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# **BOOK OF ABSTRACTS**

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# **I AGRICULTURAL MACHINERY**

## Effects of the divers olive harvesting systems on oil quality

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**Abstract.** Three olives harvesting systems from the tree have been compared (manual, facilitated and mechanical) through experimental trials carried out respectively in three plots of a Calabrian olive orchard in the Province of Crotone. The grove is traditional and monovarietal, composed of *Carolea* cultivar with a planting density of about 150 plants ha<sup>-1</sup>. In this study, work productivity in three divers sites where harvesting was achieved according to different systems has been examined, as well as their effects on produced oil quality. Olives have been harvested by mean of sticks and nets in the manual harvesting (system I), by mechanical aids and nets in the facilitated harvesting (system II) and finally, by mean of trunk shaker and nets in mechanical harvesting (system III). The different work sites have been examined in terms of work productivity, as well as in terms of impact on final product quality, through the withdrawal of a series of oil samples extracted separately and analyzed in laboratory. From the effectuated trials, it has emerged that the site operating with mechanical harvesting has achieved the best results, both from quantitative and qualitative points of view. Indeed, olives harvested mechanically, certainly more intact than those harvested with other systems, produced oil with the best organoleptic parameters.

**Key words:** olives, mechanical harvesting, oil quality.

## Maintenance interval optimization based on fuel consumption data via GPS monitoring

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**Abstract.** Properly performed preventive maintenance is one of the basic conditions for ensuring the operability of the mobile machines. There are basically two types of preventive maintenance: scheduled maintenance with pre-determined intervals and maintenance by the technical state. Common practice shows that maintenance intervals are often determined only by a qualified estimate of the machine manufacturer or maintenance manager, which results in costs increase. The authors proposed new method of using the modern technology of Global Positioning System, in order to reduce costs of preventive maintenance. Mentioned technologies allow users to monitor a number of operational parameters of mobile machinery in real time. Collected data obtained from the operation can be used for decision-making of maintenance activities. For ensuring the availability of mobile machinery it is important to determine the optimal maintenance interval. The authors proposed method for using data from satellite monitoring using the criterial function in order to determine the optimal interval for performing preventive maintenance. Proposed method is demonstrated on the example of accurate determination of preventive maintenance intervals for several mobile machines. Using data from satellite monitoring and subsequent data processing contribute to better maintenance planning and consequently to economical operation.

**Key words:** maintenance interval, preventive maintenance, maintenance costs, satellite monitoring.

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## Determination of power loss of combine harvester travel gear

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**Abstract.** This contribution aims at determining the power loss in hydraulic circuits of the John Deere S680i combine harvester travel gear. The individual elements of the circuit were measured, followed by an energy intensity analysis. The analysis includes the calculation of pressure losses in direct piping, local resistance, as well as pressure losses in the individual elements of the circuit. Subsequently, power loss was calculated based on pressure losses. In the case of the John Deere S680i combine harvester, the power loss equals 16.95 kW.

**Key words:** combine harvester, hydrostatic travel, pressure loss, power loss.

**ACKNOWLEDGEMENTS.** This contribution has been drawn up on the basis of the solution of project 2014: 31160/1312/3118 financed by the Internal Grant Agency of the Faculty of Engineering of the Czech University of Life Sciences Prague.



## Use of Euler equations in research into three-dimensional oscillations of sugar beet root during its vibration-assisted lifting

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**Abstract.** Following the results of the research into the physical process of the vibratory interaction between the digging tool and the beet root, it has been found that the latter, while standing in soil, i.e. amid an elastic medium, has strong attachment to the soil in its lower (the densest and driest) part, which virtually implies one conventional fixed point. This finding provides the basis for examination of the three-dimensional motion of the beet root's body during its lifting from the ground in case of its asymmetric interaction with one of the shares of the vibrating digging tool. We have studied the gyration of the beet root's body about a point initiated by its interaction with the inclined face of the vibrating digging tool share that makes oscillatory movements in the longitudinal vertical plane. The aim of the study is to establish the values of the angular displacements of the root's body at the moment of its getting in asymmetric contact with the vibrating digging tool followed by the breaking of its bonds with the surrounding elastic medium, i.e. to develop a new mathematical model of the vibration-assisted digging of a beet root out of the soil. Basing on the use of the original equations of Euler, a new differential equation system has been obtained, which facilitates the analytical treatment of the mentioned work process. That system of differential equations for the three-dimensional oscillations of the root caused by the action of a perturbing force comprises three dynamic and three kinematic equations. It is a determined system, which makes possible its solution, i.e. the numerical modelling of the process of root lifting from the ground under different digging conditions, because it includes all necessary parameters of the vibrating digging tool, the sugar beet root and the soil surrounding it.

**Key words:** sugar beet root, vibrating digging tool, three-dimensional motion, lifting, modelling.

## Mulcher energy intensity measurement in dependence on performance

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**Abstract.** Conventional impact grass cutting and chopping is energy intensive and therefore it is important to reduce energy demands of such a device. In the paper the energy demands of three-rotor mulcher with vertical axis of rotation was measured and analyzed in dependence on the mass performance of the mulcher. Different mass performance was achieved by different ground speed and yield of the grass cover. The measurement was performed on clover-grass meadow hay, from which the samples were taken and analyzed in order to determine the yield and moisture content of the vegetation. The results showed relatively high energy demands of the mulcher. In dependence on the mass performance of the mulcher it is necessary to deliver in average 10.4–22.6 kW m<sup>-1</sup> of the width of the machine. Specific energy consumption varied in average from 3.35 to 6.34 kWh t<sup>-1</sup> of the processed material and unit fuel consumption varied in average from 2.56 to 0.94 kg t<sup>-1</sup>.

**Key words:** mulcher, energy consumption, grass cutting, meadow hay.

**ACKNOWLEDGEMENTS.** The paper was created with the grant support project CULS 2014:31190/1312/3127 – Utilization of biobutanol as a fuel for diesel engines and with institutional support for long-term conceptual development VÚZT, v.v.i. RO0614.

## Comparison of tyres for self-propelled sprayers

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**Abstract.** This article deals with comparison of two types of tyres (MITAS VF and MITAS AC 85) for self-propelled sprayers in terms of their grip properties and effect on soil. The MITAS VF tyre has a new construction allowing it to work with lower inflation pressure and in higher speed than standard tyre. In order to compare the grip properties there was measured dependence of slippage on tractive force. In order to compare the effect on soil there will be measured footprint area of tyre, specific pressure on base (material), compaction of topsoil by means of wire profilograph and penetration resistance of soil by means of penetrometer. The measurement has been taken place on medium-heavy soil, on stubble after wheat cultivation. The MITAS AC tyres showed lesser tread pattern than the MITAS VF tyres. The VF tyres showed also better grip properties and lesser effect on the topsoil. The soil cone index showed statistically not significant difference in comparison with non-compacted soil and it was approximately the same in case of both variants.

**Key words:** tyres, sprayer, tractive force, slippage, soil compaction.

**ACKNOWLEDGEMENT.** The paper was created with institutional support for long-term conceptual development VÚZT, v.v.i. RO0614.

## The influence of a system with permanent traffic lanes on physical properties of soil, soil tillage quality and surface water runoff

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**Abstract.** The system with permanent driving tracks at the module of machines working width 6 metres, practised in a 10-ha field, allowed to consistently separate the area designed for restricted traffic lanes of farm machines from the production area of the field. The aim of the study is to assess the selected indicators of the condition of topsoil, which is characterized by soil porosity, indicators of soil workability, soil ability to absorb water from rainfall and soil loss by wash after four years of controlled traffic system application in a field trial. Indicators of soil condition were evaluated in four variants with different wheel impacts of tractors and other machines on the soil. A field trial was established in the spring 2010; the measured values in the study are from 2013 and 2014. The results show an advantage, which represents concentration of passages into permanent tracks aimed at protection of most part of a plot from soil compaction. Hardness of clods after tillage in autumn 2013 was five times higher in places with random traffic (356.7 kPa) than outside traffic lanes in the system of controlled traffic (70 kPa). An important result is that the system with permanent traffic lanes made it possible to increase the soil capacity of taking up water under intensive rainfall – in comparison to a part of the land with random passes. The results of measurements with a rainfall simulator in April 2014 showed that cumulative surface runoff after sixty minutes was 7.6 l m<sup>-2</sup> on the land with random passes while 3.9 l m<sup>-2</sup> outside the traffic lanes (32% of the area of the field). The soil loss by wash during water surface runoff was also lower with controlled traffic compared to the variant with random passes. Therefore it is to assume that suitable application of the controlled traffic farming system may be a contribution to soil protection from water erosion.

**Key words:** soil compaction, controlled traffic farming, surface water runoff, water erosion.

**ACKNOWLEDGEMENTS.** Supported by the Ministry of Agriculture of the Czech Republic under the institutional support for long-term strategic development of RIAE, p.r.i., RO0614.

## Investigation of the technological spring harvesting variants of the industrial hemp stalk mass

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**Abstract.** One of the simplest technological solutions of hemp harvesting applied in practice in Latvia and some other countries is harvesting of the hemp stalks in spring. Implementation of this technology does not require expensive specialised machinery. However, there are significant losses of the mass and quality of the product. The loss of hemp stalk mass in two-stage harvesting (Option A: harvesting of the seedy part of the yield by means of grain harvesting combines and subsequent gathering of the stalks in spring) constitutes approximately 50–80%. The basic possible solution for reducing these losses is raising the cutting height of the stalks when the seedy part of the yield is harvested. With spring harvesting, Option B, the mass of the stalks is preserved, while the seedy part of the yield is completely lost. A rational solution for spring harvesting can be established by calculations, considering the crop volume and the prices of the seeds and stalks sold, as well as the value of technological losses. In the tests conducted during a subsequent harvest in spring the tensile strength of the fibres of the uncut hemp stalks was 25–52% lower than the strength of the fibres harvested in autumn.

**Keywords:** industrial hemp, spring harvesting, loss of stalks.

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## Use of combined pneumatic conveying in the processing of granular waste materials

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**Abstract.** This paper focuses on the structural design, verification and operational functions of combined pneumatic and mechanical transport systems in processing granular materials. A pilot plant was designed in laboratory conditions and the combined pneumatic and mechanical transport system was tested in operation. Subsequently, transport possibilities for granular waste materials, which varied in size and specific particle weight, were evaluated. A combined pneumatic and mechanical transport system was designed as a transport line for pneumatic conveying at low pressure in combination with a mechanical towing component. The combination of both modes was designed so that the towing component in the form of an axis-less helix was inserted into the conveying pipe. Transport efficiency was monitored by comparing common pneumatic transport and combined pneumatic transport (pneumatic and mechanical transport). Both systems were tested under the same operating conditions with various granular waste materials, which varied in size and specific particle weight. Crushed electric waste was used as granular material to assess the operational functions used. Properties of the proposed transport system were tested by constructing and operating the system. The evaluation of transport options featuring pneumatic and combined (pneumatic and mechanical) transport systems proved that the system was reliable and highly efficient for the transportation of dry granular waste.

**Key words:** pneumatic conveying, mechanical conveying, granular waste.

## Continuous airflow rate control in a recirculating batch grain dryer

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**Abstract.** As the energy efficiency requirements in agriculture increase, offers grain drying opportunities for substantial energy saving. Earlier work indicated that energy savings in grain drying can be achieved by controlling the drying airflow rate during the drying process. Aim of this study was to design an embedded control system, based on microcontroller, for continuous airflow rate control in a recirculating batch grain dryer and to test it in a scaled-down research dryer. The control system proved to be working as designed, reducing the dryer airflow rate smoothly towards the end of the process. However, additional research of the energy efficiency and performance of the dryer using the airflow rate control is needed.

**Key words:** grain drying, grain dryer, energy efficiency, airflow rate control, drying air temperature.

**ACKNOWLEDGEMENTS.** This study was funded by the foundation of Marjatta and Eino Kolli.

## Measurement of tensile force at the fundamental tillage using tractor's build-in sensor and external sensor connected between machines and their comparison

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**Abstract.** The value of tensile force during soil tillage is crucial for estimating the energy performance of trailed machines.

For tensile force measurements, a mouldboard plough with working width of 4 m was used. The ploughing speed was approximately 7 km h<sup>-1</sup>. Measurements were carried out on two plots with different soil texture. Loam-sandy soil dominated on the first plot, whereas clay soil dominated on the second one. The slopes of the plots are 1.1° and 2.4° respectively. Both plots have been left without stubble modification after harvest. The dynamometer LUKAS type S-38 was used for measuring tensile force. The dynamometer was placed on a hinge, which was positioned between two tractors. As a second method of tensile force measurement, electro-hydraulic hitch sensors were used, from which the values were recorded.

The obtained values of tensile force were approximately 30 kN on the first plot and 54.3 kN on the second plot. The interdependence values of tensile forces between internal and external sensors showed a high coefficient of determination  $R^2 = 0.91$  in regression data analysis.

The comparison of tensile force measurements using a special dynamometer and electro-hydraulic tractor sensor proved that the outputs of serial sensors can be used for the continuous monitoring of tensile forces during operating the machine. The automated storage of data collected from tractor sensors during tillage can greatly simplify this work, while no additional expenses are incurred to obtain data. Thus, the findings can be used to determine the variability of the land.

**Key words:** force sensing, soil tillage, tensile force, soil variability, soil mapping.

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## Dependency of hop material fall through on the size of gaps between rollers of the roller conveyor in separating machine

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**Abstract.** This paper deals with a roller conveyor which forms a part of the separating machine for hops harvested from low trellises. One of the parameters that influences the correct operation of this conveyor is tested, namely the gap between the rollers. The aim of the test was to discover whether the fact that hop matter falls through the rollers depends on the size of the gap between the rollers. For testing purposes a model of the roller conveyor was designed, made and subsequently tested in a series of experiments with the purpose of integrating it into a separating machine. The measurements were carried out using a sample of hop matter harvested from low trellises. The dependency of falling matter upon the gaps was determined in view of eight gaps between the rollers. The measurements revealed that the gap size has an influence on the falling of hop cones and small-sized admixtures only if the gap size is larger than the size of the hop cones. At the same time, this parameter has no substantial influence on the separation of medium-length and long stems which were separated perfectly.

**Key words:** hops, separating machine, roller conveyor.

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## Measurement of electrical conductivity of DAP fertilizer

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**Abstract.** Paper deals with the measurement of electrical conductivity of significant size groups of mineral fertilizer DAP divided in the air stream. Samples of these groups were dissolved in distilled water and the values of electrical conductivity recorded. Measurements will be used to monitor the electrical conductivity of other mineral fertilizers and to create a standard for qualitative assessment of fertilizer solutions.

**Key words:** electrical conductivity, air flow, fertilizer solution, concentration, DAP.

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## Plant remains distribution quality of different combine harvesters in connection with conservation tillage technologies

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**Abstract.** Conservation tillage technologies are nowadays a part of modern agriculture. These technologies are used in plant production all around the world. Typical feature for these shallow soil tillage technologies is that all plant residues are left on the soil surface or in the treated (tilled) upper soil layer. The plant residues can significantly influence the next plant germination and growth, especially when they are unevenly placed on the field surface. Today's modern combine harvesters are able to crush and distribute all plant remains quite evenly with satisfactory results but all their mechanisms have to be properly set and sometimes some small improvements have to be done. This paper describes and evaluates the husk and straw distribution quality – the distribution pattern, on two very commonly used combine harvesters – CASE IH and JOHN DEERE. The measurement was carried out on serially manufactured machines without any change on them and with a small improvement on distribution mechanisms. The measurement of husk and straw distribution pattern was carried out on CASE IH combine harvester with an axial threshing system and on John Deere with a conventional tangential threshing system. Thereby it was possible to compare two completely different systems of threshing process and to observe a possible influence on straw and husk distribution quality (distribution pattern).

The most important outcome of the measurement of straw and husk distributors' work quality on combine harvesters is that cross irregularity of husk and straw distribution depends on instantaneous material feedrate through the harvester.

**Key words:** straw crushing, combine harvesters, conservation tillage, plant remains, distribution pattern.

## Sensitivity of capacitive throughput sensor to the change of material relative permittivity

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**Abstract.** The capacitive throughput sensors have been tested in many applications (e.g. the throughput measurement of potatoes, sugar beet, chopped maize and hops). The results showed that the capacitive throughput sensors can be very perspective in some cases. The capacitive sensor for the throughput measurement can be described as a parallel plate capacitor where the dielectric is a mixture of air and the measured material. The equivalent dielectric constant increases with the increasing thickness of the material layer between the plates and the electric capacitance of the capacitor is increasing as well. The thickness of the material layer between the plates can be then determined via the electrical capacitance measurement. The main goal of this work is to describe the relationship between the relative permittivity of the material and the sensor output. The sensor values output directly depend on the sensor impedance and it is influenced by the electric field between the electrodes. The electric field is most influenced by the dielectric properties of the material and the distribution of the material. It was found that the influence of the relative permittivity change is significant only for less values (approximately 10 and less). These results mean that the material with the higher relative permittivity is useful for the capacitive throughput sensor. Also this behaviour can explain why the influence of the moisture is less significant for the moister material, because moister materials have higher relative permittivity.

**Key words:** capacitive throughput sensor, relative permittivity, moisture content.

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## Production of high quality hemp shives with a new cleaning system

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**Abstract.** A shortage as well as a rise in costs for raw materials as used for production of derived timber products and fibre composites can be observed for quite some time. Especially the use of wood as energy source has led to an increased demand for cellulose raw materials. Non wood resources e.g. from agricultural production are coming into consideration as alternatives or as replenishment to conventional raw material stock. Therefore, there is an increasing demand for high-grade hemp and flax fibres as a raw material e.g. for production of natural fibre reinforced composites. Within this context also the non-fibrous fraction of fibre plants – shives or hurds – are suitable for different applications in composite or fibre board industry. At present, approx. 50% of the income of a hemp fibre processor is generated by marketing quality shives. There is still a substantial need for efficient shive processing and cleaning technologies. Cleaned high quality hemp shives can be used not only for animal bedding, but also for particle board or composite production. Hence, ATB has developed a simple but efficient technology for cleaning of shive-fibre mixtures. It allows classification and cleaning of shives as well as recovering of short fibres in only one processing step. On basis of these results, the developed fractionating system has been patented and scaled up to an industrial system in cooperation with a machine supplier for hemp processing equipment. The machine has been successfully tested with different machine settings as well as different varieties of input material.

**Key words:** hemp, fibres, shives, shive-fibre mixture, cleaning machine.

## The effect of genotype on table grapes soluble solids content

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**Abstract.** Sugar concentration in fresh consumed table grapes is mainly connected with technological maturity and primarily expressed by soluble solids content. The EU Regulation has laid down maturity requirements for *Vitis vinifera* L. cultivars (OJ L 157, 15.6.2011). The lowest allowed soluble solids content is 13 °Brix for seeded cultivars and 14 °Brix for seedless cultivars. In cool climate there are mainly cultivated grape hybrid cultivars which refractometric index is not regulated with this regulation. The aim of the present experiment was to investigate the accumulation dynamics and content of soluble solids from the beginning of veraison to harvest in table grapes with protected cultivation condition. The research was conducted with 3 black ('Osella', 'Kosmonavt', 'Mars'), 3 red ('Swenson Red', 'Somerset Seedless', 'Canadice') and 2 white ('Arkadia', 'Supaga') vine cultivars in 2013 and 2014. The results of the study indicated, that fruits of all table grape cultivars achieved the minimum content of soluble solids required for table grapes. Two years mean of soluble solids content varied among black, red and white grape cultivars respectively from 15.0 to 22.1 °Brix, from 15.6 to 22.5 °Brix and from 13.9 to 18.9 °Brix. The highest soluble solids content was observed in both years among black cultivars in Osella, among red cultivars in Somerset Seedless and among white in Supaga.

**Key words:** Brix, *Vitis* sp., hybrid cultivars.

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## Theoretical research into the frictional slipping of wheel-type undercarriage taking into account the limitation of their impact on the soil

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**Abstract.** The frictional slipping of the tractor's wheels causes great damage to the soil fertility. To ensure the minimal disturbance of its structure, it has been proposed to determine the maximum slippage of driving wheels taking into account the value of their permissible pressure on the soil in the horizontal plane. As a result, it has been established that for the substantial reduction of the soil structural damage during the spring agricultural field operations the maximum permissible frictional sliding  $\delta_{max}$  of the wheel-type undercarriage of tractors classified into drawbar pull categories 5, 3 and 1.4 (drawbar pull based classification approach is used in Ukraine and some other countries) has to be equal to 15%, 12% and 9% respectively. In the summer/autumn period, the values  $\delta_{max}$  can be greater and, accordingly, be equal to 20%, 16% and 13%. Wheeled tractors in drawbar pull category 5 equipped with single standard tyres can be used for field operations only in the summer/autumn period. For their operation in spring they must certainly be equipped with twin tyres. The implementation of this design solution is appropriate for all wheeled tractors.

**Key words:** agricultural engineering, tractor, undercarriage, driving wheel, tyre, drawbar pull category, slipping.

## Application of overlaying material on surface of ploughshare for increasing its service life and abrasive wear resistance

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**Abstract.** Soil processing is one of the most basic operations in vegetable production. This research project focuses on extending the service life of ploughshares by covering the tools with an oblique deposited overlaying material which is resistant to abrasive wear. The overlaying material was put in place parallel to the ploughshare's head, both to the front part as well as the back. The new functional profile of the conventional tool was created with overlaying electrodes so that the processed soil could drop from the tool. Carbide type (Soudokay A43-0, OK Tubrodur 14.70, OK Tubrodur 15.82) and martensitic type (Filarc PZ 6159) materials were used. Tested variants (overlays OK Tubrodur 15.82 and Filarc PZ 6159 above all) proved that the service life of the area at the top of the ploughshare's cutting edge was prolonged. This parameter is essential for effective ploughing.

**Key words:** soil processing, extending service life, functional profile.

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## Laser scanner based collision prevention system for autonomous agricultural tractor

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**Abstract.** In manned agricultural vehicles, the automated systems assist the driver by reducing the workload. This is achieved e.g. by using an automatic guidance system to steer the tractor along the desired path. However, increasing automation tends to cause a reduction of awareness, so risks to collide obstacles in the field are higher. In this study, an autonomous tractor was equipped with front side laserscanner (LIDAR) to sense the environment in front. The laserscanner scans the environment at 50 Hz rate. The theoretical maximum range of the sensor is 25 m, but it was found in the tests, that in agricultural field conditions, the feasible range is not more than 7 m, due to the sunlight disturbance. Agricultural vehicles weigh tons, so the deceleration is limited and the limited range causes challenges to detect the obstacle and decelerate without colliding it. The developed algorithm is able to detect solid objects, like electricity poles in the trajectory. The deceleration algorithm is based on the known dynamics and actuator delays of the tractor locomotion system, by taking into account the maximum deceleration rate. In field tests, the system was evaluated in grass fields. In the first test, the system was tested with real electricity poles with no implement. In the second test, the system was tested with a mower and by using artificial obstacles placed into the grass. The system was able to detect the obstacles with high accuracy and stop precisely, but in the corners of the field the system caused false positives when the sensor was sensing beyond the edges of the field plot.

**Key words:** tractors, vehicles, robotics, environment sensing, autonomous emergency brake, accidents, control systems.

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## Temperature distribution analysis inside the strawberry flower head

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**Abstract.** Different studies by numerous researchers were carried out recently to describe different heat flux components of heat balance equations for radiation frost condition in plants. The aim of most of the papers was to present more simple and clear mathematical algebra to show the plant heat balance formulas. To achieve this aim several simplifications were made. Nevertheless there are studies reporting different flower damage rates during spring frost sessions that mentioned studies cannot explain. This leads us to the need to find the temperature distribution inside the flower to understand why during the similar energy flux conditions the flowers act against frost stress differently. It's easy to measure the flower surface temperature but rather difficult to measure temperature distribution inside the flower head due to very small flower head scale compared to sensor sizes. To help to overcome these difficulties the authors make simplification by substituting the strawberry flower head with spherical homogeneous body though it is clear that the flower head is not homogeneous because of varying flower structure.

The aim of this study is to present mathematical formulas for temperature distribution calculation inside the spherical body in terms of heat transfer conditions characteristic to radiation frost. Transient numerical methods are implemented for different conditions in case of spherical body. This approach enables us to decide if suggested mathematical solution is usable for non-homogeneous body. Computer program was prepared to analyse the results.

**Key words:** radiation frost, temperature distribution, plant, transient numerical method.

## Compaction capacity rating of agricultural tyres

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**Abstract.** Compaction Capacity (CC) rating of tyres presents a unique numerical CC index evaluating soil compaction risk of loaded tyres. The CC rating is a final product of experimental research and analysis of relations between external load and soil compaction, avoiding the intermediary role of soil stress. The research included laboratory model measurements of soil compaction by rigid round pressure plates in a cylindrical soil container. Equation for the CC index reads:  $CC = 1,000 [(soil\ dry\ density/1420) - 1]$ , where the number 1,420 indicates the dry density of loam in  $kg\ m^{-3}$ , critical for plant growth. The CC rating takes into account the area of tyre-ground contact patch and tyre load, which depends on inflation pressure. If the average dry density is 10% higher than the critical dry density, the CC index equals 100. This is considered as a practical limit to ecological tyre operation on cultivated crop-producing land. The paper consists of these main conclusions: Laboratory soil compaction measurements by means of a selected rigid pressure plate can serve to the assessment of soil compaction below tyre footprints under certain conditions. The laboratory measurements and its applications must deal with a specified soil, specific loam type, denoted as standard soil, the standard soil in the laboratory cylindrical container must show a uniform dry density, suitable moisture content below the plastic limit and small size of particles, the compaction function  $CF_1$  under a certain pressure plate  $P_1$  can be point by point converted into compaction function under a different pressure plate  $P_2$  if the mean contact pressures of both plates are equal, the soil dry densities under a tyre footprint in the depths 20, 30, 40 and 50 cm below the ground surface are determined, using this conversion, by means of databank of measured compaction functions CFC of the pressure plate C. The auxiliary items entering above mentioned conversion were: (a) the tyre footprint area, which is calculated from a proper equation or measured using the tyre footprint attachment; (b) the depth of rut pressed by a tyre, which is calculated from an empirical equation based on the depths of modelling imprints by pressure plates and field measurements with loaded tyres; (c) the relationship between the soil dry density at zero depth under a tyre footprint and the tyre footprint area with mean contact pressure as a parameter, expressed by the G-function which satisfies boundary conditions for a footprint area equalling zero or infinity and complies with the regression of the soil dry density at zero depth as a function of mean contact pressure for standardized pressure plate. The comprehensive computer program was created and it enables to evaluate CC-rating of arbitrary tyre.

## Evaluation of measuring frame for soil tillage machines draught force measurement

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**Abstract.** The knowledge of energy demands of the machines for soil tillage is useful factor for machinery design and also farm management. Currently used methods of draught force measurement are based on the use of the measuring rod. Basic part of this measurement apparatus is strain gauge load cell which is protected against damage by steel cage so that the forces were applied only in tension or compression. The main disadvantage of this solution is the necessity of using two tractors for the measurement: pulling one and pulled one equipped with soil tillage machine.

To avoid this disadvantage, measuring frame for soil tillage machines draught force measurement was developed. For the evaluation of measuring frame function consequent measurement arrangement was used: crawler tractor John Deere 8320 RT as a pulling device, measuring frame mounted on its three point hitch, measuring rod connecting measuring frame and pulled wheel tractor New Holland T7050 and Kőckerling Exact Gruber Vario soil tillage machine with 5 m working width.

When comparing draught force results from strain gauge load cell placed into measuring frame with those from measuring rod it was found that there existed no statistically significant difference between the data from measuring frame and measuring rod. Measuring frame can be used for the aim of soil tillage machines draught force measurement and pulled tractor is not necessary in this case.

**Key words:** soil tillage, draught forces, soil properties.

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## Taxonomic diversity of bacterial populations inhabiting gametophytes of *Sphagnum* mosses from different geographic regions of Russia

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**Abstract.** In this study we have analyzed the diversity of the endophytic bacterial community associated with *Sphagnum* mosses from North-West Region and Khanty-Mansiysk Autonomous District of Russia during the years 2009–2012. We isolated a more than 400 strains which were identified by means of phenotypic tests and by 16S rRNA sequences. The ribosomal data showed that the isolates belonged to genera *Pseudomonas* (20–57%), *Colimonas* (7–10%), *Flavobacterium* (6–8%), *Burkholderia* (5–6%), *Serratia* (3%). The data reported in this work are consistent with the results of research performed by the Berg group with samples of mosses of the Austrian Alps. It was found that *Sphagnum* mosses are a promising source for the isolation of beneficial microorganisms.

**Key words:** *Sphagnum* mosses, endophytic bacteria, microbial community, biodiversity.

**ACKNOWLEDGEMENTS.** This study was financially supported by the Government of the Russian Federation, grant 074-U01 and performed on the equipment of the Centre for Collective Use 'Genomic technologies and cell biology' ARRIAM. The work of A.V. Shcherbakov and V.K. Chebotar was supported by the Russian Scientific Fund (project no. 14-16-00146).

## Development of in-store dryer model for corn for varying inlet conditions

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**Abstract.** Many thin layer drying models have been developed for constant inlet conditions. During deep bed drying, drying air conditions vary with position in the bed and also vary with time, so models developed for thin layers under constant conditions are not valid for deep bed drying analysis. A new thin layer drying rate model (called the two-layer model) is presented which allows for varying air conditions. The model was applied to corn by retro-fitting the model to Page's mode as fitted by Li and Morey (1984). The model was then incorporated into a deep bed simulation and the results compared with pilot plant drying data. During drying experiments, constant air conditions and varying air conditions were both tested. For constant conditions, all models gave reasonable agreement, but for varying drying conditions, the diffusion model showed an ability to respond better to changes.

**Key words:** drying, corn, diffusion model, two layer model, varying air conditions.

**ACKNOWLEDGEMENTS.** The contribution of Ingredion ANZ Pty Ltd, who provided the corn samples, is acknowledged.

## **II LIVESTOCK TECHNOLOGY**

## Forced convection in drying of poultry manure

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**Abstract.** Pollution of environment by animal waste can be problem of intensive animal production in many countries with high density of animal farms. The aim of this paper is to inform about the experimental and theoretical investigations of moisture content reduction from poultry manure by forced convection. The experimental data created the background for calculation and modelling, which resulted in definition of the theoretical drying coefficient, useful for description and modelling of the drying process. The theoretical model has been verified and compared with experimental results obtained from the measurement. The laboratory equipment was used for test the forced convective drying of poultry manure due to vertical air streams going from bottom through supporting trays with holes and therefore through the manure up. Changed opened area of trays with different density has been used for definition of main parameters, which can serve especially in designing and construction of the new equipment for housing of poultry or improvement of the use of drying tunnel or in similar applications. The experimental data show that the air flow significantly increase the amount of moisture carried away from the material. Holes' size does not significantly affect water runoff by convection without additional air flow.

**Key words:** air, bottom drying, drying coefficient, model, moisture.



## Comparison of dairy potential in Europe and its effect on assessment of milking systems

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**Abstract.** The development of milking systems is one of the most important examples proving the dynamic improvement of dairy production on the basis of a technical infrastructure. Farm milking systems incorporate many technical solutions—this provides a basis for analysing and assessing different milking systems in use today. Milking systems can be evaluated on the basis of a set of data and indices directly connected with the work of milking installations. The purpose of the analysis is to show how different kind of milking systems can be assessed in view of milk and its selected features, especially the value of the milk.

**Key words:** assessment, milking system, dairy production, technical equipment.

## Security methods for livestock buildings including assessment aspects

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**Abstract.** The problem of security methods affects a large proportion of intrusion and hold-up alarm systems (I&HAS). In a time of increasing property crime, it is highly important for the security methods of livestock buildings to be able to achieve efficiency, reliability and faultlessness. In case it is proposed to place detectors, it is essential to determine the position of the detectors, the types of the detectors, but also to guarantee their capability of detection for use in livestock production buildings. The security proposals, which have been conducted, examine both the normal security methods in livestock production as well as cost and long-term financial expenses (investment in the communicator, private security guards etc.). These security proposals are important both from an informative perspective and also because of the possibility of using individual proposals in securing livestock production in practice. The aim was to compare the two kinds of security methods for a livestock building object. The compared values become the acquisition costs of security system.

**Key words:** security risks, sabotage, intrusion and hold-up alarm systems, glass break detector.

## Cow crowding in waiting yard using mechanical drivers and its influence on productivity of rotary type milking equipment

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**Abstract.** At present rotary type milking equipment is popular in Latvia. It is used almost on all farms where there are 400 and more cows. Nevertheless, the maximal productivity of work can be reached if the cows are continuously driven from the waiting yard to the milking equipment and if sufficient intensity of animal traffic is ensured. Therefore, the rotary type milking equipment is usually supplemented with a mechanical cow driver that crowds the cows in the waiting yard at the same time driving them towards the milking parlour. In the research it has been stated that using the heavy type mechanical cow drivers Cow Mander 640 or Cow Mander 740 the maximal cow crowding in the waiting yard reaches 1.1–1.2 m<sup>2</sup> calculating per one cow and it ensures the cow traffic intensity 8–11 s cow<sup>-1</sup>. If, in turn, the medium heavy driver Cow Mander 015 is used, the cow crowding is only 1.5–1.7 m<sup>2</sup> cow<sup>-1</sup> and the cow traffic intensity reaches 15–23 s cow<sup>-1</sup>. Using rotary type milking equipment with 20–30 milking places such cow traffic intensity is sufficient but if the rotary milking equipment has 50 and more milking places the necessary cow traffic intensity cannot any more be ensured by increasing the cow crowding. Therefore, the exploitation work productivity of the rotary type milking equipment with 50 and more places is by 30–40% less than its technological productivity of work that is obtained by means of calculations.

**Key words:** cow crowding, cow traffic intensity, mechanical cow drivers, productivity of work, rotary type milking equipment.

## Heating and ventilation in milking parlours

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**Abstract.** The aim of this paper is to show the results of the measurement of main microclimatic parameters (temperature and relative humidity) in milking parlours and compare the obtained results with values recommended in relevant standards. Temperature and relative humidity can affect animal welfare as well as the well-being of workers. These parameters were measured in three rotary milking parlours with herringbone type of stalls, each for 24 dairy cows. Two of these milking parlours were built in 2001 and one was built in 2009. Measurements were taken during the winter and summer periods, under extremely cold or high temperature conditions. Measurements were taken during the milking process for about two hours using suitable sensors for measurement of indoor temperature and relative humidity. The data of outside temperature and relative humidity were also obtained and compared with indoor data. The final results of the research were generalized. It is obvious from the results of measurements of selected milking parlours that heating and ventilation of milking parlours is insufficient. To set up adequate heating power, the heat balance of milking parlours was calculated. For adequate ventilation, the necessary flow of fresh air was calculated for both winter and summer periods. Also the methods of how to achieve these air flows are presented.

**Key words:** measurement, relative humidity, temperature, THI.

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## Producing the vacuum in modern drawn milking systems

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**Abstract.** This paper deals with the measurement of the modern method of producing and regulating the vacuum in milking equipment which is currently in use. Individual measurements are primarily focused on evaluating the latest knowledge in the design, management and stabilization of the vacuum in modern milking systems. In the evaluation, emphasis was placed on economic efficiency with regard to energy consumption, environmental friendliness, high performance, operational reliability and ease of operation in the creation and control of the vacuum. The basic element of every milking system is the vacuum pump. This feature of the machine provides a vacuum for milking, milk transportation and for the activities of other devices whose task is, e.g., scanning the milking equipment or controlling movable barriers at milking parlours.

In this paper, a frequency converter was used, which is, used in milking technology for regulating and controlling the vacuum through changing the rotational speed of the vacuum pumps which do not require the use of centrifugal force to seal the working space to create a vacuum. The aim of the measurements using the above-mentioned inverter was to check the performance of the pump at different speeds and different vacuum levels to determine the actual air flow need over the milking cycle.

**Key words:** milking system, milking unit, vacuum system, vacuum regulation, vacuum air pump, frequency converter.

## Direct energy consumption and saving possibilities in milk production

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**Abstract.** Direct energy consumption in milk production varies largely because of machinery, production systems, working habits and maintenance. There are good possibilities to save energy in milk production. The magnitude of energy savings are in the order of tens of percent, which means that energy saving potential is quite high. Energy saving can be achieved with efficient system and machinery choices. Also adjustments and maintenance have an effect on energy consumption. To save energy the farmers should have means to measure energy and follow energy consumption. There should also be more information of energy saving possibilities and machinery energy consumptions.

**Key words:** energy, milk production, ventilation, lighting, milking, milk cooling.

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## **III BIOENERGY**

## Biogas: Research needs and the potential contribution to European targets

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**Abstract.** The paper considers the contribution that anaerobic digestion can make in producing renewable energy, reducing greenhouse gas emissions, improving environmental sustainability and performing a waste management function. It takes examples from across Europe to show the flexibility of use of biogas in CHP, as a vehicle fuel, for heating and cooling and for grid injection. GHG emissions are considered in the context of both reducing fugitive emissions from alternative management options by the adoption of biogas technology and also how it can contribute to GHG reduction through fossil fuel displacement. The waste management function is considered in light of the European Landfill Directive and the need to divert organics and ideally to recover the resource potential of these. Anaerobic digestion can be used as a key technology in meeting environmental targets and improving sustainability by being integrated into both urban and agricultural waste management systems thus promoting the concept of a circular economy by linking urban food usage to rural food production. The growth of AD as a technology in the EU has, however, only been possible by 'drivers' being put in place at both national and European level, these are a mixture of subsidies, penalties and regulations and are not uniform across the member states.

Research needs are focussed on the need to capture more feedstock through diversification of the process to new sources and types of biomass and the problems that this may create. This is exemplified by the technical difficulties of bringing food waste digestion to a reality in the UK, this was achieved through systematic research and troubleshooting problems in the growing industry.



## **Above ground and below ground biomass in grey alder *Alnus incana* (L.) Moench. young stands on agricultural land in central part of Latvia**

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**Abstract.** Young grey alder stands under 10 years of age that are growing on abandoned agricultural lands in Central Latvian lowlands were selected for this study. In the framework of the research the biomass of the trees was studied and an equation was developed for grey alder stands on abandoned agricultural lands. An allometric equation for the different biomass fractions of grey alder was developed. Tree biomass is characterised by a power model with a single independent variable (DBH), which also indirectly substitutes for the effect of the stand age. The model is adapted to each fraction by changing its ratio values. The determination coefficient of the model is high, varying from  $R^2 = 0.89$  to  $R^2 = 0.94$  and the confidence level of the model is 95%. The biomass of particular fractions is defined by a power regression, with the tree stem diameter at the height of 1.3 m used as an argument. In young grey alder stands on abandoned agricultural lands the majority, 64%, of root fractions is composed of coarse roots, followed by the stump fraction and fine roots, 28% and 8%, respectively. For aboveground biomass the largest fraction is stem, which constitutes 75% of the total aboveground biomass, while the share of branches is 25%.

**Key words:** allometric equations, coarse roots, fine roots, stump, stem, branches, power model.

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## Production of fermentation feedstock from lignocellulosic biomass: applications of membrane separation

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**Abstract.** The development of cost-efficient, highly productive technologies for fermentation feed production from lignocellulose biomass is still a challenge. In this paper, the production of fermentable sugars from lignocellulosic biomass using hydrolysis techniques with membrane separation systems is studied. The research was conducted on both a laboratory and pilot level to evaluate and optimize the efficiency of the proposed technology. The results demonstrated that UF and NF permeate recovery increased efficiency and the highest sugar recovery rates were obtained when secondary waste recirculation was introduced after NF and UF, reaching an almost 40% yield from all produced sugars.

**Key words:** fermentable sugars, lignocellulosic biomass, pre-treatment, membrane separation.

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## Anaerobic digestion of vegetables processing wastes with catalyst metaferm

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**Abstract.** There are 54 active biogas plants in Latvia today. It is necessary to investigate the suitability of various biomasses for energy production. Maize is the dominating crop for biogas production in Latvia. The cultivation of more varied crops with good economical characteristics and a low environmental impact is thus desirable. One of the ways for improving biogas yield in Latvian conditions is using biological catalysts. This paper explores the results of the anaerobic digestion of vegetables' processing wastes using the new biological catalyst Metaferm. The digestion process was investigated in view of biogas production in sixteen 0.7 l digesters operated in batch mode at the temperature of  $38 \pm 1.0$  °C. The average methane yield per unit of dry organic matter added (DOM) from the digestion of onions was  $0.433 \text{ l g}_{\text{DOM}}^{-1}$ ; with 1 ml of Metaferm:  $0.396 \text{ l g}_{\text{DOM}}^{-1}$  and with 2 ml of Metaferm:  $0.394 \text{ l g}_{\text{DOM}}^{-1}$ . The average methane yield from the digestion of carrots was  $0.325 \text{ l g}_{\text{DOM}}^{-1}$ ; with 1 ml of Metaferm:  $0.498 \text{ l g}_{\text{DOM}}^{-1}$  and with 2 ml of Metaferm:  $0.426 \text{ l g}_{\text{DOM}}^{-1}$ . The average additional methane yield per unit of dry organic matter from the digestion of 50%:50% mixed onions and carrots was  $0.382 \text{ l g}_{\text{DOM}}^{-1}$  with 2 ml of Metaferm. The average additional methane yield per unit of dry organic matter from the digestion of cabbage leftovers was  $0.325 \text{ l g}_{\text{DOM}}^{-1}$ ; with 1 ml of Metaferm:  $0.375 \text{ l g}_{\text{DOM}}^{-1}$  and with 2 ml of Metaferm:  $0.415 \text{ l g}_{\text{DOM}}^{-1}$ . The average additional methane yield per unit of dry organic matter from the digestion of potato cuttings was  $0.570 \text{ l g}_{\text{DOM}}^{-1}$ ; with 1 ml of Metaferm:  $0.551 \text{ l g}_{\text{DOM}}^{-1}$  and with 2 ml of Metaferm:  $0.667 \text{ l g}_{\text{DOM}}^{-1}$ . The average additional methane yield per unit of dry organic matter from the digestion of 50%:50% mixed cabbages and potatoes was  $0.613 \text{ l g}_{\text{DOM}}^{-1}$  with 2 ml of Metaferm. All investigated vegetable wastes can be successfully cultivated for energy production under agro-ecological conditions in Latvia. Adding the catalyst Metaferm increased methane yield, except for onions.

**Key words:** anaerobic digestion, onion, carrot, cabbage, potato, biogas, methane, biological catalyst.

## Comparison of technologic parameters of pellets and other solid fuels produced from various raw materials

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**Abstract.** The article relates results of experiments and problem studies, the main goal of which was comparing four alternatives of solid biofuels suitable for heating private houses by low-power boilers. The results were obtained by burning of selected biofuels in an automatic pellet boiler specifically designed for combustion of pelletized fuels with high ash content. The emissions were set up related to the mass of burnt fuels and to the fuels' net calorific value (specific emissions), they were measured and analysed. Based on the emission concentration measurements and stoichiometric calculations, the fuel gas emissions' properties and boiler efficiency were compared at a range of power outputs of 7.5 kW, 12.5 kW and 18.5 kW. With regard to fuel properties and boiler outputs, the emissions of carbon monoxide (CO) were determined as well as emissions of nitrogen oxides (NO<sub>x</sub>) and sulfur dioxide (SO<sub>2</sub>) were measured and compared too. The results permitted to formulate conclusions that the wood pellets were having the lowest values of measured emissions, whereby Jatropha seed cakes showed several times higher emissions in comparison with emissions from wood pellets, oil palm shells and wheat straw pellets, where the last one is a typical representative of the agricultural biomass with relatively high nitrogen content and as was shown higher emissions of NO<sub>x</sub> as compared to wood pellets. Oil palm shells measured emissions were relatively similar to wood pellets emissions, especially concerning emissions of SO<sub>2</sub> and CO. All tested materials were having very low combustible sulphur contents and therefore the specific SO<sub>2</sub> emissions were negligible at all these fuels. A very important finding was that the amount of emissions was dependent on boiler output, where with the output decreasing the amount of emissions was growing. The other linkage – dependence of the boiler efficiency on power output was also proved in the present paper.

**Key words:** wood pellet, wheat straw, Jatropha seed cake, oil palm shell, emissions, biomass combustion.

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## Energy crops utilization as an alternative agricultural production

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**Abstract.** Nowadays an increasing attention is given to the production and use of solid biofuels as an alternative to traditional fossil fuels. The common raw material for the production of solid biofuels is a biomass of vegetal origin, which is mainly represented by waste and secondary agricultural products as well as forest or wood residues. Unfortunately, these types of materials do not always meet the quality requirements for the production of biofuels in the form of pellets and briquettes. This is primarily due to the fact that much of the agricultural wastes have low calorific value, high ash content, low density, etc. and at the end all these facts also negatively affects the price of biofuels. In addition, an intensive use of agricultural waste as a raw material for the purpose of biofuels' production could have a negative impact on soil fertility. Based on abovementioned disadvantages of agricultural biomass, there is a big potential in utilization of alternative biomass such as energy crops. Several energy crops from the same biological family *Asteraceae* were selected for the research purposes. The main focus of this article is evaluation and comparison of the main solid biofuels' properties, which were measured according to European and International standards. Assessment of an energy potential of selected crops for the Republic of Moldova is presented here as well.

**Key words:** energy crops, solid biofuel, briquettes, gross calorific value, ash content.

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## Lipid production from diverse oleaginous yeasts from steam exploded corn cobs

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**Abstract.** Corn cob hydrolysate was used as substrate for growth and lipid accumulation via oleaginous yeast species. A mass based suspension of 10 g 100 g<sup>-1</sup> corn cob hydrolysate contained 26.0 g L<sup>-1</sup> glucose, 8.5 g L<sup>-1</sup> xylose. The inhibitor concentrations were 0.16 g L<sup>-1</sup> acetic acid, 1.50 g L<sup>-1</sup> formic acid, 0.48 g L<sup>-1</sup> HMF and 0.06 g L<sup>-1</sup> furfural. These conditions reduced the cell growth of non-adapted yeast. Successful adaptation of the tested yeasts over several generations in corn cob hydrolysate was performed. The adapted yeast *Candida lipolytica* produced 19.4 g 100 g<sup>-1</sup> lipids in relation to the dry weight in 7.5 g 100 g<sup>-1</sup> dry matter corn cob hydrolysate in fed batch mode. The scale up was done up to a volume of 2.5 litres – here lipid accumulation up to 17.5 g 100 g<sup>-1</sup> was demonstrated with the quantitative GC/FID analyses. Predominantly oleic acid, palmitic acid, linoleic and palmitoleic acid were produced. This lipid spectrum is suitable for biodiesel production.

**Key words:** biodiesel, oleaginous yeast, corn cobs.

**ACKNOWLEDGEMENTS.** The project ‘Next Generation Biodiesel’ (Project-Code: DAABAA\_00565) was financed within the scope of the European Union Program ‘Regionale Wettbewerbsfähigkeit OO 2007–2013 (Regio 13)’ from the purse of the European Funds for Regional Development (EFRE) and the Federal State of Upper Austria, Austria.



## Economic evaluation of hemp (*Cannabis sativa*) grown for energy purposes (briquettes) in the Czech Republic

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**Abstract.** Depletion of fossil fuels and their environmental risks have brought to the foreground energy crops as a possible source of bioenergy. Industrial hemp (*Cannabis sativa* L.) has been suggested for production of solid biofuels (briquettes) due to good physic-mechanical properties as well as positive energy and combustion characteristics. This study determined economic potential of hemp briquettes production in the Czech Republic. A field trial was conducted in 2009–2014 in Prague in order to compare biomass yield (BY) of hemp varieties Bialobrzeskie (B) and Ferimon (F) harvested in autumn and spring period. Based on obtained results this study determined production costs of hemp briquettes (CZK t<sup>-1</sup>), revenue (CZK t<sup>-1</sup>) and rate of return (%) for four scenarios (B, F harvested in autumn and B, F harvested in spring). Briquettes production costs ranged from 4,015 CZK t<sup>-1</sup> to 4,707 CZK t<sup>-1</sup> for B in spring and B in autumn, respectively, due to 30% lower biomass yield in spring harvest. Results indicated that hemp briquettes production was not profitable if the selling price was the same as the price of wood briquettes and with BY obtained in experiment (7.18–10.7 t ha<sup>-1</sup> of dry matter). Briquettes production in autumn made profit of 9% for B and 7% for F when subsidies for hemp cultivation were considered. In current conditions in the Czech Republic, utilization of hemp for briquettes production did not prove to be economically feasible.

**Key words:** hemp briquettes, economic analysis, production costs, revenue, rate of return.

**ACKNOWLEDGEMENTS.** The research was supported by Internal Grant Agency of the Faculty of Tropical AgriSciences, Czech University of Life Sciences Prague (grant N°20155015).

## Examination of commercial additives for biogas production

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**Abstract.** The formation of biogas from biomass is a complex process with a multitude of variable process parameters. Stability of biogas production and production rate can be vastly improved by keeping these parameters close to their optimum. One possibility to achieve this is by use of additives. In Germany alone there currently are over 250 additives on the market which demonstrates the demand for optimisation of biogas plants. The effects of these additives are hardly investigated and can only be evaluated by costly, time consuming tests (e.g. continuous anaerobic digestion experiments). A new, fast and easy to handle method was developed to evaluate some of the effects of additives. To verify the method trace elements, organic acids, FOS/TAC, ions and cations were quantified. Three additives were tested: The addition of a commercial zeolite increased biogas production by 15%. Calcium carbonate increased performance by 8% after 16 days. No negative effect on biogas production could be observed for the addition of 0.03 and 0.06 g l<sup>-1</sup> of iron(III) chloride, commonly used to reduce hydrogen sulphide concentration in biogas.

**Key words:** biogas, additives, zeolite, iron(III) chloride, calcium carbonate.

**ACKNOWLEDGEMENTS.** This project is financed within the scope of the European Union Program ‘Regionale Wettbewerbsfähigkeit OÖ 2007-2013 (Regio 13)’ from the purse of the European Funds for Regional Development (EFRE) and the Federal State of Upper Austria, Austria. Project code: DAABAA\_00477





## Direct and indirect energy input in the harvesting of Scots pine and Norway spruce stump-root systems from areas cleared for farmland

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**Abstract.** The aim of this study was to find the net energy and energy ratios for the recovery of Scots pine and Norway spruce stump-root systems when clearing land for cultivations. The energy analyses were carried out for direct and indirect energy under Finnish conditions. In the base study case for direct energy input; the net energy yields for stump-root system harvesting were 446–698 GJ ha<sup>-1</sup> and the energy ratios were 22–33. In the case of indirect energy input the net energy yields were 440–692 GJ ha<sup>-1</sup> and the energy ratios were 17–26. The proportion of indirect energy was low, because the amount of operating hours annually was high. When calculating indirect energy, only the energy input of machine manufacturing was used, since there was no data on the indirect energy used for repair and maintenance of the machines. The energy assessment for repairing and maintenance operations for heavy forest machines and vehicles in bioenergy procurement will need to be assessed.

**Key words:** agricultural land, bioenergy, clarification of forest land, energy assessment, forest machines, wood-based energy.

**ACKNOWLEDGEMENTS.** Dr. Hannu J. Mikkola gave valuable comments for the manuscript. University of Helsinki and Seinäjoki University of Applied Sciences provided work sites and facilities for this study. Mr John Pearce checked the English text. M.Sc. Tuomas Hakonen and M. Sc. Ismo Makkonen helped in the photograph processing.

## Influence of lammas shoots on productivity of Norway spruce in Latvia

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**Abstract.** The Norway spruce is widely spread in Eastern Europe and it is managed mainly for the production of sawlogs, though its logging residues are now increasingly used for the production of wood chips for bioenergy. The growth of the Norway spruce is and will be affected by climatic changes; one of the possible effects might be an increase in the frequency of trees with lammas shoots. Therefore, the aim of this study was to assess the influence of lammas shoots on the length of height increment of young Norway spruce in Latvia. Tree height and height increment was repeatedly measured and the presence of lammas shoots, bud flushing grades and frost injuries were assessed in two young (8–13 years) open-pollinated progeny tests in the central part of Latvia (56°46'N, 24°48'E). The mean portion of trees with lammas shoots in one experiment was 6% at the end of 8<sup>th</sup> growing season. In another experiment, it was 8.7%, 26.9% and 8.1% at the end of 10<sup>th</sup>, 11<sup>th</sup> and 13<sup>th</sup> growing seasons, respectively; 32.3% of trees had lammas shoots at least in one of three seasons. Faster growing and earlier flushing trees had a significantly higher frequency of lammas shoots. Lammas shoots increased the length of annual height increment by 10 to 14 cm, resulting in a 14–20% taller tree height at the age of 13 years. The reduction of height increment as a result of frost damages for very early flushing trees was less pronounced for trees with lammas shoots than without them.

**Key words:** height increment, tree height, open-pollinated family.

**ACKNOWLEDGEMENTS.** The study was carried out in Forest Competence Centre's (ERAF) project 'Methods and technologies for increasing forest capital value' (No. L-KC-11-0004).

## Harvest technology for short rotation coppices and costs of harvest, transport and storage

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**Abstract.** The lack of knowledge regarding cost-efficient design of whole production chains as well as the availability of powerful harvest machinery are some of the main obstacles for competitive production of bioenergy from short rotation coppices (SRC) at practice. In general, two different harvest lines are available: the cut-and-chip and the cut-and-store lines. Whereas the cut-and chip line provides wood chips which have to be stored until next heating season, the product for intermediate storage of the cut-and-store line are whole trees. Both process lines have major differences not only in harvesting, but also in transport, storage and process losses leading to different costs of the end product wood chips. On basis of data from several SRC harvest campaigns, production costs for wood chips have been calculated to identify best practice solutions taking the following factors into account: chip size determined by the harvest system, storage including related costs and losses, field size and shape as well as transport to storage. According to the results, mower-chippers and forage harvesters can provide wood chips at lowest production costs ( $43...45 \text{ € t}_{\text{dm}}^{-1}$ ) if field shape is favourable for harvest operations. Under less favourable field conditions costs are approx. 7 to 14% higher. Highest production costs have to be accepted if whole trees are harvested with a shoot harvester ( $64 \text{ to } 72 \text{ € t}_{\text{dm}}^{-1}$ ). The reduction in storage losses and storage costs are not sufficient to compensate higher machine costs for harvest and additional comminution with mobile chippers from forestry.

**Key words:** short rotation coppice, poplar, willow, harvest, costs.

## **Environmental consequences of anaerobic digestion of manure with different co-substrates to produce bioenergy: A review of life cycle assessments**

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**Abstract.** Consequential life cycle assessment approach is needed to assess the environmental impacts of increase in biogas production. To see the full impacts of anaerobic co-digestion all possible environmental consequences caused by this change, i.e. the impacts of changed management and possible substitution impacts of substrates, should be taken into account. Generally anaerobic digestion of manure shows great environmental benefit instead of managing it conventionally, especially for the global warming potential. Environmental performance of co-digestion depends strongly on the initial use of the substrate. Co-digestion with wastes/residues has a great potential to produce bioenergy and reduce global warming potential. Co-digestion with land dependant special energy crops increases the bioenergy output but also increases the environmental impacts due to the need to substitute the substrate and thus should be avoided or limited.

**Key words:** life cycle assessment, biogas, anaerobic digestion, environmental impacts.

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## Biochemical oxygen demand sensor arrays

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**Abstract.** Biochemical oxygen demand (BOD) is one of the most widely utilized parameters in water quality evaluation. BOD as a parameter illustrates the amount of organic compounds susceptible to biochemical degradation in the water. The BOD test lasts for at least 5–7 days or even up to 21 days. An incubation time this long is not acceptable for monitoring purposes or system control. In order to shorten the BOD measurement time, a multitude of biosensors have been proposed. Unfortunately, BOD biosensors have several limitations, such as short lifetime, limited substrate range, precision etc. Some of those limitations can be overcome by using microbial sensor-arrays. Such bioelectronic tongues can achieve the much wider substrate range usually attributed to multiculture sensors and still maintain the long lifetime of a single culture sensor. This is achieved by separating different cultures from each other in the array and using the signals of separate sensors to produce summarised information via statistical analysis. The purpose of this review is to give a short overview of BOD measurements and discuss the potential of using sensor-arrays for BOD measurements.

**Key words:** sensor-array, BOD sensor-array, electronic tongue, biosensor, biochemical oxygen demand.

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## Amount of manure used for biogas production

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**Abstract.** Methods for calculation of the amount of manure from every agricultural animal species and subgroup for production of biogas have been developed in compliance with the 2006 IPCC Guidelines. These methods can be applied for future forecasts if the amount of biogas produced in the country increases. It has been stated that in 2013 in Latvia for production of biogas mostly chicken and pig manure was used – correspondingly 33.7% and 26.7% from the amount of manure obtained from these animals. In the forecast for 2020, in turn, it is expected that the consumption of manure will be 31.9% of chicken manure and 31.5% of pig manure, from the amount of manure obtained from the corresponding group of animals.

**Key words:** biogas, manure, 2006 IPCC Guidelines.

## Effect of lignin content of lignocellulosic material on hydrolysis efficiency

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**Abstract.** Lignocellulosic material is the most promising feedstock for bioethanol production; however, due to the varying physicochemical characteristics of different biomasses, it is necessary to select a biomass with a composition suitable for bioethanol production. For this purpose several different alternative non-food energy crops were chosen to investigate their suitability for bioethanol production, considering their cellulose, hemicellulose and lignin content. The traditional three-step bioethanol production process was used, where dilute acid was applied for biomass pre-treatment. Glucose and ethanol concentrations were measured during the process. Glucose and ethanol yields and hydrolysis efficiency were used to evaluate the suitability of different energy crops for bioethanol production. The results show that, with most biomass types, the glucose yield increases as the cellulose content in the biomass rises. However, a sharp decrease in hydrolysis efficiency was noted in the lignin content range of 7 to 9 g 100 g<sup>-1</sup>. The lower hydrolysis efficiency also resulted in a lower ethanol yield in the next step of the bioethanol production process for these samples.

**Key words:** bioethanol, lignocellulosic biomass, lignin, biofuel, acid pre-treatment.

## Energy use of compost pellets for small combustion plants

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**Abstract.** The purpose of this paper is to explore the thermal emission characteristics of alternative fuels gained from the composting process and intended for local energy use. The first goal is to determine the basic parameters of the examined samples (elemental analysis). The thermal emission parameters of the combustion device, such as the flue gas temperature and emission concentration of carbon monoxide, carbon dioxide and nitrogen oxides in relation to the operating conditions of the combustion device with an automatic feed fuel burner furnace are also considered. Pellets from oversized chips gained from the composting process and the pelleted mixtures of compost and spruce sawdust in the ratio 1:1 were burnt in the burner furnace.

The resulting values of the samples' individual elemental analyses indicate the optimal properties for further energy utilization. The amount of excess air generated during combustion, however, is high and this is also reflected in the great loss of flue gas sensible heat. The resulting parameters further prove that the excess air coefficient ( $n$ ) depends on flue gas temperature, as well as carbon dioxide, monoxide and nitrogen oxides content in the flue gas. It was concluded during the combustion tests that the pollutants monitored in the flow did not reach the limit values. The scientific hypothesis of the author confirms that the stabilized dried mixture of plant biomass and appropriate biodegradable waste is suitable for biomass combustion. The available data suggest that the use of compost for energy purposes through combustion is possible, if biodried biomass is used, i.e., special products of composting processes are used in medium-sized and large combustion devices.

**Key words:** alternative fuel, elemental and stoichiometric analyses, emission concentrations.

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## Green energy from different feedstock processed under anaerobic conditions

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**Abstract.** The possible use of energy crops and aquaculture for bioenergy production has only recently become a research target, so there is little information on their properties and advantages. The aim of this study was to investigate the possible use of cup plant, as well as marine and freshwater algae (*Scenedesmus sp.* and *Chlorella sp.*) for biogas production. Research of a batch anaerobic digestion process at a mesophilic temperature were performed using wet wastewater sludge, cattle manure, fresh microalgae biomass and dry marine algae, cup plant biomass and mixtures of these materials. The highest biogas yield (541.28 ml g<sup>-1</sup> VS) was obtained by using a new feedstock from the microalgae *Scenedesmus sp.* biomass. That yield was 1.4 times higher than the biogas yield from cattle manure and 15% lower than the biogas yield from wastewater sludge. It was found that adding microalgae biomass to a cattle manure substrate increases biogas production approx. 1.5 times. The highest methane concentration in biogas produced from microalgae ranges from 64.87% to 66.66% and exceeds the methane amount (64.26%) in biogas produced from wastewater sludge. The methane amount in biogas produced from cattle manure, cup plant and marine algae biomass is lower than 60%. In addition, it was found that it is possible to produce 5,092.3 m<sup>3</sup> of biogas or 113 GJ of energy from 1 ha of harvested cup plant biomass.

**Key words:** biogas production, microalgae, marine algae, cup plant, cattle manure, wastewater sludge.

## Profitability of hybrid aspen breeding in Latvia

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**Abstract.** Hybrid aspen (*Populus tremuloides* × *P. tremula*) has fast growth in climatic conditions of Northern Europe and relatively high wood quality. Therefore, breeding of it has been carried out in a number of Baltic Sea Region countries. Breeding requires notable financial investment; therefore, the aim of our study was to estimate the profitability of hybrid aspen breeding in Latvia and the factors affecting it. Financial analysis was based on the differential approach, that is, only the costs and benefits that differ between two compared alternatives – planting of hybrid aspen and natural regeneration of silver birch or common aspen – were compared. Differential gain in this case included additional monetary value of the above-ground parts of trees in planted hybrid aspen stands (values obtained from trials in Latvia); differential costs were the costs of tree breeding, plants, planting, cleaning and protection against browsing damages (repeated use of browser repellents or fencing). Profitability of hybrid aspen breeding was significantly affected by the size of the area planted annually, soil fertility (site index) and length of rotation period. The differential gain from investments in tree breeding and establishment and management of plantations ( $r = 3\%$ ), assuming that selected clones would be used for 15 years and 500 ha are planted annually, in comparison to natural regeneration of common aspen and to silver birch, was 662 EUR ha<sup>-1</sup> and 1136 EUR ha<sup>-1</sup>, respectively. In contrast, if only 50 ha are planted annually, the respective figures were 588 and 756 EUR ha<sup>-1</sup>. If fencing was used for protection of the hybrid aspen plantation against browsing, the differential gain was positive only on the most fertile soils (site index Ia).

**Key words:** differential benefits, *Populus tremuloides* × *P. tremula*, site index.

**ACKNOWLEDGEMENTS.** The study was carried out in Forest Competence Centre (ERAF) project 'Methods and technologies for increasing forest capital value' (No. L-KC-11-0004).

## Critical technology factors of biogas plants using mixed materials

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**Abstract.** Biogas production is a well spread, up-to-date technology to utilise biomass in Europe. The applied technologies are based on mesophile, or thermophile methods and the mixture of them. The applicable, effective energy production for biomass always depends on the input materials and the essential preparation of them, the “recipe” and technological parameters that must be strictly controlled during the process. Based on the operation of an existing Hungarian biogas plant our article deals with these critical points of the biogas production technology.

## Formation of height increment of hybrid aspen in Latvia

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**Abstract.** Annual increment of hybrid aspen exceeds that of other tree species (including common aspen) in Baltic States. Notable (several-fold) differences in productivity between clones have been detected and therefore tree breeding programs are established to select the best genotypes (clones) for large-scale propagation. In order to aid the selection as well as understand the potential changes in growth of hybrid aspen as a result of climatic changes, it is important to analyse the intra-annual growth dynamics. Therefore aim of our study was to assess height growth intensity of hybrid aspen and factors affecting it. Weekly measurements of height increment were carried out through the third growing season of trees in two plantations, consisting of 19 clones (10 ramets per clone), on abandoned agricultural land in western (Mazirbe, 56° 36' N, 24° 30' E) and central (Vecumnieki, 57° 40' N, 22° 19' E) part of Latvia. Mean height growth period of hybrid aspen ranged from 119 ± 8.9 days for late flushing clones to 137 ± 8.6 days for early flushing and was tightly ( $r = 0.69$ ) linked to total length of height increment. Mean height growth intensity during this period for respective groups of clones ranged from 7.7 ± 3.04 mm day<sup>-1</sup> to 11.7 ± 2.93 mm day<sup>-1</sup>. Growth intensity (and height increment) was significantly affected by genotype (clone) and in both sites tightly ( $r = 0.57...0.84$ ) linked with daily mean temperature, but not with precipitation. Increasing temperature in future might boost the productivity of hybrid aspen plantations, especially with early flushing clones.

**Key words:** height growth intensity, growth period, *Populus tremula* × *P. tremuloides*.

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## **IV RENEWABLE ENERGY**

## Impact of synthetic hormone $17\alpha$ -ethinylestradiol on growth of microalgae *Desmodesmus communis*

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**Abstract.** Microalgae has recently attracted much attention as a feedstock for biogas. Using wastewater as microalgae nutrition is a way how to produce algal biomass with low cost and minimum impact on environment. However, wastewater often is polluted with chemicals like pharmaceuticals which are among the commonly used chemicals in everyday life. The present study was aimed at the toxicity evaluation of a commonly used synthetic hormone,  $17\alpha$ -ethinylestradiol, using freshwater green algae *Desmodesmus communis* as a biotest organism. Parameters like healthy cell number and photosynthetic activity were determined and used to assess the toxicity. Lowest Observed Effect Concentration (LOEC) and 50% Effective Concentration (EC<sub>50</sub>) values were calculated for the parameters at different incubation times. It was found out that  $17\alpha$ -ethinylestradiol affects algal cell ability to grow, inhibits cell division and reduce photosynthetic processes in algal cells. Our research shows that inhibitory effect on growth of green algae *D. communis* start on concentration below 10  $\mu\text{g L}^{-1}$  (4–8  $\mu\text{g L}^{-1}$ ). Concentrations in the range of concentration 80–100 reduce growth by 50%, but concentrations 100–500  $\mu\text{g L}^{-1}$  induce 100% reduction of growth rate and even calls initial algal cell destruction. Presence of EE2 in wastewater used for algal growth can affect productivity of a microalgae aquaculture.

**Key words:** microalgae,  $17\alpha$ -ethinylestradiol, EC<sub>50</sub>, carbon, photosynthesis.

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## **A proposition of management of the waste from biogas plant cooperating with wastewater treatment**

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**Abstract.** The energy policy relevant to ecological aspects in all EU members since couple of years is determined by renewable energy sources (RES) development. Specific activities related to the increase of the share of RES in national energy like certificates of origin, penalties and fees all together make up a kind of enforcement that would encourage society to searching new possibilities to generate energy in accordance to respect to the natural environment. Seeking alternatives to fossil energy sources is the best option to force the approaching energy crisis.

The paper aimed at analysis of possibility in using the digestate coming from biogas plant which cooperating with wastewater treatment. In details, some aspects of underestimated energy potential of digestate was developed as well as energy flow in analysed technological solution to demonstrate that it is possible to close this balance circle. As a result of the undertaken considerations there are some suggestions how to adopt the treatment system to improve effectiveness of waste management in accordance with energy production.

**Key words:** biogas, pellet, waste water treatment.

## Modeling greenhouse gas emissions from the forestry sector – the case of Latvia

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**Abstract.** A system dynamics model for assessing the greenhouse gas (GHG) emissions from forestry and forest land is presented in the paper. The model is based on the IPCC guidelines for national GHG inventories and includes the main elements of the forestry sector, i.e. changes in the living biomass, dead organic matter and soils. The developed model allows simulating various policies and measures implemented and decisions made and their impact on change in the GHG emissions. Various scenarios of potential development in the medium-term planning were simulated till 2030 to assess their impact on the GHG emissions. It is found that the most sustainable option would be use of wood processing waste for production of e.g. wood chips or some added-value products. The case of Latvia is selected for simulations, as forests compose about 52% of the country's area. Nevertheless, by changing specific parametric values the model can be adapted and applied for estimation and analysis of GHG emissions from forestry in other countries, as well.

**Key words:** GHG emissions, forestry, living biomass, wood waste, system dynamics.

**ACKNOWLEDGEMENTS.** The work has been supported by the National Research Program 'Energy efficient and low-carbon solutions for a secure, sustainable and climate variability reducing energy supply (LATENERGI)'.



## Conceptual design of experimental solar heat accumulation system with phase change materials

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**Abstract.** The research on solar heating systems often is faced with choice of carrying out experiments in real systems with changing parameters or to use modelling software with constant parameters but many undefined parameters or assumptions. The design of experimental system for simulating solar heat accumulation is proposed in this paper. The proposed design allows testing of phase change materials which provide higher thermal density compared to water. Results from computational fluid dynamic simulations carried out by other studies have been analysed for implementation into designing of the tank. All of these factors have been taken into account to create a system that resembles real case and can simulate for a long periods of time.

**Key words:** thermal, energy, renewable, hot water, PCM.

**ACKNOWLEDGEMENTS.** The work has been supported by the National Research Program 'Energy efficient and low-carbon solutions for a secure, sustainable and climate variability reducing energy supply (LATENERGI)'.

## Seasonal temperature variation in heat collection liquid used in renewable, carbon-free heat production from urban and rural water areas

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**Abstract.** A renewable energy source called sediment energy is based on heat collection with tubes similar to those used in ground energy and is installed inside a sediment layer under water body. In this paper, an investigation of temperature behaviour of heat carrier liquid is made during several years to evaluate utilization of sediment energy. This is done by evaluating temperature variations of heat carrier liquid and its correlation to air temperature. This increases advancement of knowledge how the temperature of the sediment recovers from the heat collection. The temperature variation of the liquid seems to correlate with the mean monthly air temperature. The selected methods clearly indicate that sediment energy seems to be yearly renewable because there is a clear correlation between air temperature and heat carrier liquid temperature.

**Key words:** renewable, energy source, carbon-free, heat energy, sediment energy.

**ACKNOWLEDGEMENTS.** We thank Mr. Juhani Luopajarvi, Mr. Mauri Lieskoski (Geo-Pipe GP Oy), City of Vaasa and TEKES (the Finnish Funding Agency for Technology and Innovation).

## Hot-air distribution in the floor heating

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**Abstract.** The aim of this paper is to present results of measurement of hot-air floor heating system. The energy from fireplace directly heats the house near to the chimney and partly is distributed by the special ventilation under the floor in the whole heated room. The main principle is based on specially designed accumulative floors, consisting of a set of special chambers, which enable to heated air from the fireplace to flow through them. The layer of concrete floor is installed on the surface of these chambers. Hot-air can be intensively distributed around the house with time shift, but the air flow is not uniform and some places are warmer or colder. The results of measurements in the building showed that the accumulation in the floor compensates temperature differences. The result of proper application of this type of heating is a stable thermal comfort and saving of heating costs. Based on the results of measurements, practical recommendations for the design, installation and use of these types of heating were summarised in the conclusions.

**Key words:** energy accumulation, fireplace, floor, temperature.

**ACKNOWLEDGEMENTS.** Author is grateful and express many thanks to the company Atelier Zilvar and Mr. Lipka who permitted and enabled to author to carry out all measurements of indoor environment in room equipped by the AKU heating system.

## Investigation of fuel effect on biomass gasification process using equilibrium model

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**Abstract.** Gasification is one of the most promising technologies of converting biomass into energy. Different type of biomass can be used for gasification process since there are no strict limitations for parameters of used fuel. Various types of biomass are used in Latvia for production of energy. Wood fuels make up the main part of used biomass in Latvia. However, many non-wood biomass types are available as well.

This study presents the comparison of wood and non-wood biomass use in gasification process. Biomass gasification model based on thermodynamic equilibrium was used to simulate gasification process with various biomass types. All input parameters were constant in model except fuel properties. In general gasification process was simulated with seven types of biomass – draff from beer production, common reed, middling from oats and wheat sieving, straw from grain cultivation, buckwheat hulls, rapeseed by-product from biofuel production, as well as wood. These non-wood biomass types are available in Latvia.

Produced syngas calorific value and gasification process efficiency are taken as the indicators to examine the gasification performances using various biomass types. The regression model was proposed to describe relation between fuel properties and efficiency of the gasification process. Results show that non-wood biomass can be successfully used for gasification process. Ash content growth in the fuel promotes temperature decrease in the reactor. Fuel chemical composition has effect on the produced syngas composition and heating value.

**Key words:** biomass gasification, non-wood biomass, thermodynamic model, syngas.

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## Charcoal production environmental performance

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**Abstract.** Charcoal is a well-known material obtained through thermal conversion of different types of biomass in an anoxic environment. The greatest share of the overall charcoal amount is produced in inefficient batch pyrolysis chambers. Thus contribution in an in-depth charcoal production process research for process optimization is of great importance. In this study an industrial experiment of charcoal production in a continuous up-to-date retort is performed. The selected industrial object has a high level of automation and process control. The retort is connected to a continuous monitoring system that records and stores the process parameter values. Apart from the process control parameter measurements attention has to be paid to the charcoal production plant pollution as this industry often gets contradictory attention towards its environmental performance. The air pollution is evaluated by air quality measurements at the production facility site. The obtained experimental results from an industrial facility with a state-of-the-art technology give an opportunity to evaluate the potential of the charcoal industry to be a sustainable player in the renewable energy market.

**Key words:** industrial experiment, sustainable energy, production, emissions.

**ACKNOWLEDGEMENTS.** The work has been supported by the National Research Program ‘Energy efficient and low-carbon solutions for a secure, sustainable and climate variability reducing energy supply (LATENERGI)’.

## **Methodology of demand side management Study course. experience of case studies**

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**Abstract.** The role of environmental and energy security issues due to political issues are increasing and this stimulates governments to review sustainable energy strategies. One of the ways to reach the targets set by many countries for cuts in greenhouse-gas emissions, free competition and security of supply is energy efficiency. Energy efficiency can be achieved by demand side management (DSM) programs. DMS requires regular and intensive work with energy users and it makes a platform for introduction of DSM strategies in engineering education. The paper discusses the integration models of DSM in the engineering education, analyses the components significant for ensurance of sustainable engineering education and energy efficiency and climate change targets. Based on analysis a methodology for of integration of DSM is developed.

Methodology shows how to introduce environmental specialists, students and municipality employees with demand side management in public buildings and how to evaluate efficiency of such integration. Methodology is analysed through several case studies and conclusions and recommendations developed.

**Key words:** energy efficiency, energy audits, study program.

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## Application of industrial wastes in renewable energy production

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**Abstract.** This research focuses on the industrial waste application as raw materials to create composite material and its characterisation for their possible application in anaerobic digestion. As the limitation of effective biogas digestion process is associated with inhibition of the some elements and acidification of biodegradable organic matter, therefore a highly porous alkaline composite material was evaluated in this research as buffer capacity increasing material. Batch experiments were provided with composite material additive in anaerobic digesters. Results indicate that alkaline composite materials in anaerobic digesters treated acidic whey could increase BMP up to 22%, but pH value could be kept in the optimal range (7.2–7.4) to ensure the effective digestion process.

**Key words:** biogas, anaerobic digestion, alkaline composite material.

## Measurement and analysis of temperature changes of ground massif with Slinky heat exchanger

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**Abstract.** The article is describing temperature changes in the ground massif with Slinky heat exchanger. The exchanger serves as a heat source for a heat pump which is used for cold water warming and a heating of the administration building. The aim of the research is to analyse the influence of the Slinky heat exchanger to the temperature of the ground massif while extracting heat energy at the beginning and during the heating season, as well as beyond it. The temperature process of the ground massif is described near the exchanger, on a reference lot in burial depth of the heat exchanger and also in a depth of 0.2 m. The energy potential of the ground massif was evaluated using the temperature differences of ground massif in the area of the Slinky heat exchanger at the beginning and at the end of the heating season.

**Key words:** ground massif, heat source, heating season, Slinky heat exchanger.

**ACKNOWLEDGEMENTS.** It is the project supported by the IGA 2013 ‘The University Internal Grant Agency’ (Regenerační schopnosti horninového masivu a jejich využití jako zdroje nízkopotenciálního tepla pro tepelné čerpadlo s vertikálním výměníkem).



## Hybrid greenhouse with automated use of renewable energy sources systems

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**Abstract.** Until today, agricultural applications are based on conventional methods and techniques regarding their energy supply and operation. Hybrid renewable energy systems are expected to become competitive to conventional power generation systems in the near future and, thus, optimization of their operation is of particular interest. In this work, a hybrid power generation system is integrated to an existing conventional greenhouse. The hybrid system consists of the following main components: photovoltaic array, wind generator, geothermal pump, biomass burner, biofuel burner, batteries as well as all the relevant sensors for temperature, relative humidity, CO<sub>2</sub> content, O<sub>2</sub> content in soil, inorganic elements content in soil, PH etc.). The key advantage of the hybrid smart greenhouse compared to conventional ones is that it can become fully energy autonomous. However, decision making regarding the operation of this system is a rather complicated task. A complete framework is proposed for managing such systems by integrating advanced monitoring and control techniques targeting to the final decrease of the energy and product cost.

**Key words:** greenhouse, hybrid systems, renewable energy, control.

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## **V VEHICLES and FUELS**

## **Influence of butanol and FAME blends on operational characteristics of compression ignition engine**

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**Abstract.** The issue of the use of alternative fuels in diesel engines is discussed in this paper. The purpose is to reduce the dependence of EU Member States on fuels of petroleum origin. One of the possibilities is the use of butanol produced from organic products. The use of pure butanol in diesel engines is not possible. However, it may be used as an additive for fuels of petroleum origin or adding to oil for improving the operating conditions of the engine. Successively 10, 30 and 50% n-butanol was used as an additive. Turbocharged combustion engine of the tractor Zetor 8641 Foretrra was used to the test. This engine was burdened using a dynamometer to the PTO. Performance parameters and fuel consumption of the engine were monitored during measurements. Performance parameters of the engine decreases and fuel consumption increases due to the properties of butanol. Cleansing properties of butanol which restrict carbonization on functional surfaces of the engine seems advantageous.

**Key words:** Biofuels, power, fuel consumption, combustion engine, butanol, FAME.

**ACKNOWLEDGEMENTS.** The paper was created with the grant support project CIGA CULS Prague 20153001 – Utilization of butanol in internal combustion engines of generators and with institutional support for long-term conceptual development VÚZT, v.v.i. RO0614.

## Determination of the phase separation temperature and the water solubility in the mixtures of gasoline with biobutanol and bioethanol

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**Abstract.** Original hydrocarbon composition, volatility, compatibility with materials, calorific value and stability of the mixture in the presence of water are monitored usually. This paper deals with the stability of gasoline-biobutanol and gasoline-bioethanol mixtures in the presence of water. Biobutanol is better biofuel than bioethanol using the same raw materials. Different contents of alcohol and oxygenated cosolvents are evaluated. Experimental analysis are focused on the water solubility and phase stability. Solubility in water of butanol and ethanol mixtures is very similar. Butanol-gasoline mixture provides better phase stability upon contact with water or atmospheric moisture oppose to ethanol mixtures. Butanol also does not enter to the aqueous layer and fuel properties remain in phase separation preserved. Further, it was found that crystals occur at low temperatures after exclusion of water was seen. Moreover, the temperature of phase separation can affect the content of alcohol, water, hydrocarbon composition and cosolvents added. The only difference found between more beneficial butanol and less beneficial ethanol was ABE (Aceton–Butanol–Ethanol) fermentation with *Clostridium Acetobutylicum* allowing to ferment also saccharidic cellulose to biobutanol according to standard of second generation biofuels.

**Key words:** BioEthanol, BioButanol, Water, MTBE, ETBE.

**ACKNOWLEDGMENTS.** The paper was created with the grant support project CIGA CULS Prague 20153001 – Utilization of butanol in internal combustion engines of generators.

## The distillation characteristics of automotive gasoline containing biobutanol, bioethanol and the influence of the oxygenates

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**Abstract.** Bioethanol and fatty acid methyl esters are a regular part of the production of gasoline and diesel fuels, although in limited quantities. Introduction of bioethanol as part of automobile gasoline was associated with high production costs, technical and logistical problems. This article analyses changes of distillation curve of biobutanol and isobutanol as an alternative to bioethanol. Added alcohol to gasoline causes reduction of boiling point due to the formation of azeotrope. This phenomena of distillation curve are called Plato effect. Therefore, ethers (MTBE and ETBE) are added to fuel to affect the most central part of distillation curve. Especially, to decrease the distillation temperature oppose to gasoline without oxygenates of wide range of distilled volume. This article replaces simple universal models predicting properties of alcohol-gasoline mixtures. It was found that mixture of ETBE with bioethanol in gasoline the distillation curve summarise its effects. Butanol and MTBE influence distillation curve of gasoline only in values of its boiling points. Therefore, butanol is mixable with all listed fuel components without any additional adaptations.

**Key words:** BioEthanol, n-Butanol, IsoButanol, MTBE, ETBE.

**ACKNOWLEDGMENTS.** The paper was created with the grant support project CIGA CULS Prague 20153001 – Utilization of butanol in internal combustion engines of generators.

## The analysis of the influence of biobutanol and bioethanol mixture with ethers on the vapour pressure of gasoline

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**Abstract.** In addition to widely known species automotive fuels that are currently on the market, there are many other chemicals which are used or can be used as fuels or fuel components for current automotive internal combustion engines. Implementation of such ingredients can bring a number of technical problems. The vapour pressure is the pressure in the system in which they are at a certain temperature gaseous and liquid phases in equilibrium. The addition of alcohols such as gasoline constituents significantly affects the volatility of the resulting mixture. The article is focused on assessing the addition of biobutanol as n-butanol or isobutanol vapour pressure compared to the already commonly used in bioethanol. Also included is the possibility to use ethers for influencing the vapour pressure of the resulting mixture. Part of the experiment is to assess the influence of the quantity and type of oxygenates and composition of gasoline. Based on the measured data it is clear that addition of alcohol to gasoline creates complications. Effect biobutanol as possible alternatives is different than bioethanol. It is therefore necessary to take into account the influence of alcohol, even at low concentrations corresponding to the limit according to standard EN 228. Biobutanol compared to bioethanol can be used as 100% fuel. For the low vapour pressure of the fuel experiment also aims to increase its value using pentane.

**Key words:** BioEthanol, n-Butanol, IsoButanol, MTBE, ETBE.

## Determination of the optimal injection time for adaptation SI engine on E85 fuel using self-designed auxiliary control unit

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**Abstract.** Article deals with problems of the operation of spark ignition combustion engine on high-percentage of blend bioethanol. The aim of the experiment was to find the optimal value of injection time of the engine injection valves with respect to the adaptive ability of the original engine control unit (ECU) when using a special auxiliary control unit (ACU) was adjusted injection time. Special dynamic driving cycle has been designed to assess the effects of prolonged injection time on the adaptive abilities of the ECU that stemmed from a real recording vehicle's rides with the same engine as was used in conducted experiments. The results proved that by changing the extension of the period of injection occurs a gradual adaptation of the original ECU, but this adaptation is gradual and underway predominantly in modes functional closed-loop control, thus in modes of low to medium of loads. Results of the experiment provide determination of the efficient frontier of the percentage extension injection time with regard to adaptive abilities of original ECU.

**Key words:** E85, bioethanol, emission, power, control unit.

**ACKNOWLEDGEMENTS.** This work has been realized with the contribution of Czech University of Life Sciences in Prague Internal Grant Agency, project 2014:31150/1312/3116 'Evaluation of the environmental benefits of bioethanol blending into motor fuels'.

## The energy consumption of public transit under rural and suburban conditions

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**Abstract.** The aim of paper is to investigate an energy consumption of public transit focused on regular commuting from suburban locations. Surveyed suburban settlements have become a part of ‘urban sprawl’ process in the suburbanized hinterland of Prague’s city. The transport links are strongly influenced by the catchment area of Prague’s city that has a dominant position in surveyed region and the most of the existing transport links are carried out in relation to the Prague’s city on radially oriented roads. The traffic intensities are often on a roads’ full capacity during peak hours or the roads are even congested alongside a ride to the city. The 10 suburban settlements were selected for the purpose of the fuel consumption investigation. Authors have focused on the journeys carried out during the morning peak hours of the ordinary working days when the transport demands are saturated. The fuel consumption investigation has involved the journeys by public transit (commuter bus) and by passenger car. Obtained results have proved possibilities of significant fuel consumption savings under condition that the bus transit preference would be effectively used. The energy efficiency of bus public transit allows to achieve the similar energy consumption per passenger as an ordinary passenger car has at a low occupancy rate of bus.

**Key words:** transit, passenger car, fuel consumption, peak hours, suburbanization.

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## Energy consumption of commuting from suburban areas

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**Abstract.** The process of suburbanization begun half a century later in the Czech Republic in comparison to Western Europe. It has given rise to similar changes in the individual behaviour of potential residents, resulting in different land use and the emergence of new requirements involving technical and transport infrastructures. Many factors that characterize suburban land use, e.g., density of population (households), free access to public facilities, availability of transport modes, etc., are closely associated with energy consumption, specifically in transport. Suburban development affects not only transportation inside expanding suburban municipalities but also their surroundings, e.g., the cumulative effect of traffic intensity increasing on roads radially oriented towards the city centre has been observed in recent years. The construction of manufacturing facilities, logistic and commercial complexes, entertainment centres, etc. continues within the suburban areas and it tends to significantly increase traffic movements (e.g., in tangential directions towards the core of the city). The current capacity of transport infrastructures does not correspond to the increased vehicle intensity (even not only during peak hours) and it does not guarantee an adequate quality for transport operation. The results of performed traffic surveys proved that morning traffic intensity (during peak hours) on the roads (of 2<sup>nd</sup>. or 3<sup>rd</sup>. class) leading to the city centre has doubled in the last five years. These results mean that transport energy consumption has increased enormously. Transport energy consumption is higher than usually expected in these cases. The energy consumption (fuel consumption) determined according to a vehicle's homologation does not take into account the conditions that may affect driving style in a negative manner, e.g., slow driving, traffic congestions road, vertical alignment and tortuous roads. The mean consumption was 9.2 (l 100 km<sup>-1</sup>) on the selected trail sections –that is 1.66 more than the combined consumption figure presented by car producers. The selected sections make up 54% of the total trail length. This 'local consumption' is linked with higher emission production, details are available below. The author compared specific fuel consumption per 100 km and found that real consumption is evidently always higher than the quantities claimed to be correct by car producers in view of mixed modes. The same has been found by, e.g. Marique & Reiter, 2012 and other authors.

The conclusions of the research are potentially relevant and should be used in a spatial planning or decision making processes to prevent 'urban sprawl' and the accompanying high energy consumption. Suburban development should go hand in hand with the construction of new transport infrastructures and high-quality public transport.

**Key words:** energy, transport, commuting, suburban settlements, fuel consumption.

**ACKNOWLEDGEMENTS.** This paper and the obtained results were supported by the Internal Grant Agency 2014, project IGA 2014: 31150/1312/3117 'Energetická náročnost dopravních systémů v městských a suburbánních podmínkách' (The energy demands of transport systems in urban and suburban conditions).

## Evaluation of stability of elastomer packing exposed to influence of various biofuels

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**Abstract.** The aim of the European Union Member States is to reduce dependence on fuels derived from oil. For this reason, significant attention is paid to the use of organic products as a substitute or an additive in the fuel of petroleum origin. The usage of biofuels in conventional combustion engines is not easy due to the different properties of the products. The aim of the research was to determine the effect of biofuels on mechanical properties of O-rings type ACM (polyacrylate elastomer). The research was evaluated by the change of density, Shore A hardness, permanent deformation CS, tensile strength and deformation after exposure in the test environment for a period of 15 months. Comparing the O-rings immersed in standard diesel fuel it is clear that similar behaviour of the hardness shows are sunflower oil and canola oil. RME – Rapeseed Methyl Ester 20% and oil from *Jatropha* has a negative effect on the increase in hardness. Comparing the O-rings immersed in standard diesel fuel it is evident that except RME – Rapeseed Methyl Ester 20% other fuels have negative influence on permanent deformation CS.

**Key words:** biofuels, O-ring, compression and tensile properties.

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## Comparison of the operating characteristics of the internal combustion engine using rapeseed oil methyl ester and hydrogenated oil

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**Abstract.** The issue of the use of alternative fuels in diesel engines is discussed in this paper. The purpose is to reduce the dependence of EU Member States on fuels of petroleum origin. One of the possibilities is the use of oils from biological materials. The use of the oil in standard engines is not usually possible. The engine modification or the fuel modification is necessary. Esterification or hydrogenation of oils can be used as the fuel modification. Impact of these changes on the operational characteristics of a turbocharged internal combustion engine is observed in the paper. The internal combustion engine of the tractor Zetor Foretrra 8641 was used for testing. This engine was burdened using a dynamometer to the PTO. Performance and fuel consumption of the engine were monitored during measurement. As fuels the 100% rapeseed methyl ester and 100% hydrogenated oil was elected. Based on the results we can say that the operating parameters of the internal combustion engine does not change significantly when using these fuels.

**Key words:** biofuels, power, fuel consumption, combustion engine, vegetable oil, RME, HVO.

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## **VI PRODUCTION ENGINEERING**

## FEM based numerical simulation for heat treatment of the agricultural tools

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**Abstract.** Quenching as a heat treatment method is commonly used to control the mechanical properties of steels. This article deals with the modelling and simulation of quenching of steel chisel using a multi-phase model. The process of the heat treatment is non stationary phase due to temperature variation with time. In this study, the problem of heat transfer in three dimensional phase was transformed into a two dimensional axisymmetric case. ElmerFem solver was used for the heat transfer through different cooling media such as water, oil and salt bath. The results from heat solver were used for austenite transformation modelling by applying Johnson–Mehl–Avrami–Kolmogorov equation in TTT diagram. The Scheill's decomposition was used for anisothermal transformation of austenite. The hardness prediction was done according to simple mixture rule where total hardness of the steel was calculated based on volume of the phases and their Vickers hardness.

**Key words:** numerical simulation, FEM, heat treatment, ElmerFEM.

## Effect of chemical modification of wood flour on the mechanical properties of wood-plastic composites

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**Abstract.** The poor compatibility between the highly hydrophilic wood fibres and the hydrophobic polymers is associated with a loss of mechanical properties. Therefore, to improve the interfacial adhesion between the polymer matrix and wood flour (WF), a chemical modification of WF is an appropriate solution. This study analyzes the influence of different chemical modifications of WF on the mechanical properties of wood-plastic composites (WPCs). WPC test samples were prepared from birch (*Betula*) WF with a mesh size of 0.63 mm as the filler material and polypropylene (PP) as the matrix material. WF was chemically modified by six different methods to increase its adhesion to and compatibility with, the polymer matrix. The six chemical methods used were: alkaline (NaOH) modification, polyvinyl alcohol (PVA) modification, silane treatment with 3-aminopropyltriethoxysilane (APTES), acetylation with acetic anhydride, cyanoethylation and wood fibre esterification. The composites were produced using a twin-screw extruder and the test samples were prepared by injection moulding. The composites' mechanical properties (three-point bending test), Charpy impact strength and thermal properties were tested. In addition, SEM micrographs of WPC surfaces were generated. WF as a filler material enhanced the flexural properties, while impact strength decreased, making the material more rigid and brittle. The test results revealed that the chemical modifications of WF improved the mechanical properties and crystallinity of WPC materials, while the melting temperature decreased. However, the influence of the chemical modification on the mechanical and thermal properties of WPC varied by method.

**Key words:** wood-plastic composite, wood flour, chemical modification, mechanical properties, thermal properties.

## **Influence of dusty micro-particles contamination on adhesive bond strength**

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**Abstract.** A necessity for a bond creation is one of common attributes of production companies. An adhesive bonding technology is a method of a connecting. This method is suitable for workings with a single and serial production. Many research projects dealt with a preparation of adhesive bonds, degradation aspects etc. An area, which has not been properly investigated at present, is an influence of a contamination of the adhesive bonds by dusty micro-particles, e. g. from a ventilation of assembly shops, production hall etc. The research was focused on the evaluation of the influence of dusty micro-particles contamination of the two-component epoxy adhesive at the hardening process. The dusty micro-particles were gained from the filtering equipment used in a production hall. Sizes of gained dusty particles were analysed on sieves of dimensions 315  $\mu\text{m}$ , 250  $\mu\text{m}$ , 160  $\mu\text{m}$ , 90  $\mu\text{m}$ . Subsequently, these particles were added in various ratios into the mixture of the adhesive during its preparation. The adhesive bonds containing the dusty particles of the sizes 250  $\mu\text{m}$ , 160  $\mu\text{m}$  and 90  $\mu\text{m}$  showed the fall of the adhesive bond strength. The adhesive bonds containing the dusty particles of the size 315  $\mu\text{m}$  showed the mild increase of the adhesive bond strength. The failure area did not change owing to the contamination of the adhesive bond with the dusty particles.

**Key words:** adhesive bond, elongation, failure area, dusty micro – particles.

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## Sandwich wall constructions made of perforated metallic materials

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**Abstract.** The formation of cellular core for sandwich wall constructions made of perforated steel band is presented in the paper. The information about the main mechanical properties of perforated tapes and plates is provided. Basic technological methods for obtaining cellular structures from perforated metallic tape achieved from waste material by stamping are suggested. The main attention is focused on the analysis of the compressive strength of key elements of obtained cellular structures. Examples of the use of cellular structures made of perforated metallic materials in sandwich wall constructions are given. The main benefits of perforated metallic materials usage in sandwich wall's construction are outlined.

**Key words:** metallic sheets and profiles, perforation, cellular core, sandwich wall.



## Improving the accuracy of manufacturing of hydraulic power cylinders using vibration-proof cutting tool

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**Abstract.** The article introduces new results on designing multilayer cutting tool holder. Experimental study of metal turning process workpieces shows efficient dynamic damping of oscillations. The coefficient of oscillations absorption and damping is increased due to large dissipative force of the material holder oriented in different deformation directions of holder material.

**Key words:** flat rolled stock, heterogeneity of structures, oriented deformation, adjustable anisotropy, multi-layered damping tool holder.

## Mechanical behaviour of polymeric composite with fibres of false banana (*Ensete ventricosum*)

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**Abstract.** This study was focused on the analysis of the deformation characteristics of the polymer composite with continuous phase in the form of two-part epoxies and discontinuous phase (reinforcing particles) in the form of fibres of false banana (*Ensete ventricosum*). The aim of the experiment was to describe the mechanical behaviour of polymeric composite reinforced by fibres of false banana under tensile loading and to determine the modulus of elasticity and deformation energy. The fibres of *Ensete ventricosum*, originally from Ethiopian region Hawasa, were used in this experiment. Reinforcing fibres were prepared in sizes of lengths 1–2, 2–3, 3–5, 5–6, 7–8, 9–10, 15, 20, 25, 30 and 35 mm with randomly fibres arrangement in matrix. The fibres with length of 1–2, 2–3, 3–5, 5–6, 7–8 and 9–10 mm were used in short fibres composites and fibres with length of 10, 15, 20, 25, 30 and 35 mm in long fibres composites. The composite material was created with 2 wt.% of the filler. The modulus of elasticity of the short-fibre composite material was increased of  $28 \pm 12\%$  by adding Enset fibres as the filler. The modulus of elasticity of the long-fibre composite material was increased of  $46 \pm 14\%$ . The influence of the fibre length on the value of the volume deformation energy was not proved.

**Key words:** agriculture, deformation energy, tensile strength.

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## Laboratory research of granulated heat insulation material from coniferous forestry residue

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**Abstract.** The purpose of this research paper is to determine the heat conductivity of a granular heat insulation material made of coniferous greenery (fine twigs and needles) and the suitability of the material for application as heat insulation. In order to achieve the objective, a three-factor experiment plan was developed and 11 samples produced. The thermal conductivity coefficient, moisture content and density of the samples was determined. A full analysis of the experiment plan was compiled on the basis of the obtained results. The analysis results suggest that size composition, density and tree species affect the thermal conductivity of the material. It was discovered that smaller spruce greenery insulation material pellets have a smaller thermal conductivity coefficient, which indicates a better capacity for retaining heat.

**Key words:** needles, coniferous, heat insulation, forestry residue.

**ACKNOWLEDGEMENTS.** The research has been supported by the National Research Program 'Energy efficient and low-carbon solutions for a secure, sustainable and climate variability reducing energy supply (LATENERGI)'.

## Hybrid composite materials on basis of reactoplastic matrix reinforced with textile fibres from process of tyres recyclation

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**Abstract.** The paper deals with a testing of composite materials reinforced with fabric, which were obtained after a recycling process of used tyres and a matrix is on a base of reactoplastics. The aim of the research was to set a possible utilization of unsorted textile waste from the process of the tyres recycling in the area of the polymeric composite systems. The subject of performed experiments was the hybrid polymeric composite, whose continuous phase was in a form of a two-component epoxy adhesive and a discontinuous phase (reinforcing particles) in a form of Polyamide PA (fibres) and rubber particles (granules of different sizes). An influence of a tensile stress, an elongation and an impact strength on the newly suggested hybrid composite materials were experimentally tested.

**Key words:** hybrid polymeric composite, mechanical properties, morphology of fibres, tyre recycling.

**ACKNOWLEDGEMENT.** Supported by Internal grant agency of Faculty of Engineering, Czech University of Life Sciences in Prague.

## The theoretical analysis and optimization of the cutting knife-grille pair parameters in the screws

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**Abstract.** We show how energy-force knife-grille pair parameters depend on their tightening torque which also indicate the node which is the most dynamically and thermally tensed. The research demonstrates that the temperature, at the junction of the knife-grille, varies in the 10°C and therefore this is a significant factor in the rate increasing of the grids and knives deterioration. From the condition of the screw grille and the knife blade compatibility deformations, we are shown the analytical dependence between the structural and technological characteristics, which allows us to minimize the depreciation value of the grille and the knife, as well as to reduce the energy intensity of the grinding process.

**Key words:** lattice, the cutter knife, friction, bending, wear, temperature, pressure, distortion, efficiency, performance, etc.

## Polymeric microparticles composites with waste EPDM rubber powder

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**Abstract.** Polymeric materials filled with inorganic microparticles can be described as polymeric microparticle composites. These materials combine the various mechanical, physical and chemical properties of different phases. Waste microparticles can also be used as filler. Inclusion of these waste microparticles can optimize the required mechanical properties and decrease the price. This paper describes the possibilities of using recycled waste rubber powder in polymer composite systems. The aim of the experiment was to quantify the mechanical properties of epoxy resin (Glue Epox Rapid – with increased speed of hardening) and polyurethane (Sika Power – resin based on polyol) filled with recycled EPDM rubber powder (29  $\mu\text{m}$ ) gained from a Czech company and to describe the changes in the mechanical qualities with a changeable amount of microparticles. Composites were prepared with a different filler concentration of resins (5–35 volume percent). Cohesive and adhesive characteristics were chosen for the quantification of the system. Adhesive strength to the steel adherent was tested by means of lap-shear tensile strength. Cohesive strength was tested by means of tensile strength. Hardness was measured by the Shore D method. The described use of waste material is inexpensive and offers the possibility of recycling material. The application of waste EPDM powder in the area of resins is a beneficial way of material usage which should be preferred.

**Key words:** epoxy resin, lap-shear tensile strength, material utilization, tensile strength.

**ACKNOWLEDGEMENTS.** This paper was written in the course of the grant IGA TF 2015, project: Optimizing the properties of resins and adhesives filled with organic and anorganic microparticles determined with an experimental approach (2015:31140/1312/3107).

## Pressure distribution measurement system PLANTOGRAF V12 and its electrodes configuration

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**Abstract:** This paper describes Plantograf V12, which is used for the investigation of the pressure distribution between an object, e.g. a foot sole or a tire tread pattern and the transducer. It can be used for analysing steps, assessing the great joints and improving stability, as well as in the fields of sport medicine and car industry. The system processes variable time pressure signals in real time. The instrument has 16,400 sensors (with a diameter of 2.5 mm each in a matrix arrangement of 128 x 128) concentrated in the active area as large as 500 x 500 mm; it is able to sample and process up to 1,000 frames per second. A full frame is created by all 16,400 sensors. The pressure distribution frame is represented in 256 colour levels in a 2D or 3D model view and it is possible to post-process the measured data on a PC. The design of the electrodes, the properties of the transducers, the operating software and the pressure distribution measurements in biomechanics are presented in this article.

**Key words:** Plantograf, conductive elastomer, electrodes, pressure distribution, tactile transducer.

**ACKNOWLEDGEMENTS:** The measurements were carried out in the framework of the IGA project of the Faculty of Engineering, Czech University of Life Sciences in Prague, reg. No. IGA 31200/1312/3131, entitled 'Experimental Research of Suitable Conductive Inks for Plantograf Measuring System and Electronic System Development'.

## **VII ERGONOMICS**



## Workload and health of older academic personnel using telework

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**Abstract.** Aim of the study was to measure telework usage and to explore interactions between health, workload and telework. Telework is work that is carried out outside the central office, involving new technology that permits communication. Work carried out at any time, at any place, has been very common in the case of research institutes and universities. This type of work has advantages and disadvantages for both an employee and employer. The study of telework was carried out in Tallinn University of Technology (TUT) where working at home has been very common for a long time. The questionnaires were sent to academic personnel. The study shows that academic employees preferred teleworking for better concentration on work and saving time and money. There was no significant difference in telework usage by age and teleworkers had fewer complaints about tired eyes, arterial hypertension and stress.

**Key words:** telework, work hours, diseases, stress.

## Assessment of the impact of the shape of the handle on the ergonomics of operating a handbrake

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**Abstract.** This thesis addresses the ergonomic problem of conflict between hand-operated mechanical brakes and center rests on certain types of vehicles. The hand brake is one of the basic means of control of a personal vehicle and its smooth and comfortable mastery directly affects traffic safety and driver well-being. The paper outlines a possible solution to this problem through the shape of the mechanical handbrake handle. The proposed solution is validated by using Tecnomatix Jack, which is primarily intended for solving ergonomic problems in the context of Digital Human Modeling. Specifically, in order to verify the solution, the Comfort Assessment tool is used, which in itself contains several published studies looking at driver comfort in accordance with the bending of specific joints. The results of this thesis can be used for future mechanical handbrake designs in cars.

**Key words:** Handbrake, Driver Ergonomics, Digital Human Modeling, Personal vehicle.

**ACKNOWLEDGEMENTS.** This study was financed by a project of the Czech Agricultural University in Prague (IGA 2014:31170/1312/3123).

## Dust pollution in University offices

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**Abstract.** The aim of this paper is to present results of microclimatic research focused mainly on dust pollution in several offices of Departments in the Faculty of Engineering at Czech University of Life Sciences Prague. The attention is paid to the dimensions of the room, floor covering, furniture, equipment, ventilation, frequency of the use and period of the year. In the frame of this research the concentration of air dust was measured by special exact instrument Dust-Track aerosol monitor. After the installation of different impactors the PM<sub>1</sub>, PM<sub>2.5</sub>, PM<sub>4</sub>, PM<sub>10</sub> size fractions were also measured. The obtained results of measurements were evaluated by the statistical instruments and concentrations of different size of dust particles were analyzed. Results of different indoor conditions were generalized. Based on the results of measurements practical recommendations for the design, use, cleaning and ventilation of these types of rooms and buildings were summarised in the conclusions.

**Key words:** air, dust fractions, floor, indoor environment, measurement.

**ACKNOWLEDGEMENT.** Author is grateful and expresses many thanks to the colleagues who enabled him to carry out all measurements inside their offices.

## The effect of static magnetic field on heart rate variability – an experimental study

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**Abstract.** The aim of this study was to investigate the effect of weak static magnetic fields on human heart rate variability (HRV). So far, literature has mainly focused on the health effects induced by strong static magnetic fields. HRV is a temporal fluctuation of heart rate, which the literature has shown to be an adequate indicator for assessing the state of the autonomic nervous system. By autonomic nervous system one could also assess in real time if and when the organism falls into stress. In this blind experiment the subjects were exposed to 150 microTesla magnetic field for a few minutes. The heart activity of the subjects ( $n = 116$ ) was recorded and the dynamics of the HRV frequency components i.e. reaction of the sympathetic and parasympathetic nervous system analyzed by repeated measures analysis of variance (ANOVA). No statistically significant difference ( $p < 0.05$ ) were found in low frequency (LF), high frequency (HF), total power (TP), HF/TP ratio, LF/HF ratio nor between heart rate (HR) means in between the exposure and pre- or post-control stages of the experiment. However, observations made by the researchers suggest, that a small portion of the population may indeed be affected by slightly elevated static magnetic fields but the screening method needs further elaboration.

**Key words:** static magnetic field, heart rate variability, HRV, autonomic nervous system.

## Job specific risk factors, demographic parameters and musculoskeletal disorders among military personnel depending on type of service

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**Abstract.** Current study aimed to analyse the prevalence of job specific risk factors (JSRF) and musculoskeletal disorders (MSDs) among military personnel depending on demographic factors and type of service. An anonymous questionnaire study was carried out in five departments of Estonian Defence Forces (EDF) among local service personnel (LSP) and the Peace Corp personnel (PCP) arrived back from mission. The average response rate was 38.7% (LSP 31.9% and PCP 77.6%). In LSP group there were 44.7% male participants, with mean age  $39.2 \pm 11$  years, length of service in present position  $5.8 \pm 4.9$  years and work load of  $37.9 \pm 8.4$  hours per week. In PCP group 97.4% were males, with mean age  $27.5 \pm 5.7$  years, service length on present position  $3.1 \pm 2.6$  years and work load of  $84.3 \pm 60.9$  hours per week. The dominant JSRF in LSP was 'demand for constant concentration' (76.5%) and night work (57%) in PCP (group difference  $p < 0.0001$ ). 'Fast movements' and 'lifting loads  $>40$  kg' were the specific tasks most often reported in mission. 'Job insecurity' was more often reported by the female; 'night work' and 'work-rest disbalance' by the male military personnel ( $p < 0.001$ ). The prevalence of MSDs was higher among women and LSP than in men and PCP group ( $p < 0.05$ ). In LSP mild to moderate discomfort reported by 2/3 because of neck-shoulder strain and by 1/2 because of lower back pain. In conclusion, MSDs seems to depend more on demographic parameters and type of service than JSRFs. Further studies are needed to focus on predictive factors of MSDs among military personnel.

**Key words:** job specific risk factors, demographic parameters, musculoskeletal disorders, military personnel.

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## Reliability of biometric identification using fingerprints under adverse conditions

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**Abstract.** Biometric user identification is highly topical these days. The most well-represented method is fingerprint identification, to which this study is also dedicated. However, we cannot forget other methods such as scanning the bloodstream, retina and iris, facial recognition, etc. Four reading devices were tested in this study. Tests were carried out both under standard and adverse conditions. Adverse conditions included situations such as cold finger, cooled damp finger, heated finger, soaked finger, finger with a layer of instant glue and dirty finger (soil). All tests performed under adverse conditions simulated realistic industrial plant environments. The results of the measurements showed that the measured reliability values do not correspond to those claimed by the manufacturers. It is necessary to adapt and perfect these biometric identification systems for use in industrial areas, as they are often used in these areas as access or attendance systems.

**Key words:** biometrics detector identification systems, fingerprints, user's false rejection.

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## Estimation of safety performance by MISHA method and the benefits of OHSAS 18001 implementation in Estonian manufacturing industry

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**Abstract.** The paper concentrates on safety auditing as a tool for assessment of safety system and safety management in Estonian manufacturing enterprises. The aim of the research was to estimate the safety performance in Estonian manufacturing industry and explore the benefits of OHSAS 18001. Different available safety auditing methods are described. During 2014, 8 (OHSAS 18001-certified organisations) and 8 (non-certified organisations) Estonian enterprises from different branches of manufacturing were interviewed using MISHA method which is in accordance with the present requirements and is the most comprehensive. The results showed that non-certified organisations could be sub-divided into 2 categories: organisations which belong to a larger corporation or concern and locally established and owned companies. The latter showed the lowest scores as in these firms there are deficiencies in several OHS activity areas. Safety activities in a company depend strongly on consistency. Safety needs commitment and systematic approach. If one of the key elements of safety management system is missing, then it can be seen in the results of other framework elements. Our study demonstrates that OHSAS 18001 certificate automatically will not ensure high safety activities in the company. However, following the OHSAS 18001 standard gives a good incentive for a systematic safety activity in all levels in the company and promotes strong improvement process put in use. MISHA method can be successfully used for evaluating safety management systems in manufacturing industry, but it has to be kept in mind that some modifications may be needed due to national differences in safety activities.

**Key words:** safety audit, safety management system, OHSAS 18001, safety performance, MISHA method.

## An analysis of engineering students' knowledge on the topic of occupational health and safety

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**Abstract.** Occupational health problems often result of poor knowledge of safety requirements and inadequate personnel training, especially considering specific tasks at work. A questionnaire was distributed to university students to respond, in order to analyse their answers and achieve following objectives: (1) to pinpoint the students' knowledge prior to the start of the course; (2) to reveal how many students have had experience with occupational health and safety (OHS) topics before starting the course; (3) to determine whether the knowledge of students with prior experience is greater; (4) to identify the most difficult topics or domains. The obtained results showed that the average test score was 50.2% ( $n = 151$ ). Students with prior knowledge on OHS ( $n = 53$ ) did not get higher test scores ( $p\text{-value} = 0.12$ ;  $\alpha = 0.05$ ). The objectives of the study were achieved. Further studies considering the efficiency of both teaching and learning are to be conducted.

**Key words:** OHS, occupational health and safety course, knowledge.

**ACKNOWLEDGEMENTS.** We would like to thank all of our colleagues who let us survey their students for the purpose of this study.



## Work-related musculoskeletal symptoms in industrial workers and the effect of balneotherapy

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**Abstract.** The aim of the paper is to present balneotherapy (mud treatment) effect in the rehabilitation and prevention of work-related musculoskeletal disorders (MSDs) of industrial workers. Balneotherapy significantly reduces the muscle pain complaints of the employees. The m.abductor pollicis brevis muscle tension measured decreased after the balneotherapy. The study included overall 114 industrial workers (91 female and 23 male persons from garment and woodworking industries) with professional overuse of the upper extremities. The average age of the workers was 49.1 (from 22 to 75) years, their average length of the service was 16.2 years. The main result of the questioning of the workers about the pain regions: there was quite a high incidence of musculoskeletal pain in the investigated workers with a work-related upper extremity syndrome: neck 68.4%, shoulders 63.2%, elbows 42.1% and wrists 78.9%. In the course of the study, balneotherapy was applied to 19 (13 female and 6 male) industrial workers who had pain at least in two regions of the body. The average age of these workers was 50.6 years and the average length of the service 21.3. After the balneotherapy, the 19 industrial workers' complaints of pain in the neck and in the wrists decreased from 2.37 to 1.13 points ( $p = 0.05$ ) and from 3.25 to 1.03 points ( $p = 0.007$ ) respectively on the VAS pain scale. Objective measurement of muscle fatigue with a myotonometer showed the decrease in the stiffness of hand muscles (Abd poll brev, right: from 278  $\text{nM}^{-1}$  until 342  $\text{nM}^{-1}$ ,  $p = 0.006$ ). The results indicated that more attention should be paid to the early diagnostics and preventive measures.

**Key words:** physical overload, musculoskeletal disorders, myotonometry, industrial workers, balneotherapy.

## Team learning and self-management for video display terminal employees with chronic neck-shoulders pain

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**Abstract.** In Latvia occupational musculoskeletal disorder – chronic neck-shoulders pain (NSP) – is a common complaint in the general population, also in video display terminal (VDT) employees in their giving age, working in bank and agriculture system and such patients with chronic NSP load markedly the public health care service. The biopsychosocial influence on pain for VDT employees is team learning (TL) with self-management (SM) strategies: pain-blocking imagery, mind-body relaxation, cognitive restructuring of unpleasant physical and emotional experience, improvement of workplace relations and organizational culture. The aim of the research was to evaluate the effectiveness of using TL and SM one month course for bank and agricultural advisory services VDT employees, females and males, suffering from chronic moderate NSP. The structured self-administrated questionnaire was carried out to find out which body parts suffer from pain during workload, information on work-related ergonomic and psychosocial risk factors was collected during face to face interviews. During testing for TL and SM course with follow-up assessment was selected 21 VDT employees (females = 11, males = 10; age between 22 and 50). The intensity of NSP was determined by using the Numeric Pain Rating Scale (NPRS), life quality assessment was analysed with Quality of Life Scale (QOLS), p-value, confidence interval was calculated. Patients were asked to keep a Pain Diary during treatment course. The results indicated decrease in neck-shoulders pain intensity and positive quality of life changes after TL and SM intervention in video display terminal (VDT) employees. Statistically significant reduction in pain intensity after TL and SM intervention by the biopsychosocial influence on pain according NPRS was among males and the life quality according to QOLS score – among females. The necessity to perform patient's objective clinical examinations, subjective tests of self-esteem, to keep a Pain Diary during treatment course has been proved in our research.

**Key words:** chronic moderate neck-shoulders pain, video display terminal employees, team learning, self-management.

## EMG measurements of thumb muscles of nurses and caregivers

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**Abstract.** The number of ageing people in Estonia is increasing. Convenience for personnel in the nursing homes for the elderly and enabling high-quality care is essential. This includes new work methods to relieve the physical burden of nursing workers and the mental stress decreasing interventions. In the theoretical part of the paper, the physical and psychosocial risk factors of nurses and caregivers are dealt with. **The aim** of the study is to measure the *m. abductor pollicis brevis* fatigue in connection with the physical stress of nurses and caregivers. The experimental part of the paper concentrates on the physical stress factors. Electromyography (eMotion EMG) is used as the method for the determination of the nursing workers' thumb muscle's (*m. abductor pollicis brevis*) fatigue. The results show the linear dependences between the level of fatigue of the thumb muscles at the beginning and at the end of an 8-hour workday; between the EMG signals from the muscles in the resting state and after a 5-minute strained state. The interviews with the nurses showed that the renewal of equipment and rooms in the nursing homes is the main factor to prevent the physiological stress at workplaces (pain in the hands, low back pain etc.). In the newly built nursing homes with modern equipment, the workers are satisfied and no physiological stress was noticed.

**Key words:** psychological stress, fatigue, nursing homes, nurses working conditions, job satisfaction.

## The comparison study of office workers' workplace health hazards in different type of buildings

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**Abstract.** The aim of the study is to investigate the office-workers' working conditions in the ordinary and atrium-type buildings. The indoor climate conditions in the cold season in two type of university buildings are presented. The air temperature is on the good level in the both of the buildings. The rooms in the atrium-side of the building **A** are too tight and the ergonomics is not considered designing the workplaces in the office-rooms. In the auditoriums of the building **B** it is too noisy (over 70 dB(A)) during the breaks that prevents the rest and the communication between the workers and students. The air humidity is too low in both type of the buildings (< 30% in the cold season, when the rooms are central-heated). It is recommended to moisten the air in the rooms artificially. For the health risk assessment in the workrooms a flexible risk assessment model is used. The risk levels for the indoor climate factors are different in the two type of buildings.

**Key words:** office-rooms, auditoriums, high schools, indoor climate.

## **VIII FOOD SCIENCE and TECHNOLOGY**

## Comparative study of three drying methods: freeze, hot air-assisted freeze and infrared-assisted freeze modes

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**Abstract.** The dehydration tests were conducted at three drying methods to evaluate the drying curves and the energy uptake. Apple (*Malus domestica* L.) cubes were dried under different processing conditions applying freeze drying (FD), freeze drying assisted by hot air and freeze drying assisted by infrared radiation. Control samples were produced using regular freeze drying without the pre-drying. Hot air combined with freeze drying (HAD-FD) at 60 and 80°C air temperatures was investigated. The infrared-freeze drying (IR-FD) is a relatively new processing method. The *Idared* apple cubes were dried with 5 kW m<sup>-2</sup> IR power intensity. It was observed that the infrared power level and hot air temperature affected the drying rate and time of freeze drying. The infrared radiation heating had a higher drying rate than hot air during the pre-dehydration. The water activity, colour, firmness and rehydration ratio (RR) of finished products were measured. The dried material produced with IR-FD had desirable colour, higher rehydration rate and lower firmness than dried by HAD-FD ones. The quality of single-stage FD samples was close to IR-FD materials. It was observed that the IR-FD method drastically decreased the energy consumption, compared to FD and HAD-FD drying treatments. The mathematical models such as Henderson-Pabis and third-degree polynomial are used to describe the drying kinetics of food material. It was found that those mathematical models performed adequately in predicting the changes of moisture ratio.

**Key words:** Combination or hybrid drying, quality assessment, energy uptake, modelling.

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## Effects of dairy cow diet supplementation with carrots on milk composition, concentration of cow blood serum carotenes and butter oil fat-soluble antioxidative substances

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**Abstract.** Fat-soluble constituents of milk –  $\beta$ -carotene and  $\alpha$ -tocopherol – are essential for quality and nutritional value of milk and dairy products. Provision of fat-soluble antioxidants and vitamins such as carotenoids and vitamin E necessary for cow organism and milk synthesis depends on their concentration in fodder. The aim of this study was to estimate the effect of cow feed supplementation by carrots on the total carotene concentration in cow blood serum, on fat, protein, lactose concentration in milk and milk yield, as well as to investigate the effects on  $\beta$ -carotene and  $\alpha$ -tocopherol concentration in butter oil and intensity of its yellow colour. A total 20 cows of Latvian brown ( $n = 8$ ) and Danish red ( $n = 12$ ) breed were divided into control (CG) and experimental group (EG). In the EG, cow feed was supplemented with seven kg of carrots per cow per day for six weeks at the end of the indoor period (March–May). Milk samples from indoor period ( $n = 100$ ) and grazing ( $n = 20$ ) were used for butter oil extraction.

The carotene concentration observed in blood of animals before the experiment was insufficient taking into account that the recommended  $\beta$ -carotene concentration in serum is above  $3.0 \text{ mg l}^{-1}$  level. During indoor period the increase in carotene concentration in blood of cows was significant in both groups ( $P < 0.05$ ) but in EG it was more explicit showing the positive effect of carrot supplementation. Carrot supplementation did not change milk fat, protein, lactose concentration and yield ( $P > 0.05$ ). At the same time it contributed in more stable  $\beta$ -carotene, as well as 30% higher  $\alpha$ -tocopherol concentration and more intense yellow colour of butter oil samples during the indoor period of the experiment ( $P < 0.05$ ).

**Key words:** dairy cow, milk, butter oil, carrot, fat-soluble antioxidants.

## Effects of degradation preventive agents on storage stability of anthocyanins in sour cherry concentrate

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**Abstract.** In this study the effects of sugar (sucrose, 25%), gallic acid (700 mg kg<sup>-1</sup>) and ascorbic acid (700 mg kg<sup>-1</sup>) were used in sour cherry concentrate in order to prevent the degradation of main anthocyanin compounds (cyanidin-3-glucosylrutinoside (Cy-3GR), cyanidin-3-rutinoside (Cy-3R) and cyanidin-3-glucoside (Cy-3G)) which are natural bioactive pigments responsible for red, blue and purple color of many fruits and vegetables. Thermal degradation of anthocyanins was evaluated by determination of anthocyanin content and calculation of the reaction rate constant, half-life of degradation, activation energy. Anthocyanin content decreased at all of the storage temperatures, as an example; there were 75, 51 and 55% reductions in Cy-3G contents of control samples (with no preventive agent) stored at 45, 24 and 4°C, respectively. The values of half-life time were above 200 days in most cases at all storage temperatures for sugar treated samples. Cy-3-GR (activation energy values 35.6-84.4 kJ mol<sup>-1</sup>) was found to be the most unstable among the other anthocyanins. The most contributing agent on anthocyanin stability was sugar, whereas ascorbic acid exhibited the lowest effect in terms of preventing anthocyanin degradation.

**Key words:** sour cherry, anthocyanins, degradation kinetics, storage.



## **Pork quality of autochthonous genotype Casertana, crossbred Casertana x Duroc and hybrid Pen ar Lan in relation to farming systems**

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**Abstract.** In the last decades, the development of livestock has coincided with improvements of the animals performance. The swine has been strongly selected for several traits that determined a significant spread of some genetic types, more productive than the old autochthonous genetic types (AGT). Therefore, the AGT suffered a growing demographic contraction. The AGT are able to reduce the loss of genetic variability, potentially useful for the new generation and they play an important economic role for their productive capacity in harsh environments; furthermore, they can be used to obtain natural and 'traditional' products. In the current research the black AGT Casertana (CT) was compared with the crossbreed CT×Duroc in relation to gender (castrated males and entire females) and farming systems: Open Air and Outdoor (plus access to the bush) for some qualitative properties of meat. In addition 'Fiocco' ham, a traditional product, from CT, CT×DU and Pen ar Lan pigs was analyzed. The results showed that the CT pigs had a significantly higher percentage of fat, a thicker adipose tissue and their meat had lower values of hardness, chewiness, shear force and appeared significantly redder than other genotypes meat. The farming systems and gender did not affect the carcass composition and physical traits of meat.

**Key words:** pork, meat quality, autochthonous genetic type, Casertana pig.

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## Detection of bacteriocin-producing lactic acid bacteria from milk in various farms in north-east Algeria by a new procedure

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**Abstract.** Twelve samples of bacteriocin-producing lactic acid bacteria were isolated from raw milk. The screening procedure has the advantage of differentiating directly on agar plates active colonies among the natural microbial population without subsequent culture. Five of the milk isolates had effective inhibitory activity against *Staphylococcus*, *Bacillus* and all *Listeria monocytogenes* strains tested. In addition, two bacteriocinogenic isolates were effective against Gram-negative bacteria including *Pseudomonas aeruginosa* and *Escherichia coli*. The action of the bacteriocins was eliminated by a proteolytic enzyme. Simulation tests in liquid medium showed a 3 log reduction of *Listeria* growth in the presence of bacteriocin during a storage period of 14 days at 4°C.

**Key words:** bacteriocin, lactic acid bacteria, screening procedure, *Listeria monocytogenes*.

## Functional properties of tarhana enriched with whey concentrate

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**Abstract.** Whey concentrate is often sold as a nutritional supplement and include proteins, minerals, vitamins and other components (low levels of fat and low levels of lactose). Whey concentrates is well known for their high nutritional value and versatile functional properties in food products. The aim of this study was to enrich tarhana by using whey concentrate (WC) instead of yoghurt. Foaming capacity and foam stability, water and oil absorption capacity, emulsifying activity as a functional properties, colour properties and sweetness, body-texture, colour-appearance, mouthfeel, acidity, homogeneity, consistency and overall acceptability as a sensorial characteristics of tarhana samples were determined. The highest foaming capacity values were obtained with 50% WC substitution, but 50% WC addition gave the lowest foam stability values. Oil absorption capacity and emulsifying activity values of tarhana samples were decreased by increasing WC levels. Tarhana samples containing WC were lighter according to colour values than the control tarhana samples made with yoghurt. Tarhana soup prepared with 12.5% WC addition was similar to the control in homogeneity and overall acceptability.

**Key words:** tarhana, whey concentrate, color, foaming capacity, water absorption capacity, sensorial characteristics.

## The effect of blanching temperature on the quality of microwave-vacuum dried mushroom *Cantharellus cibarius*

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**Abstract.** The objective of this study was to evaluate the effect of blanching temperature on structure, colour, chemical composition and rehydration capacity of microwave-vacuum dried chanterelle (*Cantharellus cibarius*). Fruiting bodies of chanterelle were collected from the forests in Jelgava region of Latvia. Prior to drying, fresh mushrooms were blanched in water at various temperatures of 70, 80, 90 and 100°C for 3 min, then cooled in water (20°C). After blanching mushrooms were dried in a microwave-vacuum drier according to the specially designed program. The content of dry matter of chanterelle was  $9.5 \pm 0.5\%$ . The results revealed that weight loss at 70–90°C was significantly smaller compared to blanching at 100°C temperature. The results indicated the tendency of smaller changes in microstructure, weight loss and colour for samples blanched at 70–80°C temperature comparing to the samples unblanched or blanched at higher temperatures. Electrical conductivity in water extract of microwave-vacuum dried chanterelle decreased with increased blanching temperature. Titratable acidity of chanterelle significantly reduced after blanching due to leakage of soluble acids into blanching water.

**Key words:** protein content, total phenols, structure, aroma profile, rehydration capacity.

## **Analysis of mechanical behaviour of *Jatropha curcas* L. bulk seeds under compression loading with aid of reciprocal slope transformation method and tangent curve method**

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**Abstract.** This study is focused on the utilization of the reciprocal slope transformation method (RST) and tangent curve method (TCM) for description of mechanical behaviour of *Jatropha* bulk seeds under compression loading. The experimental data derived from a compression test was done using compression device and pressing vessel with diameter 60 mm at compression speed of  $1 \text{ mm s}^{-1}$  and compressive force between 0 kN and 100 kN. Measured dependency between compressive force and deformation was fitted by RST method and TCM method and they were statistically analysed by ANOVA. Comparison of both methods in individual pressing regions is an integral part of this manuscript. It was determined that reciprocal slope transformation method describes precisely the beginning of deformation characteristics and it can cover the reorganizing process in the bulk seeds. From the conducted study it also follows that tangent curve method is suitable for description of mechanical behaviour at bulk deformations in which the reorganization process in the bulk seeds is finished yet.

**Key words:** stress, strain, oilseed, mathematical model, deformation characteristic, oil point.

## Rheological properties of whole wheat and whole triticale flour blends for pasta production

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**Abstract.** Whole grain flour can be considered as a good candidate for pasta fortification due to the health benefits. In the literature it is mentioned, that when pasta dough is fortified with non-traditional ingredients, it behaves differently. Therefore, the purpose of the current research was to investigate the rheological properties of the whole wheat and whole triticale flour blends for pasta production. Whole grain flour made from triticale and wheat grains was used in the present research. Wheat flour type 405 was used as a control. The blends were made from whole triticale and whole wheat flour in combination with wheat flour (type 405) in various proportions (from 10% to 100%). The following quality parameters were analysed by using standard methods: the rheological properties of dough were analysed using Brabender Farinograph-AT; moisture content of flour samples was determined according to AACC (2000) Method No. 44-15A. The results of the present research demonstrate that the rheological properties of dough become worse by increase the amount of whole grain flour in a blend. Water absorption is higher and dough development time of dough with whole grain flour addition is longer than the parameters of control wheat flour (type 405). The same results were obtained during analysing dough stability and development time. However, higher dough stability was obtained for the blends with whole wheat flour, compared to blends with whole triticale flour, what possibly is due to the higher gluten content in whole wheat flour.

**Key words:** whole wheat, whole triticale, flour blends, pasta, farinograph.

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## Integrated evaluation of cowpea (*Vigna unguiculata* (L.) Walp.) and maple pea (*Pisum sativum* var. *arvense* L.) spreads

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**Abstract.** The aim of this research was to develop pea spreads using local legumes and complete integrated evaluation of the spreads to find the most suitable pea spreads for shelf-life investigation. A total of twelve pea spreads were made of ground re-hydrated cooked seeds of cowpeas (*Vigna unguiculata* (L.) Walp.) or maple peas (*Pisum sativum* var. *arvense* L.), to which salt, citric acid, oil and different spices were added. Standard analytical methods were employed to determine overall preference and physicochemical composition (protein, fibre, ash, pH, etc.) of spread samples. Principles of integrated evaluation were used to select the most suitable spreads for pea spread shelf-life investigation. The overall preference of cowpea and maple pea spread samples ranged from 2.8 to 4.9 with significant differences among spreads ( $P < 0.05$ ). Physicochemical evaluation was completed with only sensory satisfactory samples. There were no significant differences in protein, ash and dry matter content among pea spread samples ( $P > 0.05$ ). Pea spreads were good sources of total dietary fibre (10.72 to 14.81 g 100 g<sup>-1</sup>). Addition of spices had a significant impact on the lightness ( $L^*$ ) and firmness of pea spreads ( $P < 0.05$ ). Cowpea spread with bruschetta spice (15.43) and maple pea spread with bruschetta spice (22.09) had the lowest integrated evaluation values among spreads from the same legume. It was concluded that shelf-life investigation should be completed with the most suitable spread (the lowest integrated evaluation value) and control sample, i.e., cowpea spread and maple spread with bruschetta spice and without spices.

**Key words:** cowpea, maple pea, physicochemical evaluation, sensory evaluation.

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## A study on bryophyte chemical composition—search for new applications

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**Abstract.** Bryophytes are the taxonomic group in the plant kingdom represented with about 25'000 species. They contain a high number of biologically active compounds; however their use as a food source is negligible. The aim of this paper is to evaluate bryophyte chemical composition and new possible applications. In order to evaluate bryophyte potential usage as a raw food material, bryophyte basic chemical content and the secondary metabolite profile was determined. To obtain best results bryophyte secondary metabolite extraction options has been studied. Couple of extraction methods were used (conventional, ultrasound, microwave, supercritical CO<sub>2</sub> extraction etc.) and different solvents (ethanol, water etc.). A total concentration of polyphenols and substances determining free radical scavenging activity has been determined. The extracts obtained from bryophytes have remarkable antioxidant activity, the extent of which depends on the extraction conditions and bryophyte species. Comparison of five extraction methods and several solvents indicates that microwave assisted extraction and supercritical CO<sub>2</sub> extraction is the most promising approach to obtain highest yields of extractives.

**Key words:** bryophytes; extraction, polyphenols, antiradical activity, optimization, food.

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## Study of functional and technological characteristics of protein concentrates from lupin seeds

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**Abstract.** The purpose of the research was to study functional and technological characteristics of concentrated protein preparations produced from lupin seeds and to demonstrate a feasibility of their usage as functional ingredients in food products. The method of production of concentrated protein preparations from seeds of *Lupinus angustifolius* was developed based on an acidic water extraction of non-protein compounds of lupin flour in presence of an optimized multi-enzyme composition composed of  $1.1 \pm 0.2$  unit g<sup>-1</sup> of Celluclast and  $5.2 \pm 0.4$  units g<sup>-1</sup> of Pentopan Mono and  $2.5 \pm 0.2$  units g<sup>-1</sup> of Amilosubtilin. It was shown that crude protein content of protein concentrate preparations obtained with enzymatic treatment of polysaccharides increased to  $(63.2 \pm 1.3)$  % on m.f.b. versus  $(50.4 \pm 1.3)$  % on m. f. b. in the control preparation produced without an enzymatic treatment. Process parameters of infrared drying of lupin protein concentrate wet residues in the short wavelength range up to 2.5  $\mu$ m were studied. The comparative analysis of functional and technological characteristics of lupin protein preparations, lupin flour and soy flour was carried out. Water-holding capacity, fat-holding capacity and emulsifying capacity of lupin protein concentrates produced via enzymatic treatment have been increased versus the control sample. The process and the formulation of fermented dairy product with inclusion of lupin protein additives in a range of 0.5% to 2.0% (% w w<sup>-1</sup>) were developed. Sensory, physico-chemical and structural-mechanical properties of a dairy product enriched with lupin protein were analyzed. It was shown that usage of lupin protein preparations as nutritional supplements was beneficial for human gastrointestinal tract. 1.5% (% w w<sup>-1</sup>) inclusion level of the lupin preparation in the food formulation provided the best consumer properties of finished products. It was shown that the lupin protein concentrate preparation can be used as a functional ingredient in fermented dairy products.

**Key words:** lupin protein concentrate, multi-enzyme composition, functional and technological properties, enriched dairy products, functional food ingredients.

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## Yeast physiological state influence on beer turbidity

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**Abstract.** The physiological state of yeast affects the intensity of propagation and biosynthesis of secondary metabolites and determines the sensory profile of beer. Besides that, yeast with low physiological activity increases the number of colloidal particles in beer, which consist of proteins and polysaccharides. The purpose of this study was to select a method for assessing the physiological state of yeast and to study the influence of yeast physiological state on the adsorption of compounds that determine the colloidal stability of beer. As a result of comparative analysis of different methods for determining the non-viable and weakened cells with dyes a certain correlation between them was found. The highest correlation ( $R^2 = 0.84$ ) was set between parameters obtained by staining yeast cells by methylene blue with Safranin O, which stains both dead and weakened cells and dihydrorhodamine 123, which detects only physiologically least active yeast. Sufficiently high correlation ( $R^2 = 0.83$ ) was observed when cells were stained with methylene blue, which identifies only dead cells and with methylene blue with Safranin O. The worse the physiological condition of yeast, the less they adsorb turbidity-inducing compounds, so more substances remain in beer, reducing its stability. Thus, the increase in the proportion of damaged and non-viable cells from 24.2 to 32.2% leads to increased beer turbidity from 1.5 to 3.3%. Z-potential of yeast cell walls determines their sorption properties. Physiologically active yeast cells are able to adsorb positively charged colloids due to the negative charge of their surface. Activation of the yeast's surface potential occurs in the presence of oxygen.

**Key words:** yeast, Z-potential, colloids, staining methods.

## Stability of vitamin A and E in powdered cow's milk in relation to different storage methods

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**Abstract.** In this article, the influence of different ways of storage on the content of vitamin A and E in powdered cow's milk was studied. The cow's whole milk powder was taken directly from the manufacturer and stored for one year in 4 different ways – in the light at room temperature, in the dark at room temperature, in a refrigerator at 8°C and in a freezer at -20°C. The content of vitamins was measured 4 times during the first month and then once a month. The samples were stored for one year. Vitamins A and E were determined by HPLC using DAD and FLD detectors. Vitamin A was identified in all samples but only  $\alpha$ -tocopherol (out of various forms of vitamin E) was detected in all samples. In all cases steeper decline of both vitamins in first 14 days of storage was identified. The highest losses of vitamin A and E in powdered milk occurred during storage in the light at room temperature. The value decreased by 91 resp. 95% of the original value.

**Key words:** stability, milk powder, storage, vitamin A, vitamin E.

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## Development of cheese product with hydrolyzed soybean emulsion

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**Abstract.** The expediency of production of food products based on complex raw material compositions is currently proved. According to the modern concept of a healthy nutrition it is important to optimize the composition of the product considering the content of biologically valuable substances in raw materials during a development of such products. This paper deals with the studies demonstrating an option of usage of soybean emulsion as a raw material of plant origin for development of a high-protein food product similar to a soft cheese. Soybean food emulsion (SFE) was developed and produced by All-Russian Scientific Research Institute of Fats. For minimizing activity of antigenic factors of soybeans (such as glycinin and  $\beta$ -conglycinin) SFE was subjected to partial proteolysis by a complex enzyme preparation. At the Department of Milk Technology and Food Biotechnology of ITMO University recipes and technology of a cheese product with HSFE were developed. Experimental samples were prepared with different doses of HSFE in recipes. The degree of hydrolysis of the HSFE was varied from 6% to 12% with intervals of 2%. Amino acid score for essential amino acid was calculated, the absence of limiting amino acids in developed products confirms their high biological value.

**Key words:** cheese product, soybean emulsion, hydrolyzed soybean emulsion, degree of hydrolysis, biological value of protein, amino acids.

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## The role of cyclic amides in the formation of antioxidant capacity of bakery products

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**Abstract.** This paper discusses the possibility of using of additives of vegetable raw materials in the manufacture of bakery products with antioxidant capacity. The optimal doses of additives in the recipe of bakery products were established. These were 3% for blueberry powder and 6% for pine nuts flour. Antioxidant capacity of hydrophilic fractions of blueberries powder, pine nuts flour, bakery crusts and crumbs were studied in vitro by chemiluminescence technique. Cyclic amides (lactams) were also identified. The antioxidant capacity of hydrophilic fraction of crust of bakery products with pine nuts flour was in 1.7 times higher than that obtained by calculation, for crumb in 1.5 times. For crust of bakery products with blueberry powder the antioxidant capacity of hydrophilic fraction was in 2.2 times higher and for crumb in 1.3 times higher. The antioxidant capacity of hydrophilic fraction of crust of bakery products with blueberry powder was in 1.2 times higher and for bakery products with pine nuts flour, conversely was higher the antioxidant capacity of the hydrophilic fraction of crumb – in 1.3 times. The antioxidant capacity of hydrophilic fraction of crumb of bakery products with pine nuts flour was in 1.1 times higher in comparison with bakery products with a blueberry powder. The amount of mono-heterocyclic  $\gamma$ -lactams in the crumb of bakery products with pine nuts flour was higher than in the product with blueberries powder, but less than in the control sample. Thus, the formation of antioxidant capacity of hydrophilic fractions of crumb and crust occurs due to Maillard reaction intermediates.

**Key words:** bakery products; blueberry powder; pine nuts flour; antioxidant capacity; cyclic amides (lactams).

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## Expression of myogenesis factors that regulate the differentiation of pigs muscle fibers in two genetic type

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**Abstract.** Muscle fibers differentiation and maturation in foetal period until birth is regulated by the expression of some genes that belong to the family of muscle regulatory factors (MRFs) with a domain “basic helix- loop-helix” (bHLH). Although all have common characteristics, the four following genes: MyoD, Myf5, MRF4 (or MYF6), Myogenin, exhibit a different temporal expression pattern that allows them functional differentiation. MyoD induces the irreversibly cell cycle arrest and the activation of myogenin and MRF2; Myf5 together with MyoD determine the formation of myoblasts; the Myogenin has an important role in the terminal differentiation of myoblasts into myotubes; MRF4 seems to have both functions. However an important role in the myogenic process is performed by gene Pax7 in satellite cells identification, which have the ability to form new tubular structures similar to myotubes when the muscle is damaged, so they contribute in formation of new fibers. The aim of this study is to highlight the relationship between the composition of fibers types in some skeletal muscle (Semimembranosus, Semitendinosus, Biceps femoris, Quadriceps femoris, Longissimus dorsi) and meat quality in Casertana and Duroc pigs. Ascertaining when and where genes are expressed is of crucial importance to understanding or predicting the physiological role of genes and proteins and how they interact to form the complex network that underlie muscle development and function. Then scientific research can supply food factory with new elements to have high meat quality standard.

**Key words:** muscle development, myogenesis, pigs.

## Automatic control and maintaining of cooling process of bakery products

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**Abstract.** During the development of automation control of the bakery products cooling process using a 'cooler' it is necessary to build an integrated control system, which allows to optimize the process parameters in case of a variety of work situations that may occur in the bakery enterprise. The main task for control of such multifactorial object is to reach a certain temperature in the center of the product by maintaining the temperature of the cooling air near the surface of the loaf set in the limits  $t \pm \Delta t$ , its velocity  $v \pm \Delta v$  and humidity  $\varphi \pm \Delta \varphi$  and maintain the speed of the conveyor within  $V_c \pm \Delta V_c$  using the frequency converters. Simultaneous exposure to multiple channels of control allows selecting the optimal combination of the cooling process control commands, yielding the product with necessary temperature and mass. Automatic control and regulation of the cooling process is based on the fact that the current value of the adjustable parameters in mismatch block is compared with predetermined values of the corresponding parameters and the mismatch signals are formed, which are amplified to a value sufficient to trigger actuators that provide executive regulators. Novelty of the paper consists in the development of the process control system based on the mathematical model which allows calculating the temperature at the center of freshly baked products by the surface temperature of the product at any time of location in the cooling zone. Experiments were carried out on the bread made in the laboratory and cooled after baking, by natural and forced convection. Baking was conducted in a special parallelepiped tins with lids. Thus, the output product had a parallelepiped shape. Process of cooling by natural convection was implemented in a cooling chamber, which allowed to measure temperature and relative humidity. Temperatures changing in the center of the loaf and weight loss were recorded during the experiments. Cooling time was determined by the time required to achieve the temperature in the center of the loaf 30°C. On the basis of the experimental data a mathematical model and the computer system, allowing calculating the parameters of cooling and in time to make a regulatory influence on one of the control channels and thus optimize the process parameters were built.

**Key words:** heat transfer, mass transfer, automation, spiral conveyor.

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## Effect of imported Duroc boars on meat quality of finishing pigs in Estonia

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**Abstract.** The objective of this study was to evaluate the carcass and meat quality characteristics of Duroc-sired progeny marketed in May and June 2014. Carcasses of the following genotypes were evaluated: purebred Landrace (LxL), crossbred Large White x Landrace (LWxL) and LWxL crosses with Duroc (DxLW/L) and Duroc x Landrace (D/LxLW/L) terminal boars. Carcass characteristics recorded: hot carcass weight, carcass length, backfat thickness and loin eye area (LEA). The following physicochemical parameters determined in the *Longissimus thoracis* muscle were pH value, colour, electroconductivity, water-holding capacity, drip loss, cooking loss and dry matter, protein, fat and ash content. Duroc-sired pigs were slaughtered at the older age, but at about the same live weight as those of other genotypes. The study revealed that genotypes incorporating Duroc breed had significantly shorter carcasses (D/LxLW/L –  $95.38 \pm 0.98$  cm and DxLW/L –  $96.88 \pm 0.95$  cm;  $P < 0.01$ ), but a larger LEA (D/LxLW/L –  $51.75 \pm 1.44$  cm<sup>2</sup> and DxLW/L –  $52.24 \pm 1.39$  cm<sup>2</sup>;  $P < 0.05$ ) compared to white-coloured genotypes (carcass length: LxL –  $101.12 \pm 0.95$  cm and LWxL –  $101.82 \pm 0.98$  cm; LEA: LxL –  $46.35 \pm 1.39$  cm<sup>2</sup> and LWxL –  $47.04 \pm 1.44$  cm<sup>2</sup>). Duroc sire had a significant effect on the muscle protein and intramuscular fat (IMF) content. DxLW/L genotype had the greatest IMF level ( $2.71 \pm 0.21\%$ ;  $P < 0.05$ ), while it was the lowest in the LxL and LWxL ( $1.23 \pm 0.21\%$  and  $1.71 \pm 0.22\%$ , respectively). Genotype combinations had no effect on carcass fat deposition. The differences that exist between the breeds of pigs make it possible to modify breed-specific traits such as growth performance, leanness and meat quality. It can therefore be concluded that Duroc boars provide Estonian pig breeders with a valuable source of genetic material for improving the carcass and meat quality of finisher pigs.

**Key words:** Duroc, Landrace, Large White, crossbreeding, carcass quality, meat quality, leanness, backfat.

**Abbreviations:** D – Duroc, L – Landrace, LW – Large White, FLA – fat layer area, IMF – intramuscular fat, LEA – loin eye area, WHC – water-holding capacity.

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## Calculation model for the assessment of animal by-product resources in Estonian meat industry

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**Abstract.** Aim of current study was the elaboration of a calculation model for monitoring system which makes it possible to assess the animal by-product (ABP) resources in cooperation with companies and state authorities. Data about quantities of processed animals by species were collected from existing public databases, Estonian Animal Waste Processing Plant and meat processing enterprises of Estonia. Data from scientific literature and available statistics as well as data about the quantities of meat and slaughtering products observed in slaughterhouses was used for estimation the average of ABP quantities per animal by species. Based on these two datagroups – number of animals (by species) and yield of ABP per animal during meat processing, functionality of the general calculation model for monitoring was tested. Inputs for this model are numbers of animals by species and outputs accordingly the quantities of ABP by risk-categories and types. During evaluation of the calculation model it was estimated that nearly 22 thousand tons of ABP are generated in the recognized slaughterhouses of Estonia annually. 1,900 tons of it consists of 1<sup>st</sup> category ABP, 3,400 tons 2<sup>nd</sup> category and over 17,000 tons 3<sup>rd</sup> category ABP. On the other hand quantities of ABP delivered from meat industry to the reprocessing as a 1<sup>st</sup> category was 4,900 tons which exceeded the estimated (by calculation model) amounts about 3.5 times. Thus a great deal of other ABP categories had also been sent for reprocessing as the most dangerous waste. This fact indicates to the insufficient use of 2<sup>nd</sup> and 3<sup>rd</sup> category ABP as raw material in Estonian meat industry. Existence of an efficient monitoring system will promote the management of ABP recourses in slaughterhouses and meat processing companies. For this the relevant databases, procedures and methods should be worked out.

**Key words:** animal by-products, meat processing, monitoring system.

## The effect of packaging type on quality of cereal muesli during storage

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**Abstract.** Cereal-derived breakfast products (cereal flakes, bread and muesli) are increasingly consumed because they are an important source of energy for adults and children. Shelf-life of foods is highly dependent on the permeability characteristics of the packaging materials, which emphasize the importance of packaging design. The aim of this study was to evaluate changes of physically-chemical, microbiological and sensory parameters of cereal muesli with chocolate and apricots during storage. Samples of muesli with chocolate and apricots were packaged in 3 different types of packaging—paper bag, paper tubes and *Doypack* (stand-up pouches) and stored for 9 months (at  $20 \pm 2^\circ\text{C}$  temperature and relative air humidity –  $55 \pm 3\%$ ). During the storage moisture content, water activity, total plate count of mesophilic aerobic and facultative anaerobic microorganisms (MAFAM), mould and yeast, volatile compounds and sensory quality were evaluated in analysed muesli samples. The lowest moisture content after 9 months storage was determined for muesli samples stored in paper bag. Total number of mesophilic aerobic facultative anaerobic microorganisms (MAFAM, mould and yeast) of muesli in all samples during storage slightly increased. After 9 months storage muesli with chocolate and apricots in the *Doypack* had the best sensory properties. In muesli with chocolate and apricots there were identified 18 volatile compounds. The results indicated that paper bags were the least suitable for packaging of cereal muesli with chocolate and apricot, because of essential quality changes of samples during their storage. The shelf-life of 9 months can be recommended for cereal muesli with chocolate and apricots packaged in paper tube or *Doypack*.

**Key words:** cereals, muesli, packaging, storage time.

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## Upgrading the technology of functional dairy products by means of fermentation process ultrasonic intensification

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**Abstract.** Intensification of milk fermentation without negative influence on product quality is a priority research direction in dairy industry. One of the perspective tools for solving this problem is usage of ultrasound. Careful selection of ultrasonic treatment regimens allows to activate lactic-acid bacteria metabolic activity and to improve the efficiency of dairy production. A number of cultivations were carried out for ultrasonic processing effect estimation on *Lactococcus* mixed culture, *Streptococcus thermophilus* and *Lactobacillus delbrueckii ssp. bulgaricus* symbiotic cultures that are often used for dairy fermentation. Milk with added starter culture was treated with ultrasound by means of ultrasonic homogenizer at a frequency of about 30 kHz. Processing duration varied from 1 to 3 minutes and ultrasound power varied from 2 to 8 W. Ultrasonication regimens of fermenting milk allowed accelerating of fermentative process by 10% and improving the quality of final product.

**Key words:** ultrasound, ultrasonic processing, dried skim milk, reconstitution, intensification, fermentation, *Lactococcus lactis*, *Lactococcus cremoris*, *Lactococcus diacetyllactis*, *Streptococcus thermophilus*, *Lactobacillus bulgaricus*.

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## Optimization of the recipe of yoghurt with additives and control of some quality attributes of new yoghurt recipe

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**Abstract.** According to the data and the results of clinical trials received in Nutrition Institute of 'Russian Academy of Medical Sciences', it was found that 80% of Russians suffer from lack of selenium. Saint-Petersburg University Innovation Company 'Littoral' has developed a biologically active food supplement 'Selenium Alga plus'. The aim of this research was to investigate the possibility of using dietary supplement 'Selenium Alga Plus' in yoghurt manufacture. Almost all groups of the population consume such fermented milk drink as yogurt, so that it is considered that this method increasing selenium as the most effective. People suffering from diabetes may have lack of selenium in the organism, as well as healthy people. Since traditional yogurt contains 11% of sucrose, it is necessary to choose sweetening components with vegetable origin. Selecting sweetening components of vegetable origin we pursued the dual purpose. Firstly, we created a sweet product, which would be a source of organic selenium. Therefore the sucrose was replaced with the plant origin sweeteners such as syrup of Jerusalem artichoke and stevioside. Secondly, it was the development of technology and composition of functional food product, intended not only for mass consumption, but also for people suffer from diabetes. It becomes possible due to the absence of sucrose, the presence of selenium and Jerusalem artichoke, which are able to reduce the blood sugar level.

**Key words:** nutrition, yogurt, selenium, stevioside, Jerusalem artichoke.

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## Investigation of beaver meat obtained in Latvia

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**Abstract.** There is a high interest on the part of consumers to obtain meat from animals which have been reared as close to natural conditions as possible. Game meat, characterised by high nutritional value and specific organoleptic qualities, complies also to this claim. Game animals, including beaver, meat provide an excellent investment, diversification of many consumer meals. The meat of wild animals is more favourable for human health because it has lower saturated fatty acids. Investigations about biochemical composition of beaver meat are not very common worldwide.

The aim of study was evaluate biochemical composition of beaver meat hunted in Latvia. Therefore protein, amino acids, fat, ash, cholesterol content and fatty acid composition of beaver meat samples were done.

Conclusion was made that beaver meat samples protein content was 20.07–22.68% and fat content 3.31–5.27%. The sum of essential amino acids in beaver meat samples was determined from 0.99 mg 100 g<sup>-1</sup>, less than other game meat. While the content of polyunsaturated fatty acids in meat samples of beaver (42.54%) was significantly higher than content of saturated (26.80%) or monounsaturated (27.42%) fatty acids. Ratio of polyunsaturated fatty acids n–6 : n–3 in beaver meat samples were 1.26, PUFA : SFA in beaver meat samples were 1.60 and cholesterol content 49.51 mg 100 g<sup>-1</sup> was lower in comparison of domestic or wild animals meat. From this point of view beaver meat is very healthy source of fat.

**Key words:** wild animals, beaver, meat, biochemical composition.

## The micro-flora of gills, gut and skin of European eels (*Anguilla anguilla*) in lakes of Latvia

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**Abstract.** The microbial contamination of fish is the most important factor in assurance of food safety. The microflora on the surface of skin, gills and gut of fish is constantly under the influence of the water environment and this may support colonization of fish by microorganisms.

The goal of this study was to evaluate the bacterial contamination level on the skin, gills and in the gut of the European eel (*Anguilla anguilla*) detecting TBC and *Enterobacteriaceae* counts, as well as *Listeria* spp. and *Salmonella* spp. in freshly caught fish.

Among the three lakes TBC on skin, gills and gut varied from 0.66 to 4.93, from 0.40 to 5.51 and from 0.30 to 6.37 CFU cm<sup>-2</sup>, respectively. *Enterobacteriaceae* count on skin, gills and gut was from 0.00 to 4.30, from 0.00 to 2.47 and from 0.00 to 1.72 CFU cm<sup>-2</sup>, respectively. The highest mean count of TBC in gills, skin and gut was found in samples from Sīvers lake, while the lowest in samples from Alūksnes lake and differences were significant ( $P < 0.05$ ). Also the highest mean counts of *Enterobacteriaceae* were found on gills and skin of eels from Sīvers lake, but the highest count in gut was found in Usmas lake. All tested samples were *Listeria monocytogenes* and *Salmonella* spp. negative 0/31 (0).

TBC and *Enterobacteriaceae* counts of skin, gills and gut were typical for wild fish in clear water. Foodborne pathogens as *Salmonella* spp. and *Listeria monocytogenes* have not been found in the present study indicating that fish are safe for human consumption.

**Key words:** Freshwater fish, lake, microbial contamination, European eel, *Salmonella* spp., *Listeria monocytogenes*

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## Pigments in mint leaves and stems

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**Abstract.** Mint is the genus belonging to the *Labiatae* family and includes a huge diversity of varieties with different sensory properties. An important quality parameter is its colour and the compounds responsible for it are pigments such as chlorophyll *a* and *b*, carotenoids etc. The aim of the current research was to determine the pigment content in the leaves and the stems of different mint varieties grown in Latvia. Mint of nine varieties (*Mentha suaveolens* ‘Apple mint’, *Mentha suaveolens* ‘Variegata’, *Mentha spicata* ‘Marokko’, *Mentha piperita* ‘Swiss’, *Mentha piperita* ‘Granada’, *Mentha piperita* f. *citrate* ‘Grapefruit’, *Mentha piperita* ‘Chocolate’, *Mentha piperita* ‘Almira’, *Mentha piperita* ‘Bavarian’) collected in Latvia was analysed. Chlorophyll *a*, chlorophyll *b* and carotenoids were determined spectrophotometrically in the acetone extracts of fresh leaves and stems at various wavelength 470, 645 and 662 nm. To analyse a relationship between chlorophyll *a* and *b* in the leaves and the stems a calculation of ratio *a/b* was performed. Additionally the colour of samples was measured in CIE L\*a\*b\* system. For the statistical analysis – linear correlation, analysis of variance, hierarchical cluster analysis was performed. The differences were considered significant at  $P < 0.05$ . Among studied mint leaves the highest content of chlorophyll *a* and *b*, carotenoids was determined in the ‘Bavarian’ mint. The colour component L\* value for variety ‘Bavarian’ leaves was one of the lowest among studied samples (showing a darker colour intensity). The stems of the mint variety ‘Bavarian’ had a high content of chlorophyll especially chlorophyll *b*. The highest content of carotenoids was determined in *Mentha spicata* ‘Marokko’. Analysing a relationship between the colour components L\*a\*b\* and the content of pigments no significant correlations were determined.

**Key words:** mint varieties; chlorophyll *a*; chlorophyll *b*; colour.

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## Evaluation of size distribution of fat globules and fat and protein content in Estonian Goat milk

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**Abstract.** The objectives of this study were to investigate size distribution of fat globules, fat and protein content in Estonian goat milk. The bulk milk samples were collected from three different crossbreed goat herds. These herds consist of 30% of the Saanen breed and 70% did not belong to any certain breed. Lactation of goats was scattered over the year. Goat milk samples were examined weekly during a 10 month period. Fat and protein content in goat milk ranged from 3.09% to 5.04% and from 2.74% to 3.96% respectively. Fat content in cow milk ranged from 3.77% to 4.75% and protein content ranged from 3.14% to 3.75%. The average fat content in goat milk (3.88%) was less than the mean fat content in cow milk (4.0%). The average protein content in goat milk (3.41%) was higher than the mean protein content in cow milk (3.38%). Depending on the season, fat and protein content in goat milk varied by as much as 0.38% and 0.28% accordingly. The diameter of milk fat globules (MFG) was estimated using microscope Nikon SMZ 1000, equipped with the digital camera Nikon DS-U2/L2 USB and the software NIS-Elements D3.1. The average diameter of fat globules was 2.22  $\mu\text{m}$ , ranging from 0.34 to 6.99  $\mu\text{m}$ . The average size distribution of MFG had unimodal and slightly right skewed shape: 5.7% of globules were in range 0.5–1.0  $\mu\text{m}$ , 15.9% in range 1.0–1.5  $\mu\text{m}$ , 22.1% in range 1.5–2.0  $\mu\text{m}$ , 21.0% in range 2.0–2.5  $\mu\text{m}$ , 16.1% in range 2.5–3.0  $\mu\text{m}$ , 10.0% in range 3.0–3.5  $\mu\text{m}$ , 4.3% in range 3.5–4.0  $\mu\text{m}$ , 0.9% in range 4.5–5.0  $\mu\text{m}$ .

**Key words:** goat milk, fat, protein, fat globules size distribution.



## Stability of rapeseed oil with horseradish *America rusticana* L. and lovage *Levisticum officinale* L. extracts under medium temperature accelerated storage conditions

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**Abstract.** This study examined the antioxidant activity of horseradish leaves and lovage leaves and stems extracts added to crude rapeseed oil, under medium temperature accelerated storage conditions. To evaluate efficiency of plant extracts they were added to oil in different concentrations (0.25, 0.5, 1.0 and 1.5%). As a control rapeseed oil without extracts were analysed. For comparison 0.01% butylatedhydroxytoluene (BHT) were added to oil. Efficiency of extracts in oil were tested at  $+60 \pm 1^\circ\text{C}$  in the dark for 22 days. For all samples peroxide value, acid value and 2,2-diphenyl-1-picrylhydrazyl (DPPH<sup>•</sup>) activity were determined. In all steps of the experiments for samples with extract peroxide value was significantly ( $P < 0.05$ ) lower comparing to the control. The control sample without extract reached  $15\text{meq O}_2 \text{ kg}^{-1}$  oil (maximal allowed value in Latvian legislation) in 3 days. The best results showed the horseradish leaves extract (1%) and the lovage leave extract (1.5%) reaching this value in 8.3 days and 7 days, respectively. DPPH<sup>•</sup> activity of the oil was compared after 3 days (when blank sample reached maximal allowed a peroxide value) and it shown that for all samples it was higher compared to the control sample. The highest activity showed the samples with horseradish leave extracts. A acid value in oil samples changed slightly. Lovage leave as stem and horseradish leave extracts could be successfully used for retarding of oxidation of rapeseed oil and in further experiments their activity in meat products will be tested.

**Key words:** horseradish, lovage, extract, rapeseed oil, oxidation.

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## Effect of age on composition and quality of *Longissimus thoracis* muscle of the moose (*Alces alces* L.) harvested in Estonia

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**Abstract.** The aim of this study was to determine the biochemical composition and technological parameters of muscle (*Longissimus thoracis*) from adult and calf moose (*Alces alces* L.) hunter-harvested in the forest of southern Estonia. The experiment was based on 13 hunted moose, of which seven were adults (two males and five females) and six calves (two males and four females). The highest intramuscular fat (IMF) level was found in adult female moose muscles (1.50%) and the lowest in adult male moose muscle (0.46%). Adult moose muscles had higher IMF level (1.14%) than calves (0.98%) ( $P = 0.451$ ). The protein content found in the muscle samples of adult moose was 0.64% higher than that in calves (21.80%) ( $P = 0.045$ ). The moisture content of muscle from adult moose was lower (75.30%) and varied more than that of calves (76.07%) ( $P = 0.051$ ). The initial (5.00–5.59) and ultimate (5.40–5.64) pH in muscle samples were within the normal range, both in adults and calves, except in one of the hunted female calf that had high pH values ( $\text{pH}_{45\text{min}} = 6.60$  and  $\text{pH}_{72\text{hr}} = 6.90$ ), obviously because of stress. The WHC of moose muscles was considerably high (60.50–75.20%) and cooking loss for thermally processed moose muscle ranged between 19.10% and 33.39%. Muscle sample from adult moose had the highest cooking loss (29.69%) while that from the calves was the lowest (26.42%) ( $P = 0.191$ ). More force (32.54 N) was needed to share muscle samples from adult moose compared to cutting the samples from calves (23.92 N) ( $P = 0.374$ ). Based on the results of the experiments it can be concluded that the meat from younger moose had better technological quality and tenderness.

**Key words:** moose, *Longissimus thoracis*, meat quality, age, meat composition.

## Effect of aging technologies on some qualitative characteristics of Longissimus dorsi muscle of Marchigiana beef

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**Abstract.** In order to determine sensory preference and value of fresh beef steak differing in aging technique, this study evaluated two aging methods: dry and wet; a quality grade on physic-chemical traits of instrumental tenderness, color and sensory properties of Longissimus dorsi beef muscle of Marchigiana bovine, correlated to calpain proteolytic activity too. Dry-aged loins had higher ( $P < 0.0001$ ) weight loss than wet aged loins. Wet aged loins had higher ( $P < 0.01$ )  $L^*$  values than dry aged loins. Warner-Blatzer shear force of steaks was not affected ( $P > 0.05$ ) by aging method. We made a sensory panel evaluation too that showed no effect ( $P > 0.05$ ) of aging method on myofibrillar tenderness, juiciness, connective tissue amount, overall tenderness or off flavor intensity.

**Key words:** beef, dry aging, wet aging, tenderness.

## Glyphosate attachment on aminoactivated carriers for sample stabilization and concentration

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**Abstract.** Glyphosate (N-phosphonomethylglycine) is the most widely used non-selective postemergence herbicide for weed and vegetation control. The need for monitoring glyphosate levels in environmental samples and agricultural products proceeds from its extensive use due to the unregulated application and contradictory information about its toxicity on living organisms.

In order to achieve high sensitivity and reliability of glyphosate assessment, stabilization and preconcentration steps are generally required for its determination in different samples. The aim of the present study was to develop and optimize possibilities for effective glyphosate stabilization and concentration using aminoactivated nano- and microparticles of different materials. The results show that the usage of aminoactivated iron (II,III) oxide magnetic nanoparticles for the attachment and concentration of glyphosate is a prospective option to be integrated with *in situ* analytical technologies (e.g. biosensors), as the whole processes of glyphosate attachment was efficiently and reproductively carried out within 20 minutes.

**Key words:** glyphosate, stabilization, concentration, analysis, amino-activated, magnetic iron oxide nanoparticles, silica.

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