liquid-phase biological product. Thus, there was an activation of growth processes, the yield increased by 35%, the content of crude protein - by 20.9%, digestible protein - by 10.9%, and crude fat - by 78.8%.

Key words: cobalt nanoparticles, liquid-phase biological product, barley, yield, nutritional value.

IX FOOD SCIENCE & TECHNOLOGY

CFD modelling of the thermal performance of fruit packaging boxes – Influence of vent-holes design

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Abstract: The shelf life of perishable products depends mainly on the conservation air temperature. Packaging boxes are usually used to accommodate food products during cold storage and/or transport and/or display. The design of the vent-holes of the packaging box must promote the cold airflow and the heat transfer during storage (cooling phase). By other hand, it should constrain the heat transfer when box is taken out from the refrigerated environment, such as during loading/unloading tasks for transportation or display (heating phase). This paper describes the influence of the vent-holes design on the thermal performance of fruit packaging boxes. Three new packaging box configurations with the same size but with different vent-holes design (size, shape and position) and a reference box are modelled using Computational Fluid Dynamics (CFD). The transient CFD model predicts the dynamic airflow pattern and air temperature distribution for cooling and heating phases. The best thermal performance packaging configuration achieved a fruit model temperature 1.5 K to 5 K lower than the other configurations at the end of 8 hours of cooling. These predictions allow developing new packaging box designs that promote the shelf life extension of perishable products.

Keywords: CFD modelling; Thermal performance; Fruit packaging boxes; Vent-holes design.

ACKNOWLEDGEMENTS: This study is within the activities of project “Pack2Life – High performance packaging”, project IDT in consortium n.º 33792, call n.º 03/SI/2017, Ref. POCI-01-0247-FEDER-033792, promoted by COMPETE 2020 and co-funded by FEDER within Portugal 2020. The authors thank the opportunity and financial support to carry on this project to Fundação para a Ciência e Tecnologia (FCT) and R&D Unit "Centre for Mechanical and Aerospace Science and Technologies" (C-MAST), under project UIDB/00151/2020.

Compositional evaluation of hot-pressed rapeseed cake for the purpose of bioplastic production

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Abstract: Rapeseed is widely cultivated for biodiesel or food-grade oil production. As the oil production process generates huge amounts of wastes and by-products (e.g. oil press cake and meal) that have relatively high crude protein content, valorisation as input material for protein-based bioplastics has a lot of potential. There is a limited number of studies undertaken on using rapeseed cake directly (without prior protein extraction) for biomaterial production, but the initial results have been very promising. As rape and turnip rapeseeds are also some of the most harvested crops in Estonia, the rapeseed oil press cake as a by-product is also available from local food-grade rapeseed oil production. In this regard, we investigated locally available rapeseed oil press cake for chemical composition and explored suitability for bioplastic production. The results indicate suitability for direct biomaterial production, meaning properties for biomaterial formation could be further explored.

Key words: biomaterial, bioplastic, by-product, rapeseed cake, valorisation.

ACKNOWLEDGEMENTS: This work was supported by the European Union's Horizon 2020 research and innovation programme under grant agreement No 810630: ERA Chair for Food (By-) Products Valorisation Technologies of the Estonian University of Life Sciences (VALORTECH). In addition, funding received from Mobility Plus ERA-Chair support (Grant no. MOBEC006 ERA Chair for Food (By-) Products Valorisation Technologies of the Estonian University of Life Sciences) is also gratefully acknowledged.

The influence of germinated hull less barley sourdough fermentation conditions on the microbiota development

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Abstract: The importance of whole grain products today is increasingly appreciated by nutritionists. Sourdough plays an important role in quality assurance, especially when developing wholegrain wheat bread products. Barley as a cereal has cultivated for human consumption since ancient times. The value of barley and hull-less barley grains determined by the low lipid and high carbohydrate (starch and resistant starch) content, balanced amino acid profile, vitamin E, minerals, dietary fibre and phenolic compounds. The results of previous studies show (T.Kince, E.Straumite, D.Klava et.al.), that during germination (24h) the amount of fibre in barley grains increases from 1.64 % to 2.18 %, vitamin B2 content by 88.9%, vitamin E content increases 1.7 times, and niacin content increases 2.1 times. It could be a beneficial effect on the growth of microorganisms during the fermentation of sourdough. Rye and wheat are traditional ingredients for sourdough preparation, but hull less barley could be a good alternative in the development of wholegrain bread to improve quality and nutrition value. The goal of the research was to find optimal technological parameters and to study microorganism development dynamic during the fermentation of sourdough with germinated hull less barley. The study was performed using three stages of fermentation, with different temperature and time parameters. At each stage, pH changes, dynamics of lactic acid bacteria (LAB), yeast and Mesophilous Aerobic and Facultative Anaerobic microorganism (MAFAM) development were determined used standard methods. The results of the study show that the optimal fermentation conditions for the first stage are 48 h and t = 26 □ 1 □C, because the maximum reduction of unacceptable microorganisms has been achieved. For the second stage 8 h and 26 □ 1 □C are best parameters for reaching the maximum number of LAB CFU g-1 and for the third stage 20 h and 28 □ 1 □C. During the fermentation of the sourdough, the pH 3.91 is reached, LAB 8.8 lg CFU g-1, and the yeast 8.7 lg CFU g-1, which indicates a quality of sourdough and possibility to use it in bread production.

Key words: spontaneous sourdough, germinated hull less barley, lactic acid bacteria.

ACKNOWLEDGMENTS: Latvia University of Life Sciences and Technologies program "Fundamental researches in the LLU" scientific project G3 "Investigation of the fermentation process of biologically activated barley and hull-less barley for development of sourdough with increased content of exopolysaccharides".

Change of shelf-life liquid pancake dough, depending on different types of packaging

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Abstract: The packaging is a crucial part of any advanced integrated product supply system. Food products must be supported before they can be moved from one place to another. The containment function of packaging contributes to protecting the environment from the myriad of products transferred from one place to another on numerous occasions each day. This paper is reviewed with analysing the properties of plastics and biodegradable as packaging materials for the liquid pancake dough (PD). In this article also reflects on the emerging trends in technology that address innovations on high-density polyethylene (HDPE), Tetra Rex® Bio-based packaging (TR) and *Doypack* (stand-up pouches, DP). Analyse of impacts packaging on the shelf life of foods under storage and distribution conditions. The future of these packaging materials in the food industries and their impacts on the environment and society. Shelf-life of liquid PD has forty days, making it difficult to increase the exportation of this product. The final product to be packaged using an HDPE packaging, TR packaging and DP packaging was used as an alternative - 50 units of samples for each kind of packaging. The changes in quality of samples during storage were characterised by measuring *Colony-forming unit* (CFU/g) with method: LVS ISO 4833-1:2014 and the study gives the results of a change in the pH (*pondus Hydrogenii*) value in the analysis of the HDPE package and fixes the stability of the pH value in TR and DP packaging. Data that was obtained emphasises the importance of packaging type, which could provide a stable quality of ready to use products for the duration of up to fifty days.

Key words: Bio-based packaging, plastic packaging, doypack, shelf-life, carton packaging

ACKNOWLEDGEMENTS: Publication and dissemination of the research results have been made due to the funding of the Rural Support Service of the Republic of Latvia project "Development of smart packaging for liquid egg products", project: Nr. 19-00-A01620-000087.

Effects of α-amylase, endo-xylanase and exoprotease combination on dough properties and bread quality

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Received: date; Accepted: date; Published: date.

Abstract: The enzymes composition is an actual alternative to chemicals to improve functional properties of flours and to generate changes in the structure of the dough and bread quality. The objective of this study was to analyze the individual and synergistic effects of enzymes preparation (α-amylase, endo-xylanase and exoprotease), newly produced in Russia, on dough properties and bread quality made from wheat flour with different amylolytic activity. Reofermentometric results revealed decreases in gas-forming capacity of dough by 10.0-13.9% when single α-amylase preparates were used. The α-amylase addition had significant effect on gas retention coefficient in flour possessed low amylolytic activity. The effect of endo-xylanase and exoprotease on hydration and amount of wheat gluten was established. The fractional composition of gluten proteins in the dough made with combination of endo-xylanase and exoprotease was established using Lowry method immediately after kneading and after fermentation. It was found that mainly water-soluble, alcohol-soluble and alkaline-soluble proteins were undergone by transformation. The bread with enzymes had a higher specific volume, porosity and aldehyde content and lower shape stability indicator than the control bread made without enzymes. Bread with enzymes was characterized by tenderer and not crumbly crumb with developed thin-walled uniform porosity compared to the control. The crusts were more brightly colored. The combined usage of α-amylase and endo-xylanase and exoprotease retarded bread staling during 5-day storage period. New enzyme composition may be a potentially strong candidate for future applications in the bread-making industry.

Keywords: alpha-amylase, bread quality, dough, endo-xylanase, enzymes, exopeptidase.

Obtention of omega-3-fatty acids cryoconcentrated fish oil from by-products of preserves industry

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Abstract: The technology for obtaining and cryoconcentration of high-quality fish oil from collagen-containing wastes of slightly salted herring under gentle conditions using electrochemically obtained catholytes has been developed. Physicochemical analysis of raw materials was carried out and the yields of products from raw materials at all stages of processing were determined. Concentration of omega-3 fatty acids in oil was carried out using the cryo method. The main phase transitions in oil with decreasing temperature have been determined. The mass yields were determined and the biochemical composition of the cryoconcentrated fish oil fractions was investigated. It was defined the temperature of −14° C at which a phase transition is observed, providing an increase in the concentration of omega-3 fatty acids in oil by 3 times. The usage of cryoconcentrated fish oil allows to produce biologically active food supplement or raw materials for a functional food.

Key words: cryoconcentration, omega-3 fatty acids, by-products, fish oil, salted herring preserves, biologically active substances, hydrolyzate, functional food, extraction.

ACKNOWLEDGEMENTS: This work was financially supported by ITMO University Grant 620142 from 01/09/2020.

Experimental study of thermal performance of different fruit packaging box designs

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Abstract: Packaging was recently identified as an essential element to address the key challenge of sustainable food consumption and is gaining interest among researchers. It is a central element to food quality preservation due to its role in heat and mass exchanges with the external atmosphere, contributing to preserving food quality during storage and extending food shelf-life. This work proposes three new packaging configurations with the same size but differing in the geometry and size of the ventilation holes in order to allow varying the conditions in which the heat and mass exchange occurs, either during the cooling periods of the product in the inside of the cooling chamber, either during the period when the packaging is exposed to ambient conditions, outside the cooling chamber. For this purpose, packages with fruit models which replicate the properties of real fruit were subjected to a cooling process inside a cooling chamber for eight hours. Subsequently, during the heating phase, the packages were exposed to ambient conditions for 10 hours. During the experimental tests, the temperature of the product in different positions inside the package was monitored through temperature sensors positioned inside the product simulators. The thermal conditions were also monitored, both inside the chamber and outside. Additionally, and for comparative purposes, the thermal behavior of a commercial packaging was also evaluated for the same operating conditions in the cooling and heating phases. The results show that the new packages do not substantially affect the conditions of preservation of the product in the cooling phase, but, on the other hand, present an extension of the thermal conditions of conservation of the product in the heating phase of up to 50% in relation to the conventional packaging. This result is particularly important since the heating phase, in which the product is outside the storage chamber, is the period with the greatest impact on the product's useful life.

Keywords: Fruit Packaging Box, Thermal performance, Experimental study.

ACKNOWLEDGEMENTS: This study is within the activities of project “Pack2Life – High performance packaging”, project IDT in consortium n.º 33792, call n.º 03/SI/2017, Ref. POCI-01-0247-FEDER-033792, promoted by COMPETE 2020 and co-funded by FEDER within Portugal 2020. The authors thank the opportunity and financial support to carry on this project to Fundação para a Ciência e Tecnologia (FCT) and R&D Unit "Centre for Mechanical and Aerospace Science and Technologies" (C-MAST), under project UIDB/00151/2020.

The effect of bean flour addition on the rheological properties and baking quality of a triticale flour blends

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Abstract: The aim of this research work was to study and compare the main parameters of the rheological state of the dough made from triticale flour (a variety of George selection by the FSBIS Agricultural Research Institute of the South-East), dough made from flour of white and red bean seeds, as well as parameters of dough from flour of composite mixtures based on them. The rheological properties of the dough were determined using a Mixolab device according to the GOST ISO 17718-2015 method. The mixing ability of the blends was additionally tested by the SDS sedimentation method. It was found that the moment of force, which characterizes the gelatinization process, correlates well with the SDS sedimentation index. To a lesser extent, this indicator correlates with the values of the moments of force characterizing the process of "starch retrogradation" and the energy intensity of the dough formation process. The water absorption capacity of flour highly correlates with the moment of force during the liquefaction phase and with the moments of force characterizing the minimum and maximum consistency of the dough during the "starch retrogradation" phase. The correlation between the SDS sedimentation rate and water absorption capacity was found to be rather low. The rheological parameters were also significantly influenced by the type of beans. Taking into account the results of studies of the rheological state of the dough, test baking of bread with various mass fractions of components was carried out. The results obtained confirmed the improving effect of bean flour.

Key words: beans, triticale, composite mixtures, rheological properties, bakery qualities.

Evaluation of selected lactic acid bacteria as starter cultures for gluten-free sourdough bread production

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Abstract: Sourdough is one of the most promising technologies for gluten-free bread. The selection of appropriate starter cultures for the production of gluten-free sourdoughs is of a great importance, since not all microorganisms can adapt equally to the same raw material. The aim was to create a new starter microbial composition for gluten-free sourdough preparation, allowing improving the quality and the microbiological safety of gluten-free bread. Screening was conducted on 8 strains of lactic acid bacteria (LAB) and 5 strains of yeast previously isolated from spontaneously fermenting rice and buckwheat sourdoughs. The strain *S. cerevisiae* Y205 had the highest fermentative activity and alcohols content. The lactic acid bacteria *L. brevis* E139 and *L. plantarum* E138 were also experimentally selected for new gluten-free sourdoughs on the basis of acidity and volatile acids production and antagonistic activity. Two types of microbial composition were created and its influence on sourdough biotechnological indicators was studied. Sourdough with *L. plantarum* E138 had in 1.2 times lower titratable acidity, in 3.4 times lower volatile acids content compared to sourdough with *L. brevis* E139. Alcohol content was the same in both sourdoughs similarly to yeast cells amount. Sourdough dough proofing time increased in 1.2-1.3 times compared to the control. Sourdough did not affect the specific volume, porosity and compressibility of gluten-free bread, but its sensory characteristics were improved. Bread made with sourdoughs had more pronounced taste and flavor, brighter crust color and better texture compared bread without sourdough. The microbiological safety of sourdough gluten-free bread was also increased, especially when *L. brevis E 139* was used.

Keywords: celiac disease, biotechnology, sourdough, lactic acid bacteria, yeasts, gluten-free bread.

Rheological properties of hull-less barley spontaneous sourdough during the fermentation

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Abstract: The fermentation of the sourdough has an important role in providing the bread quality and nutritional value. Hull-less barley sourdough is a suitable medium for the development of microbiota to obtain the optimal rheological properties of sourdough. The scientific literature reports, that the metabolites of lactic acid bacteria and yeast including organic acids, microbial exopolysaccharides, enzymes and CO_2 modify rheological properties of the sourdough. The aim of the study was to investigate rheological properties of the hull-less barley spontaneous sourdough during its fermentation. The study was performed analysing three-stage technological process of the hull-less barley spontaneous sourdough preparation. The viscosity was analysed using a MCR 302 rheometer, consistency of the samples – by a texture analyser TA.HD.plus. Sourdough microstructure was evaluated using 3D Digital microscope RH-2000. The complex viscosity of sourdough was evaluated during the fermentation process considering that pH characterise the rate of acidification, the development of the microbial community and the formation of metabolites. The viscosity and consistency of sourdough decreased with the fermentation time. Sourdough microstructure images showed the formation of air pockets and an increase in the gaseous phase. The acidity decreased from pH 5.8, immediately after flour mixing with water, to 3.8 at the end of the third stage. Both storage and loss moduli decreased during fermentation. This indicates also a decrease in sourdough viscosity.

Key words: hull-less barley, rheological properties, sourdough, fermentation.

ACKNOWLEDGEMENTS: The research was carried out with the support of Latvia University of Life Sciences and Technologies program “Strengthening of scientific capacity at LLU” scientific project Z45 “The biotechnological solutions for barley sourdough”.

Comparative study of extraction of soy molasses isoflavones and in vivo bioconversion of daidzein into S-equol in rats models

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Abstract: We compared different extraction methods for isolation of isoflavones from soybean molasses. Since conventional extraction methods are time-consuming, expensive and unsustainable, we have compared them with the NADES extraction method, which does not have these disadvantages. Fermentation-assisted technique and extraction with Natural Deep Eutectic Solvents (NADES) were compared to the conventional extraction methods. Based on the results obtained, we selected the optimal technique for isoflavones isolation. Isoflavones were identified by gas chromatography equipped with mass spectrometer (GC-MS), whereas their quantities were determined using high performance liquid chromatography (HPLC). In vivo metabolism of daidzein to S-equol was performed in rats with quantification of a yield of S-equol as a result of daidzein in vivo conversion in rats' intestines

Key words: soy molasses, S-equol, NADES, extraction, daidzein, genistein, fermentation, GC-MS, HPLC.

ACKNOWLEDGEMENTS: This work was supported by the Russian Science Foundation RSF (Grant 20-66-47017).

Improving single cell protein yields and amino acid profile via mutagenesis: review of applicable amino acid inhibitors for mutant selection

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Abstract: Single cell protein (SCP) is a good alternative for substituting plant and animal derived dietary proteins, since SCP production is more environmentally friendly, consumes less water, requires smaller land areas and its effect on climate change is much less pronounced than it is in the case of agriculturally derived proteins. Another advantage of SCP is that it is possible to use a wide variety of biodegradable agro-industrial by-products for the cultivation of SCP producing microorganisms. However, to make single cell protein technology more widely available and improve its economic viability in such markets as animal and fish feed industries, it is necessary to improve the protein yields and amino acid profiles in microorganism strains capable of using agro-industrial by-products. One way to improve the strains used in the process is to create and select SCP-rich mutants. In this review authors propose a novel approach to create SCP-rich mutants with improved total protein content and essential amino acid profiles. In this approach amino acid inhibitors are used to create selective pressure on created mutants. It is expected that mutants with the most pronounced growth would either have higher total protein content, increased essential amino acid concentrations or both, when cultivated on selective plates containing one or multiple amino acid inhibitors. This paper reviews the most suitable groups of amino acid inhibitors that could be used for selection of new strains of SCP-producing microorganisms.

Key words: mutagenesis, microbial protein, essential amino acids, amino acid inhibitors, herbicides, low-cost substrate, agricultural residues.

Evaluation of ozone influence on wheat grain quality during active drying

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Abstract: The aim of this study was to evaluate the effect of ozone on the quality of wheat grain during air ventilation drying process. After harvesting, the wheat grain was placed in two storage tanks. In one storage tank for grain drying was used air but in the other – ozone as the drying agent. The following quality parameters - moisture, water activity, gluten, starch and protein content, as well as the total plate count of microorganisms were determined during storage. Wheat grain quality parameters were analysed by taking samples from the top and bottom of the storage tanks. Two-year experiments showed that ozone treatment did not significantly affect ($P > 0.05$) the moisture content, water activity, gluten, starch and protein content of the analysed wheat grain, but all parameters were significantly affected ($P < 0.05$) by the sampling location - top or bottom of the storage tank. All samples taken from the top of the tanks throughout the drying process had higher water activity ($a_w < 0.800$). It should be noted that in both series of experiments it was found that there is a very large difference (up to 10%) in grain moisture between grain sampled at the top and bottom of the tanks. Favourable conditions for the development of microorganisms are increased moisture and free water available in the products and raw materials. According to the results obtained in the experiments, it can be concluded that the total plate count in the analysed wheat grain did not exceed the permissible norms (10^5 CFU g^{-1}).

Key words: grain safety, ozone treatment, wheat quality.

ACKNOWLEDGEMENTS: This research is supported by Support Service project No l8-00-A01620-000003 "Technology development of grain drying with active ventilation using ozone".

X PRODUCTION ENGINEERING

Influence of Different Methods of Treating Natural Açai Fibre for Mortar in Rural Construction

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Abstract: Açai is a typical Amazonian fruit that has enormous potential for use in medicines and foods, whose consumption has been growing year after year. One of the major environmental impacts related to Açai is the generation of agro-industrial wastes, which are disposed of in landfills. One of the major problems related to the reuse of natural fibres in cementitious materials is related to their durability due to the alkalinity of the matrix. Thus, the objective of this work was to evaluate three different methodologies for surface treatment of Açai fibre, by immersion in NaOH, KOH and $Ca(OH)_2$ solution to mortar application in rural construction. After the treatments, the fibres were added in a proportion of 2.5 and 5.0% in relation to the cement mass, in addition to the reference mortar (without fibre) in the making of the prismatic specimens (40 x 40 x 160 mm) and cured for 28 days in room temperature. Right after the curing period, the specimens were evaluated according to the mechanical strength of flexion and compression, workability, water absorption by capillarity and mass density in the hardened state of each methodology. The results showed that the best treatment methodology is with NaOH solution, with the addition of 5% Açai fibre in relation to the cement mass, producing a suitable mortar for use in rural buildings.

Key words: Agro-industrial wastes, açai, reuse, rural constructions, sustainability.

ACKNOWLEDGEMENTS: The authors thank the Brazilian agencies: CNPq, an FAPERJ, proc. No. E-26/210.150/2019 and E-26/010.001953/2019, for supporting this investigation.

XI VEHICLES AND FUELS

Operational parameters of diesel engine running on diesel fuel–rapeseed oil–methanol–iso-butanol fuel blends

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Abstract: The contribution is focused on utilization of blended biofuels of diesel fuel, rapeseed oil and methanol. Rapeseed is one of the most cultivated energy crop in Europe and its purpose in the blends is to increase the bio-content. The purpose of methanol in the blends is to increase bio-content and compensate the higher viscosity of the rapeseed oil. As methanol is almost insoluble in diesel fuel or rapeseed oil the iso-butanol is used as co-solvent. The fuel blends were tested in volumetric concentrations of diesel/rapeseed oil/methanol/iso-butanol 60/30/5/5, 50/30/10/10 and 50/10/20/20. The neat diesel fuel was used as a reference. The measurement was performed using a turbocharged diesel engine Zetor 1204, loaded by means of power-take-off shaft of the tractor Zetor Forterra 8641. In the paper, the effect of the blended fuels on performance parameters, engine efficiency, production of solid particles and regulated and unregulated emissions are monitored and analyzed. It was found that engine power decreased by up to 27%, efficiency was decreased by up to 5.5% at full engine load, emissions of NO_X were increased by up to 21.9% at 50% engine load and production of solid particles was decreased, however, the mean size of the particles was smaller.
Keywords: diesel engine; fuel consumption; harmful emissions; biofuels; rapeseed oil; methanol; iso-butanol; diesel fuel.

ACKNOWLEDGEMENTS: The research and APC was funded by the Ministry of Education, Youth and Sports of Czech Republic - Development of primary alcohols fueled engine prototype - LTAIN19029.

Productive efficiency and density and viscosity studies of biodiesels from vegetable oil mixtures

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Abstract: Currently in Brazil the minimum content of biodiesel in mixtures is 11% and, according to Brazilian laws, the goal is to reach 15% in volume in diesel fuel available for final consumers by 2023. Therefore, studies about different matrices of biodiesel and distinct mixtures are essential. The present work had two goals, the first one was to analyse physico-chemical properties of 16 biofuels produced from soybean and cotton oils, using S10 diesel, in mixtures B8, B10, B20 and B30. The second goal was to verify the vantages and disadvantages of biodiesel production through prior mixing of the oils, before and after the transesterification process. All biofuels produced presented results of specific mass values at 20° C and kinematic viscosity at 40° C within the limits established by ANP Resolution no 30/2016 and International Resolutions. The soybean B20 biofuel showed the best overall results, with the second highest production yield of 65.36%, the fifth lowest kinematic viscosity with 3.48 mm s^{-1}. The mixture of soybean and cotton oils before the transesterification process presented the highest production yield when compared with the production from a single oil or biodiesel mixtures. The results found proved to be satisfactory and corroborate to continue with the increase of biodiesel in the mixture with diesel to B15 until 2023 and support the possibility of planning for a gradual increase of this mixture in the following years.

Keywords: transesterification, biodiesel, physical characterization, yield, mechanical performance.

Storage stability of rapeseed methyl ester stored in a sealed barrel for seven years

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Abstract: Storage stability is one of the main quality parameters related to fatty acid methyl esters (FAME) biofuels. The deterioration of biofuels´ properties during storage is a more serious issue than with conventional fuels. In particular, lengthy storage threatens the oxidative stability of FAME fuels because factors such as the presence of air, elevated temperatures or presence of metals promote the oxidation process. Consequently, the acceptable storage time for FAME fuels is generally regarded to be regrettably short, at no more than six to12 months. However, storage conditions play an important role in determining actual storage stability. This study aimed to investigate and evaluate any deterioration in the quality of rapeseed methyl ester (RME) fuel that has been stored for as long as seven years in adequate storage conditions. The fuel was stored in the dark, contained in a sealed steel barrel in an insulated shipping container outdoors. The temperature of the container varied with seasonal fluctuation, but the fuel never froze during storage. The study analysed six key fuel properties of the RME: ester content; water content; density; kinematic viscosity; oxidation stability index; and acid number. The analyses were conducted immediately after opening the barrel, and again after two months of storage in a laboratory. The results were compared to those measured for the fresh fuel, seven years earlier. The comparison of the results indicate that the fuel quality had suffered no serious deterioration during the seven-year period.

Key words: biodiesel, RME, shelf life, storage stability.

ACKNOWLEDGEMENTS: The fuel was purchased for research use within a national research project, Trends in real-world particle emissions of diesel and gasoline vehicles (TREAM). The authors wish to thank Business Finland (formerly Tekes - the Finnish Funding Agency for Innovation) for the financial support of the program.

Waste fish oil as an alternative renewable fuel for IC engines

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Abstract: Bio-oils are potential fuels for internal combustion engines because of they have advantageous properties such as biodegradability, renewability, high oxygen content and low sulphur. However, the high viscosity, surface tension, and density of crude bio-oils pose challenges for engine use. Those properties affect fuel spray characteristics, mixture formation and combustion. In turn, these impact engine, efficiency, power and emissions. This study investigated the use of crude fish oil (FO) at medium and low engine-loads at two engine speeds in an off-road engine. The injectors had 6-hole high flow rate tips. The results were compared with those of fossil diesel fuel oil (DFO). Fish oil increased hydrocarbon (HC), carbon monoxide (CO) and partly oxides of nitrogen (NOx) emissions. Smoke number, however, decreased. Crude fish oil also showed lowered total particle number (TPN) at low load at low engine-speed compared with DFO.

Keywords: Diesel engine, bio-oil, combustion, gaseous emissions, particle number.

ACKNOWLEDGEMENTS: This project was one part of the national Future Combustion Engine Power Plant research program (grant number: 2804/31/2009). The authors wish to thank Business Finland for the financial support of the program.
The authors offer their appreciation to Ms. Katriina Sirviö, Mr. Olav Nilsson, Mr. Markus Uuppo Mr. Henri Huusko and Mr. Marko Vallinmäki for their kind assistance in the measurements.

Effects of storage on the properties of rapeseed oil and alcohol blends

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Abstract: Kinematic viscosity and density are important fuel properties because they influence fuel atomisation during injection into the engine cylinder. The viscosity and density of neat vegetable oils usually are too high to allow optimal use of these oils in compression ignition engines. Blending vegetable oils with alcohols can improve these properties, but it is not known whether the blend properties remain stable during storage. This study measured kinematic viscosity (at 40 °C), density (at 15 °C) and surface tension of rapeseed oil–alcohol blends that had been stored in closed borosilicate glass bottles at room temperature in the dark for 49 weeks. The values were compared with those of the fresh blends. Further measurements of oxidation stability for the rapeseed oil and the blends were taken after 72 weeks of storage. The blends consisted of rapeseed oil with ethanol at 5 vol–%, and rapeseed oil with 1–butanol at 5 vol–%, 10 vol–%, 20 vol–% and 30 vol–%. All in all, the observed changes during storage were small. Density values deviated by less than 1%, surface tension by no more than 3% and kinematic viscosity differed from the fresh blends' values by 1% to 8%. Surface tension had increased in some blends and decreased in others. Kinematic viscosity rose in all blends, with the smallest increase measured for the rapeseed oil–butanol 30 vol–% blend. This blend also showed the best oxidation stability, which was close to six hours.

Key words: blending, butanol, ethanol, stability, vegetable oil.

ACKNOWLEDGEMENTS: This research received no external funding. The research was supported by the University of Vaasa, School of Technology and Innovations.

Prospect on agro–industrial residues usage for biobutanol production

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Abstract: Climate changes, environmental pollution and resource depletion are one of the numerous major problems humanity faces. United Nations sustainable development goals are aimed at solving these problems. The requirement for affordable, renewable, sustainable, biodegradable and environmentally friendly fossil fuel alternative sources is prompted by the development and advancement of biofuel production technologies. Of the various biofuel alternatives, biobutanol has increased the interests of researchers due to its desirable characteristics such as hydrophobicity, relatively high heating value and energy density, relatively low vapour pressure, etc. Nowadays, sustainable production of the biobutanol depends on the used feedstock source and its pre–treatment method, selected enhancing microorganism strain, acetone–butanol–ethanol fermentation effectiveness and titer of biobutanol. The main research challenges in biobutanol production are an improvement of production efficiency and increasing the financial viability of the technology. This review summarizes the latest results of lignocellulosic components content and fermentable sugars composition in different agro–industrial residues; biobutanol production depending on the *Clostridium* enhancing strategy, process optimization and selection of substrate. Such analysis provides a better perception of the capability of using agro–industrial residues for biobutanol production efficiency.

Key words: ABE fermentation, agricultural residues, biobutanol, *Clostridium*, lignocellulosic.

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