BioPhys Spring 2020

19th International Workshop for Young Scientists

BioPhys Spring 2020

BOOK OF ABSTRACTS

Conference Organisers:

Czech University of Life Sciences Prague, Czech Republic
Institute of Agrophysics, Polish Academy of Sciences, Lublin, Poland
Foundation of the Polish Academy of Sciences
Slovak University of Agriculture in Nitra, Slovak Republic
Szent István University, Gödöllő, Hungary

Prague, 2020

Edited by: Martin Libra

Edition: 100 copies
Printed by: Perfekta info Pawel Markisz, ul. Doświadczalna 48, 20-280 Lublin, Poland

www.perfekta.info.pl

ISBN 978-83-89969-64-4

TABLE OF CONTENTS

Dear friends and colleagues,

It is our privilege and great pleasure to welcome you on behalf of organising institutions – Czech University of Life Sciences Prague (Czech Republic) together with The Bohdan Dobrzański Institute of Agrophysics of the Polish Academy of Sciences (Poland), Slovak University of Agriculture in Nitra (Slovakia) and Szent István University, Gödöllő, (Hungary) – in the 19th International Workshop for Young Scientists "BioPhys Spring 2020" in Prague on 19th – 21st May 2020.

The workshop is oriented on the deeper insight into the physical processes occurring in biological, agricultural and food systems. The workshop combines two basic tasks of international meeting: exchange of professional experience and integration of young people from different countries.

We cordially invited young scientists to participate in the BPS 2020 Workshop and to present results of your research in application of physical methods to agriculture, biology and/or life sciences.

The workshop is organised as an open English spoken event. **A**bstracts of contributions are published in this Book of Abstracts of the BPS 2020 Workshop.

Martin Libra

Chairman of the Organising Committee

SCIENTIFIC BOARD

Prof. Martin Libra, Czech University of Life Sciences, Prague, Czech Rep., chairman
Prof. Jiří Blahovec, Czech University of Life Sciences, Prague, Czech Rep.
Prof. Józef Horabik, Institute of Agrophysics PAS, Lublin, Poland
Prof. István Farkas, Szent István University, Gödöllő, Hungary
Assoc. Prof. Vlasta Vozárová, Slovak University of Agriculture in Nitra, Slovak Rep.
Assoc. Prof. Ľubomír Kubík , Slovak University of Agriculture in Nitra, Slovak Rep.

ORGANISING COMMITTEE AND CONTACT:

Prof. Ing. Martin Libra, CSc. – chairman
libra@tf.czu.cz

RNDr. Jan Sedláček, Ph.D. – vice-chairman
sedlacek@tf.czu.cz

Dr. Ing. Magdalena Lahodová – secretary
lahodova@tf.czu.cz

Ing. Jana Šafránková – secretary
janicka.safrankova@gmail.com

Contact Address:

Czech University of Life Sciences Prague
Faculty of Engineering
Department of Physics
Kamýcká 129
16500 Prague 6
Czech Republic
http://www.tf.czu.cz/

BPS – Origin and Aims

J. Blahovec

Czech University of Life Sciences Prague, Kamýcká 129, 16521 Prague 6, Czech Republic

Corresponding author: Jiří Blahovec, e-mail: blahovec@tf.czu.cz
Keywords: BPS, aims, first years

Abstract

In my speech I would like to return to the beginning of this activity [1] and I would like to repeat the main ideas of my speech from the first BPS in 2002. It had three basic headlines:

History of Physics Related to Agriculture

It was the "industrial revolution" in the 19-th Century that formed nearly all the basic physical disciplines known in the present courses of the General Physics. The increasing role of Physics in Agriculture has its deep roots also in the middle of the 19-th century, in time in which development and production of the agricultural machines was taken from hands of craftsmen by the bearing agricultural industry.

Present State

This process had continuation also in the 20-th Century in USA, Soviet Union and many east European countries. The physics found his permanent position among the agricultural engineers, mainly in the "golden era" of Mohsenin's physical properties of agricultural materials in 1960s-1980s.

Physics in the last years of the 20-th century directly penetrated into biology and change qualitatively the base of this science. Principal role of sophisticated instruments and mathematical theory formed *new form of biology* - *Biological Physics - BioPhys.*

Outlook

New tasks lying before Physics in Agriculture are rather complex and complicated. Activity in this area is instrumentally expensive. The success in solving the tasks will need much more co-operation among the scientists, institutes and laboratories than the co-operation before.

BPS Spring

BPS Spring was firstly opened on 2002 in Prague. Initially it was student workshop organized on basis: no fee, no service with organization fully done by PhD students. It was very good school for them. One part of every workshop was usually some trip into history of the hosting country. For illustration I include my informative presentation [2] from 2006 containing overview of the presentations and information to a planned visit of the Bohemian oldest church in Levy Hradec.

References

[1] Blahovec J., Perspectives of Physics in Agriculture, BioPhys Spring, Prague 2002.
[2] Blahovec J., BioPhys Spring, International Workshop for Young Scientists, Prague 2006.

Monitoring of energy sources regarding to distribution grid stability

M. Daneček, I. Uhlíř

Czech University of Life Sciences Prague, Kamýcká 129, 16500 Prague 6, Czech Republic

Corresponding author: Milan Daneček, e-mail: milan.danecek@gmail.com
Keywords: blackout, distribution grid, power measurement

Abstract

This paper discloses the method for fast active power monitoring of the renewable and traditional power sources connected to a distribution grid. To achieve reliable and stable operation of energy sources we need to perform fast active power measurement [1,2]. In past years we have observed increasing ratio of generated power from renewable energy sources [3,4]. Renewable energy sources have specific behaviour under a specific weather condition. Under the definition "specific behaviour" are meant particularly oscillations of output power supplied to the distribution grid. Those oscillations are caused e.g. from wind gusts – wind turbine, or passing clouds – photovoltaics. Those active power oscillations supplied to the distribution grid can lead to large blackout. To detect problematic operation of energy sources we have to perform fast active power measurement. This paper describes the method of the fast active power measurement and its application for monitoring the dynamic response of the distribution grid.

Acknowledgement

The work was supported by the internal research project of Faculty of Engineering IGA 2020:31120/1312/3106.

References

[1] Milligan, M., 2018. Sources of grid reliability services. Electricity Journal, 31(9), 1–7. doi: https://doi.org/10.1016/j.tej.2018.10.002.

[2] Madruga, E. P., Bernardon, D. P., Vieira, R. P., & Pfitscher, L. L., 2018. Analysis of transient stability in distribution systems with distributed generation. International Journal of Electrical Power & Energy Systems, 99(1), 555–565. doi: https://doi.org/10.1016/j.ijepes.2018.01.039.

[3] Chuang, M. T., Chang, S. Y., Hsiao, T. C., Lu, Y. R., & Yang, T. Y., 2019. Analyzing major renewable energy sources and power stability in Taiwan by 2030. Energy Policy, 125(October 2018), 293–306. doi: https://doi.org/10.1016/j.enpol.2018.10.036.

[4] Fiedler, T., 2019. Simulation of a power system with large renewable penetration. Renewable Energy, 130, 319–328. doi: https://doi.org/10.1016/j.renene.2018.06.061.

Data evaluation of three unique photovoltaic power plants

M. Havrlík[1], J. Šafránková[1], V. Beránek[2], M. Libra[1], V. Poulek[1], J. Sedláček[1], R. Belza[1]

[1] Czech University of Life Sciences Prague, Kamýcká 129, 16521 Prague 6, Czech Republic
[2] Solarmonitoring, Ltd., Prague, Czech Republic

Corresponding author: Havrlík M., e-mail: m.havrlik@seznam.cz
Keywords: Photovoltaics, PV power plant, data monitoring

Abstract

We have recently developed a unique monitoring system for photovoltaic power plants and have gradually improved it in recent years [1]. The system is installed at about 80 power plants in several European countries and at one power plant in Chile. We collect and evaluate all data in our laboratory.

In this paper, we compare data from three photovoltaic power plants installed in the southtern and northtern hemisphere. Fig. 1 shows the amount of electricity produced in said PV systems during one year. The values are given by months and for the whole year. In the southern hemisphere of Cuz Cuz, the seasons of the summer and winter are opposite to that of Europe, so there are the highest values of electricity produced in December and January and the lowest values are in May and June.

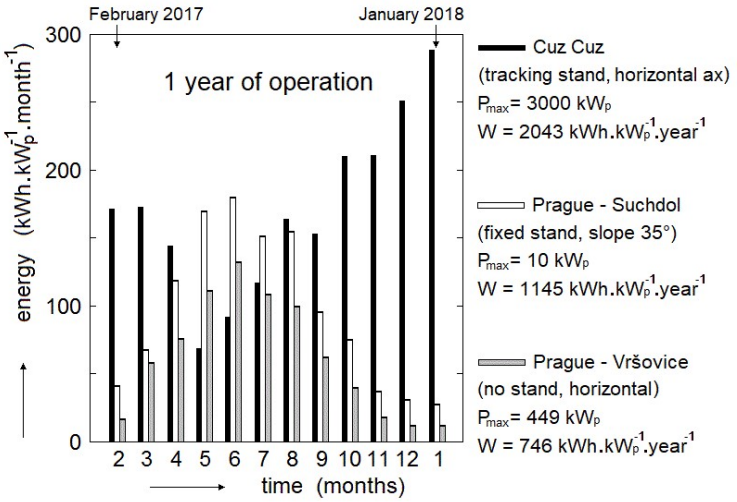

Fig. 1 The amount of electricity produced in the said PV systems during one year

Sun tracking stands slightly increase the amount of electrical energy produced, but at higher latitudes they must have an inclined polar axis. The individual racks must be set apart from each other so that they do not shield each other. In this way, however, the use of the area of the PV power plant is reduced and the price of the area is high in Central Europe. Conversely, in subtropical half-desert regions, the rotational axis can be oriented horizontally, thereby minimizing shielding. In addition, the price of the power plant area is lower.

Acknowledgement

The work was supported by the internal research project of the Faculty of Engineering IGA 2020:31120/1312/3106.

References

[1] Beránek, V., Olšan, T., Libra, M., Poulek, V., Sedláček, J., Dang, M.Q., Tyukhov, I., 2018. New Monitoring System for Photovoltaic Power Plants' Management. Energies, 11, Article ID 2495, 1-13.

Comparison of hop varieties using vegetation indices derived from Sentinel 2 satellite images

Z. Jelínek, K. Starý, J. Kumhálová

Czech University of Life Sciences Prague, Kamýcká 129, 165 00 Prague, Czech Republic

Corresponding author: Zdeněk Jelínek, e-mail: zdenek.jelinek@pekass.eu
Keywords: hop garden, spectral indices, remote sensing

Abstract

The aim of this study is to compare vegetation indices of several hop varieties planted in various agronomical strategies. For this research hop gardens in conventional and biological systems of planting were chosen. Sentinel 2 images were pre-processed and used in spatial resolution of 10 m/pixel for purpose of this study. Vegetation indices were chosen with the aim to compare overall condition, health and development of different hop varieties. For these purposes, the indices comparing the chlorophyll content were chosen as follows: Green Normalized Difference Vegetation Index (GNDVI), Triangular Greenness Index (TGI) and Red Edge Normalized Vegetation Index (RENDVI).

The results showed that the average values of GNDVI and RENDVI had very similar trend within the whole measured vegetation period. The TGI index reflects different run especially in earlier stages of vegetation period. The TGI and chlorophyll content have equal correlation as broad-band indices in later phenology stages, when the leaf area index (LAI) has high values. The use of TGI index is preferable in later phenology stages of the vegetation period.

Acknowledgement

The study was supported by the internal research project of the Faculty of Engineering IGA no. 2020:31160/1312/3110.

Operating cycle of an absorption heat pump (GAHP)

P. Misek[1], R. Adamovsky[2], P. Neuberger[2]

[1] Robur s.r.o. Vintrovna 4g, 664 41 Popuvky, Czech Republic
[2] Czech University of Life Sciences Prague, Kamýcká 129, 16521 Prague 6, Czech Republic

Corresponding author: Misek Pavel, e-mail: pavel.misek@robur.cz
Keywords: heat pump, absorption, working cycle

Abstract

The absorption heat pump made by the company Robur Ltd (IT) was tested in association with the Czech University of Life Sciences Prague in a boiler room of the Czech representative of Robur Ltd.

The method of describing the effectivity of energy transport through the heat pump using the Coefficient of Performance is described by the European standard EN 14511 [1]. However, this standard describes measurements performed under the ideal determined conditions. It does, though, provide input conditions for further calculations. The description more accurate to reality is to be found in the standard EN 14825 [2]. This standard describes the calculation of a heating seasonal performance factor during a partial workload. This procedure is also adopted in the European Commission regulation 811/2013 [3].

As proved during the measurements performed by the Fraunhofer company (DE), the resulting order of magnitude of the heating factor within the heating pump may differ almost twice at its value (SCOP = 2,8 – 5,2) [4]. It is obvious from the principle of heating pumps themselves the determinative impact on resulting values lies in technology, system and source choice. However, it can be supposed the operating loss also contributes significantly to the result. The values are different even within a very similar use. One of the most significant operating losses is the loss caused by source cycling. The impact of cycling on a typical electric heat pump was described by the agency EA Technology [5].

This publication aims to describe the parameters for the absorption heat pump (NH3/H2O) by analysing the heating cycle. The derived results will be subsequently verified by an actual measuring during operation and compared to the producer's documentation and the calculations by following the ČNS – Czech Standards.

References

[1] ČSN EN 14511 – Klimatizátory vzduchu, jednotky pro chlazení kapalin a tepelná čerpadla s elektricky poháněnými kompresory, ÚNMZ 2014.
[2] ČSN EN 14825 – Klimatizátory vzduchu, jednotky pro chlazení kapalin a tepelná čerpadla – Zkoušení a klasifikace za podmínek částečného zatížení. ÚNMZ 2014.
[3] NAŘÍZENÍ KOMISE V PŘENESENÉ PRAVOMOCI (EU) č. 811/2013. In: Úř. věst. L 239, 6.9.2013, s. 1-82. EU: Evropská komise, 2013.
[4] MIARA, Marek. Heating Pump Efficiency: Analysis and Evaluation of Heat Pump Efficiency in Real-life Condition [online]. Fraunhofer Institute for Solar Energy System. Freiburg, 2011 [cit. 2020-02-11]. Dostupné z: https://wp-monitoring.ise.fraunhofer.de/wp-effizienz//download/final_report_wp_effizienz_en.pdf.
[5] GREEN, Robert. The Effects of Cycling on Heat Pump Performance [online]. EA Technology- Department of Energy and Climate Change. Chester, 2012 [cit. 2020-02-11].

Dielectric properties of materials for 3D printing

T. Pícha, S. Papežová

Czech University of Life Sciences Prague, Kamýcká 129, 16500 Prague 6, Czech Republic

Corresponding author: T. Pícha, e-mail: pichat@tf.czu.cz
Keywords: 3D printing, ABS-T, PLA, PET-G, dielectric properties

Abstract

3D printing is a widespread and rapidly developing technology, which is mostly used in areas such as aerospace, automotive, medical instruments and apparatus [1]. This technology is used across these different sectors due to possibility of rapid prototyping [2, 3]. This paper is focused on comparison of dielectric properties of materials commonly used for 3D printing, such as loss factor and permittivity. These tested materials are PLA (poly lactic acid), PET-G (polyethylene terephthalate glycol) and ABS-T (acrylonitrile butadiene styrene - transparent) [2]. PLA samples were made in two different colours sets: silver (S) and metallic green (MG). The aim of these two different coloured samples was to compare the effect of pigmentation on the dielectric properties of the printed object. Tested objects were printed by method called Fused Deposit Modelling (FDM). PLA samples were measured by the HP 4291A analyser, PET-G and ABS-T samples by the Agilent 4991A analyser. Measurements were performed in the range 1-100 MHz. The following parameters were measured: total capacity (Cp) and Q factor. The loss factor (tgδ) is determined from the measured Q factor. The relative permittivity of the measured sample is determined from the measured data of the sample capacity and the capacity of the teflon control sample. The average value of the relative permittivity of ABS-T material was 3.2 in the measured frequency range. The value of relative permittivity in the frequencies range 1-50 MHz was determined for PET-G 3.8, PLA S 3, PLA MG 3.4. In the frequency range 50-100 MHz it reached values for PET-G 3.7, PLA S 2.9, PLA MG 3.3.The difference of the permittivity of both PLA materials is 0.4 over the whole measured range and it is most likely caused by different pigments of both materials. The average value of tgδ of ABS-T and PLA MG was 1%. The loss factor PET-G was around 2 % over the entire measured range. The average tgδ value of PLA-S was determined to 2 % at frequency of 50 MHz and to 3 % at higher frequencies.

Acknowledgement

The work was supported by the internal research project of Faculty of Engineering IGA 2019:31200/1312/3112. The authors thanks to CTU in Prague, Faculty of electrical engineering for measuring of complex permittivity of tested samples.

References

[1] Ning F., Cong W., Wei J., Wang S., Zhang M. Additive Manufacturing of CFRP Composites Using Fused Deposition Modeling: Effects of Carbon Fiber Content and Length. In: [online]. Charlotte, North Carolina, USA: ASME International, 2015 [vid. 2020-03-04]. doi:10.1115/msec2015-9436.

[2] Veselý P., Horynová E., Tichý T., Šefl O. *Study of electrical properties of 3D printed objects* [online]. 2018 [vid. 2020-03-03]. http://poseidon2.feld.cvut.cz/conf/poster/proceedings/Poster_2018/Section_PE/PE_043_Vesely.pdf.

[3] Dichtl C.,Sippel P., Krohns S. Dielectric Properties of 3D Printed Polylactic Acid. *Advances in Materials Science and Engineering* [online]. 2017, **2017**, 1–10 [vid. 2020-03-03]. doi:10.1155/2017/6913835.

PV panel with energy accumulation – a compact unit

J. Šafránková[1], V. Poulek[1], V. Beránek[2], M. Daneček[1], M. Libra[1]

[1] Czech University of Life Sciences Prague, Kamýcká 129, 16521 Prague 6, Czech Republic
[2] Solarmonitoring, Ltd., Prague, Czech Republic

Corresponding author: Jana Šafránková , e-mail: janicka.safrankova@gmail.com
Keywords: Photovoltaics, PV panel, battery

Abstract

Building integrated PV (BIPV) panels with integrated Li-ion batteries can be used as emergency power source. But cooling of Li-ion batteries integrated with PV panels is very important for successful design. We developed a compact unit – PV panel with integrated Li-ion batteries in our laboratory [1]. The compact unit was placed at the flat roof of our department facing south with tilt angle 30°. We measured the temperature of Li-ion batteries integrated with PV panels for period of one year. Even at high ambient temperature +37°C in Prague the temperature increase of Li-ion batteries was at maximum +13°C during 8 A (0.2 C) charging/discharging cycles (see Fig. 1). Safe use of Li-ion batteries is limited to +65°C. The aluminum cooling profile box was integrated into our construction.

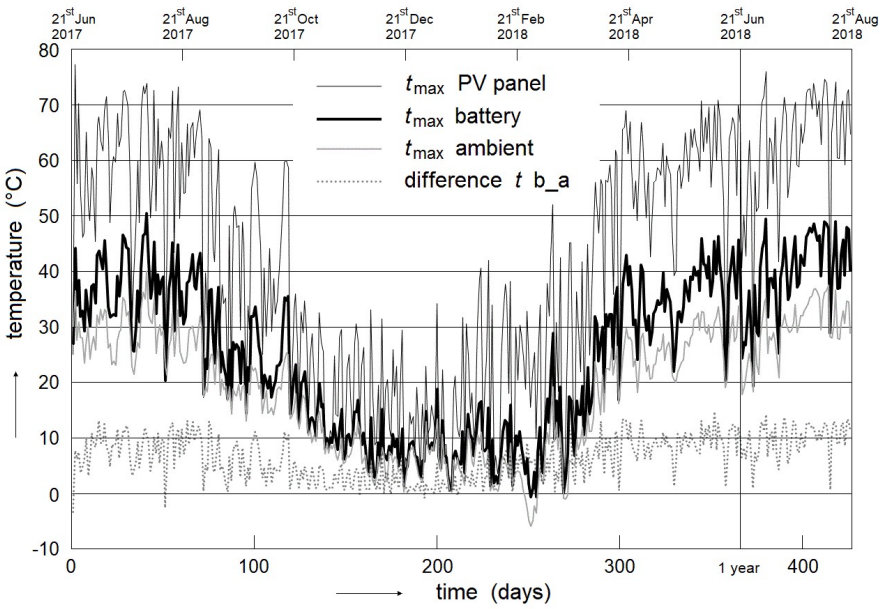

Fig. 1 PV panel, Li-ion battery, air temperature and battery-air

The compact unit should work well in BIPV applications in regions with ambient temperatures +50°C. It is very important for commercial application of Li-ion batteries integrated with PV panels. The thermal design of the batteries integrated with PV panels will be further improved to keep the battery temperature increase below +10°C in the next experiments.

Acknowledgement

The work was supported by the internal research project of the Faculty of Engineering IGA 2019:31120/1312/3111.

References

[1] Poulek, V., Dang, M.Q., Libra, M., Beránek, V., Šafránková, J., 2020. PV Panel with Integrated Lithium Accumulators for BAPV Applications - One Year Thermal Evaluation. IEEE Journal of Photovoltaics, 10, 1, pp.150-152.

Flocculation in algal biomass harvesting

W. Babiak, I. Krzemińska

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

Corresponding author: Wioleta Babiak, e-mail: w.babiak@ipan.lublin.pl
Keywords: algae, biomass harvesting, flocculation

Abstract

One of the stages of algal biomass production is the harvesting process, which is aimed at separation of cells from the liquid cell growth medium. Algal cells are difficult to harvest due to their small size (2-50 μm), negative surface charge, and low biomass concentration (0.5-5 g L^{-1}). The harvesting methods include e.g. centrifugation, sedimentation, chemical coagulation, flotation, filtration, and immobilization techniques. The methods ensure efficient biomass harvesting, but concurrently require large amounts of chemicals or energy [1,2]. An alternative method is flocculation. Flocculation is a process of linking small particles in a colloid solution to form larger aggregates with high molecular weight, thereby facilitating settling of particles. Inorganic salts (ferric chloride) and synthetic polymers (PAM polyacrylamide) are the most popular chemical flocculants, as they are cheap and effective. However, synthetic preparations used in the flocculation process may cause contamination, which is unacceptable if algal biomass is intended for use in food or pharmaceutical applications. Bioflocculants synthesized by microorganisms may therefore be an alternative solution. Extracellular polymeric substances (EPS) synthesized by microalgal cells are promising flocculants, due to their high molecular weight and long chain. Microalgal cells are able to synthesize these compounds in specific conditions. Additionally, EPS are biodegradable and non-toxic.

References

[1] Bleeke F., Milas M., Winckelmann D., Klöck G., 2015. Optimization of freshwater microalgal biomass harvest using polymeric flocculants, Int Aquat Res, 7:235–244.

[2] Lv J., Guo J., Feng J., Liu Q., Xie S. A. 2016 comparative study on flocculating ability and growth potential of two microalgae in simulated secondary effluent. Bioresource Technology, 205, 111–117.

[3] Alam M.A., Vandamme D., Chun W., Zhao X., Foubert I., Wang Z., Muylaert K., Yuan Z, 2016. Bioflocculation as an innovative harvesting strategy for microalgae, Rev Environ Sci Biotechnol, 15:573–583 DOI 10.1007/s11157-016-9408-8.

Impact of drought priming on two grass species

A. Furtak, K. Siecińska, K. Kondracka, A. Nosalewicz

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

Corresponding author: Adam Furtak, e-mail: afurtak@ipan.lublin.pl
Keywords: drought memory, photosynthesis, chlorophyll fluorescence

Abstract

Drought are expected to be more potent and frequent [1] and this may affect grasslands, which are important for agricultural systems and food production. Plant adaptation to reoccurring drought is called drought memory and this effect affects various plant processes that may lead to improved response to recurrent drought [2].

The effect of reoccurring soil drought on roots, stomatal effects and on photosynthesis was tested on two grass species: drought tolerant *Festuca Arundinacea* (Fa) and drought sensitive *Lolium perenne* (Lp). Plants were divided into 3 groups: control (C) with optimal water availability, plants affected by one drought (D2) and plants affected by two droughts with 3 days of re-watering between them (D1D2). Relation between changes of soil moisture and root length (RL) with soil depths was analysed. Transpiration (E), stomatal conductance (g_{H2O}), photosynthesis rate (A) and leaf temperature (T_{leaf}) were measured as well with chlorophyll fluorescence parameters: photochemical quantum yield of PSII (Y(II)), quantum yield of non-photochemical quenching (Y(NPQ)) and relative electron transfer rate (ETR).

Differences in soil moisture distribution with depth were observed for both Fa and Lp D1D2 treatments in comparison to D2 treatments. Drought primed (D1D2) plants were able to maintain higher soil moisture and the differences were more apparent for Lp than Fa. The drought in D2 resulted in stronger inhibition of RL in Fa than in Lp, but reverse was noted in D1D2 treatment. Drought priming allowed for maintaining higher E in D1D2 as compared to D2 treatment for both Fa and Lp plants, but effect was stronger for Fa than Lp. The changes in the response to single and two drought events were also noted for A, g_{H2O} and $T_{leaf.}$ As for the chlorophyll fluorescence parameters the response to first and second drought were similar in case of Fa but significantly different for Lp when comparing D2 and D1D2 treatments.

The results shows that drought priming has stronger effect on drought sensitive Lp than on drought resistant Fa. Stronger improvement in the response to drought was noted for Lp, both stomatal and non-stomatal response was altered as compared to Fa, which response was mostly limited to stomatal effects.

Acknowledgement

The authors wish to thank Rien Louwes from Barenbrug Holland BV for providing plant material.

References

[1] Spinoni J., Vogt J., Naumann G., Barbossa P., Doiso A., Will drought events become more frequent and severe in Europe? International Journal of Climatology, 2018, 38, 4, pp.1718-1736.

[2] Zandalinas S., Rivero R., Martínez V., Tolerance of citrus plants to the combination of high temperatures and drought is associated to the increase in transpiration modulated by a reduction in abscisic acid levels. BMC Plant Biology, 2016, 16, 105.

Strength of soil silt aggregates. Measurements and Discrete Element Method modeling

J. Horabik, G. Józefaciuk

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

Corresponding author: Józef Horabik, e-mail: j.horabik@ipan.lublin.pl
Keywords: soil silt aggregates, strength, discrete element method

Abstract

Soil aggregates strength, structure and stability have a significant impact on agricultural and geotechnical outcomes. Purpose of this study was to model mechanical strength of the simples case: aggregates artificially formed from silt fraction of soil and ground kaolinite. Cylindrical aggregates of 10 mm in diameter and 20 mm height were formed from homogenized water-saturated pastes made from mixtures of silt and kaolinite in different proportion of components and dried at laboratory conditions. Strength of agglomerates was determined in an uniaxial compression test and modeled via DEM simulation.

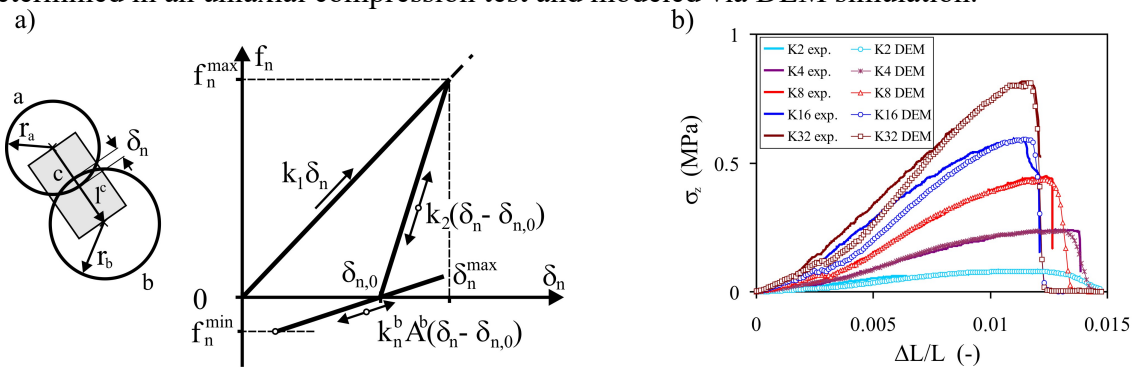

Fig. 1. a) Contact model, b) Experimental and DEM simulated stress-strain response on uniaxial compression.

Soil aggregates revealed a semi-brittle breakage mode. Mechanical strength of aggregates increased almost linearly with the kaolinite concentration up to 32%, i.e. up to filling all macro-pores between sand particles. Young's modulus of agglomerates increased slower than linearly with kaolinite dose increase up to approximately 170 MPa for sample composed of 100% of kaolinite.

DEM simulations were performed with use of the linear hysteretic contact model and the parallel bonds (Fig. 1a) [1,2]. Simulations reproduced well the stress-strain relationship during the uniaxial compression test (Fig. 1b) and allowed for deeper insight into mechanism of soil aggregates breakage and searching for relationships between micro- and macro-variables. Young's modulus and compressive strength of agglomerates determined in this study were comparable with values applied by researchers to model interactions between soil agglomerates [3].

References:

[1] Cundall P.A., Strack O.D. 1979. A discrete element model for granular assemblies. Géotechnique 29, 47–65.

[2] Potyondy D.O., Cundall P.A. 2004. A bonded-particle model for rock. Int. J. Rock Mech. Min. Sci. 41, 1329–1364.

[3] Kotrocz K., Mouazen A.M., Kerényi G. 2016. Numerical simulation of soil–cone penetrometer interaction using discrete element method. Comput. Electron. Agr. 125, 63–73.

The Effect of Selected Phenolic Acids on the Structure of Gluten Proteins in Gluten Dough Using FT-Raman

M. Krekora, W. Rumińska, Z. Niewiadomski, A. Miś, A. Nawrocka

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

Corresponding author: Magdalena Krekora, e-mail: m.krekora@ipan.lublin.pl
Keywords: phenolic acids, gluten proteins, FT-Raman spectroscopy

Abstract

Polyphenols are classified as health-promoting substances. This is due to their ability to neutralize free radicals that contribute to the emergence of civilization diseases. Among polyphenols, two large groups can be distinguished, such as phenolic acids and flavonoids. They can be added to the bread as components of dietary fiber preparations or bran, and as a polyphenol extracts [1]. However, addition of such ingredients to bread may degrade its quality. The quality of bread is closely related to the structure of gluten proteins present in wheat dough. As a result of kneading the dough, these proteins combine with each other through hydrogen bonds and disulfide bridges to form a gluten network. The proper structure of this network is necessary to obtain bread of adequate quality and structure [2].

The aim of the conducted research was to study the influence of selected phenolic acids (cinnamic, ferulic, coumaric, caffeic, chlorogenic, gallic, ellagic, and tannic acid) on the structure of gluten proteins in gluten dough (prepared without starch). These compounds were added at three concentrations 0.05%, 0.1% and 0.2%. The dough was mixed for 3 min in vibrating kneader SŻ-1. Then, the gluten was washed out from gluten dough. Next, gluten was frozen, lyophilized and pulverized. The samples in the form of powder were tested using FT-Raman spectroscopy.

Analysis of the results obtained using FT-Raman spectroscopy showed that the addition of caffeic and ferulic acids to the gluten dough causes the largest changes in the secondary structure of proteins. It is probably due to the fact, that these acids have the highest antioxidant activity among the tested acids. Analysis of the results also shows, that the phenolic acids do not cause changes in the tyrosine doublet value. This may indicate that no hydrogen bonds are formed between tyrosine and phenolic acids. However, the tryptophan band intensity increases, which indicates that the residues are hiding inside the protein. These results may also indicate that gluten proteins may form hydrophobic pockets in which phenolic acids are enclosed and then do not form any bonds with the polypeptide chains [3].

References

[1] Dziki D., Różyło R., Gawlik-Dziki U., Świeca M., 2014. Current trends in the enhancement of antioxidant activity of wheat bread by the addition of plant materials rich in phenolic compounds. Trends in Food Science & Technology, 1-14.

[2] Nawrocka, A., Szymańska-Chargot, M., Miś, A., Ptaszyńska, A. A., Kowalski, R., Waśko, P., Gruszecki, W. I., 2015. Influence of dietary fibre on gluten proteins structure - a study on model flour with application of FT-Raman spectroscopy. Journal of Raman Spectroscopy, 46(3), 309–316.

[3] Ozdal, T., Capanoglu, E., Altay, F., 2013. A review on protein–phenolic interactions and associated changes. Food Research International, 51(2), 954–970.

The effect of selected biochar doses on gas exchange in mineral soil

A. Kubaczyński, A. Walkiewicz, M. Brzezińska

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

Corresponding author: Adam Kubaczyński, e-mail: a.kubaczynski@ipan.lublin.pl
Keywords: soil, biochar, gas exchange

Abstract

Climate changes are more and more visible, and one of the most important causes is increase of greenhouse gas (GHG) emissions, such as CO_2 and CH_4. Soil is considered as a one of the largest sources of GHGs on Earth but it can also be a sink. From this reason a lot of studies are focused on reducing CO_2 and CH_4 emission from soil [1]. One of the method could be use of biochar as a soil additive. Biochar is produced from biomass submitted for pyrolysis under anaerobic conditions. Large group of study confirmed the effectiveness of biochar as an additive improving soil properties [2]. Good results in reducing GHG level are also know, but this process still need future research [3].

Following the global research trend, an laboratory experiment was performed to assess gases exchange (CO_2 emission and CH_4 uptake) in *Haplic Luvisol* with the addition of wood offcuts biochar. Soil samples were incubated for 28 days, without (as a control) and with three doses of biochar, corresponding 10, 20 and 30 Mg ha^{-1} at 60% WHC (Water Holding Capacity) and 1% v/v CH4 in the headspace.

Our study has shown that biochar addition had a positive influence on CH_4 uptake in the tested soil. Methane oxidation in soil with higher dose of biochar (20 and 30 Mg ha^{-1}) was significantly faster than in soil without biochar (control). On the other hand, increasing CO_2 emission was observed directly after biochar application. However five years after biochar addition, emission of CO_2 wasn't significantly higher than in control soil. Improving of CH_4 uptake in soil showed effectiveness of biochar as a tool to reduce GHG emission.

Acknowledgement

Research was conducted under the project “Water in soil - satellite monitoring and improving the retention using biochar” no. BIOSTRATEG3/345940/7/NCBR/2017 which was financed by Polish National Centre for Research and Development in the framework of “Environment, agriculture and forestry” - BIOSTRATEG strategic R&D programme.

References

[1] Kammann, C., Ippolito, J., Hagemann, N., Borchard, N., Cayuela, M.L., Estavillo, J.M., Fuertes-Mendizabal, T., Jeffery, S., Kern, J., Novak, J., Rasse, D., Saarnio, S., Schmidt, H.P., Spokas, K., Wrage-Mönnig, N., Biochar as a tool to reduce the agricultural greenhouse-gas burden–knowns, unknowns and future research needs. J. Environ. Eng. Landsc. Manag., 2017, 25, pp. 114–139.

[2] Wu, Z., Song, Y., Shen, H., Jiang, X., Li, B., Xiong, Z., Biochar can mitigate methane emissions by improving methanotrophs for prolonged period in fertilized paddy soils. Environ. Pollut., 2019, 253, pp. 1038–1046.

[3] He, Y., Zhou, X., Jiang, L., Li, M., Du, Z., Zhou, G., Shao, J., Wang, X., Xu, Z., Hosseini Bai, S., Wallace, H., Xu, C., Effects of biochar application on soil greenhouse gas fluxes: a meta-analysis. GCB Bioenergy 2017, 9, pp. 743–755.

Genetic diversity of microbial communities in soils amended with biofertilizers

M. Mącik, A. Gryta, M. Frąc

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

Corresponding author: Mateusz Mącik, e-mail: m.macik@ipan.lublin.pl
Keywords: biofertilizers, soil microorganisms, agriculture, t-RFLP, NGS

Abstract

Microorganisms are considered as a key element of soil ecosystems, performing significant functions in biogeochemical cycles of nutrients and in maintaining ecological balance. High genetic diversity of microorganisms is one of particular important factors in agricultural lands since it is used as good soil condition indicator [1]. Various agrotechnical practices i.a. fertilization, contribute to changes in the composition of soil microbial communities. Nowadays, great emphasis is placed on organic farming, which aims to reduce the negative effects associated with traditional agricultural methods and increase the biodiversity of belowground microorganisms [2].

The goal of the studies was to evaluate the influence of microbiologically enriched phosphorus mineral fertilizer on the genetic diversity of microorganisms inhabiting degraded soils with the application of terminal restriction fragments length polymorphism (t-RFLP) and next generation sequencing (NGS).

The studies were conducted in the field experiment conditions and included the following fertilization treatments: i) optimal dose without microbial enrichment, ii) optimal dose containing microorganisms and iii) microbiologically enriched dose reduced by 40%. Soil samples were taken on three dates: before sowing, one week after fertilizers application and after maize harvest.

The obtained results indicate shifts in the genetic diversity of microorganisms in treatments with the addition of microbiologically enriched phosphorus mineral fertilizer in 100% and 60% doses as compared to the control soil. In the DNA patterns it was noticed that some terminal restriction fragments were specific only for treatments with applied biofertilizers. The analysis performed with the use of next generation sequencing indicated a clear clustering of bacteria and fungi communities in treatments where microbiologically enriched fertilizer was applied.

Acknowledgement

The work was co-financed by The National Centre for Research and Development in frame of the project BIOSTRATEG, contract number BIOSTRATEG3/347464/5/NCBR/2017.

References

[1] Wang P., Dick W. A., Microbial and Genetic Diversity in Soil Environments, Journal of Crop Improvement, 2004, 12, 1-2, pp. 249-287.

[2] Lori M., Symnaczik S., Mäder P., De Deyn G, Gattinger A., Organic farming enhances soil microbial abundance and activity – A meta-analysis and meta-regression, PLoS ONE, 2017, 12, 7, e0180442.

Detection of crucial fungal pathogens of soft fruits in environmental samples derived from organic strawberry plantations

D. Malarczyk, J. Panek, M. Frąc

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

Corresponding author: Dominika Malarczyk, e-mail: d.malarczyk@ipan.lublin.pl
Keywords: multiplex real-time PCR, fungal pathogens, environmental samples

Abstract

Cultivations of soft fruits in the world are being repeatably attacked by fungal pathogens, such as fungi belonging to *Botrytis*, *Colletotrichum* and *Verticillium* genera [1, 2]. This fact causes reduction of yield and losses during storage. Early, specific and sensitive detection of the threat allows to introduce appropriate protection measures for the inhibition of the given pathogen.

The aim of this study was to verify and validate multiplex real-time PCR detection method using environmental samples.

The assay was tested on the DNA extracted from various environmental samples, collected from organic strawberry fields located in Eastern Poland. Samples consisted of: bulk soil, rhizosphere, strawberry fruits, shoots and roots (n=320).

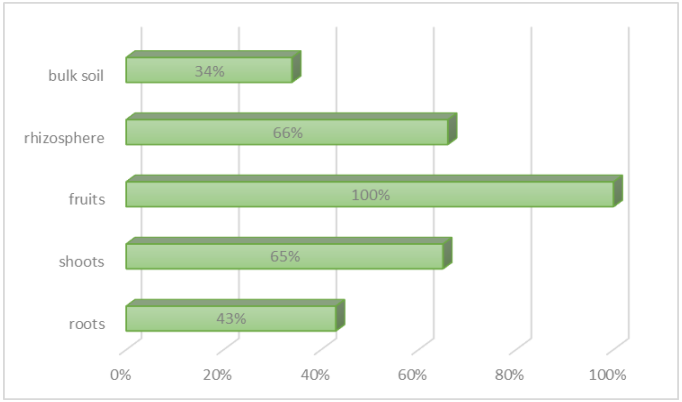

Fig. 1 Percentage of environmental samples infested with fungal pathogens.

The genetic material was isolated with MP Biomedicals FastDNA Spin Kit for Feces and the multiplex real-time PCR was performed. All of the reactions were carried out in the 7500 Fast thermocycler (Applied Biosystems), with application of the MP qPCR Master Mix (2x) (EURx).

The results revealed that tested environmental samples were infested with phytopathogens. Pathogens were detected in 34% of bulk soil, 66% of rhizosphere, 100% of strawberry fruits, 65% of shoots and 43% of root samples (Fig. 1).

Developed multiplex real-time PCR assay was confirmed to be an efficient method for the detection of crucial berry pathogens.

Acknowledgement

This paper was financed by The National Centre for Research and Development in frame of the project BIOSTRATEG, contract number BIOSTRATEG3/344433/16/NCBR /2018.

References

[1] Dean R., Van Kan J. A. L., Pretorius Z. A., Hammond-Kosack K. E., Di Pietro A., Spanu P. D., Rudd J. J., Dickman M., Kahmann, R., Ellis, J., Foster, G. D., The Top 10 fungal pathogens in molecular plant pathology. Molecular Plant Pathology, 2012, 13, 4, pp. 414-430.
[2] Osbourn A. E., Verticillium wilt of strawberry. PNAS, 2001, 98, 24, pp. 14187-14188.

Drop impact onto saturated glass beads bed - analysis of ejection of bed elements and deformation of surfaces

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

[1] Institute of Agrophysics, Polish Academy of Sciences, Doświadczalna 4, 20-290 Lublin, Poland
[2] Maria Curie-Sklodowska University, pl. Marii Curie-Skłodowskiej 1, 20-031 Lublin, Poland

Corresponding author: R. Mazur, e-mail: r.mazur@ipan.lublin.pl
Keywords: soil erosion, splash, crater

Abstract

The splash is the first stage of the water erosion. The phenomenon is caused by the impact of a drop on the soil surface, whose particles are ejected and the surface is deformed. Due to the scale and dynamics of the splash, current studies aimed at extension of the knowledge of this phenomenon are based on the use of modern measuring equipment, such as high-speed cameras or surface scanners. In addition, in some works, the complicated soil structure is replaced by simpler models, e.g. glass bead beds.

The work presents the results of experiments on the single drop impact on saturated beds of glass beads [1]. The research was conducted to determine the influence of sample saturation on the course of the phenomenon. The analyses included displacement of ejected particles and deformation of sample surfaces.

The water drops with diameters of 4.2 mm used in the research fell freely from a height of 1.5 m. Bead beds were placed in 40 mm diameter and 10 mm high aluminium rings. The bottom of the rings was secured with chiffon. Full saturation of the beds was provided by placing them in Petri dishes, which were filled with water to a level consistent with the surface of the samples. Coloured beads were placed on the surface of the deposits to serve as markers. Displacement of elements was analysed by comparing the initial and final location of the markers. The source of data included photos taken before and after the drop impact. The deformation analysis was based on measurements made with a microtomograph.

Based on the results, the movement of the displaced elements was divided into two groups: displacement inside the deformation and ejection. It was observed that only beads initially located 2 to 5 mm from the point of the drop impact were ejected. The highest average displacement of 92.80 mm (SD=36.80 mm) was noted for beads located 3 mm from the impact point. The impact of the drops on the surface of the bed resulted in formation of a crater consisting of a hole and a surrounding rim. The dimensions of the analysed craters were as follows: diameter 14.16 mm (SD=0.52 mm), depth 1.22 mm (SD=0.05 mm), and height 0.76 mm (SD=0.09 mm).

Acknowledgement

The study was partially funded from the National Science Centre, Poland in the frame of project no. 2014/14/E/ST10/00851.

References

[1] Mazur R., Ryżak M., Sochan A., Marciszuk K,, Beczek M., Lamorski K., Bieganowski A., 2020. Surface deformation and displacement of bed elements during splash – Model tests. Catena, 185, 104277.

Ability of insect *Hermetia illucens* to bioaccumulate micro- and macroelements

K. Proc, P. Bulak, D. Wiącek, A. Bieganowski

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

Corresponding author: Kinga Proc, e-mail: k.proc@ipan.lublin.pl
Keywords: black soldier fly, bioaccumulation, microelements, macroelements

Abstract

Hermetia illucens, also called black soldier fly (BSF), is a saprophagous insect from the order Diptera that comes from the southeast region of the United States, but now is spread on all northern hemisphere. Black soldier fly larvae (BSFL) have received extensive attention due to their high levels of lipids and proteins (35% and 55% dry weight, respectively). BSFL have a wide range of applications. They are capable of transforming low-value organic wastes such as: coffee, vegetable, urban organic waste, and animal manure into full value animal protein and oil, which can be used for feeding e.g., chickens, without negative changes in their growth parameters. Production waste from *H. illucens* insect breeding can also be used for biogas generation because it has a high biomethane potential.

Due to the constantly growing interest in *H. illucens* for feed production and other technological purposes it is important to investigate the phenomenon of bioaccumulation in the insect. Therefore, the aim of the study was to determine its ability to bioaccumulate different elements, such as macro- and micronutrients (Ca, Cu, Fe, Mg, Mn, Mo, P, S, Se and Zn), from optimal larvae feed, consisting of a commercial fish feed. The major method used in the study was inductively coupled plasma optical emission spectrometry (ICP-OES), with which the concentrations of individual elements were examined. Our results showed that bioaccumulation of Cu, Fe, Mg, Mo, Se and Zn occurred in all stages of insect development and in puparia, whereas Ca, Mn, P and S were bioaccumulated only in some developmental stages of *H. illucens* [1].

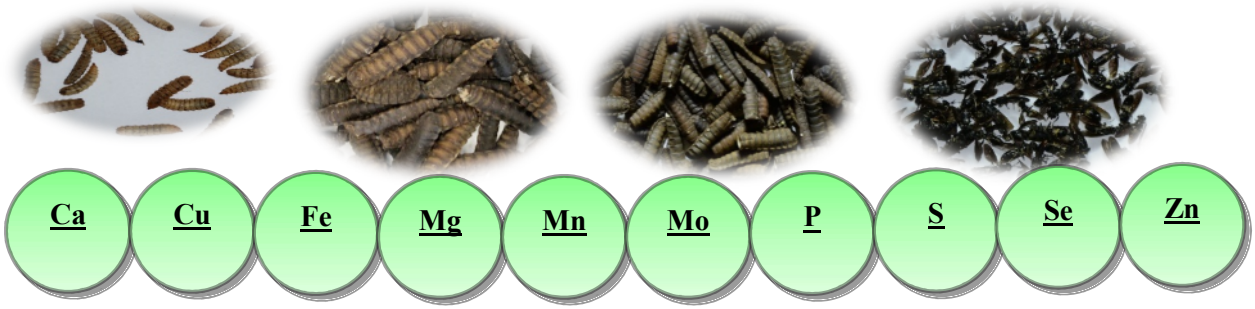

Fig.1 Micro- and macroelements that bioaccumulate an insect *Hermetia illucens*.

References

[1] Proc K., Bulak P., Wiącek D., Bieganowski A., *Hermetia illucens* exhibits bioaccumulative potential for 15 different elements – implications for feed and food production. Science of the Total Environment, 2020.

Development of optimal growing medium for plant beneficial bacteria

M. Pylak, K. Oszust, M. Frąc

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

Corresponding author: Michal Pylak, e-mail: m.pylak@ipan.lublin.pl
Keywords: PGPR, rhizosphere, bacteria, growing medium

Abstract

Plant growth-promoting bacteria (PGPB) are microorganisms capable of enhancing plants growth, reducing severity of pathogen diseases or decreasing effect of environmental stresses. PGPB are associated with nearly all plant species and are present in majority environments. Most of the research is focused on plant growth-promoting rhizobacteria (PGPR) colonizing rhizosphere soil [1].

Growth optimization of these bacteria in laboratory conditions is one of the most important factors when designing new biopreparations. Organisms isolated from their natural environment, from various ecological niches, have different requirements for nutrients, temperature or pH [2]. When composing medium for bacterial growth, especially if it is going to be used in industry it is crucial for this medium to be suitable for growing many different strains of bacteria in similar conditions [3].

In our research medium for the growth of 4 different strains of bacteria *Rhodococcus* sp. B12/18, *Pseudomonas* sp. B37/18, *Arthrobacter* sp. B58/18, unidentified B75/18 were optimized. All of them are environmental isolates originated from rhizosphere of wild raspberries. Those isolates have proven to be effective against fungal plant pathogens that are a serious threat in raspberries during organic farming. We have optimized medium in terms of the best carbon source, nitrogen source, pH and temperature. This medium ensures a fast growth of chosen bacterial isolates and will be used in future research upon biopreparation formulation.

Acknowledgement

The work was financed by The National Centre for Research and Development in frame of the project BIOSTRATEG, contract number BIOSTRATEG3/344433/16/NCBR/2018.

References

[1] Compant S, Duffy B., Nowak J., Clement C., Ait Barka E., Use of Plant Growth-Promoting Bacteria for Biocontrol of Plant Diseases : Principles , Mechanisms of Action , and Future Prospects, Applied and Environmental Microbiology, 2005, 71(9): 4951–59.

[2] Du Jardin P., Plant biostimulants: Definition, concept, main categories and regulation, Scientia Horticulturae, 2015, 196: 3–14.

[3] Laggett M., Leland J., Kellar K., Epp B., Formulation of microbial biocontrol agents – an industrial perspective, Canadian Journal of Plant Pathology, 2011, 33(2): 101–107.

The effect of selected dietary fibre supplements in the form of pomace after oil production on the thermal properties of gluten proteins

W. Rumińska, M. Krekora, A. Nawrocka

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

Corresponding author: W. Rumińska, e-mail: w.ruminska@ipan.lublin.pl
Keywords: DSC, TGA, Gluten proteins, oil pomaces

Abstract

The pomaces obtained as a results of oil production from oil seeds are a source of unsaturated fatty acids, dietary fibre, antioxidants and macro- and microelements. Wheat bread is still one of the leading bakery products in the European diet. Therefore, bread can be a valuable carrier of many health-promoting ingredients. Supplementing bread with oil pomaces and studying the interaction between them is extremely important in the bakery industry. Thermal analysis includes methods which are used to determine changes in selected physical properties under the influence of temperature. Understanding the effect of reduced or elevated temperature on food properties significantly helps producers to adapt the processing conditions of food raw materials and improve the quality of final products [1,2].

The aim of the research was to determine changes in thermal properties of gluten proteins obtained from model dough as a result of adding selected oil pomaces using thermogravimetry (TGA) and differential scanning calorimetry (DSC). Model flour was reconstituted from wheat gluten and wheat starch. The selected pomaces after oil production were obtained from: primrose (PRS), black seed (BLS), pumpkin (PKIN), milk thistle (MTH) and hemp (HP) and were added to model flour in the amount of 3%, 6%, and 9%. The gluten samples were washed out from unmodified and modified by oil pomaces model dough samples and analysed.

The results obtained from DSC indicates the presence of exothermic and endothermic phenomena. Analysis of DSC thermograms showed that all thermograms had a negative peak in the 70-100 ^{o}C range that indicates water evaporation. In the case of gluten supplemented with BLS, HP, MTH and PRS only exothermic phenomena are observed, while in the case of PKIN both phenomena are observed. This difference may be due to the fact that pumpkin among the remaining pomace contains the least fatty acids. The results obtained from TGA show that oil pomaces, regardless of concentration, does not affect the thermogravimetric parameters, so that the gluten network can be considered as thermally stable.

References

[1] Nawrocka, A., Szymańska-Chargot, M., Miś, A., Wilczewska, A.Z., & Markiewicz, K.H., 2016. Dietary fibre-induced changes in the structure and thermal properties of gluten proteins studied by Fourier transform Raman spectroscopy and thermogravimetry. Journal of Agricultural and Food Chemistry, 64, 2094-2104.

[2] Nawrocka, A., Szymańska-Chargot, M., Miś, A., Wilczewska, A.Z., & Markiewicz, K.H. 2017. Effect of dietary fibre polysaccharides on structure and thermal properties of gluten proteins – A study on gluten dough with application of FT-Raman spectroscopy, TGA and DSC. Food Hydrocolloids, 69, 410-421.

Analysis of the punch test of potato starch

J. Wajs, M. Stasiak

Institute of Agrophysics, Polish Academy of Sciences, ul. Doswiadczalna 4, 20-290 Lublin, Poland

Corresponding author: M. Stasiak, e-mail: m.stasiak@ipan.lublin.pl
Keywords: potato starch, punch test, food powders, mechanical properties, fungal spoilage, powder quality

Abstract

The potato starch market accounts for a very large proportion of the global production of bulk materials not only in the food industry but also in other industries such as pharmacy, the textile and paper industries as well as the chemical industry. The growing interest in potato starch requires additional production expenditure, which is associated with an increase in the storage of this product and providing them with the right conditions. Incorrect storage of the material may affect the quality of the products. Additional problems associated with improper storage conditions that result in the deterioration of product quality are biological agents.

The aim of this study was to identify the changes taking place in the punch test and development of fungal impurities of potato starch during long-term storage in the 75% RH. The samples of potato starch were stored in perforated containers in a climatic chamber at 75% humidity and at 21 ºC for 5 months. The samples of material in perforated containers after subsequent days of storage was have been measured by the punch test in Lloyd LRX Materials Testing Machine. Measurement of the degree of fungal contamination was done by counting colonies according to the protocol of ISO 21527:2009.

As a result of the punch test, three categories of waveforms were obtained. In the first stage, a long-lasting linear increase was observed, which decreased with time. The change in the length of the linear growth showed a statistically significant correlation with the development of fungal impurities. An increase in the number of peaks was also observed with increasing storage time.

During long-term storage of potato starch in 75% RH, changes in the punch test run occur. In the starch observed changes in the strength noted by the sensor, which may be due to increased humidity as well as in some cases the development of fungal impurities.

References

[1] Fitzpatrick J.J., O'Connor J., Cudmore M., and Dos Santos D., 2017. Caking behaviour of food powder binary mixes containing sticky and non-sticky powders. J. Food Eng., 204, pp. 73-79.

[2] Wajs J., Bańda M., Panek J., Nawrocka A., Frąc M., 2020. Stasiak M., Influence of storage under unfavourable conditions on the caking properties and fungal contamination of potato starch and wheat flour. Int. Agrophys., 34, accepted, in press.

[3] Hruskova M., Machova D., 2002. Changes of wheat flour properties during short term storage. Czech J. Food Sci., 20, pp. 125-130.

[4] ISO 21527: 2009. Microbiology of food and animal feeding stuffs – Horizontal method for the enumeration of yeasts and moulds. Polish Committee for Standardization.

The power changes identification of two different photovoltaic modules construction technologies

M. Bilčík, M. Božiková, J. Csillag, A. Petrović, P. Kotoulek, M. Kišev

Slovak University of Agriculture in Nitra, Tr. A. Hlinku 2, SK - 949 76 Nitra, Slovak Republic

Corresponding author: M. Bilčík, e-mail: bilcikmatus@gmail.com
Keywords: experiment, PV system, monofacial, bifacial

Abstract

The conversion of solar energy to the electricity is one of the most usable technologies from renewable energy sources. The article presents research results which are primarily focused on identifying of the tilt angle changes influence to the power balance of photovoltaic systems. The next interest of experiments was detection of power change differences for two different construction technologies of photovoltaic modules – bifacial monocrystalline and monofacial (classic) monocrystalline photovoltaic modules. The experimental observations were done on the photovoltaic systems which are operated by the Laboratory of renewable energy sources at the Faculty of Education Masaryk University in Brno. In the text are compared results of power balances for PV modules installed on the roof with tilt angle 25° with PV modules integrated on the building façade which have tilt angle 90°. The next comparison was done for bifacial and monofacial technology of PV module construction. At the last were simulated power changes for bifacial photovoltaic modules installed on roof with different black and white surface. The measured data were collected from solar invertors FRONIUS IG and pyranometer Kipp & Zonen CMP 11. The results are presented as the time – power graphical relations. From obtained results is clear that the PV system integrated into building façade had better power balance than the same system installed on the roof during the time range from October to January. The power of bifacial PV modules was higher than power of monofacial and the energy production of bifacial PV modules strongly depend on reflection coefficient of roof surface material.

Acknowledgement

This work was supported by project VEGA 1/0803/20 Qualitative parameters of biomaterials Ministry of Education, Science, Research, and Sport of the Slovakia.

References

[1] Cviklovič, V., Olejár, M. (2013). Temperature dependence of photovoltaic cells efficiency. International Conference: Trends in agricultural engineering 2013. Prague: Czech University of Life Sciences, Prague, Czech Republic, 128 – 131.

[2] Poulek V., Libra M., Photovoltaics, theory and practice of solar energy utilization, ILSA, Prague, 2010, 169 pages, ISBN 978-80-904311-2-6.

[3] Sládek, P. (2005). 40 kWp Photovoltaic system on Pedagogical faculty, Masaryk University in Brno, TZB-info, Praha, Topinfo (in Czech).

[4] Sládek, P. (2008). Longtime experiences with operating of 40kWp photovoltaic plant on Pedagogical faculty, Masaryk University in Brno. Conference: 3. Czech photovoltaic conference, Brno, Czech Republic, 77 – 80 (in Czech).

Electrical Properties of Value-Added Chocolate

Z. Hlaváčová, V. Ardonová, P. Hlaváč, E. Ivanišová

Slovak University of Agriculture in Nitra, Tr. A. Hlinku 2, SK-949 76 Nitra, Slovakia

Corresponding author: Zuzana Hlaváčová, e-mail: Zuzana.Hlavacova@uniag.sk
Keywords: electrical properties, chocolate, admixtures

Abstract

The electrical properties can be used in various disciplines and industries. The rheological response of milk chocolate when subjected to electric fields was described e.g. in [1]. Our measurements were made on samples of value-added chocolate from Department of Technology and Quality of Plant Products, Faculty Biotechnology and Food Sciences. First sample was control, second with dried leaves of mint (*Mentha piperita* L.), third with candied young shoots of spruce (*Picea abies* L.), fourth with candied pumpkin flesh (*Cucurbita moschata* Butternut), fifth with dried capuchin (*Tropaeolum majus* L.) leaves, sixth with candied josta (*Ribes nidigrolaria* L.) fruit and dried rose (*Rosa canina* L.) petals. The control sample has the highest dry matter content 97,93 %.

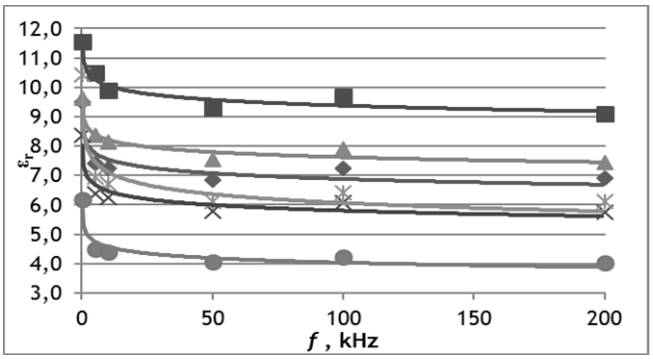

Fig. 1 Frequency dependence of relative permittivity for value-added chocolates (▲ – control, with ■ – pumpkin, ♦ - capuchin, * - spruce, × - mint, ● - josta and rose)

Low-frequency electrical properties of chocolate were measured by GoodWill Instek LCR meter 821 at different frequencies using four-electrode (tetra polar) system. A plate capacitor was used as sample holder. We measured capacitance, resistance, impedance and loss tangent. Each property was measured in the frequency range from 0.1 kHz to 200 kHz, at all frequencies three times. In Fig. 1 are shown frequency dependencies of relative permitivity for measured samples. Relative permitivity was calculated on the base of measured capacitance and dimensions of plate. For frequency dependencies of electrical properties, we used power model [2]. This model describes the curves very well and has high value of coefficients of determination. The added substances cause the displacement of curves. Mainly at a frequency of 50 kHz, we could use the curves displacement to determine the type of chocolate additive.

Acknowledgement

This work was co-funded by the European Community under the project No 26220220180: Building the Research Centre AgroBioTech.

References

[1] Daubert C.R., Steffe J.F., Srivastava A.K., Predicting the electrorheological behavior of milk chocolate, Journal of Food Process Engineering, 1998, 21, pp. 249-261.

[2] Kertész Á., Hlaváčová Z., Staroňová L., Electrical properties of dried quinces utilization. Journal on Processing and Energy in Agriculture, 2011, 15(3), pp. 127-129.

Structure of the Flour

Ľ. Kubík

Slovak University of Agriculture in Nitra, Trieda A. Hlinku 2, 949 76 Nitra, Slovak Republic

Corresponding author: e-mail: Lubomir.Kubik@uniag.sk
Keywords: powder, flour, fractal

Abstract

The properties of the flour are very important for the quality of the cereals and bread. The examination how a slight modification of the standard bread-making procedure for the evaluation of wheat cultivars (Zvezdana and NS 40S) affects bread making properties were realized from the flour of these samples (Živančev et al., 2019). Box-Counting method was used for evaluating of the fractal properties of the flour particles texture. The method is often used to determine fractal box dimension of digitised images of fractal structures. Nežádal et al. (2001) and Buchníček et al. (2000) have implemented Box-Counting procedure in software called HarFA ver. 5.1.0. HarFA software analyses black&white images.

The evaluation of the microscopic, powder samples of the flour by means of the fractal analysis was realized. The three flours were studied, the smooth flour, semi-flour and thick flour. The five samples of the each sort of the flour were tested by the fractal analysis. The samples were digitized by the digital microscope Motic DM 1802-A with software Motic Image Plus ver. 2.0. Each image was processed by the thresholding operation and the fractal analysis was realized by the software Harfa ver. 5.1.0 and the samples were compared by the correlation analysis. The obtained fractal dimensions described the segmentation and distribution of flour powder and the fractions of the flour. The fractal dimension of the smooth flour was D_{WBW} = 1.29266, of the semi-flour D_{WBW} = 1.70734 and of the thick flour DWBW = 1.57978. On the base of the particles distributions were the semi-flour and thick flour very similar, but on the base of fractal analysis were different and we can distinguish them.

Acknowledgements

Author express the appreciations of the Scientific Grant Agency of the Ministry of Education of Slovak Republic and the Slovak Academy of Sciences within the framework of the research was realized in the project Qualitative parameters of biomaterials (VEGA 1/0803/20)

References

[1] Buchníček, M., Nežádal, M., Zmeškal, O., (2000) Numeric Calculation Of Fractal Dimension, 3rd Coference on Prediction, Synergetic and more ..., Faculty of Technology Zlin, BUT Brno, October 2 - 3, ISBN 80-214-1668-8, p. 10-15.

[2] Nežádal, M., Zmeškal, O., Buchníček, M. (2001) The Box-Counting: Critical Study, 4th Conference on Prediction, Synergetic and more ..., the Faculty of Management, Institute of Information Technologies, Faculty of Technology, Tomas Bata University in Zlin, October 25 - 26, , ISBN 80-7318-030-8, p. 18.

[3] Živančev, D., Jocković, B., Mirosavljević, M., Momčilović, V., Mladenov, N., Aćin, V., Pribić, M. (2019) How a Slight Modification of the Bread-Making Procedure for the Evaluation of Wheat Cultivars affects the most important Properties of Bread (Bread Volume and Bread Crumb). Journal on Processing and Energy in Agriculture, 23, no. 4, pp. 180-184.

Relative Permittivity Measurement of Mung Beans (*Vigna Radiata L.)*

J. Novák

Slovak University of Agriculture in Nitra, Tr. Andreja Hlinku 2, 949 76 Nitra, Slovakia

Corresponding author: Ján Novák, e-mail: jan.novak1@uniag.sk
Keywords: relative permittivity, electric properties, mung beans

Abstract

This paper contains the results of measuring the relative permittivity (dielectric constant) of mung beans (Vigna radiata L.) set. Mung bean or green gram (Vigna radiata L.) has been cultivated in India since prehistoric times and is believed to be a native crop of India [1]. It is cultivated throughout Southern and Eastern Asia, Central Africa, some parts of China, South and North America and Australia, particularly for its protein-rich grains. Mung bean is a warm seasonal annual legume, grown mostly as a rotational crop with cereals like wheat and rice. This crop has been intensively researched in work of Dahiya [1]. The research and determination of physical properties of agricultural materials has also resulted in the development of many instruments. The study of electrical properties is important for predicting the behaviour of a material in electric field or for knowing of how the presence of material can influence the field or associated electrical circuit [2]. Electrical measurements on these materials are of fundamental importance in relation to the analysis of quantity of absorbed water and dielectric heating characteristics. The research of electric properties is utilised in many technical applications. Measurements results are used for determination of moisture content, the surface level of liquid and grainy materials, controlling the presence of pests in seed storage, the quantitative determination of mechanical damage, and in many other cases. The relative permittivity is one of the main parameters of dielectric material electrical properties. The electrical properties of mung beans samples had not been sufficiently measured, and the aim of this work was to perform the measurements of this property. Measurements were performed under variable moisture content and the frequency of electric field from 1 MHz till 16 MHz , using Q meter. It was concluded that relative permittivity increased with increase of moisture content, and relative permittivity decreased as the frequency of electric field increased. The measurement results indicate that most suitable frequencies of alternating electric field for dielectric heating of mung beans are higher than 10 MHz. The relationships of the relative permittivity of mung beans set samples provide the basis for the design of many commercial moisture-testing instruments. In the future, the performance of additional measurements at a wider frequency range would be desirable.

References

[1] Dahiya, P. K., Linnemann, A. R., Van Boekel, M. A. J. S., Khetarpaul, N., Grewal, R. B., Nout, M. J. R. (2015). Mung Bean: Technological and nutritional potential. Critical Reviews in Food Science and Nutrition, 55(5), pp.670–688.

[2] Khaled, A. Y., Abd Aziz, S., Khairunniza Bejo, S., Mat Nawi, N., Abu Seman, I., Izzuddin, M. A. (2018). Development of classification models for basal stem rot (BSR) disease in oil palm using dielectric spectroscopy. Industrial Crops and Products, 124, pp.99-107.

DSC methods as a tool of fast originality control

V. Vozárová, A. Petrović, D. Kunecová, J. Csillag

Slovak University of Agriculture in Nitra, Tr. A. Hlinku 2, 949 76 Nitra, Slovakia

Corresponding author: Vlasta Vozárová, e-mail: vlasta.vozarova@uniag.sk
Keywords: thermal analysis, differential scanning calorimetry, originality control

Abstract

The contribution deals with the possibilities of use one of the most common methods of thermal analysis – differential scanning calorimetry (DSC) in the fast originality control of products. Differential scanning calorimetry provides information on endothermic or exothermic processes in the material and information on thermal stability of material at the same. Experimental results, in graphical form – DSC curves, allow identification of processes running in the materials, changes of physical and chemical properties and the conditions under which they take place.

The present work deals with DSC study of different materials:

- food material – oils (pure olive oil and mixture of olive and sunflower oil)
- non-food material – technical liquids (pure coolant and mixtures with distilled water).

Monitoring of crystallisation and melting behaviour together with enthalpy of transitions is provided by DSC method [1]. Based on the results of DSC analysis temperature interval of samples thermal stability is defined, as well as comparison of crystallisation and melting behaviour including enthalpy of transitions of individual samples – pure olive oil and mixed with sunflower oil and pure coolant and mixtures with distilled water.

It is concluded that the pour point of the mixtures is shifted in proportion to the percentage of added sunflower oil. In case of technical liquids (coolant) it was observed that the pour point slowly increases with percentage of distilled water. Obtained results prove that application of DSC method is promising tool for detection of olive oil adulteration with sunflower oil [2]. DSC method allows fast originality control of technical materials, for example coolant, as well.

Investigation methods and used experimental equipment are presented in the paper more in details. Research of thermal behaviour of food material (oils) and technical liquids by DSC methods was provided in the Laboratory of Physical Properties of Raw Materials and Foodstuffs (Research Centre "AgroBioTech" of Slovak University of Agriculture in Nitra).

Acknowledgement

The work was supported by European Community under project no 26220220180: Building Research Centre „AgroBioTech", by the project GA SPU I-17-010-00.

References

[1] Wagner, M. 2013. Thermal analysis in Practice. Switzerland: METTLER TOLEDO.

[2] Chiavaro E., Vittadini E., Rodriguez-Estrada M. T., Cerretani L., Capelli L., Bendini A. 2009. Differential scanning calorimetry detection of high oleic sunflower oil as an adulterant in extra-virgin olive oil, Journal of Food Lipids, 16, 227 – 244.

Improvement Attempts for the Efficiency of Hybrid Solar Collectors

Ahssan M.A. Alshibil, I. Farkas, P. Víg

Szent István University, Páter K. u. 1., Gödöllő, H-2100 Hungary

Corresponding author: Ahssan M.A. Alshibil, e-mail: ihssanm.ali@uokufa.edu.iq
Keywords: electrical efficiency, thermal efficiency, solar energy

Abstract

Between 5% to 20% of the solar radiation falls on the photovoltaic (PV) cells is converted to the electrical energy, while a part of residual radiation is reflected, and the significant part is turned into heat efficiency and productivity decrease. Such heat causes the solar cell temperature to increase and reduce their lifetime. Bődi et al. (2018) and Rusirawan and Farkas (2014) have been concluded that high temperature and low irradiation conditions will reduce the power conversion capability. The heat absorbed from the solar modules can decrease the surface temperature of the PV modules. Thus, the electrical yield turns out to be increasingly ideal and the heat energy gathered can be used in different applications. So, electrical and thermal energy can be extracted from hybrid photovoltaic (PV) and thermal (T) collector, e.g. PV/T solar collector.

This study reviews new innovations, technologies, possibilities and attempts to improve and evaluate the hybrid solar collector systems and different modifications and assessment techniques applied to them in order to improve their efficiency and performance. The performance of PV/T collectors has been thoroughly studied by many researchers with regards to approaches used and tools and techniques applied.

The recent work focuses on concept of hybrid solar collector and principal, performance appreciation, air or/and water-based PV/T collectors in various attempts, nano-based PV/T collectors, concentrated PV/T system. The literature showed many attempts to change the original design of the hybrid solar collectors, which led to improved efficiency. Such approaches included both the experimental and the theoretical studies mainly taking into consideration the most affecting parameters.

Additionally, the different materials that are used as a coolant which it has high thermal conductivity can also be used to improve the efficiency as well as change of the general configuration of PV/T collectors, which enhances a better heat transfer between the absorber and the coolant.

Finally, it can be concluded that still there are a lot of constructional details to be improved to increase the efficiency of PV/T collectors and make them more market reliable.

Acknowledgement

This work was supported by the Stipendium Hungaricum Programme and by the Mechanical Engineering Doctoral School, Szent István University, Gödöllő, Hungary.

References

[1] Bődi, S., Víg, P., Farkas, I., 2018. Possibilities of improving PV/T system efficiency. Hungarian Agricultural Engineering, 33, pp. 55-58. https://doi.org/10.17676/hae.2018.33.55.
[2] Rusirawan, D., Farkas, I., 2014. Identification of model parameters of the photovoltaic solar cells. Energy Procedia, 57, pp. 39-46. https://doi.org/10.1016/j.egypro.2014.10.006.

On Thermal Efficiency of Parabolic Trough Solar Collectors

Asaad Yasseen, I. Farkas and I. Seres

Szent István University, Páter K. u. 1., Gödöllő, H-2100, Hungary.

Corresponding author: Asaad Yasseen**,** E-mail: asaadyasseen@gmail.com
Keywords: parabolic though solar collector, solar energy, control measurements

Abstract

The energy demand in the world is continuously increasing with the depletion of conventional energy sources. The parabolic trough solar collector (PTSC) technology is mainly used for power generation such as steam temperature is gotten from high temperature [1]. The collector receives the direct solar radiation from the sun over a big surface and focus. A fluid flowing inside the tube absorbs the heat energy that is generated from focused solar radiation raises its enthalpy and causes an increase in the temperature of the tube wall [2]. Generally, concentrates solar thermal energy in a focal line to convert it into high temperature. Depending on the application, temperature up to 550°C is achievable in these systems [3].

The goal of this research is increasing the thermal efficiency of PTSC by optimization of the working fluid passing through the absorber tube. Furthermore, studying the absorber tube material effects on the heat transfer between the working fluid and the metal. In this research, using ANSYS simulation models describing the heat and mass transfer processes of PTSC system. The effective method to increase the thermal energy by mixing of nanoparticles to the working fluid. The volume fraction of nanoparticles effects on the hydrodynamic and thermal efficiency of the PTSC. The thermophysical properties improves such as the density, viscosity, specific heat capacity, and thermal conductivity, by adding the nanoparticle to the working fluid [4]. Therefore, it could raise the heat transfer coefficient and improving the thermal conductivity.

Acknowledgement

This work was supported by the Stipendium Hungaricum Programme and by the Mechanical Engineering Doctoral School, Szent István University, Gödöllő, Hungary.

References

[1] Yilmaz, S., Ozcalik, H.R., Dincer, F., Modeling and designing of the solar thermal parabolic trough concentrator and its environmental effects, Wiley Online Library, 2017, DOI 10.1002/ep.12536.

[2] Montes, I. E. P., Benitez, A. M., Chavez, O. M., Herrera, A. E. L., Design and Construction of a Parabolic Trough Solar Collector for Process Heat Production, Energy Procedia, 2014,57, pp. 2149 – 2158.

[3] Tian Y, Zhao C-Y., A review of solar collectors and thermal energy storage in solar thermal applications, Applied Energy,2013, 104, pp. 538–53.

[4] Pak BC, Cho YI., Hydrodynamic and heat transfer study of dispersed fluids with submicron metallic oxide particles, Experiment Heat Transfer Int J,1998, 11, pp.151–70.

Long-Term Performance Assessment of a 10 kWp Grid Connected Photovoltaic System

D. Atsu, I. Seres, I. Farkas

Szent István University, Páter K. u. 1, Gödöllő, H-2100 Hungary.

Corresponding author: D. Atsu, e-mail: atsud22@yahoo.com
Keywords: performance, solar PV, energy yield

Abstract

Solar radiation levels and the potential for solar energy exploitation in Hungary compares favourably with other countries in the sub-region. In terms of solar PV market attractiveness, Hungary ranks among the top ten countries in Central Eastern European and South-Eastern Europe. However, Hungary has seen a relatively low growth in Solar PV systems dissemination over the years. This study investigates the state of solar PV in Hungary. It also assesses the performance of PV systems in the Hungarian climate, using a 15-year-old 10 kWp roof-mount grid-connected solar PV system installed at Szent István University, Gödöllő [1], as a case study. The system consists of pc-Si technology and amorphous a-Si technology, divided into three (3) sub-structures. Each sub-system connected to a separate inverter. PVsyst software was used to simulate the performance of the system per its specifications and constraints. Results were analysed and compared with the measured data in assessing the performance of the system. It entailed evaluating the energy output of the PV array, energy injected into the grid, performance ratio and the normalized energy productions per installed kWp.

The annual energy output from the total system for the year of study is 8838.95 kWh. The energy output for the subsystems is 3761.98 kWh, 2608.88 kWh and 2468.10 kWh for ASE (pc-Si), DS2 (a-Si) and DS1 (a-Si) respectively. The annual sub-system efficiencies are 9.8%, 2.9% and 2.8% for ASE (pc-Si), DS2 (a-Si) and DS1 (a-Si) respectively. 42.6% of energy was fed into the grid by the ASE (pc-Si) system, 29.5% and 27.9% from the DS2 (a-Si), and DS1 (a-Si) respectively [2].

Acknowledgement

This work was supported by the Stipendium Hungaricum Programme and the Mechanical Engineering Doctoral School, Szent István University, Gödöllő, Hungary.

References

[1] Farkas,I. Seres,I., Kocsis,L. Development of a 10 kWp photovoltaic grid connected system – desing of PV arrays and data logging, CD-ROM Proceedings, EuroSun 2004, Freiburg, Germany, 2004, pp. 94-102.

[2] Atsu D., Seres I., Farkas I. Performance analysis of grid connected SI-poly and SI-amorphous photovoltaic systems, Book of Abstracts, 25th Workshop on Energy and Environment, Gödöllő, Hungary, November 28-29, 2019, p. 9.

Main Characteristics of the Recent Solar Thermal Energy Status

I. Farkas

Szent István University, Páter K. u. 1., Gödöllő, H-2100 Hungary

Corresponding author: István Farkas, e-mail: farkas.istvan@gek.szie.hu
Keywords: Global market, thermal capacity, solar enegy

Abstract

The paper deals with the recent status of the use of solar thermal energy use. The worldwide situation is analysed based on the topic touched upon at the Solar World Congress organized by the International Solar Energy Society in Santiago, Chile in 2019, and also at the EuroSun 2018 Solar Conference organized in Rapperswil, Switzerland in 2018. Additionally, the most recently published books in this topic serve information overviewing the statements.

The key thematic questions, specifically related to the solar thermal, are as follows: solar buildings and architecture, solar thermal heat for industrial processes, solar thermal collectors, solar heating and cooling, solar buildings and architecture, energy storage, solar assisted district heating and cooling and large-scale applications and solar energy market.

The Fig. 1 shows the global solar thermal capacity and energy yield for the period of 2000-2018 (IEA Solar Heating and Cooling Programme, May 2019).

Fig. 1 Global solar thermal capacity and energy yield for the period of 2000-2018

The main characteristics of the recent solar thermal energy status can be summarized as:

The cumulated solar thermal capacity in operation by end of 2018 was 480 GWth (686 million square meters of collector area) compared to the year 2000 the installed capacity grew by a factor of 7.7.

The corresponding annual solar thermal energy yield in 2018 amounted to 396 TWh, which correlates to savings of 42.6 million tons of oil and 137.5 million tons of CO_2.

Although the global solar thermal market fell by 3.9% in 2018, there are positive growth figures in nine of the top 20 countries. This this trend continued also in 2019.

The traditional mass markets for small-scale so lar water heating systems for single-family houses are under market pressure from heat pumps and PV systems.

References

[1] Weiss, W., Spörk-Dür, M., 2019. Solar heat worldwide, Global market developments and trends in 2018, SHC - Solar Heating and Cooling Programme, International Energy Agency.

Experimental Study of Chimney Used in Solar Drying Applications

G. Habtay, J. Buzas, I. Farkas

Szent Istvan University, Pater K. u.1, Gödöllő, H-2100, Hungary

Corresponding author: István Farkas, e-mail: farkas.istvan@gek.szie.hu
Keywords: chimney, dryer, temperature

Abstract

The uses of solar dryer in preserving agricultural products is essential for long period of time without deterioration. Drying rate of any agricultural product depends on the airflow of the air used for drying. Well-designed chimney dependent solar dryer can boost the drying rate of the product [1]. In passive solar dryers, the use of chimney shows a significant effect in enhancing the airflow movement inside the drying system.

The chimney was constructed with a 2 m PVC material with circular cross-section and installed above the drying chamber and the experiments were done under no-load condition. Five thermocouple probes were placed along the chimney height. Two similar probes were used measuring the chimney surface and ambient temperatures. It was clearly showed that the temperature along the chimney were higher than the ambient temperature which indicated that the chimney used in this experiment has significantly affect the airflow inside the system (Fig. 1) [2]. Additionally, solar radiation and surrounding temperature play an important role in the performance of the chimney. In this paper we are showing how the implementation of the chimney can enhance the airflow movement in drying application.

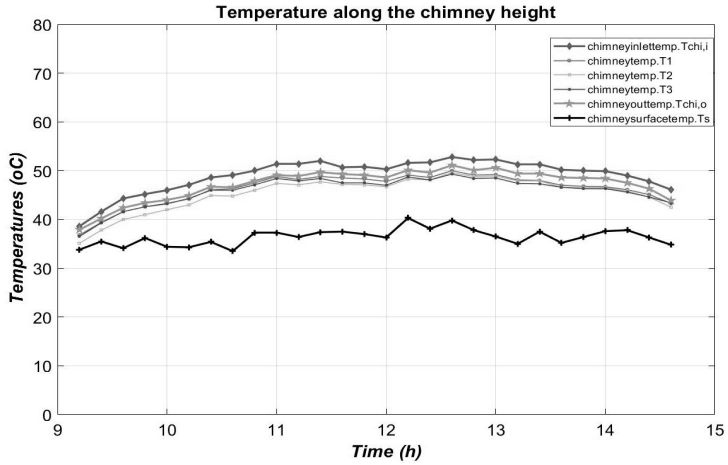

Fig.1 Variation of temperature along the chimney height

Acknowledgement

The work was supported by the Stipendium Hungaricum Programme and by the Mechanical Engineering Doctoral School, Szent Istvan University, Gödöllő, Hungary.

References

[1] Afriyie J.K., Nazha M.A., Rajakaruna H., Forson F.K., Experimental investigations of a chimney-dependent solar crop dryer. Renewable Energy, 2009, 34, 1, pp. 217-222.

[2] Habtay G., Farkas I.: Heat transfer calculation of chimney applied for indirect solar dryer, Proceedings, 7th European Drying Conference, Politecnico di Torino, Italy, July 10-12, 2019, pp. 128-132.

Effects of Solar Radiation on the Absorber Plate

I. Kocsány, I. Seres, I. Farkas

Szent István University, Páter K. u. 1., Gödöllő, H-2100 Hungary

Corresponding author: I. Kocsány, e-mail: kocsany.ivett@gmail.com
Keywords: solar energy, absorber, heat transfer coefficient, active surface

Abstract

In solar collectors the heat is collected by the heat transfer fluid, flowing through the tubes. However, the absorber and tube wall material have good thermal conductivity, it has to be taken into the account in an appropriate model, the heat flow from the absorber to fluid through the tube wall has been analyzed. A numerical model was developed to determine the relation between the absorbed solar energy and the heat transfer coefficient of an absorber plate of a flat plate collector. Our model is based on the heat transfer from copper absorber plate to copper tubes.

Accordingly, it must be considered how the optical attribution of the materials influences the efficiency of a flat plate collector. The amount of the absorbed solar radiation by the absorber plate has been determined, included the multiple reflection, cover transmittance and absorptance of the absorber plate. Models were carried out for vacuum tube and flat plate solar collectors. Based on simulated results the conclusions have been performed.

In this paper the authors investigated the process of absorption of a flat plate collector is to be studied. It is important to decrease reflected radiation, by the different shape of collector can be solve this problem. The ratio of the reflected irradiance from any surface position to global irradiance has been calculated, with special attention to the incoming radiation. Two numerical models were developed to analyze the multiple reflections inside of the collectors and another one to determine the relationship between the temperature of the absorber plate and the heat transfer coefficient.

Acknowledgement

The work was supported by the Mechanical Engineering Doctoral School, Szent István University, Gödöllő.

References:

[1] Duffie JA, Beckman WA. Solar engineering of Thermal Processes. 2nd ed. John Wiley and Sons Inc., New York, 1991

[2] Spuckler C.M., Siegel R., Refractive index effects on radiation behavior of heated absorbing-emitting layer, J. Thermophys Heat Transfer, 6 (4), 1992. pp. 596–604

[3] Shah L.J, Furbo, S., Vertical evacuated tubular-collectors utilizing solar radiation from all directions, Applied Energy, 2004, 78, pp. 371–395

[4] Ari Rabl. Active Solar Collectors and Their Applications. Oxford University Pressed, New York. 1985, pp. 243–263

[5] Kocsány, I., Seres, I.: Performance of solar collectors by reflected spectral measurements, Szent István University, Faculty of Mechanical Engineering, Mechanical Engineering Letters, Gödöllő, Hungary, 2012, Vol. 8, pp. 53-60

Exciton Theory at Solar Energy Applications

C. Mészáros [1], Á. Bálint [2]

[1] Szent István University, Páter K.u.1., H-2100 Gödöllő, Hungary
[2] Óbuda University, Doberdó u. 6, Budapest, Hungary, H-1034e

Corresponding author: C. Mészáros, e-mail: Meszaros.Csaba@gek.szie.hu
Keywords: chain-type molecules, exciton-type collective elementary excitations, solar energy

Abstract

It is well-known nowadays, that the detailed experimental and theoretical investigation of basic structural and physical properties of different types of carbon nano - tubes plays a role of continuously increasing importance in the whole condensed matter physics [1], because of the very promising experimental investigation of the solar energy applications, too.

Among them, the very powerful and useful symmetry analysis methods based on the representation theory of line groups (i.e. quasi - one dimensional (Q1D) symmetries) [2] are recognized as the most promising ones.

The quantum theory of collective elementary excitations has also been developed in detail and very accurately (e.g. [3]), but surprisingly, without applications of the representation theory of line groups.

Moreover, the applications of the projective representations of crystallographic point groups in solid state physics are known for decades [4], but they are completely absent even from the most complete recent works about applications of line groups in various types of structural investigations of condensed matter systems.

Therefore, we decided to fill this gap, and have successfully introduced the concept of the projective (i.e. ray-) representations of line groups together with some basic applications into theory of the incommensurately modulated crystal structures [5].

In the present work, we demonstrate explicitly the applicability of the same technique in the cases of simple-, and multiple - type optical scattering processes in incommensurate systems, including multiple-type Raman processes, too.

References

[1] Barros, E. B., Jorio, A., Samsonidze, G.G., Capaz, R.B., Souza Filho, A.G., Mendes Filho, J., Dresselhaus. G., Dresselhaus, M.S., Review on the symmetry-related properties of carbon nanotubes. Physics Reports, 2006, 431,6, pp. 261-302.
[2] Damnjanović, M., Milošević, I., 2010, Line Groups in Physics (Theory and Applications to Nanotubes and Polymers) Springer-Verlag, Berlin-Heidelberg.
[3] Agranovich, V., Excitations in Organic Solids, 2009, International Series of Monographs on Physics, University Press, Oxford.
[4] Streitwolf, H.W., 1971, Group Theory in Solid-State Physics: McDonalds, London.
[5] Mészáros, Cs., Nikolényi, I., Bálint, Á., 2020, Symmetry Analysis of Some Basic Structural Properties of Incommensurately Modulated Crystals by Projective Representations of Unimodular Groups, Physica Status Solidi 257,3, pp. 1900403.

Hubbard Model for Efficiency Estimations of Organic Solar Cells

I.R. Nikolényi, J. Tóth

Szent István University, Páter K. u. 1., Gödöllő, H-2100 Hungary

Corresponding author: Nikolényi I.R., e-mail: nikolenyi.istvan@gek.szie.hu
Keywords: maximal efficiency, polythiophene, PCBM

Abstract

Polymer–based solar cells (PSC) are under great attention in both theoretical and experimental research works nowadays thanks to their environment friendly nature, low cost production technology and the compatibility of flexible substrates. The main part of this type of devices is the electron donor/acceptor interface where the separation of excitons, after their generation, takes place by the influence of the incident light. The formation of this, in the majority of cases, is the polymer/fullerene coupling. The maximal attainable efficiency of PSCs is in relation with the energy level alignment of donor and acceptor materials (Fig. 1).

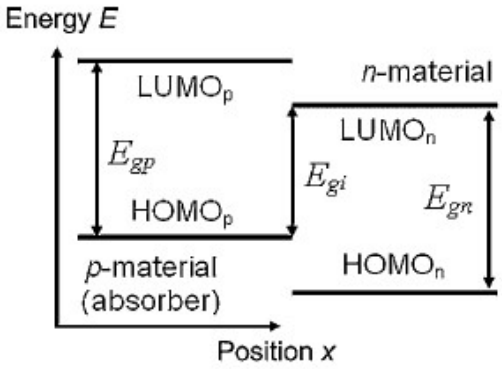

Fig. 1 Maximal efficiency formula os PSC and energy level alignment of electron donor/acceptor materials [1]

In our presentation we wish to demonstrate the power of the Hubbard model and its band structure technique on the theoretical estimations of the maximal efficiency of organic solar cells (Eq. 1). By the help of this tool we able to carry out some optimization calculations for polythiophene/PCBM–based PSC. The obtained diagrams can serve as guidelines for molecula-designers.

$$\eta_{max} = \frac{E_{g,i}\int_{E_{g,absorber}}^{\infty} N(E)dE}{\int_0^{\infty} EN(E)dE} \quad (1)$$

Acknowledgement

The authors would like to thanks to Prof. Gulácsi Zsolt for helpful discussions.

References

[1] Minnaert B., Burgelman M., Efficiency Potential of Organic Bulk Heterojunction Solar Cells. Progress in Photovoltaics: Research and Applications, 2007, 15, pp. 741–748.

Colour sensing

I. Seres

Szent Istvan University, Páter K. u. 1, H-2100 Gödöllő, Hungary

Corresponding author: István Seres, e-mail: Seres.Istvan@gek.szie.hu
Keywords: human sensing, colours, RGB, relative scale

Abstract

During the last several years we traditionally introduced (bio)physical experiments to demonstrate the importance of the practice beside the theory. Of course, these experiments are enjoyable if only you watch them personally, not watch through screens. That was the reason why this year a different topic was chosen, which is hopefully goes through among the screens and gives some answers for practical questions.

From time to time special pictures appear in the social media, which generate huge debates about the colour of a given object. As an example, you can see one here, but the printing can change its shades (especially if it is printed in grey scale :), so you should watch it in a display or online – hopefully in the presentation of this abstract.

Fig. 1 What is the colour of the clothes? (white and gold or blue and black?)

If we check the internet for the "What is the colour of this dress" debate, the google search engine finds numerous hits, and huge number of pictures to describe why everybody is right in this debate. During the presentation we will discuss the working of the human senses – especially the human eye – and prove that our colour vision can be made fool quite easily.

One part of the presentation, beside of the relative sensing, deals with the technical solutions, how we can make more objective the investigation of the colours, and how this can be used in the technology.

During the presentation more examples of the problem will be demonstrated, and the studied pictures will be analysed.

Acknowledgement

The work was supported by the Mechanical Engineering Doctoral School, Szent István University, Gödöllő.

References

[1] https://www.nationalgeographic.com.au/science/blue-or-white-dress-why-we-see-colours-differently.aspx

[2] Daniel Kernell: Colours and Colour Vision: An Introductory Survey, Cambridge University Press, 2016

Model-predictive Control of a Solar Thermal System

J. Tóth, I. Farkas

Szent István University, Páter K. u. 1., Gödöllő, H-2100 Hungary

Corresponding author: J. Tóth, e-mail: toth-janos@outlook.com
Keywords: Simulink, MPC, solar energy

Abstract

The development of the solar systems is highly speeded up in the recent years. For that reason, a lot of experiments were carried out and several prototype systems were built. Generally saying, it is expensive to build a full-scale physical system to do experiments. With the help of the computer-aided modelling methods these costs can be reasonably reduced.

The model-based design is a possible way to resolve this issue. This design method uses mathematical models and the simulation of them reducing the cost and the time of the development. Such approach is useful to analyse and develop an existing solution, as well.

A verified mathematical model, capable of describe a solar thermal system, has been developed during the research [1]. First the on-off and the PID controlling algorithms were successfully tested using this model of the solar thermal system [2].

In the current stage of the research the main focus is on the study the possible use of a model predictive controller (MPC). The preliminary results of these experiments will be presented in this work. The implementation of the studied system can be seen in Fig 1.

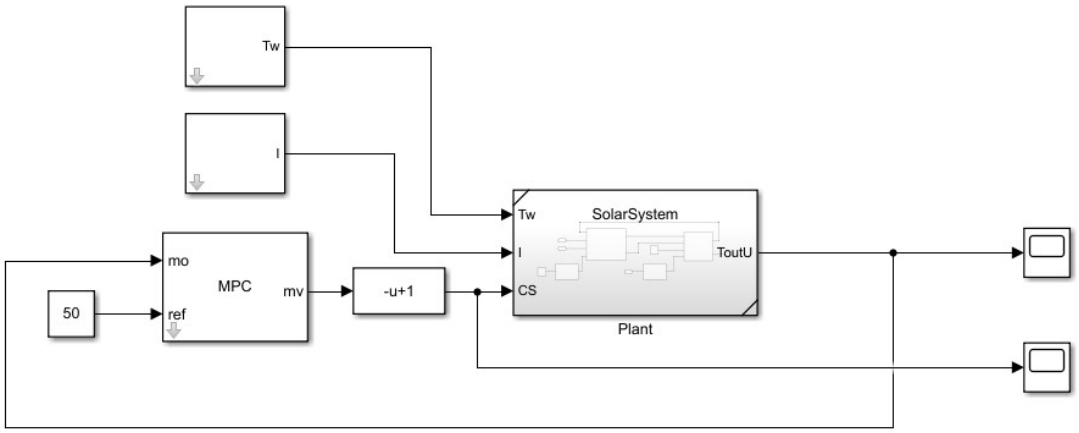

Fig. 1 Simulink implementation of the MPC controlled solar system

Acknowledgement

This work was supported by the Mechanical Engineering Doctoral School, Szent István University, Gödöllő, Hungary.

References

[1] Tóth J., Farkas I., Mathematical modelling of solar thermal collectors and storages. Acta Technologica Agriculturae, 2019, 22, pp. 128-133.

[2] Tóth, J., Erdélyi V., Jánosi L., Farkas I., On-off and PID control of a small-scale solar system. Book of Abstracts, 25th Workshop on Energy and Environment, Gödöllő, Hungary, November 28-29, 2019, p. 21.

Light polarisation at solar modules

P. Víg

Szent Istvan University, Gödöllő, Páter K. u 1. H-2100, Hungary

Corresponding author: Piroska Víg, e-mail: Vig.Piroska@gek.szie.hu
Keywords: photovoltaics, polarisation, reflection

Abstract

A new form of environmental pollution is caused by the ecological light. This includes the artificial light sources with its fluctuation and the reflected light from different surfaces, which is affected on the sensitive organisms. The reasons of this contamination are the light intensity which differs from the natural environmental lights and appearance the objects with resulting more and more light polarization [1]. Although the polarization of light is not perceived by the human eye, the research of polarization provides additional information about our world.

In particular, the water insects are not only sense polarized light, but also use it for orientation. In natural optical environment, only the reflected light from the water surface is polarized, but as technology advances, there are more artificial surfaces which reflect polar light (e.g. asphalt surfaces, black plastic foils used in agriculture, glass wall, dark car bodies, solar modules with dark surfaces). The insects which attracted to these surfaces may dry out and their surface deposited eggs die, so such surfaces are an ecological trap for polarisation oriented insects.

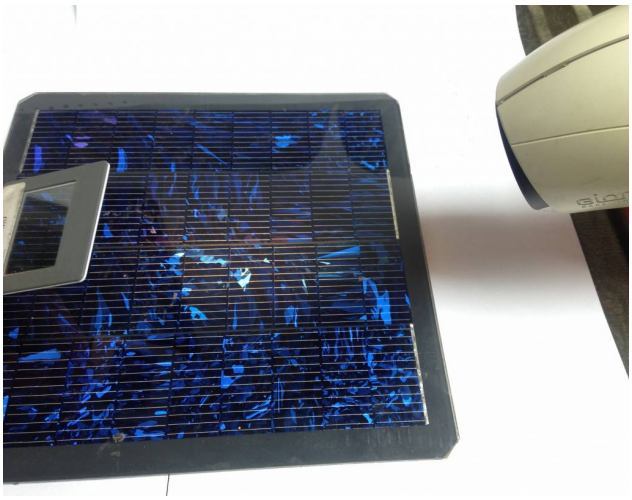

Fig. 1. Basic tools at measuring

The aim of this work is to study of the light polarization especially at solar modules. If the solar modules serve as an ecological trap, it may result the depletion in insect population and also reducing the efficiency of the modules, due to the presence of contamination [2]. For that reason, the study of polarization at solar modules is important and useful from both sides. The light sources used in the experiment were natural and polarized ones. The polarization of reflected light was studied by polar filter (Fig. 1).

The work details the results obtained by studying the polarization of the light reflected from the solar modules in different directions.

References

[1] Horváth G., Kriska Gy., Malik P. and Robertson B., Polarized light pollution: a new kind of ecological photopollution, Front Ecol Environ 2009; 7(6), pp. 317–325.

[2] Adinoyi, M. J., Said, S. A. M., Effect of dust accumulation on the power outputs of solar photovoltaic modules, Renewable Energy, 2013, Vol. 60, pp. 633-636.

Hydrocolloids as texture forming additives in processed cheese product based on acid casein and whey proteins

J.O. Szafrańska, B.G. Sołowiej

University of Life Sciences in Lublin, Skromna 8, 20-704 Lublin, Poland

Corresponding author: J. O. Szafrańska, e-mail: jagoda.szafranska@poczta.fm
Keywords: hydrocolloids, texture, processed cheese sauce

Abstract

As functional additives, the most common used hydrocolloids in processed cheese sauce production are: alginates, xanthan gum, carrageenan and guar gum [1]. Increasingly, dietary fibres can be also used to prepare dairy products with good texture and taste features. There are very useful nutritional compounds that are contained in dietary fibres, like carbohydrate polymers and polysaccharides (cellulose, hemicellulose, resins, resistant starch, pectic materials or inulin). They are not digested and absorbed in the human small intestine [2] and can cause positive effects on the human body like shortening the time of presence in the digestive tract and increasing the stools bulk. They can reduce the LDL cholesterol, glucose and insulin levels [3]. Also, nutritional benefits of whey proteins, that were discovered during research focused on reducing pollution caused by pouring whey into rivers by producers, are important to final rheological features [4].

In our study, we have tested four different fibres: bamboo, acacia, potato and citrus fibre. Because of their different chemical composition, that can affect the texture of prepared processed cheese sauce, they are good examples of new approch to dairy food production. We tested rheological properties of final products and observed the effect of dietary fibres.

Improvements in textural properties of processed cheese sauces, manifested by lower hardness and adhesiveness in most samples, suggested that potentially fibres can be used as an addition to the above-mentioned products based on acid casein and whey protein concentrate (WPC80). The conducted research is the basis for further experiments related to the use of dietary fibres in dairy products, especially cheese sauces.

References

[1] Hassan, Z. M. R., Award, R. A., El-Mahdi, L. D., Saad, S. A., The use of food stabilizers in manufacture of cheese sauce. Journal of Biological Chemistry and Environmental Sciences, 2015, 9, pp. 357-372.

[2] Gazi, S. K. N., Hosseini, S. E. H., Yakhchali, S. Y. & Borajee, M., The Application of the statistical methods to measure the effect of adding a bamboo fiber and combine it with animal collagen on the physical, chemical and sensory characteristics of nags tilapia fish. International Conference on Literature, History, Humanities and Social Sciences, 2017, pp. 28-31, https://doi.org/10.15242/ICEHM.ED0117031.

[3] Phillips G. O., Dietary fibre: A chemical category or a health ingredient?. Bioactive Carbohydrates and Dietary Fibre, 2013, 1(1), pp. 3–9.

[4] Brodziak, A., Król, J., Litwińczuk, Z., Whey proteins - functional properties and application, Przemysł Spożywczy, 2012, 66, pp. 35-37 [In Polish].