

## FOODBALT-2013

8th Baltic Conference on Food Science and Technology

*“Food, Health and Well-being”*



## CONFERENCE PROGRAM AND ABSTRACTS

May 23-24, 2013, Tallinn, Estonia

*“Food, Health and Well-being” May 23-24, 2013, Tallinn, Estonia*

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## CONFERENCE PROGRAM



## FOODBALT-2013

Thursday, May 23

<b>10:00</b>	<b>11:00</b>	<b>Registration+coffee</b>			
<b>11:00</b>	<b>11:15</b>	<b>Opening - Erkki Truve, Professor, Vice-Rector for Research</b>			
11:15	11:45	Thierry	Talou	Fr	Kitchen Flavor Chemistry (KFC) concept : Development of various generators of herbs and spices volatiles based on modified kitchen devices and utensils
11:45	12:00	Kristel	Vene	Est	Identifying the flavor and aroma profiles of basil using quantitative descriptive sensory and instrumental analysis
12:00	12:15	Aurelia	Kemzūraitė	Lt	Antioxidant activity of lovage ( <i>Levisticum officinale</i> Koch.) extracts isolated by supercritical carbon dioxide extraction
12:15	12:30	Vaida	Kraujaliene	Lt	Release of antioxidant components from bread enriched with rye and wheat bran by an in vitro physiological extraction
12:30	12:45	Paulius	Kraujalis	Lt	Antioxidative properties of rich in squalene amaranth seed oil extracted by supercritical carbon dioxide
12:45	13:00	Vaida	Kitryte	Lt	Release of flavour compounds by the thermal degradation of model melanoidins
<b>13:00</b>	<b>14:00</b>	<b>Lunch+Poster session</b>			
14:00	14:15	Rafał	Wołosiak	Pl	Comparison of anticarcinogen contents in chosen conventional and organic vegetables
14:15	14:30	Malgorzata	Nowacka	Pl	Influence of different parameters of ultrasound treatment on osmotic dehydration process
14:30	14:45	Anna	Pisponen	Est	Estimation of particle size distribution in lactose solution using dynamic light scattering
14:45	15:00	Christine Maria	Gutschelhofer	Ger	Quality Assurance aspects of mycotoxin testing
15:00	15:15	Dorota	Derewiaka	Pl	Evaluation of sterol oxides daily intake
15:15	15:30	Marta	Ciecierska	Pl	Assessment of polycyclic aromatic hydrocarbons' dietary exposure in the Polish population
<b>15:30</b>	<b>16:00</b>	<b>Coffee break+Poster session</b>			
16:00	16:15	Anna	Mihhalevski	Est	Factors affecting the rye sourdough bread staling
16:15	16:30	Vaida	Sulniute	Lt	Effect of rye and wheat bran extracts on the stability of beef meat burgers
16:30	16:45	Darius	Povilaitis	Lt	Properties of the extracts obtained from dried onions by different extraction methods
16:45	17:00	Riin	Uusna	Est	Novel extruded probiotic feed for rabbits
<b>19:00</b>		<b>Dinner</b>			



## FOODBALT-2013

Friday, May 24

<b>9:30</b>	<b>10:00</b>	<b>Registration+coffee+Poster session</b>			
10:00	10:30	Toomas	Paalme	Est	Foodomics
10:30	10:45	Urszula	Tylewicz	It	Influence of biodegradable packaging on the quality characteristics of frozen spinach
10:45	11:00	Ernesta	Malinauskyte	Lt	An in vivo lipids digestion of concentrated O/W emulsions and yogurt
11:00	11:15	Vilma	Speiciene	Lt	Influence of freezing on the physicochemical properties of concentrated emulsions stabilized by whey proteins and chitosan
11:15	11:30	Katrin	Laos	Est	The influence of guar gum/furcellaran and guar gum/carrageenan stabilizer systems on the rheological and sensorial properties of ice cream during storage
11:30	11:45	Kristi	Kõrge	Est	Ice re-crystallization in ice cream using ice structuring proteins from fish
<b>11:45</b>	<b>12:00</b>	<b>Closing</b>			
<b>12:00</b>	<b>13:00</b>	<b>Lunch</b>			
13:00		Excursions	TUT Department of Food Processing		
			CCFFT – Competence Centre of Food and Fermentation Technology		

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## FORMATION OF THE MULTITUDE OF FUNGI IN THE BARLEY YIELD GROWN AS PURE AND MIXED CROPS UNDER DIFFERENT AGRO-ECOLOGICAL CONDITIONS

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For centuries barley has been an important food crop for mankind. But fungi in cereals cause health problems to humans and animals. In Estonia, there has not been much research carried out on the link existing between the agro-ecological conditions and the microbiology of cereal yields. In 2009 and 2010, we carried out field experiments in Northern-Estonia (59°18'N,24°39'E), in the experimental station of Estonian Research Institute of Agriculture, and in Mid-Estonia (58°33'N,25°34'E), in the experimental station of Olustvere School of Service and Rural Economics. The variants of experiment were as follows: barley in pure crops with added ammonium nitrate-N120; barley in pure crops with added ammonium nitrate-N60; barley in pure crops with no added ammonium nitrate-N0, and barley-pea mixed crop. After harvest, drying grain at 14% moisture and sorting grain samples were taken for each variant. The multitude of molds, yeasts and *Fusarium* spp. fungi was determined in barley samples. The objective of our study included: 1) to compare the multitude of molds, yeasts and *Fusarium* spp. fungi on the barley yields grown in different region of Estonia; 2) to determine impact of weather during the growing season on the multitude of molds, yeasts and *Fusarium* spp.fungi in barley yields; and 3) to find whether different levels of nitrogen would affect the multitude of molds, yeasts and *Fusarium* spp. fungi on barley yields. Our results showed that yeasts were the most frequent fungi in barley yields. In yield of barley grown in Northern-Estonia the multitude of molds was lower compared to the multitude of molds in the barley yield grown in Mid-Estonia. The multitude of fungi was not affected by the fact whether the barley yield had been grown at different levels of nitrogen or as a barley-pea mix. It was the weather of the given year which proved to have the greatest impact on the multitude of fungi.

**Keywords:** cereal, yield, molds, yeasts, *Fusarium* spp.

## INFLUENCE OF HEATING TEMPERATURE AND PH ON TEXTURAL CHARACTERISTIC OF WHEY PROTEIN-PECTIN GELS

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Polysaccharide-protein connections are common in the world of plants and animals. Also in food products interacting proteins and polysaccharides are the subject of many researches since the effects produced by such products are often different from the substrate in terms of the structural and functional characteristics which gives the possibility of modeling and creation of new applications and food.

Whey protein, usually derived from whey, is the source of many active and health-beneficial amino acids and peptides and functional features especially important in maintaining the quality and stability of food products. The main functional properties include emulsions and foams stabilization, creating spatial networks (gels and edible coatings), the formation of stable sols used in the production of nutritional beverages.

Pectin is a polysaccharide composed of units of polygalacturonic acid partially esterified with methyl groups. Pectin low-methoxyl aminated gels are formed by interaction with the calcium in a wide pH range and used to produce low-sugar jams, jellies or soft melted cheese.

Common connection polysaccharides and proteins are characterized by better properties than the functional properties arising from individual components. The combination of these characteristics may be desirable hydration and rheological properties of a surface depends mainly on the pH, ionic strength, temperature, pressure, processing and application of mechanical forces.

The aim of this study was to determine the effect of the ionic environment (pH) and the processing temperature of whey protein on selected textural properties of pectin-protein gels. The gels were tested in the pH range from 4 to 10, and temperature treatment of whey proteins in the range 50 to 90<sup>0</sup>C. Investigated changes in hardness, adhesiveness, gumminess and chewiness. Also shown changes in the appearance of the gels on the impact of the parameters.

There was a correlation between the conditions of heat treatment and acidity and the appearance and textural properties of tested gels. High hardness and adhesiveness of gels characterized in alkaline pH (pH > 8), whereas weakest gels were in acidic pH (pH < 5). The increase in temperature of heat treatment of whey protein increases chewiness, hardness, elasticity index, gumminess and adhesiveness.

## IMPROVEMENT OF MILK LIPID DIETARY HEALTH INDICES: THE IMPACT OF COW'S FEED SUPPLEMENTATION BY CARROTS

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Milk lipid nutritional value depends on the composition of its constituents and influences the healthiness of milk and dairy products. The **aim** of the present study was to evaluate the effect of carrots as cow feed supplement on milk  $\omega 6 / \omega 3$  fatty acid ratio (Gebauera et al., 2005), as well as on milk lipid Dietary Health indices of atherogenicity and thrombogenicity (IA, IT), that are used for the prediction of lipid impact on cardiovascular disease. Milk was obtained from one experimental and one control cow group (EG – n=5, CG – n=5) in a conventional dairy farm. The basic feed was equal in both groups; EG cows received carrots 7 kg per cow per day. The fatty acid composition of milk was analyzed by gas-liquid chromatographic method, e.g. 7-15 mg of the extracted milk fat was mixed with 1 ml of hexane and 10  $\mu$ l of Na methylate (12.5 g 100 ml<sup>-1</sup> wv<sup>-1</sup>), shaken 1 min, and centrifuged 5 min at 4 °C and 13000 rpm. The upper layer was analyzed by an ACME model 6100 (Young Lin Instrument Co.) fitted with flame ionization detector, and a 30 m long, 0.25 mm i.d. Alltech AT-FAME analytical column. Lipid Dietary Health indices IA and IT were calculated by following formulas proposed by Ulbricht and Southgate (1991):

- $IA = [C12:0 + (4 \times C14:0) + C16:0] / [\Sigma MNTS + \Sigma PNTS\omega 6 + \Sigma PNTS\omega 3];$
- $IT = [C14:0 + C16:0 + C18:0] / [(0.5 \times MNTS) + (0.5 \times PNTS\omega 6) + (3 \times PNTS\omega 3) + (PNTS\omega 3 / PNTS\omega 6)];$

Where: MNTS – monounsaturated fatty acids; PNTS – polyunsaturated fatty acids

A stronger decrease in  $\omega 6 / \omega 3$  fatty acid ratio, as well as in IA and IT indices was observed in EG milk, showing that cow feed supplementation by carrots can lead to the improvement of milk lipid dietary properties related to cardiovascular disease prevention.

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**Key words:** milk lipids, dietary health indices, fatty acids, cow feed, carrots

## PHYTOCHEMICAL COMPOSITION AND PROPERTIES OF OREGANO *OREGANO VULGARE* SSP. *VULGARE* GROWING WILD IN LITHUANIA

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Wild oregano (*O. vulgare* ssp. *vulgare*) herb was collected in Kaunas Karmėlava district at three different growth phases: butonization (06/24), full flowering (07/18) and seed ripening (09/04). Plant material was dried at room temperature in the dark. Essential oil (EO) was isolated by hydrodistillation in a *Clevenger* type apparatus (AOAC) and analysed by GC-MS. The residues after hydrodistillation were separated into solid and liquid fractions. The liquid fraction was freeze-dried yielding 26.3% of water extract (WE). The solid fraction was dried and further extracted with acetone yielding 2.9% of deodorised acetone extract (DAE).

The EO yield varied from 0.3 (seed ripening) to 0.7 cm<sup>3</sup> 100g<sup>-1</sup> (full flowering). More than 40 constituents accounting 98.7% of total EO volatiles were identified by GC-MS. It is evident that analysed oregano depends to sabinene/β-ocimene/β-caryophyllene/germacrene D chemotype. The fluctuations in the percentage composition of the major compounds in EO throughout harvesting time were rather complex: the content of sabinene was 7.3-25.0%, sum of *cis*- and *trans*-β-ocimenes 7.5-16.5%, β-caryophyllene 13.7-18.0%, germacrene D 11.9-14.9%, linalool 1.3-4.8%, bicyclogermacrene 3.6-4.5%, spathulenol 3.5-3.8%.

The antimicrobial properties of oregano EO and WE isolated from herb harvested at different growth periods were analysed by the agar well diffusion method. The food spoilage bacteria, including pathogens (*Escherichia coli*, *Bacillus subtilis*, *Listeria monocytogenes*, *Micrococcus luteus*, *Staphylococcus aureus*) and yeast strains (*Saccharomyces cerevisiae*, *Candida parapsilosis*, *Torulasporea delbrueckii* and *Rhodotorula rubra*) were selected as test cultures. The antimicrobial activity of WE was significantly weaker compared to EO, however both extracts were effective against *St. aureus*. Oregano EO was also effective against yeast cultures, while WE has no effect on yeast tested and *E. coli*. The most sensitive bacteria to oregano EO were *B. subtilis* and *L. monocytogenes*.

The total content of phenolic compounds (TPC) was analysed by Folin-Ciocalteu method. The highest TPC 330 mg galic acid equivalents (GAE) in g extract was in WE extracted from oregano at full flowering; at butonization period TPC was 269 mg GAE/g. While in DAE extracted with middle polarity solvent acetone TPC was only 32.02 mg GAE/g. It shows that the major part of non-volatile oregano phenols is dissolved in water during hydrodistillation procedure. Antioxidant activity was tested by ABTS<sup>+</sup> radical scavenging assay: the 0.05% concentration DAE solution inhibited 70% of ABTS<sup>+</sup> radicals present in the reaction. Phytochemical analysis of oregano extracts carried out by UPLC coupled with quadrupole time-of-flight mass analyser (Q-TOF). The peaks were identified by comparing the retention times with standards or by the characteristic mass spectrometric fragmentation patterns and accurate masses by using, KEGG, Chempidder and Metlin databases. The highest amount of bioactive compounds was in WE. The major compounds were quinic, rosmarinic, 3-(3,4-dihydroxyphenyl)-2-hydroxypropanoic acids, luteolin-7-*O*-glucuronide and apigenin-7-*O*-glucuronide.

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**Keywords:** oregano; essential oil; water extract; acetone extract; phenolic compounds.

## INFLUENCE OF HARVESTING TIME ON THE YIELD AND CHEMICAL COMPOSITION OF THYME (*THYMUS VULGARIS* L.) GROWN IN LITHUANIA

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Thyme herb, essential oil (EO) and extracts are valuable sources of natural functional ingredients for using in foods as flavourings, preservatives and antioxidants. Phenolic compounds, thymol and carvacrol, possessing strong antioxidant and antibacterial activities against various food borne pathogens are the most important constituents of thyme EO. EOs may be also applied for various non-food applications (pharmaceutical, agronomy, sanitary, cosmetic and perfume industries) due to their fungicidal, antimicrobial, cytotoxic/anticancer, antitoxigenic, antimutagenic, antiviral, antimycotic, antiparasitic, disinfectant, insecticidal properties, which are related to the function of phenolic compounds (Burt, 2004; Bakkali, 2008; Lang and Buchbauer, 2011). Therefore, industrial production of such oils is gaining an importance, particularly by increasing the technological and economical effectiveness in the uses of natural EOs instead of synthetic compounds. Determination of optimal harvesting period would increase the grower's ability to control crop yield and EO quality in the thyme plants and would be the most important factor in further commercialization and application of such products for industrial uses in food and agriculture, the environment and in medicine for human health.

The influence of harvesting time (seasonal variation) on the yield of crop, as well as accumulation and composition of EO and some other chemical characteristics of thyme grown in Lithuania was investigated. The yield of crop depended on plant growing phase and varied between 2.0÷5.0 t ha<sup>-1</sup> and 0.4÷1.6 t ha<sup>-1</sup> of fresh and dried thyme herb, respectively. EO content at different growing periods was 0.19÷0.46 cm<sup>3</sup> 100 g<sup>-1</sup> (fresh herb) and 0.79÷1.53 cm<sup>3</sup> 100 g<sup>-1</sup> (dried herb). 70 constituents were identified in thyme EOs by capillary GC-MS. It was evident that *Thymus vulgaris* grown in Lithuania depends to thymol chemotype: it constituted 58.0÷67.2 % (fresh herb) and 56.8÷71.2 % (dried herb). The amount of thymol precursors *p*-cymene and  $\gamma$ -terpinene were [5.8÷12.6 % (fresh) and 4.5÷9.9 % (dried)] and [4.9÷17.3 % (fresh) and 2.7÷9.7 % (dried)], respectively in all EOs of thyme aerial parts at different growing phases. Other important components were carvacrol, myrcene, linalool and  $\beta$ -caryophyllene. The chemical composition of thyme was also investigated and the amount of dry soluble solids, ascorbic acid, carotenes, nitrates and total sugars were determined in fresh raw material at different growth stages.

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**Keywords:** Thyme; *Thymus officinalis*; Seasonal variation; Chemical composition; Essential oil; Crop; Yield.

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## THE INFLUENCE OF CERTAIN LAB SOURDOUGH FERMENTATION OF THE JERUSALEM ARTICHOKE (*HELIANTHUS TUBEROSUS* L.) TUBERS ON THE QUALITY AND SAFETY OF WHEAT BREAD

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The main focus in this study was to investigate the effects on wheat bread safety and quality due to addition of Jerusalem artichoke (*Helianthus tuberosus* L.) tubers, fermented by different lactic acid bacteria (LAB) strains that produce bacteriocin-like inhibitory substance (BLIS).

For the Jerusalem artichoke (JA) sourdough fermentation several different LAB (*Pediococcus acidilactici* KTU05-7, *Pediococcus pentosaceus* KTU05-8, *Pediococcus pentosaceus* KTU05-9, *Lactobacillus sakei* KTU05-6, *Pediococcus pentosaceus* KTU05-10) were used. The mass fraction of fermented or untreated tubers of JA in the wheat bread formula was 15%.

We found experimentally that JA tubers fermented with LAB contained more L(+) lactic acid than D(-) lactic acid, which resulted in safer products than by spontaneous treatment. The concentrations of biogenic amines in all analysed fermented JA products were far below levels causing a health risk, while the products fermented with LAB contained lower amounts by 50; 55; 55; 68 and 54 %, respectively. We also found that the proteolytic activity of LAB does not correlate with acrylamide content in bread made with JA additives (R = 0.3683; P = 0.2015), but there was a strong correlation between acrylamide and the sourdough pH (R = 0.8801; P = 0.0056), and with LAB amylase activity excreted in JA material (R = 0.9719; P = 0.003).

We conclude that the use of lactic acid fermentation allows wheat bread enrichment with 15 % JA fermented with LAB, without deterioration in bread quality parameters.

**Keywords:** wheat bread, tubers of Jerusalem artichoke, lactic acid bacteria, fermentation, acrylamide

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## THE INFLUENCE OF SOLID STATE FERMENTATION WITH CERTAIN LACTOBACILLUS ON FLAXSEED PRODUCTS PARAMETERS AND FERMENTED FLAXSEED PRODUCT EFFECT ON THE QUALITY OF WHEAT - FLAXSEED BREAD

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The aim of the study was to investigate if differences in acidification, L+/D- lactate, biogenic amines and flavour compounds occur production can be obtained when *L. sakei*, *P. acidilactici* and *P. pentosaceus* are used as starter cultures in solid state (SSF) fermentation of flaxseed. Also, the impact of SSF flaxseed on wheat - flaxseed bread making was assessed.

The *L. sakei* KTU05-6, *P. acidilactici* KTU05-07 and *P. pentosaceus* KTU05-8, strains previously isolated from spontaneous rye sourdough were cultured at 25-35 °C temperatures for 48 h in MRS broth (CM0359, Oxoid Ltd, Hampshire, UK) with the addition of 40 mmol/l fructose and 20 mmol/l maltose prior to be used.

Results shown, that flaxseed flour is a suitable medium for the cultivation of lactic acid bacteria (LAB). D(-)-lactate and biogenic amines in SSF flaxseed were far below those levels causing a health risk. The biggest total content of phenolic compounds and flavonoids was found in fermented products with *P. acidilactici* and the highest radical scavenging activity was found in samples fermented with *P. Pentosaceus*. The use of lactobacillus for flaxseed fermentation have an influence on volatile compounds formation. SSF flaxseed could be used for the improvement of wheat bread quality and functional value.

**Keywords:** solid state fermentation, flaxseed, lactobacillus, wheat - flaxseed bread

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## POLLEN DIVERSITY IN HONEY COLLECTED FROM LITHUANIA'S PROTECTED LANDSCAPE AREAS

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The aim of present work was to describe the most unique pollen found in the honey collected in protected landscapes of Lithuania. Honey samples from seven Lithuania's protected landscape areas were collected to study botanical origin of pollen. A total of seventeen samples of honey were obtained from Zemaitija National Park, Varduva Scenic Landscape Reserve, Dzukija National Park, from the border between Poland and Lithuania, in the Eastern Suwałki Lake (Lazdijai district), Gomerta Landscape Reserve, Armona geological reserve, Krekenava Regional Park. Botanical origin of honey was determined by the melissopalynology method. Monofloral lime honey was specific for the south of Lithuania (National park of Dzukija) and east (Armona geological reserve) containing pollen of *Tilia cordata* Mill. 79.0% and 53.9% respectively. Monofloral caraway honey was found in the National park of Zemaitija and Armona geological reserve. *Carum carvi* L. pollen in this type of honey accounted for 50.19% and 82.8% respectively. Honey with the highest content of *Fagopyrum* Mill. (close to 100%) pollen was collected from the National park of Dzukija. Monofloral honey from *Onobrychis* Mill. was characteristic mainly of Lazdijai district. *Onobrychis* Mill. pollen accounted for 52.1 - 54.4% of the monofloral honey and 9.2 – 17.8% of the polyfloral honey. Monofloral *Frangula alnus* Mill. honey was found only in Lazdijai district, where the dominant *Frangula alnus* Mill. pollen made up 52.1%. *Salix caprea* L. pollen were identified in all kinds of honey collected in different locations of Lithuania.

**Key words:** melissopalynology, monofloral honey, protected landscape

## ASSESSMENT OF POLYCYCLIC AROMATIC HYDROCARBONS' DIETARY EXPOSURE IN THE POLISH POPULATION

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Polycyclic aromatic hydrocarbons (PAHs) constitute a diverse and ubiquitous class of chemical contaminants present in our environment, among which many compounds show genotoxic, mutagenic and carcinogenic properties. Available literature reports that food is the main source of human's exposure to PAHs. Their occurrence in food can originate not only from the environmental deposition but also from the thermal treatment processes used in the preparation and manufacturing of foods.

The objective of the research was to assess dietary exposure to PAHs in the Polish population. The levels of 15 heavy PAHs, genotoxic carcinogens listed by the EU Scientific Committee on Food (including benzo[a]pyrene, benzo[a]anthracene, chrysene and benzo[b]fluoranthene, which should be monitored in foodstuffs according to the Commission Regulation (EU) No. 835/2011) were determined in different groups of foodstuffs. Material investigated was both plant products and animal-origin foodstuffs available in the Polish market. Methodology applied for the PAHs determination consisted of fat extraction, PAHs isolation using GPC (gel permeation chromatography) and consequently qualitative-quantitative compounds determination by HPLC-FLD/DAD and confirmation by GC/MS.

On the basis of the Polish Statistical Yearbook of Agriculture of 2012 and data on average monthly per capita consumption of selected foodstuffs in households in 2011, the average total dietary exposure to 15 PAHs was equal to 39.7 ng/kg b.w./day. This level of intake being similar to the median dietary exposure to 8 heavy PAHs for average European consumers, stated in the opinion of European Food Safety Authority from 2008, indicates low concern for Polish consumer health. Vegetable oils and smoked meat products were two the most contributing sources in total dietary PAHs intake (34 and 28% respectively). The group of canned fish products, grilled meat products, bread and cereal products consisted 17, 14 and 5%, respectively. The two lowest contributors to the dietary exposure were teas (2%) and roasted coffees (0.25%).

**Keywords:** PAHs, foodstuffs, intake from diet, Polish consumers

## GROWTH FACTORS INFLUENCE FOR LACTIC ACID BACTERIA PRODUCED BLIS

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Lactic acid bacteria (LAB) play a very important role in food fermentations where they contribute to their microbiological safety. The antimicrobial effect of LAB is mainly related to the production of organic acids, hydrogen peroxide, diacetyl, ethanol, phenolic- and proteinaceous- compounds, however some strains are able to synthesize antimicrobial substances – bacteriocins or bacteriocin-like inhibitory substances (BLIS). Was found that *Lactobacillus sakei* KTU05-6, *Pediococcus acidilactici* KTU05-7 and *Pediococcus pentosaceus* KTU05-8, KTU05-9 and KTU05-10 produced BLIS are very active against various *Bacillus subtilis* and *Fusarium culmorum* strains. According to literature different LAB strains required specific nutrients for bacteriocin production.

The aim of this study was to evaluate the effect of nutrients source, inocula size and temperature for *L. sakei*, *P. acidilactici* and *P. pentosaceus* produced BLIS antimicrobial activity.

Antimicrobial activity determination was performed using the agar well diffusion assay method by measuring the diameter (mm) of inhibition zones, as well as by expressing as arbitrary units (AU) per ml. One unit was defines as the reciprocal of the highest dilution showing the inhibition of the indicator lawn and was expressed in activity units per millilitre (AU/ml).

The results show that detectable levels of BLIS recorded after 6 h of growth in MRS and mMRS media, indicating that the peptide is a primary metabolite. Analysis shows that LAB cells inocula and composition of fermentation medium has the significant impact on BLIS activities of tested LAB.  $Mn^{2+}$ ,  $Mg^{2+}$ , glucose and cysteine supplements significantly increased the antimicrobial activity of all tested LAB produced BLIS.

These studies highlight the possibility of increase antimicrobial activity of LAB fermented products with the aim to improve food safety.

The research was funded by a grand (project No 31V BIOEKOTECH) from Lithuanian Agency for Science, Innovation and Technology.

**Keywords:** lactic acid bacteria, antimicrobial activity, bacteriocins, nutrient influence

## EVALUATION OF STEROL OXIDES DAILY INTAKE

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Phytosterol and cholesterol present in foodstuffs can be altered during the oxidation process as a result of many factors (oxygen, presence of free radicals and peroxides, high temperature etc.) The main products of oxidation are hydroxy-, keto- and epoxy- derivatives and triols. The sterol oxidation can be observed during processing and storage of foods.

Cholesterol oxidation products (COPs) as well as phytosterol oxidation products (POPs) are suspected to contribute to disorders like arteriosclerosis and are characterised by mutagenic and cancerogenic activities.

A gas chromatography/mass spectrometry (GC/MS) was applied for sterol oxidation products identification and quantitation. The objective of the study was to determine the content of sterol oxidation products in selected foodstuffs mainly animal but also plant origin to evaluate daily intake of sterol oxidation products.

The results of the research show that sterol oxides content in various foodstuffs was between (0.1-33.0 µg/g of product). Evaluated daily intake of sterol oxides was about 2 mg.

**Keywords:** daily intake, sterol oxidation products, thermal processing, GC-MS.

## **KITCHEN FLAVOR CHEMISTRY (KFC) CONCEPT: DEVELOPMENT OF VARIOUS GENERATORS OF HERBS AND SPICES VOLATILES BASED ON MODIFIED KITCHEN DEVICES AND UTENSILS**

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Native flavors of herbs and spices are actually highly searched by flavorists for developing new formulations with fresh top notes requested by consumers. Indeed, due to temperature, hydrolysis or enzymatic cleavages, overall odor of extracts differs with leaving plant ones whatever was extraction process used, e. g. hydrodistillation in the case of essential oils. In order to avoid or to limit such artefacts molecules, it is mandatory to capture flavor compounds just after their emission with a strictly limited processing duration.

With this objective we have first developed a laboratory instrumental device which mimics crushing of leaves between fingers practiced by farmers for evaluation of aromatic potential of their herbs. The so-called Artificial Crushing Finger allowed to control the exposure of storage vesicles located on leaves, to trap the emitted volatiles by using Tenax trap or SPME system followed by their GC-FID, GC-O and GC-MS analysis.

Then, we modified kitchen devices and utensils in order to reach to the objectives of studying either native herbs and spices volatiles (whipped cream dispenser, garlic and onion chopper, pepper mill,) nor evaluation of direct flavoring during cooking (steam cooker + cooking bell).

With whipped cream dispenser, gas (NO<sub>2</sub> or CO<sub>2</sub>) flash pressure increase, allowed to reach to a partial exposure of storage vesicles of aromatic plants leaves followed by immediate emission of volatiles inside the flask prior to their trapping on the SPME fiber during depressurization. In the case of mill and grinders, volatiles generated either during cutting of entire garlic or onion clove nor during grounding of pepper berries were concentrated on SPME fiber directly inside the glass bowl or the metal tray.

Modified steam cooker allowed to use the water steam for both cooking food (rice) and extracting volatiles from herbs and spices allowing a “one pot flavoring-cooking”. Then, processed food was placed in a dish which is covered with a cooking bell equipped with a SPME port (called HeadsSpaceDome).

All these modified kitchen devices and utensils constituted the basis of a novel concept, the so-called Kitchen Flavor Chemistry (KFC).

## CONTENTS OF SOME BIOACTIVE COMPONENTS IN DIFFERENT RICE VARIETIES AND THEIR ANTIOXIDANT PROPERTIES

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Purpose of the work was the examination of antiradical properties and determination of some bioactive components in different rice varieties.

Subject of examination were five varieties of rice: white, long-grain (Eco farming, Italy), white, long-grain (traditional cultivation, Italy), parboiled (Eco farming, Italy), brown, long-grain (Eco farming, Italy), black, long-grain (Eco farming, Italy) available on the Polish market. Studies were conducted on raw and cooked rice. The raw rice was ground at the mill. The rice was cooked according to the package instructions.

In acetone extracts from rice varieties (acetone: water 70:30) total polyphenols by Folin-Ciocalteu method was indicated. In these extracts antiradical properties to stable, synthetic DPPH radicals and kation-radicals ABTS were specified and the ability of those extracts to chelate iron II ions were examined. The content of vitamin E in rice was determined with a HPLC method (column C<sub>18</sub>, Merck, UV detection - 292 nm, the mobile phase consisted of methanol).

Most polyphenols were found in the extract coming from the black long-grain rice from ecological farming in both the raw (645.2 mg/100 g d.m.) and the cooked (436.5 mg/100 g d.m.). The content of polyphenols in other extracts was significantly lower (from 198.6 mg/100 g d.m. in raw brown long-grain to 27.9 mg/100 g d.m. in white long-grain eco).

Based upon conducted research it has been found that the content of vitamin E in examined rice was the highest in the dark varieties (0.72 mg/100 g d.m. in brown raw rice). In all types of white rice content was similar (about 0,1 mg/100 g d.m.).

Antioxidative properties were examined with three methods. It has been found that acetone extracts from all raw examined models deactivated DPPH radicals on the same level, i.e. almost 95 %. Radical scavenging in extracts from cooked rice was lower. The highest was in black rice (94%) and the lowest in white rice, traditional cultivation (13%). The highest antioxidative activity to ABTS<sup>•+</sup> radicals showed extract from raw brown long-grain rice (99%). Other extracts revealed less ability to deactivate these radicals (from 44 to 3%).

All examined extracts showed ability to chelate iron II ions. The highest showed black rice, both raw and cooked (respectively: 89.7% and 75. 1%). All other extracts showed a lower tendency to chelate iron II ions.

**Keywords:** rice, antiradical properties, bioactive compounds

## THE SYNERGISTIC EFFECT OF STARTER CULTURES AND FREEZE-DRIED VEGETABLES POWDER ON THE FERMENTED SAUSAGES RIPENING PROCESS

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The objective of this work is to examine the influence of different freeze – dried vegetables powder and starter culture on the physicochemical properties of fermented sausages during 4 days of ripening. The fermented sausages were manufactured with 0.016% of starter culture mixture (*Staphylococcus xylosus*, *Staphylococcus carnosus*, *Pediococcus pentosaceus*) and 3 % of different lyophilized vegetables: celery, parsley, parsnip. As control the sausages without additives or with starter culture addition only were used.

The ripening process was evaluated by changes of pH, water activity and colour. pH was measured by using standard method. The water activity was measured by Novasina M1 - aw. The colour was estimated by the value of coordinate a\*, which describes the pink color, measured by CHROMA METER CR-410 (Konica Minolta).

The changes of water activity, which describes the drying of sausages during ripening, has been quite tendentious: after the first day of ripening  $a_w$  slightly increased in all samples, meanwhile, during the other days – it decreased. It should be noted that the smallest value of the water activity was obtained in sausages with celery addition (0,947) and the highest – in the control made with starter culture (0,961).

It was established that after 4 days of ripening the pH value of sausages with vegetables and starter culture addition varied in 4.93 - 5.08 range, meanwhile in control sausages (without vegetables)- pH was from 5.27 to 5.62. The rapid decrease in pH value can be explained by the fact that the starter culture uses carbohydrates of freeze – dried vegetables as a nutritional medium, resulting in the release of acids.

The value of coordinate a\* was used for the evaluation of colour. It was determined that the variation of coordinate a\* decreased from 16.97 to 12.57 in the control sausages (it became brownish), while in the sausages with vegetables and starter culture addition coordinate a\* ranged from 11.77 - 15.52 to 15.59 - 16.48; this shows that the formation of pink color in the samples with vegetables and starter culture addition is more intensive.

The rapid decrease in water activity and pH values which was observed in sausages with vegetables and starter culture addition resulted in the unfavorable conditions for spoilage and pathogenic microorganisms; therefore the safety of the product was increased. On the other hand, the incorporation of freeze – dried vegetables powder and starter culture into meat product might result in additional nutritional benefits for the consumer.

**Keywords:** freeze-dried vegetables, starter culture, ripening

## QUALITY ASSURANCE ASPECTS OF MYCOTOXIN TESTING

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Mycotoxin testing poses some unique challenges for analytical laboratories. Using solid validated analytical methods are only part of the solution to providing the best analytical results possible. By utilizing some basic tools as part of the overall QA program, laboratories can build additional quality into their systems.

Understanding that sampling contributes more to variability of results than any other component of mycotoxin analysis is a critical concept. Mycotoxins are not evenly distributed PLUS they may be present at extremely low levels of contamination. Large samples of whole grains must be collected and subsampled properly, the entire probed sample should be ground finely and then mixed well before taking an analytical sample for testing.

Next, knowledge of the type of samples is crucial. Samples submitted for mycotoxin analysis may be as simple as corn or wheat or as complex as nutraceuticals or complex animals' feeds. Knowing your sample will give you insight on potential mycotoxins. For example wheat products are more commonly contaminated with DON and zearalenone and only in some unusual instances are aflatoxin and fumonisin detected. In addition evaluating the matrix that will be analyzed can help determine the best method for the analysis.

Complex matrices typically require analytical methodology such as HPLC, LC/MS or GC and also require multiple steps to remove interferences so that a purified extract with minimal interferences can be utilized for analysis. When unusual matrices are analyzed it is always good practice to analyze a matrix spike to confirm an acceptable toxin recovery through the method. This use of mycotoxin standards to prepare matrix spikes is an excellent tool to measure overall success of the method on an unusual matrix that may not have been specifically validated on any method.

Reference materials (RM) can serve as a cornerstone to build daily quality assurance data. Utilizing a RM such as a naturally contaminated grain sample with each sample run provides valuable information about all of the method parameters. When reference materials are used from the extraction step all the way through the method, the reference material provides a complete check on the entire system. It insures extraction was efficient, technician techniques were solid, standards were accurate and instrumentation was running as it should be. Technician training and documentation is a critical part of any laboratory and RM can also be used as both a training tool and as an on-going check on analyst capabilities. Reference materials are available in a wide variety of matrices and toxin combinations. These reference materials can also be used when method validations need to be completed. Another application is the use of RM in proficiency testing (like the Double Check program from Trilogy Analytical).

Quality assurance in a mycotoxin analysis may be more challenging than for other compounds, however with some basic tools the accuracy of the results reported can be assured.

## POLYPHENOL CONTENT COMPARISON IN YERBA MATE, TEA AND COFFEE INFUSIONS

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Polyphenols occur in lots of plant foods like vegetables, cereals, fruits or nuts and beverages: wine, tea, yerba mate, cocoa and beer. Polyphenols have ability to scavenge free radicals, prevent and slow down age-related diseases including cardiovascular diseases and many more.

The objective in this research was the evaluation of overall polyphenol concentration in water extracts of few different kinds of coffee, tea and yerba mate. Research material consisted of instant coffee, ground coffee, home-ground bean coffee, black, green and pu-erh tea, three kinds of dried yerba mate: with cut leaves and twigs (1), only with dried leaves (2) and with cut leaves and twigs matured for two years (3) and non-dried green yerba mate.

0,2 g samples were weighted, then steamed for 15 minutes in 100 ml of water in different temperature conditions respectively to material type: 90°C - coffee, 95°C - tea and 70°C - yerba mate. Polyphenols concentration was measured by Folin-Ciocalteu method on Shimadzu UVmini-1240 spectrophotometer at the wavelength exhibiting maximum absorbance ( $\lambda = 725$  nm). Results were calculated basing on calibration curve for chlorogenic acid ( $r^2=0,996$ ).

The highest content of polyphenol compounds was determined in one of the instant coffees (37,3 mg/sample weight) than in green tea (34,3 mg/s. w.) and in “only with dried leaves” mate (31,7 mg/s. w.). The richest research material in total polyphenols are yerba mates (27,6 mg/s. w.) followed by coffees (23,8 mg/s. w.) and teas (19,7 mg/s. w.). The poorest in polyphenols was pu-erh tea (7 mg/s. w.).

A high diversity was found in the contents of polyphenols in studied infusions. Results show similar concentrations in different kinds of brewes so consumers can choose according to their taste.

**Keywords:** polyphenols, coffee, tea, yerba mate, Folin-Ciocalteu method

## MICROENCAPSULATION OF PIGMENTS FROM BEETROOT BY SPRAY DRYING

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In food colorants microencapsulation process, except of appropriate carrier selection, the determination of the spray drying parameters which can affect the retention of active ingredients is essential. The aim of this study was to investigate the effect of drying parameters on the beetroot pigments retention after microencapsulation.

Raw material used in the study was the 100% beetroot juice. Low-crystallized maltodextrin DE=11 (MD) was used as a carrier. To obtain 30% dry matter concentration in the solution, to the beet root juice with 15% of dry matter the proper amount of maltodextrin was added. Drying was carried out in a spray-drier at a disc speed of 39,000 rpm and a solution flux rate  $0.3 \cdot 10^{-6}$  and  $0.8 \cdot 10^{-6} \text{ m}^3 \cdot \text{s}^{-1}$ . The inlet air temperature was 120, 140 and 160°C at a constant air flow rate was  $0.0055 \text{ m}^3 \cdot \text{s}^{-1}$ . Before drying, viscosity and density of the solutions were measured. Dry matter content, apparent density, a loose bulk density of the powder and the porosity was determined. The particle morphology was tested as well. Pigment content was measured by Nillson (1970) and Von Elbe (2001) methodology to determine the efficiency of encapsulation. The viscosity and density of solutions of beet juice with maltodextrin was 3.86 mPa·s and  $1100 \text{ kg} \cdot \text{m}^{-3}$ , respectively. In both cases, the values of viscosity and density were higher compared to the raw juice. Increase of solution flux rate caused a decrease of dry matter content, apparent density and loose bulk density. The increase of inlet air temperature caused an increase of dry matter content, average diameter and a decrease of both densities. It was observed that the increase of inlet air temperature caused a decrease in the yellow pigment. However, no clear correlation was observed for violet pigment. There were no changes in porosity and shape factor. The obtained microcapsules were sphere-like shaped with numerous deep cracks. In the whole range of experiment the retention of beet root pigments was almost at the same level and it was equal to 28%

**Keywords:** microencapsulation, morphology of powders, betalain pigments, density of powders

## CAFFEINE CONTENT COMPARISON IN YERBA MATE, TEA AND COFFEE INFUSIONS

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Caffeine is a naturally occurring alkaloid in cacao beans, guarana berries, coffee beans, tea leaves and yerba mate. Caffeine operates antagonistically towards adenosine receptors, thereby deceives the human body, giving it a “boost of energy”.

The purpose of the study was the comparison of caffeine concentration in few different kinds of coffee, tea and yerba mate infusions. Research material consisted of instant coffee, ground coffee, home-ground bean coffee, black, green and pu-erh tea, three kinds of dried yerba mate: with cut leaves and twigs (1), only with dried leaves (2) and with cut leaves and twigs matured for two years (3) and non-dried green yerba mate.

0,2 g samples were weighted, then brewed for 15 minutes in 100 ml of water in different temperature conditions respectively to material type: 90°C - coffee, 95°C - tea and 70°C - yerba mate. From obtained infusions caffeine extracts were gained by triple chloroform extraction. Caffeine concentration was measured on Shimadzu UV-160A spectrophotometer at the wavelength exhibiting maximum absorbance ( $\lambda = 276$  nm) and applying high performance liquid chromatography (HPLC).

In the study it has been proved that the highest caffeine content occurred in instant coffee infusions (5,2-7,4 mg/100 ml) followed by green (5,5 mg/100 ml) and black teas (4,2 mg/100 ml). The least caffeine concentration was gained in yerba mate infusions (avg. 1,6 mg/100 ml). The most powerful from studied kinds of mate was “only with dried leaves” (2,0 mg/100 ml). Little more caffeine than mate was found in ground coffee infusions- 2,5 mg/100 ml of water.

All studied infusions have high caffeine content except mate ones due to not typical brewing conditions for this kind of material, including time and number of steaming. In this research similar results were obtained using spectrophotometric and HPLC methods.

**Keywords:** caffeine content, coffee, tea, yerba mate, HPLC, spectrophotometry

## THE ASSESSMENT OF APPLE SHELF LIFE AFTER STORAGE AT MODIFIED ATMOSPHERE

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Fresh fruit definitely go together with healthy food. In order to preserve the quality of fruits it is essential to choose the most suitable storage technology. One of the most widely used is modified atmosphere packing which only minimally affecting fresh fruit quality can preserve them for up to one year. Nevertheless it is also very important to maintain the quality of fruits during a shelf life period after preservation. To acquire that precisely defined ratio of gases is crucial, if not obeyed shelf life of the fruit will significantly decrease. During preservation fruit quality attributes are physical and biochemical properties, and ripening index. Four apple cultivars grown in Latvia have been used in the research (‘Gita’, ‘Auksis’, ‘Orlik’, ‘Belorusskoje Malinovoje’, ‘Antej’, ‘Sinap Orlovskij’), apples were preserved in modified atmosphere for five months, after that two weeks of shelf life period in retail (supermarket, T=18° C). According to biochemical attributes at the end of the shelf life period the amount of dry matter has significantly increased, other physical and biochemical attributes like density and quantity of acids have decreased. During shelf life period apples of the cultivar ‘Sinap Orlovskij’ rotted the most (25%) and lost weight (6%) which can be explained with using inappropriate gas mixture. The best gas combination was O<sub>2</sub> = 1.50%, CO<sub>2</sub> = 2.50% used with cultivars ‘Auksis’, ‘Orlik’, ‘Belorusskoje Malinovoje’ and ‘Antej’ turned out that unmodified atmosphere had more beneficial effect on other cultivars ‘Gita’ and ‘Sinap Orlovskij’.

**Keywords:** Ripening index, quality, total acid, density, soluble dry matter

**ACOUSTIC SENSING OF DON IN MALTING CEREAL GRAINS**

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A fast acoustic screening method in combination with an ELISA method was applied for the detection of deoxynivalenol (DON) in malting cereal grains. Strong correlations between the amplitude of the acoustic signal that penetrated through the malting wheat and barley samples and near it belonging quantity of DON also quantitative verified by an ELISA method, were found ( $R^2 = 0.787$  and  $R^2 = 0.771$ , respectively). These correlations suggest that quantitative and qualitative screening of DON in malt with a non-invasive acoustic spectrometer is world's fastest and cheapest method to determine this marker mycotoxin in by *Fusarium* infected grain intended for malting. The dependency determined between the acoustic signal and structural physical characteristics (1,000-kernel-weight) of the grain matrix could therefore be the basis for the developed rapid acoustic method for cereal quality and safety control. Additional examination of the microstructure of wholesome and by *Fusarium* affected kernels under the scanning electron microscope revealed that obvious damage to the starch granules and lack of protein matrix was caused by the increase of several enzyme activities in the infected grains. Significant positive relationships between xylanase ( $R^2 = 0.682$ ),  $\alpha$ -amylase ( $R^2 = 0.623$ ) and protease ( $R^2 = 0.823$ ) activities, and the degree of *Fusarium* infection were found in malting wheat, and xylanase ( $R^2 = 0.601$ ),  $\alpha$ -amylase ( $R^2 = 0.571$ ) and protease ( $R^2 = 0.649$ ) activities, in malting barley. An intriguing characterization may contribute to explanations as how and to what extent malting cereal starch granules of different sizes stay more or less intact by lightly infected grains while by seriously infected grains the malting cereal starch granules are damaged and/or completely destroyed. The changes of the protease activity had a slightly detectable influence on the crude protein content in seriously infected grain samples which might certainly have its effect on properties and the quality of malt.

**Keywords:** mycotoxins, malting cereals, deoxynivalenol (DON), acoustic method, enzymatic activity, microstructure

## A PUMPKIN AS “A FRUIT”– AN ATTEMPT OF DEVELOPING A RECIPE OF PUMPKIN-FRUIT JAMS

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A pumpkin is known for its nutritional properties and low calorific value.

Nevertheless, it is still a vegetable which is rarely processed on an industrial scale and occasionally used in a kitchen.

The aim of the project was to develop a recipe of jams made from a pumpkin and various fruits. An increase of consumers' and food producers' interest in that vegetable might be caused by designing a new product.

Various tastes of jams were thought taking into account not only organoleptic considerations but also the nutritional properties of individual components. As a result, six different types of jams were produced: pumpkin-pineapple, pumpkin-orange-lemon, pumpkin-orange-lemon with ginger, pumpkin-apple-lemon with clove, pumpkin-apple-orange with cinnamon and pumpkin-peach-orange.

The produced jams were assumed to be low sugar jams (extract around 38%). Before developing initial recipes, extract and acidity were analyzed. The amount of a pumpkin (from 300 to 350 grams a kilo), fruits and spices was assumed and the amount of sugar, pectin and citric acid was calculated. Developing initial recipes allowed to produce the prototypes of final products.

Evaluation of consumer preferences was carried out using a 10-point scale with edge definitions by a 30-person group of potential consumers in the age group 19-25 years.

Consumers considered pumpkin-fruits jams as an innovative product characterized by an interesting taste and desired colour.

The research was preliminary. Due to good consumers reaction concluded necessity for further research which should be focused on improving the recipes, investigating colour stability during storage and a better understanding of consumer preferences.

**Keywords:** pumpkin, jam, fruits, vegetables

## COMPARATIVE ANALYSIS OF FATTY ACID PROFILES IN DRY CURED HAMS

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Dry cured hams are a group of regional products which is increasingly preferred by Polish consumers. The composition and the relative proportions of the various lipid fractions, including fatty acids, are important to human health.

The aim of this study was to compare the fatty acid profiles of inter- and intramuscular fat in Polish dry cured hams and Serrano and Parma dry cured hams.

The samples of inter- and intramuscular fat were analyzed. The samples were homogenized, extracted and transesterification to fatty acid methyl esters (KOH-methanol) was carried out. The analysis was performed using high performance gas chromatography-mass spectrometry. The identification and qualitative analysis of esterified fatty acids was performed using GC-MS-TIC/SIM system.

There were no significant differences in the composition of fatty acids between intramuscular and intermuscular fat in all examined samples. The highest share of monounsaturated fatty acids (inter- and intramuscular, 51.5% and 54.7% respectively) was identified in “Kumpiak podlaski”. In both foreign hams, Serrano and Parma, the share of saturated and monounsaturated fatty acids were similar and accounted for around 45%. Polish ham had the lowest content of polyunsaturated fatty acids in comparison with the other products tested (5-7%). Palmitic acid (16:0) and oleic acid (18:1) had the highest share of total fatty acids in each of the analysed hams. The observed differences in the composition of fatty acids can be originated from the manufacturing process, feed and environmental conditions.

**Keywords:** „kumpiak podlaski”, fatty acids, GCMS, dry cured ham.

## ANTIOXIDANT ACTIVITY OF LOVAGE (*LEVISTICUM OFFICINALE* KOCH.) EXTRACTS ISOLATED BY SUPERCRITICAL CARBON DIOXIDE EXTRACTION

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Lovage (*Levisticum officinale* Koch.) is used as raw material in food, beverage, pharmaceutical and cosmetic industry; it contains various bioactive compounds. The objectives of this research were to determine the effective supercritical carbon dioxide extraction (SCE-CO<sub>2</sub>) parameters and to assess the antioxidant activity of different anatomical parts of lovage.

The optimal extraction conditions for achieving high yield of extract was 45 MPa pressure, 60 °C temperature, 90 min of dynamic extraction time for lovage roots and 45 MPa, 60 °C, 30 min extraction time for lovage leaves and stems.

Direct measurement (Quencher method) of the trolox equivalent antioxidant capacity (TEAC) was performed by ABTS<sup>•+</sup> (2,2'-azinobis-(3-ethylbenzothiazoline-6-sulfonic acid cation radical), DPPH<sup>•</sup> (2,2-diphenyl-1-picrylhydrazyl radical) and ORAC-Fluorescein (oxygen radical absorbance capacity) assays while total phenolic content was measured by Folin-Ciocalteu method in air dried samples and residues obtained after SCE-CO<sub>2</sub>.

The highest TEAC values were determined for lovage leaves containing the highest TPC (48.6±1.4 µg gallic acid equivalents g<sup>-1</sup> dry weight): they were 399.2±1.2 and 802.9±3.8 µMol Trolox g<sup>-1</sup> in ABTS<sup>•+</sup> and ORAC assays, respectively. There was a strong correlation between the TPC and antioxidant capacity determined by the two applied methods.

The TEAC and TPC of residues obtained after SCE-CO<sub>2</sub> were approx. 3 times lower in roots comparing with dried samples before SCE-CO<sub>2</sub>.

**Keywords:** lovage (*Levisticum officinale* Koch.), supercritical carbon dioxide extraction, antioxidant activity, Quencher, total phenolic content.

## RELEASE OF FLAVOUR COMPOUNDS BY THE THERMAL DEGRADATION OF MODEL MELANOIDINS

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The nonenzymatic browning reactions are the main source of flavour compounds during thermal food processing and storage. In line with the decomposition of various endogenous food ingredients, volatiles with particular aroma attributes also arise from the thermal degradation of the final Maillard reaction products – melanoidins, which is particularly evident for coffee bean roasting and bread baking. For the purposes of this research, various water-soluble high molecular weight (HMW) and nonsoluble melanoidins, isolated from model mixtures of amino acids (L-(+)-lysine, L-(+)-arginine and glycine), lipid oxidation products (hexanal and (*E*)-2-hexenal), carbohydrates (D-(+)-glucose or L-(+)-ascorbic acid) and phenolic compounds (ferulic acid and caffeic acid), were heated at 250 °C for 10 minutes and analysed by means of SPME-GC-MS.

Although the spectrum of thermal decomposition products was quite universal for melanoidins from different model systems, showing the highest share for carbonyl and nitrogen-containing heterocyclic compounds, some of the identified odourants were specific for melanoidins from the particular model systems. For example, alkyl substituted-2(4)-propylpyridines (up to 8 % of the total GC peak area) and alkyl substituted-3,5-dibutylpyridines (up to 7 % of the total GC peak area) were formed via amino acid and 2-hexenal or hexanal interactions, respectively. The combined presence of an amino acid, lipid oxidation product and glucose or ascorbic acid in model systems favoured the formation of pyrazines (2 – 55 % of the total GC peak area), which were not detected when carbohydrate was absent. Pyrazines are strongly associated with roasted, sweet, nutty odours and brown colour development in heated food systems. Quantitatively the most important volatiles were methylpyrazine, 2,5-dimethylpyrazine, ethylpyrazine, 2-ethyl-5-methylpyrazine, trimethylpyrazine and 3-ethyl-2,5-dimethylpyrazine, present in the headspace of all heated samples. The release of common Maillard-type odourant 2,5-dimethylpyrazine (up to 17 % of the total GC peak area) was particularly sensitive to the change of carbohydrate source, indicating the strong reducing effect of ascorbic acid. However, in both cases, the amounts of pyrazines from arginine and lysine-derived HMW reaction products were considerably higher than those measured for standard glycine-related melanoidins. The latter released the highest amount of furans (1 – 49 % of the total GC peak area), mainly, 2-methylfuran, 2-acetylfuran, 2,5-dimethylfuran, furfural and 5-methylfurfural, distinguished by pleasant caramel-like, bread crust and cereal-like notes. The presence of ferulic acid in model reactions favoured the release of various benzene derivatives from melanoidins, comprising from 6 to 93 % of the total GC peak area. Among them, 2-methoxyphenol (guaiacol), 4-ethyl-2-methoxyphenol (4-ethylguaiacol), 2-methoxy-4-vinylphenol (4-vinylguaiacol) and acetovanillone were repeatedly found in all samples. Mainly, these volatiles resulted from the thermal decomposition of ferulic acid itself and were reported as important flavour constituents of roasted nuts, coffee, popcorn, grain products, cooked vegetables and rice.

Supported by Research Council of Lithuania, grant no. SVE06/2011.

**Keywords:** Melanoidins; thermal degradation; flavour compounds.

## ICE RE-CRYSTALLIZATION IN ICE CREAM USING ICE STRUCTURING PROTEINS FROM FISH

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One of the many concerns of food technologists is controlling the growth of ice crystals in frozen foods. During freezing ice nucleation occur first, followed by re-crystallization of ice. Application of ice structuring proteins (ISP) has shown a great potential in improving the quality of frozen foods by thermal hysteresis activity and inhibition of ice re-crystallization. ISPs are naturally found in a range of species that are susceptible to freeze damage - in fish, insects, bacteria, fungi and over-wintering plants.

The objective of the study was to analyze the concentration effect (0.01-0.1 % w/w) of fish ISP type 1 on ice crystal growth in ice cream formulations. The accelerated ice re-crystallization test was used where the temperature was cycled between -20 and -12 °C.

The addition of 0.01 % ISP already significantly reduced ice crystal sizes in ice cream after temperature cycling. Increasing the concentration of ISP had no further effect on retarding the ice crystal growth.

**Key words:** Ice structuring proteins, accelerated ice re-crystallization, microscopy

## THE INFLUENCE OF GUAR GUM/FURCELLARAN AND GUAR GUM/CARRAGEENAN STABILIZER SYSTEMS ON THE RHEOLOGICAL AND SENSORIAL PROPERTIES OF ICE CREAM DURING STORAGE

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Ice-cream is a product made of milk, sweeteners, stabilizers, emulsifiers and flavours. The stabilizers are added to ice cream to hindrance the re-crystallization phenomena, to enhance the ice cream mixes viscosity, to improve the texture and mouthfeel as well as shape retention of ice cream. Different hydrocolloids such as guar gum, locust bean gum, carrageenan or xanthan gum have been used as ice cream stabilisers. Each stabilizer exhibits unique functional properties.

Furcellaran is a type of carrageenan that can be used as stabilizing, thickening and gelling agent in the food. The objective of the study was to analyse the influence of furcellaran and carrageenan as a secondary stabilizer with guar gum on the rheological and sensorial properties of ice cream during 13 months of storage.

Summarised results of the experiment showed that the stabilizers have strong effect on ice cream properties and storage time. The furcellaran showed a promising secondary stabilizer for ice cream together with guar gum. Even the addition of furcellaran to ice cream slightly decreased the scores of colour, odour and flavour characteristics, it increased the creamy sensation and had a good stabilizing effect on ice cream during 13 months of storage.

**Keywords:** Ice cream, hydrocolloids, rheology, sensory

## RELEASE OF ANTIOXIDANT COMPONENTS FROM BREAD ENRICHED WITH RYE AND WHEAT BRAN BY AN IN VITRO PHYSIOLOGICAL EXTRACTION

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Cereal antioxidants have gained a substantial interest in the past years. Increasing consumption of cereals also increases the intake of dietary components possessing beneficial health effects. On addition, there is a demand to find effective natural antioxidants for replace synthetic additives in foods.

**The physiological extraction was developed as a new approach which is related to enzymatic digestion occurring during oral, gastric and intestinal digestion processes.**

The aim of this study was to assess the release of antioxidants from bread enriched with rye and wheat bran by evaluating radical scavenging capacity (RSC) of soluble and insoluble fractions after digestion and comparing their antioxidant potential with raw material. The antioxidant activity of bran was evaluated using traditional ABTS<sup>•+</sup> radical scavenging, total phenolic content (TPC) and oxygen radical absorbance capacity (ORAC) assays and new QUENCER procedure. RSC of wheat and rye bran samples after digestion at oral-gastrointestinal conditions was remarkably lower than that of the raw material. The highest antioxidative activity demonstrated soluble fraction obtained after full physiological digestion cycle, which suggests that antioxidatively active substances are intensively released by enzymatic and acidic treatment. Antioxidative activity of bread with additives was only slightly higher comparing with bread without additives. Funded by Research Council of Lithuania, grant no. SVE-06/2011.

**Keywords:** *bread, antioxidant activity, rye bran, wheat bran.*

## ANTIOXIDATIVE PROPERTIES OF RICH IN SQUALENE AMARANTH SEED OIL EXTRACTED BY SUPERCRITICAL CARBON DIOXIDE

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Amaranth grain is a highly nutritional pseudocereal possessing beneficial functional properties. Amaranth seeds contain high quality edible oil, proteins with amino acid composition close to the ideal protein and various microconstituents. Squalene is one of the most important bioactive constituent in lipophilic amaranth fraction. Amaranth oil contains high concentration of squalene (6-8%) comparing with other commercial oils.

In this study lipophilic fraction of amaranth was extracted by supercritical CO<sub>2</sub> (SC-CO<sub>2</sub>) extraction. Squalene content in oil depending on SC-CO<sub>2</sub> extraction pressures varied from 6.3 to 14.9%. The highest squalene concentration in amaranth oil was obtained at 15 MPa and the lowest at 55 MPa. The antioxidant properties of oil and pure squalene were assessed using oxygen radical absorbance capacity (ORAC) assay and accelerated oil stability test in Rancimat apparatus. The highest antioxidant activity, 235.1 μmol trolox equivalents (TE)/g of amaranth oil was obtained for the sample extracted at 15 MPa. However, adding 5-15% of this sample to rapeseed oil resulted in prooxidation effect. The antioxidant activity of pure squalene was 304.3±6.81 μmol TE/g. Induction period of pure squalene mixed with rapeseed oil was 4.84 h comparing with control 4.65 h.

The results show that addition of amaranth oil obtained by SC-CO<sub>2</sub> extraction although containing high amount of antioxidatively active squalene, increases oxidation rate, most likely due to the presence of highly sensitive polyunsaturated fatty acids. This study was supported by Research Council of Lithuania, grant no. MIP064/2011

**Keywords:** Amaranth; Supercritical carbon dioxide; Squalene; ORAC; Rancimat.

## ANTIOXIDANT PROPERTIES OF DIFFERENT BLUEBERRY CULTIVARS (*VACCINIUM CORYMBOSUM*) FRUITS

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Berry fruits of *Vaccinium corymbosum* have gained a remarkable worldwide interest, due to their excellent sensory properties and the presence of healthy constituents, particularly high content of phenolic compounds possessing antioxidant activity. Due to these characteristics, blueberries have become one of the most desirable fresh fruits. It was reported that the content and composition of phenolic constituents in blueberries vary in a wide range. The formation of bioactive substances in fruits and vegetables depends on various factors, such as genotypic differences, environmental conditions (climate, temperature, soil) and cultivation practices.

The aim of this study was to evaluate berry juices of nineteen *Vaccinium corymbosum* genotypes grown in Lithuania, namely 'Aron', 'Bluecrop', 'Blueray', 'Bluejay', 'Bluegold', 'Bluehaven', cultivar no.16, 'Danuté', 'Freda', 'Hardyblue', 'Puru', 'Reka', 'Northblue', 'Northland', 'Nui', 'Patriot', 'Putte', 'Toro' and 'Weymouth'. 'Danuté', 'Freda' and no. 16 are new cultivars developed in Kaunas Botanical Garden. Total phenolic content (TPC) was measured by Folin–Ciocalteu method. Antioxidant activity was evaluated by well-established *in vitro* methods, ABTS<sup>•+</sup>, FRAP and ORAC. Analyzed *V.corymbosum* berries cultivars included While.

Berry juices of *V. corymbosum* cultivars were shown to be a good source of polyphenols, however the TPC varied significantly between some berry juices. Newly bred cultivars 'Freda', 'Danuté' and no. 16 possessed the highest antioxidant activity among all investigated cultivars followed by well-known cultivars 'Northland', 'Nui', 'Putte', 'Patriot', 'Weymouth', 'Northblue', while the weakest antioxidant activity was found for 'Bluejay', 'Toro' and 'Hardyblue' cultivars. The results showed that there are significant differences between different blueberry cultivars in the content of TPC and antioxidant capacity. So far as climatic and cultivation conditions were kept similar, most likely, these variations are determined by the genetic differences between tested cultivars.

Funded by Research Council of Lithuania, grant no. SVE-04/2011.

**Keywords:** *Vaccinium corymbosum*; Antioxidant activity; Phenolic compounds

## COMPARATIVE ANALYSIS OF TAGS AND FATTY ACIDS PROFILES AS A TOOL FOR ORIGIN, AUTHENTICITY AND MASS PARTICIPATION OF COCOA BUTTER IN DARK CHOCOLATES AND COCOA MASSES.

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Chocolate is a one of the most popular sweets consumed in the world. It provides big dose of energy and a lot of nutrition compounds to human body. Cocoa drinks and chocolate are good source of saturated and unsaturated acids such as oleic and linoleic acid. Profiles of fatty acids and triacylglycerols of cocoa fat can be different and depends on cocoa origin place, climate and processing conditions. That compound groups are useful tools in adulteration and nutrition evaluation of chocolate.

The purpose of the study was to analyze fatty acids (FA) and triacylglycerol fractions (TAG) composition in cocoa masses and chocolates. In this research cocoa masses from five different countries located on three continents were investigated. Also chocolates (two bars per type) which were made from each mentioned cocoa masses were analyzed. Research materials were stored in cold and dark place.

Content analysis of TAG and fatty acids consisted of: grinding the sample, extraction of fat, derivatization and suitable solution dilution for injection. Qualitative and quantitative analysis was carried out by gas chromatography coupled with mass spectrometry (Shimadzu QCMS-QP 2010 with autosampler HT280T). For TAG and FA analysis columns respectively Quadrex 65HT CC (30m x 0,25mm x 0,10 $\mu$ m) and BPX90 (60m x 0,25mm x 0,25 $\mu$ m) were used.

In the study interesting variability in composition of saturated fatty acids depending on cocoa origin was observed. In few chocolates fatty acids which belong to kind omega-3 and omega-6 was detected. The triacyloglycerol fractions content and composition were stable within the type of samples.

The usefulness of GC/MS for TAG and FA analysis in chocolate and cocoa pulp fat was confirmed. Research also proved big variety in composition of analyzed compounds in cocoa masses which has reflection in composition of this compounds in studied chocolates.

**Keywords:** fatty acids, TAG, chocolate, cocoa mass, GC/MS

## COMPARATIVE ANALYSIS OF ESSENTIAL OIL COMPONENTS OF *TILIA CORDATA* MILL. FROM VARIOUS AREAS OF EASTERN POLAND

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Little-leaved linden is considered as a very important medicinal plant. In Poland, it grows wild in hail forests (*Tilio-Carpinetum*) but also it is often planted in parks and gardens. Raw materials obtained from this tree are flowers, containing various groups of biologically active compounds, like flavonoids and essential oil. Flowers of *Tilia cordata* reveal special pharmacological activities i.e. diaphoretic, anti-inflammatory and sedative. They are used mainly in cold and respiratory diseases treatment.

The aim of the study was to determine the chemical composition of *Tilia cordata* essential oil from 3 different populations located in eastern area of Poland, far away from each other (Podlaskie, Warmian-Masurian and Podkarpackie regions). The flowers were collected in full blooming phase (June-July). The content of essential oil was carried out by hydrodistillation in Deryng apparatus. The essential oils chemical composition was analyzed using Shimadzu GC MS QP-2010S gas chromatograph GC/MS equipped with Phenomenex Zebron ZB-FFAP polar column (30 m x 25 mm x 0,25µm). The oven temperature was grown isotherm, with a gradient 4°C/minut from 60 °C to 230 °C. The carrier gas was helium. Identification of compounds was based on comparison of their retention indices (RI) and mass spectra from the Mass Spectral Databases, as following: NIST, Wiley, Pal and the literature data.

The identified compounds made up to 73-91% of total oil content. The major constituents identified in oils originated from all investigated populations were saturated hydrocarbons (11-48% of total oil content). The main alkane was tricosane (6-26%), acetophenone was also present in a high amount (4,5-12,2%) as well as phytol (1-3,5%). Some monoterpenes and sesquiterpenes, like linalool, borneol, geranyl acetate, *p*-cymene were also determined. In all samples, isobutyl phtalate was identified (1-12,7%). Investigated populations of *Tilia cordata* differed significantly in respect of essential oil chemical composition. Populations originated from various regions were characterized by the presence of special compounds, as following: kaurene, damascenone and eicosane was found only in oil from Podkarpackie region; decanone, decanal, octanoic acid - from Podlaskie as well as phenyloxiren, verbenol, nonacosane was typical to oil from Warmian-Masurian population. Such a variability of essential oil composition can be caused by many factors, e.g. genetic characteristics, geographical location of plants, climate and environmental conditions.

**Keywords:** essential oil, *Tilia cordata*, GCMS

## FATTY ACID PROFILES IN SELECTED FISH PRODUCTS

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Fish and fish food products are popular in many European countries. Their unique advantage is fat rich in polyunsaturated fatty acids from n-3 group. In order to supplement the diet in these compounds consumers reach out for both fresh and processed fish as well as dietary supplements from shark or cod liver.

The purpose of this study was to determine and compare the fatty acid profiles of selected fish products. The material used for the research was commercial fish oil preparations (drinkable and in capsules) and the cod liver preserved in its sauce.

Samples of liver oil (about 20 mg) was dissolved in hexane and subjected to alkaline hydrolysis. The extract was diluted and the determination was carried out. Homogenized canned cod liver samples (0.5 g) were extracted with hexane in an ultrasonic bath. Then the extract was collected. The next steps in the procedure were the same as in case of liver oil supplements samples. The determination was performed using a gas chromatograph QP2010S (Shimadzu) coupled with mass spectrometer. The chromatograph was equipped with a capillary column ZB-FFAP (30.0 m x 0.25 mm x 0.25 m; Phenomenex).

All the tested products were characterized by the highest share of monounsaturated fatty acids (47.6 - 63.0%), especially oleic acid. The share of polyunsaturated fatty acids varied and ranged from 13.7% to 27.0%. Fat of tested products was characterized by a high proportion of polyunsaturated fatty acids from n-3 group, which accounted for 11.6 - 18.8% of total fatty acids depending on a sample. Both supplements (liver oil capsules and drink) as well as canned cod liver are the rich source of n-3 fatty acids in the diet.

**Keywords:** fish, cod, fatty acids, GCMS

## CHARACTERIZATION OF PHYSICAL AND CHEMICAL CHARACTERISTICS OF SEA BUCKTHORN (*HIPPOPHAE RHAMNOIDES* L.) BERRIES

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There are described both physical and chemical characteristics of sea buckthorn berries in eleven different varieties (Avgustinka, Botanitcheskaja, Botanitcheskaja Aromatnaja, Botanitcheskaja Ljubitel'skaja, Gibrid Pertchika, Otradnaja, Podarok Sadu, Trofimovskaja, Vorobjevskaja with Russian origin and Hergo, Sirola with German origin) during five years (2006-2010) grown in Estonia.

From physical characteristics there are determined the moisture content, dimensions and size distribution and puncture resistance of the berries; from chemical parameters the titratable acidity and pH are determined, also reducing sugars, vitamin C and  $\beta$ -carotene content are described.

The moisture content of the berries is in the range of 80-87%. The lowest value of puncture resistance is 146 g and the highest is 469 g. From chemical parameters the titratable acidity is 1.6-3.7 g/100g and pH is 2.36-3.1. The content of reducing sugars during 2006 and 2007 is 1.4-4.8%. Brix is 5.8-12.1%. From bioactive compounds there are determined the content of vitamin C (58-162 mg/100g), and  $\beta$ -carotene (5-36 g/100g).

**Keywords:** sea buckthorn, *Hippophae rhamnoides*, puncture resistance, acidity, vitamin C,  $\beta$ -carotene

## OPTIMIZATION OF SUPERCRITICAL FLUID EXTRACTION OF BUCKWHEAT (*FAGOPYRUM ESCULENTUM*) HULLS

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Buckwheat grains are popular and widely used products in many countries. During manufacturing of buckwheat grits, the hulls are separated. They are mainly used as pillow fillers, also can be used in food as antimicrobial materials. Recently performed research revealed that hulls contain not only hemicelluloses, but also different valuable compounds, which might find application in foods or nutraceuticals. Supercritical fluid extraction (SFE) is a modern technique which mainly uses safe and cheap solvent CO<sub>2</sub> and therefore is an attractive method for the isolation of high added value compounds from plant material. The goal of this work was to determine the optimal conditions of SFE for producing the highest yield of buckwheat hulls extracts by using response surface methodology. Soxlet method combining sequential extraction with increasing polarity solvents hexane, acetone and methanol was used for comparison. Statistical analysis showed that SFE extraction pressure, temperature and time may have the most significant influence on the yield. Central composite design method was applied for experimental planning by using the following parameters: pressure – 15/35/55 MPa, temperature – 30/45/60 °C and extraction time – 30/60/90 min. CO<sub>2</sub> flow rate was kept constant - 2 L/min, and the mass of the ground buckwheat hulls was 10 g. The maximum yield was obtained and confirmed by practical experiments. The difference in yield between SFE and Soxlet methods was remarkable. The extracts and residues of extractions were evaluated by antioxidant activity measurements. Supported by Research Council of Lithuania, grant no. SVE06/2011.

**Keywords:** Buckwheat hulls, Supercritical Fluid Extraction, Response surface methodology optimization, Extract yield.

## AN *IN VIVO* LIPIDS DIGESTION OF CONCENTRATED O/W EMULSIONS AND YOGURT

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Designing food products to control stability, digestion and release of lipophilic food compounds includes developing emulsions with specific structural and physicochemical characteristics. In particular we focus on building interfacial layers from milk proteins and polysaccharides that surround lipid droplets and are resistant to enzymatic degradation so that it is possible to reduce lipid bioavailability.

Our previous research on digestibility of concentrated emulsions using *in vitro* digestion model showed that the most resistant to lipids digestion were emulsions stabilized by whey proteins and carboxymethylcellulose (CMC) prepared by the simultaneous adsorption principle. The appropriate amounts of WP and CMC solutions were homogenized for 5 min at 24000 rpm, the pH was adjusted to pH7 and the mixture was stored for 1 hour to allow for interactions between components. After 1 hour the rapeseed oil was added to whey protein and CMC mixture and homogenized for 5 min at 24000 rpm. The aim of this study was to analyse digestibility of these emulsions using *in vivo* model and find out whether it is possible to reduce lipid bioavailability from yoghurts made with these emulsions. For that reason emulsions and yogurt made with addition of emulsion were fed to rats. Rats were divided into 3 groups: control (usual diet); usual diet + 2 g emulsion (or yoghurt) without CMC (Diet 1); and usual diet + 2 g emulsion (or yoghurt) with CMC (Diet 2). Rats were given free access to food and water, emulsion was given too once a day. The duration of dietary treatment lasted 2 weeks.

To evaluate the rate of lipids hydrolysis blood triglycerides biochemical analyses, total fecal fat content analysis and fecal free fatty acids analysis were done. It was found that after 1st feeding week the difference of triglycerides in blood between Diet 1 and Diet 2 groups were almost 2-folds. After 2nd week feeding amount of triglycerides remained lower in blood of rats that were fed emulsions with CMC. Fecal fat excretion and the rate of monounsaturated and polyunsaturated fatty acid were higher in rats fed by Diet 2.

**Keywords:** *in vivo* lipids digestion, food emulsions, yogurt

## FACTORS AFFECTING THE RYE SOURDOUGH BREAD STALING

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Although the nutritional composition of wheat and rye is quite similar, the bread making properties of those flours differ significantly. Stability of sensory properties of wheat and rye sourdough breads during storage were studied. The results show that products belonging to the rye sourdough cluster stale less significantly than those of the wheat bread cluster. The rate of decrease of most important parameters like aroma, taste, softness, and moistness was slower in rye breads than in wheat breads. The differences can be related to low pH and high amount of dietary fiber as well as lower porosity of rye breads.

Effect of sourdough fermentation and isolated bacterial species on the sensory as well as structural properties was studied. The correlation of sensory (moistness, springiness, typical aroma, typical taste, crumbliness, porosity, sweetness, “old bread” taste) and instrumental parameters (pH, TTA, moisture) of breads shows that a cluster of bread made without sourdough (Blank) or with *Lb. vaginalis* or *Lb. casei* strains had poor sensory characteristics. Rye model bread made with *Lb. helveticus* showed high springiness. Porosity, adhesiveness, and sweetness are terms that best describe bread made using *Lb. panis* and *Lb. brevis* + *Lb. plantarum*. The results of sensory analysis grouped according to pH show good correlation between pH and springiness.

To understand the peculiarities of bread staling, rye sourdough bread, wheat bread, and a number of starches were studied using wide-angle X-ray diffraction, nuclear magnetic resonance ( $^{13}\text{C}$  CP MAS NMR,  $^1\text{H}$  NMR,  $^{31}\text{P}$  NMR), polarized light microscopy, rheological methods, microcalorimetry, and measurement of water activity.

No difference in relative crystallinity of rye breads made using different LAB strains was observed during storage. The degree of crystallinity of starch in breads increased during 11 days of storage from 3% to 21% in rye sourdough bread and to 26% in wheat bread.  $^{13}\text{C}$  NMR spectra show that the chemical structures of rye and wheat amylopectin and amylose contents are very similar; differences were found in the starch phospholipid fraction characterized by  $^{31}\text{P}$  NMR. The  $^{13}\text{C}$  CP MAS NMR spectra demonstrate that starch in rye sourdough breads crystallize in different forms than in wheat bread. It is proposed that different proportions of water incorporation into the crystalline structure of starch during staling and changes in starch fine structure cause the different rates of staling of rye and wheat bread.

**Keywords:** descriptive sensory analysis, LAB, rye sourdough bread staling, starch retrogradation, amylose, amylopectin, XRD, MAS NMR

## INFLUENCE OF DIFFERENT PARAMETERS OF ULTRASOUND TREATMENT ON OSMOTIC DEHYDRATION PROCESS

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Osmotic dehydration is a widely used method for partial water removing by immersion of cellular tissue in hypertonic solution. Ultrasound waves applied before osmotic dehydration treatment could improve this process.

The aim of this work was to study the kinetics of osmotic dehydration process in apple slices treated with different parameters ultrasound before osmotic dehydration.

Apples (var. *Idared*) were cut into slices 0,005 m and subjected to ultrasonic waves at a frequency of 21 and 35 kHz in distilled water. Apples were treated with ultrasound for 10, 20 and 30 minutes. Then material was subjected to osmotic dehydration process for 60 minutes at 25°C.

Kinetics of osmotic dehydration of apples in 61.5% sucrose solution was dependent on the type of pretreatment. The largest loss of water after 60 minutes was observed for the dehydrated apples treated with ultrasound for 10 minutes using frequency of 35 kHz. For tissue subjected to 21 kHz ultrasound also higher loss of water in comparison to untreated samples was obtained. However, all pre-treated apples after 60 minutes of osmotic dehydration caused significant increase in dry matter content (64-138%) in comparison to the raw tissue.

Dehydration efficiency index, expressed by the ratio between water loss and solute gain (WL/SG), is very important factor. The highest efficiency index for untreated samples was obtained. However, for the pre-treated material lower values of the efficiency index was observed.

**Keywords:** ultrasound treatment, osmotic dehydration, apple

## EFFECT OF ULTRASOUND PRE-TREATMENTS ON METABOLIC RESPONSE OF OSMODEHYDRATED KIWIFRUIT SLICES STUDIED BY ISOTHERMAL CALORIMETRY

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All fruit and vegetables are metabolic active tissues producing heat as a result of respiration. The measurement of heat production rate by isothermal calorimetry can give useful information on overall metabolic activity of fruit and vegetables exposed to stress provoked by industrial processing. Osmotic dehydration (OD) is a partial dewatering impregnation process carried out by immersion of cellular tissue in hypertonic solution. Recently the application of ultrasound (US) prior to OD process has been investigated in order to promote the enhancement of mass transfer rate during the process, by creating microscopic channels in the fruit structure. However little is known about the metabolic consequences of this pretreatment. For this purpose, this work was focused on the study of the metabolic response of OD kiwifruits slices treated with US. US power was provided at a frequency of 35 kHz for 10, 20 and 30 min in ultrasound bath. OD was carried out by dipping the samples in 61.5% sucrose solution equilibrated at 25°C for pre-established contact period of 0, 10, 20, 30, 60 and 120 min. Samples were evaluated for heat production rate which was continuously measured in a TAM-Air isothermal calorimeter (TA Instruments, USA) and for respiration rate using a static method.

The highest heat production was observed for untreated sample. US caused alteration of kiwifruit tissue, which influenced its heat production. The obtained thermograms evidenced a progressive decreased of specific thermal power by increasing the US treatment time.

A similar effect was observed for OD samples. The OD treatment for 120 min promoted consistent stress on kiwifruit tissue, which was reflected in lower metabolic heat production of OD samples respect to fresh tissue. The most relevant changes were observed in samples subjected both to US and OD treatment. The respiration rate measurements showed a good agreement with heat production data.

**Keywords:** ultrasound, osmotic dehydration, kiwifruit, TAM, respiration

## VOLATILE PROFILE OF DRIED INACTIVE TORULA YEAST

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Torula yeast (*Candida utilis*) in dried form is widely used as flavouring in processed foods, pet foods and animal feeds. It has a very clean flavour profile and does not come with bitter/strange taste like other yeast. It has a slightly yeasty odor and gentle meaty taste. Torula yeast products add mouthfeel and texture to the food to which they are added. They can also be used for their emulsification properties. Despite of the well-described impact on food texture the information about composition of aroma compounds in a spray-dried inactive Torula yeast powder is rather scarce.

The aim of this work was to identify the volatile compounds originating from the inactive Torula yeast.

A solid-phase microextraction (SPME) method was used to determine aroma compounds using gas chromatography-mass spectrometry (GC-MS-TOF) and gas chromatography-olfactometry (GC-O) where the human nose is used as a sensitive and specific detector for odor-active compounds.

The important contributors to the odor of the yeast, according to GC-O analysis, include pyrazines together with a number of derivatives of furans, aliphatic and aromatic acids, aldehydes, ketones and alcohols. Almost 150 compounds were detected with GC-MS. In addition, this study also showed that different batches of yeast from one supplier can vary in the type of volatiles.

The results also suggest that the optimized SPME-GC-MS and SPME-GC-O methodology can be used to compare volatile profile of different types of inactivated yeast and yeast derivatives.

**Keywords:** inactive yeast; volatile compounds; solid-phase microextraction; GC-MS; Olfactometry

## FOODOMICS

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Modern society no longer considers food to only be as a source of energy but also as an affordable way to maintain health, reduce the risk of diseases and be as an important component of human well-being, particularly with regards to its nutritional and sensory aspects. Recent developments in systems biology methods have opened up new possibilities to study and thereby improve food-processing technologies and human nutrition. A new approach in food science has been characterized as “foodomics” (Capozzi and Bordoni 2013). This approach makes use of systems biology methods to optimize the food supply chain “from farm to fork” considering also complex processes of human nutrition. Examples, how systems biology methods will be used to study the complex cascades of enzymatic and microbial interactions in cheese, bread processing, vitamin digestion, flavor formation and “evolution” and functions of microbial consortia in the human GIT will be given.

### **References:**

Capozzi, F., Bordoni, A. (2013). Foodomics: a new comprehensive approach to food and nutrition. *Genes & Nutrition*, 8 (1), 1-4.

## STUDYING OF KNEADING SPEED AND TEMPERATURE IMPACTS ON RHEOLOGICAL PROPERTIES OF WHEAT FLOUR DOUGH USING MIXOLAB

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Wheat flour dough is highly non-Newtonian, time-dependent, strain-dependent and viscoelastic. These rheological properties are very sensitive to temperature, water content and composition.

Dough mixing is one of the most important ways to characterize the quality of wheat flours. Proper dough development is affected by mixing intensity (kneading speed) and work imparted to the dough. The objective of this research was to study impact of mixing speed and temperature on thermomechanical properties of breadmaking quality wheat flours using Mixolab. Analysis was carried out at the constant water absorption (98% db) using standard Chopin+ protocol, which consisted of a heating/cooling cycle after a certain mixing time at constant mixing speed (60-120 rpm) .also Effect of temperature at 80 rpm, 100 rpm, 120 rpm, and effect of mixing speed at 30°C, 40°C, 50°C were also studied. Strong relationships were observed between the mixing speed (rpm) and the Mixolab parameters. Mixing temperature was observed to have higher impact on dough consistency and stability than mixing speed. Softening effect of temperature was more significant at low mixing speeds.

**Keywords:** Mixolab, kneading speed

## INFLUENCE OF GRASS PEA (*LATHYRUS SATIVUS*) PROCESSING ON STARCH DIGESTIBILITY

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In many *in vivo* studies it was proven that pulses are characterised by low glycaemic index due to high share of slowly digested starch (SDS) and resistant starch (RS). Starch digestibility is influenced not only by its origin, but first of all by the kind of thermal processing. Therefore, the aim of the study was the comparison of starch digestibility after processing of grass pea seeds and flours.

Scientific material were the seeds of grass pea (var. Krab and Derek) that were cooked after soaking (SC). A part of cooked seeds was then frozen at  $-18^{\circ}\text{C}$  and stored for 21 days (SC&F). The processed seeds were dried and ground. Also, raw flours (RF) were cooked in water for 30 min (FC) and their digestibility was analysed immediately or after 21 day storage at  $-18^{\circ}\text{C}$  (FC&F).

In the study the determinations of dry matter content, total starch content (TS, enzymatic method) and *in vitro* starch digestibility (Englyst method applying pancreatin, amyloglucosidase and invertase) were performed. The amount of starch digested after 20 min was an equivalent of rapidly digested starch (RDS) and between 20 and 120 min – of SDS. RS was the difference between TS and a sum of RDS and SDS.

Basing on performed investigations a significant decrease of SDS in SC was found, while in FC a drop of both SDS and RS was noticed. As an effect, the share of SDS and RS in SC was much higher (27 and 30%) than in FC (6 and 11%). The storage of seeds or cooked flour at a freezing temperature resulted in an increase of the sum of RS and SDS. However, in FC&F only the increase of SDS was observed, while in SC&F – both of SDS and RS. Thermal processing of seeds before milling led to the product of lower glycaemic index.

This work was supported by the Polish Ministry of Science and Higher Education (Project No. N N312 114238, 2010/2012).

**Key words:** legume, thermal processing, *in vitro* starch digestibility, resistant starch

## ESTIMATION OF PARTICLE SIZE DISTRIBUTION IN LACTOSE SOLUTION USING DYNAMIC LIGHT SCATTERING

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Dynamic Light Scattering technique has established itself as quick and reliable way to get data about particle size distribution in solution. Till now this technique practically has not been used for studying of lactose solutions. The aim of this work was to develop the methodology for analyzing of lactose solutions using DLS technique. This work aims at finding of minimum and maximum concentrations for the solution, in which particle size distribution of lactose can be analyzed.

For the tests with low concentrations, solutions of lactose from 0.1% to 1% were prepared. To study high concentrations and the effect of different solvents (ultra pure water and RPMI 1640) on the average of particle sizes, solutions of 30%, 40% and 50% were prepared. Measurements for all samples were made on a Malvern Zetasizer Nano ZS, at a temperature of 24 °C.

It was found, that minimum concentration of solution, in which lactose particles can be captured by analyzer, is 0.5%. Even at the highest concentration (50% lactose in solution) results were reliable and quite close the proposed lactose molecule size. Little difference between the sizes of particles and conterminous correlation functions, obtained using ultra pure water and RPMI, also argue that RPMI does not affects particle size distribution.

Lactose molecules and their clusters can be detected in solution from a very low (0,5%) to very high (50%) concentrations by using DLS technique, but usage of limit concentrations may give unreliable result. Difference between particle sizes, obtained using different solvents was small, so, it can be concluded, that either ultra pure water or RPMI 1640 can be used as a basis for lactose solutions in DLS analysis.

**Keywords:** dynamic light scattering, lactose, particle size, lower concentration limit

## PROPERTIES OF THE EXTRACTS OBTAINED FROM DRIED ONIONS BY DIFFERENT EXTRACTION METHODS

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Onions are one of the most widely used vegetables in the world. In addition they are used for food flavouring and possess beneficial health properties. Sulphur containing volatile compounds of onions are rapidly released into the environment after mechanical damaging of cells. They are very reactive, possess strong odour and can protect against various diseases. Furthermore, onions are a good natural source of flavonoids, mainly consisting of anthocyanins and flavonols, acting as antioxidants. The aim of this work was to evaluate antioxidant properties of extracts obtained by accelerated solvent extraction (ASE) and supercritical CO<sub>2</sub> extraction from 4 onion varieties. ASE extraction was performed in two steps (with acetone and 70% methanol in water). Methanol extract yield (~80%) was remarkably higher than acetone (~2%). Acetone extracts possessed higher radical scavenging capacity in DPPH assay and total phenolic content. The extracts of *Red Baron* red onion variety were the strongest antioxidants followed by *Stuttgart Riesen*, *Spirit* and *Babtu didieji*. Quercetin-4'-glucoside and quercetin-3,4'-diglucoside were the main flavonoid compounds in all extracts identified by HPLC/UV/MS. The extracts isolated by supercritical fluid extraction (the yield from 0.5 to 1.4) were also evaluated, but there were no glucosides or their derivatives detected during HPLC/UV/MS analysis. Funded by Research Council of Lithuania, grant no. SVE-06/2011.

**Keywords:** *Onions; supercritical CO<sub>2</sub> extraction; accelerated solvent extraction; antioxidant*

## NEW APPLICATION OF PHAGE DISPLAY: THE IDENTIFICATION OF SHORT PEPTIDES

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Phage display is a laboratory method to study protein-protein, protein-peptide and protein-DNA interactions. The DNA coding the displayed protein is cloned inside bacteriophage coat protein gene DNA and this protein is displayed on the surface of phage particle as part of coat protein. It is possible to make phage display libraries (peptide display libraries), which are mainly used display systems. Peptides differ from proteins in size, peptides contains about 50 amino acids or less.

The new technology developed enables to identify the short peptides (2aa-5aa) from mixtures, consisting possibly also a great number of different peptides. A new type phage phage display library and peptide expression library are the core components of the technology. The first step of the analysis is to sort out from the phage display library the bacteriophages, which have interacted with peptides of the mixture studies. After separation of these bacteriophages, the second step is to identify and isolate the individual peptides from a peptide expression library using the phage the phages of the library created in the result of the first step. This phage display system consisting of a new bacteriophage M13 based cloning vector and new host strains of *Escherichia coli*, only one panning step is needed, not 3-5, like in ordinary phage display systems to accomplish the identification and separation. The system will be described in detail on poster represented on the Conference, the figures helping to understand the method developed.

The technology has been used for the analysis of yeast and milk peptides.

## INVESTIGATION ON CHEMICAL COMPOSITION AND PHYSICAL-CHEMICAL PARAMETERS OF RYE BRAN.

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Since the milling process highly influences the proportions of the different cell types in the 'bran', it is expected that bran originating from different genetic/ agricultural backgrounds and produced by different processes have different chemical composition. Rye bran has not been studied in Latvia, therefore the aim of the present study was to analyze physical – chemical characteristics of rye bran from Latvia industrial mills.

All experiments were performed at the Latvia University of Agriculture, Faculty of Food Technology. Two rye bran samples collected from industrial mills Joint Stock Company (JSC) "Rigas dzirnavnieks" and JSC "Jelgavas dzirnavnieks" were analyzed. Moisture content was analyzed using standard ICC 110/1 method by sample drying for 2 h at 150 ° C. The content of titratable acidity (TA) was detected by titration with 0.1 M NaOH till pH 8.5 was stable for 1 minute. Rye bran colour was analysed by Hunter Lab colour measurement instrument using *ColorTec* colorimeter *PCM/PSM* in CIE L \* a \* b\* system. Total dietary fiber (TDF) was determined according to AOAC 985.29 methods. For  $\beta$ -glucan determination was used McCLEARY method. Protein content was detected using Kjeldahl nitrogen, AN 3002 method.

Results showed, there were not significant differences between physical – chemical parameters of rye bran samples. Results of chemical composition showed that there were differences between varieties: TDF content varied from  $25.34 \pm 0.73\%$  –  $35.03 \pm 0.31\%$ ,  $\beta$ -glucan content from  $1.48 \pm 0.24\%$  -  $1.77 \pm 0.06\%$ , protein content ranged from  $13.55 \pm 0.07$  -  $14.45 \pm 0.21 \text{ g } 100\text{g}^{-1}$  the highest content was for JSC, "Jelgavas dzirnavnieks".

**Key words:** rye bran, chemical composition, physically – chemically parameters.

## ANTIOXIDANT ACTIVITY ASSESSMENT OF STRAWBERRY (*FRAGARIA L.*) SPECIES

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In recent years the scientific interest in the natural antioxidants has been growing, the natural food supplements are more widely applied in the food and cosmetics industries. The lipid oxidation is the key factor determining the food preparation peculiarities and the expiry dates. The use of antioxidants in the food industry is becoming more popular, as the shelf life is prolonged, organoleptic and nutritional characteristics are protected. The research of the herbal raw materials is the first step in the search of natural antioxidants.

The objective of the study was to determine and evaluate radical scavenging and ferric reducing abilities of antioxidants in strawberries (*Fragaria viridis*, *F. vesca*, *F. moschata*).

Ethanollic extracts of *F. viridis*, *F. vesca*, *F. moschata* leaves and fruits were analyzed using ABTS and FRAP post-column assays. Antioxidant active compounds were quantified according to TEAC for each assay.

In *Fragaria* leaf extracts six antioxidant active phenolic compounds – (+)-catechin, (–)-epi-catechin, ellagic acid, epigallocatechin gallate, hyperoside, isoquercitrin and three quercetin derivatives were identified. In *Fragaria* fruit extracts, besides previously mentioned compounds, two anthocyanins – cyanidin-3-O-glucoside and pelargonidin-3-O-glucoside were determined.

The results demonstrate that *Fragaria* leaf extracts possess stronger antioxidant properties (range of total TEAC values 191.23 – 609.36  $\mu\text{mol/g}$  and 178.63 – 642.20  $\mu\text{mol/g}$  of ABTS and FRAP, respectively) than *Fragaria* fruit extracts (8.24 – 25.11  $\mu\text{mol/g}$  and 10.82 – 24.82  $\mu\text{mol/g}$  of ABTS and FRAP, respectively). Assessed TEAC values of leaf and fruit materials of *Fragaria L.* confirm that epigallocatechin gallate is a predominant radical scavenger and has greatest reducing activity. Ellagic acid possesses strong reducing activity and lower radical scavenging activity. Derivatives of quercetin have greatest impact on antioxidant activity of *F. viridis* leaves

Summarized experimental results revealed that greatest radical scavenging and reducing activity was of *F. viridis* leaf extract and *F. vesca* fruit extract. Epigallocatechin gallate can be used as marker for the evaluation of radical scavenging and reducing activity of herbal raw materials of *Fragaria L.*

**Keywords:** *Fragaria*, antioxidant, post-column, strawberry.

## ESSENTIAL OIL COMPOSITION AND ANTIOXIDANT PROPERTIES OF EXTRACTS FROM LINGONBERRY (*VACCINIUM VITIS-IDAEA* L.) LEAVES

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Essential oil (EO) composition and the antioxidant potential of lingonberry (*Vaccinium vitis-idaea* L.) leaves collected in Lithuania were studied. The yield of EO isolated by hydrodistillation of dried lingonberry leaves in a Clevenger apparatus was ~0.03% (v/w). More than 40 compounds were identified in EO by GC×GC/TOF-MS, the major compounds being linalool (8.4%),  $\alpha$ -terpineol (6.6%), (E)-geranyl acetone (6.3%), phytol (5.2%) and geraniol (4.7%). Other important components were limonene, (E)-3-penten-2-one, (E,E)-2,4-heptadienal, eicosane, (E,E)-2,4-decadienal, heptacosane and (E)- $\beta$ -ionone.

The methanol and acetone extracts were prepared by using an automated extraction system from the whole and deodorized plant material. Water extract was prepared by freeze-drying liquid fraction obtained after hydrodistillation. Extracts were evaluated for total phenolic content (TPC) and *in vitro* DPPH<sup>•</sup>, ABTS<sup>•+</sup> radical scavenging and oxygen radical absorbance capacity (ORAC) assays. The highest extraction yield was achieved from the whole lingonberry leaves with methanol (36.38%); this extract possessed the highest values in DPPH<sup>•</sup> and TPC (127.1±2.4 mg gallic acid equivalents (GAE)/g of leaves) assays. The water extract showed the highest values in ABTS<sup>•+</sup> and ORAC assays. The on-line HPLC–DPPH<sup>•</sup> analysis showed that flavonoid catechin is the most important radical scavenger in lingonberry leaves extracts.

The results obtained demonstrated that lingonberry leaves contain high content of phenolic compounds with high antioxidative potential; therefore this plant could be used for the developing new preparations of bioactive functional ingredients.

**Keywords:** Lingonberry leaves, *Vaccinium vitis-idaea* L., antioxidant activity, essential oil

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## DETERMINATION OF VITAMIN A CONTENT IN THE COMMERCIAL MILK

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The deficiency of micronutrients is a worldwide public health problem. Vitamin A (retinol) is one of the vitamins that are essential for health. It is involved in physiological processes such as growth, fetal development and the integrity of the immune system. Fish oils, beef and cod livers, egg yolk and other animal origins products consist of high amount of retinol. Also dairy products are important sources of vitamin A, due to high consumption of these products in Lithuanian nutrition. However, many technological aspects, such as temperature, presence of oxygen, light, pH, duration of heat treatment can influence the content of retinol. So, the main aim of the present study was to determine the content of vitamin A in pasteurized milk purchased from the Lithuanian supermarkets.

Five different types of cow milk from different dairy processing factories were used in the experiment. The samples were prepared and analysed using high performance liquid chromatography (HPLC) with UV detection. The obtained results indicate that retinol concentration of pasteurized milk varied between 2.63-3.35 µg/g of fat. Processing of milk decreased the content of retinol, however the obtained results were similar with the data's presented by other scientists.

In conclusion, milk consumption can enrich nutrition with various vitamins, including vitamin A.

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**Keywords:** retinol, pasteurized milk, HPLC

## GAME MEAT SENSORY ANALYSIS

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The objective of the applied research is to bring out differences between the Estonian game meat and farmed animal meat and their potential effect on the characteristics of meat products. Wild animals are running free in the forest and that's why all that they eat is clean from pollution and also very diverse which in return affects game meats physical and chemical and organoleptical quality. The novelty of the current study lies in the original research that has never been made, finding scientifically proven differences between Estonian game and farm animal meat flavor and texture.

Sensory analysis of meat and meat products is used to describe farm grown animal meat and game meat differences and potential impact on properties of the meat product. For sensory analysis of meat and meat products has developed the method of the descriptive sensory analysis to analyse differences between meats aromas, textures and flavours. Descriptive sensory analysis which is used in this study can be briefly described through the next steps: selection of the panel, developing vocabulary, measuring intensities of attributes, and data analysis. Meat samples for analysis are obtained from enterprise AS Linpet. Meat whose sensory characteristics are compared are: beef, pork, organic beef, wild boar meat, deer meat and moose meat.

Describing product appearance, texture, flavour, and aroma using attribute definitions and reference materials, and evaluating the intensity of an attribute on a scale by trained panelists gives a full descriptive sensory profile of the different meats and meat products. This makes understanding which kind of game meat products are liked for which reasons. Ten trained panelists from Competence Centre of Food and Fermentation Technologies (CCFFT) participated in this study, for this study they also received further orientation on meat and meat products. The sensory data from the (game) meat and meat products were analyzed using Principal Component Analysis (PCA), separately presented spider graphs for aroma, texture and flavour differences.

Sensory assessment results are very useful if linked to various instrumental measurements, for example instrumental aroma profiles, instrumental meat and meat products tenderness measurements, sugars or acids profiles and pH. These correlations are valuable for meat technologists for better understanding of the products by describing the relationship between sensory and instrumental properties of those meat products and their ingredients, processes, study quality-control, and self-life issue. Solving these issues are planned for the next two year study.

The project is carried out with the support of PRIA (Estonian Agricultural Registers and Information Board), Measure 1.7.1-New products, production methods and technologies development cooperation.

**Keywords:** game meat, descriptive sensory analysis, game flavor

## CAMPYLOBACTER SPP. AND LISTERIA MONOCYTOGENES PREVALENCE IN 2012

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Human listeriosis is a relatively rare but serious zoonotic disease which can be life threatening to vulnerable populations, especially to elderly persons, pregnant women, and persons with weakened immune systems. High prevalence and numbers of *L. monocytogenes* are often linked to ready-to-eat (RTE) fish and meat products, especially with extended self-life. Findings over the legal safety limit, which is in most cases above 100 CFU/g during the self-life of a RTE product, have been mostly reported with non-pasteurized milk cheeses, fishery and meat products.

Campylobacters are the most common registered bacterial causes of human intestinal infections in EU-countries. It is well established that poultry products are a vehicle for foodborne campylobacteriosis and they are suspected to be an important source of infection because of the frequent contamination of poultry meat at retail level.

**The objectives** of the study were: to estimate the prevalence of *L. monocytogenes* in RTE fish and meat products of Estonian origin, and to determine the prevalence of *Campylobacter* spp. in fresh broiler chicken meat products sold in Estonian retail outlets.

### Results

According to our results the prevalence of *Campylobacter* spp. in fresh broiler chicken meat was 35% from the total of 220 samples obtained from the shops of the Estonian well-known retail market chains. The percentage of *Campylobacter* positive samples among Estonian, Lithuanian and Latvian fresh broiler chicken meat products available in Estonian retail markets was 18.6%, 48.8 and 45%, respectively. The average *Campylobacter* counts in Estonian, Lithuanian and Latvian *Campylobacter* positive products were  $3.3 \times 10^2$  (330) cfu/g,  $1.4 \times 10^3$  (1400) cfu/g and  $2.8 \times 10^3$  (2800) cfu/g, respectively.

*Campylobacter* prevalence study at Estonian broiler chicken farm level in 2012 showed that the contamination appeared from July to September and among 380 cecal/fecal samples the *Campylobacter* positive percentage was 39.2% in total.

*Listeria monocytogenes* prevalence among 101 Estonian RTE meat products and among 89 RTE fish products in 2012 was 6.9% and 18%, respectively. Among positive Estonian RTE meat and fish products 78.3% had *L. monocytogenes* counts less than  $1.0 \times 10^1$  (10) per gram of product. Only in one (n=1) fish product with low salt concentration the

number of *L. monocytogenes* exceeded the legal safety limit  $1.0 \times 10^2$  (100) per gram of product at the last day of product self-life.

### Conclusions

The findings of present study showed that the prevalence of *L. monocytogenes* in RTE meat and fish products was generally low in Estonia, and only in one RTE food product the legal safety limit for *L. monocytogenes* counts was exceeded. Our results indicate low human listeriosis risks if Estonian origin industrial RTE fish and meat products are consumed.

Prevalence of *Campylobacter* spp. in fresh broiler chicken meat was low in Estonian products and it was significantly ( $P < 0.001$ ) higher in Latvian and Lithuanian products.

There was distinct seasonal variation in proportions of *Campylobacter* positive samples with seasonal peak on summer months in Estonia.

**Keywords:** *Campylobacter* spp., *Listeria monocytogenes*, prevalence, ETA-g 9315

## ANTIBACTERIAL ACTIVITY OF SOME LACTOBACILLI AGAINST PATHOGENIC AND SPOILAGE BACTERIA

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Products of metabolism of lactic acid bacteria (LAB) such as organic acids, diacetyl, hydrogen peroxide, phenolic compounds and bacteriocins (bactericidal proteins) can inhibit the growth of pathogenic and spoilage bacteria in foods. For this reason, LAB are widely used for preservation of different food products. KTU Food Institute has a unique collection of LAB including *Lactobacillus* spp.

The aim of the study was to determine the antimicrobial activity of some *Lactobacillus* spp. against reference and foodborne cultures of pathogenic and spoilage bacteria.

The following 18 lactobacilli strains from the collection of KTU Food Institute were tested for their antimicrobial activity: *Lactobacillus acidophilus* (3 strains), *Lactobacillus casei* (4 strains), *Lactobacillus helveticus* (4 strains), *Lactobacillus plantarum* (1 strain), *Lactobacillus delbrueckii* subsp. *bulgaricus* (5 strains), *Lactobacillus sakei* subsp. *sakei* (1 strain). The reference strains of pathogenic bacteria *Bacillus cereus* ATCC 11778, *Listeria monocytogenes* ATCC 19111, *Staphylococcus aureus* ATCC 25923, the reference strain of spoilage bacteria *Escherichia coli* ATCC 25922 and the foodborne strains of the species mentioned above were used in the study.

The agar well diffusion method was used for detection of antimicrobial activity. *B. cereus*, *L. monocytogenes*, *S. aureus* and *E. coli* were cultured in Brain heart infusion broth at 30 °C or 37 °C for 24 h. One milliliter of the suspension (approx. density  $5 \times 10^5$  cfu/ml) was inoculated into 20 ml of plate count agar maintained at 45 °C and the resultant mixture was poured into the Petri dishes. After the solidification of the agar, four wells (diameter 8 mm) were made. Lactobacilli strains for testing were cultured in 10 ml of MRS broth and incubated at 30 °C or 37 °C (according to the optimal temperature of the strain) for 48 h. Cells were removed by centrifuging at 6000g for 15 min. pH of supernatant was adjusted to 6.5 by 1 mol/l NaOH solution. The supernatant was filtered through 0.2 mm pore size filter and 50 µl of it was added into each well. The plates were examined for evaluating of inhibition zones after incubation at 30 °C or 37 °C for 24 h.

The antibacterial activity of the cell-free filtrate of each strain was evaluated. All lactobacilli strains produced the inhibition zones against pathogenic reference and foodborne bacteria. The diameters of the inhibition zones varied between 14.3 mm to 25.5 mm. *L. acidophilus* 336 was the most active against *L. monocytogenes* and *B. cereus* (inhibition zones were ranging between 19.5 to 21.5 mm). All strains of *L. acidophilus* and one strain *L. helveticus* 305 were more active against *E. coli* and *S. aureus* than other lactobacilli. The diameters of the inhibition zones were from 17.5 mm to 24.9 mm.

Lactobacilli strains investigated in this study inhibited the test strain *L. monocytogenes* ATCC 19111, *B. cereus* ATCC 11778, *E. coli* ATCC 25922, *S. aureus* ATCC 25923 and the cultures of the same bacterial species isolated from various food products.

The results received in this study will help to select the best strains with multi-functional properties including antimicrobial activity for improving the microbiological safety of traditional food products.

**Keywords:** *Lactobacillus*, pathogenic bacteria, antimicrobial activity

This work was supported by the Research Council of Lithuania.

## UV-A LED ILLUMINATION EFFECTS ON BIOACTIVE COMPOUNDS IN MICROGREENS

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The objective of this study was to evaluate the effect of different UV-A light wavelengths, produced by solid-state light-emitting diodes (LEDs) on variation of bioactive compounds in microgreen plants: pak choi (*Brassica rapa var chinensis*, 'Rubi'), basil (*Ocimum basilicum* L., 'Sweet Genovese') and beet (*Beta vulgaris* 'Bulls Blood').

Plants were cultivated in controlled conditions, in peat substrates for pak choi 8, basil 22, and beet - 18 days from sowing to harvesting. 21/17°C day/night temperature and 16 h photoperiod was maintained. Total photosynthetic photon flux density (PPFD) generated by LEDs was maintained at 300  $\mu\text{mol m}^{-2} \text{s}^{-1}$ : blue (455nm), red (638nm, 669nm), far-red (731nm) – basal components + 15  $\mu\text{mol m}^{-2} \text{s}^{-1}$  UV-A (366, 390, 402 nm).

Supplemental UV-A lighting had uneven effects for different microgreen plants. Basal LEDs +366 nm and +390 nm lighting resulted in significant increase in total anthocyanins in basil; +390 nm resulted in significant increase in total phenolics and flavones in pak choi and basil and DPPH free-radical scavenging capacity in beet. The ascorbic acid was significantly increased under +366nm and +402nm in both microgreen plants.  $\alpha$ -tocopherol concentration was significantly affected by supplemental +390 nm LEDs basli, and  $\beta$  and  $\gamma$  tocopherols were significantly effected by +390nm UV-A LEDs in basil and +402nm in pak choi and beet. In summary, supplemental UV-A lighting had different, but significant effect on microgreens plants.

**Keywords:** anthocyanins, ascorbic acid, DPPH, phenols, tocopherol.

**Acknowledgements:** This research was funded by a grant (No. SVE-03/2011) from the Research Council of Lithuania.

## IMPACT OF CO<sub>2</sub> ON INTERNAL QUALITY OF BABY LETTUCE GROWN UNDER LED LIGHTING

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The impact of elevated carbon dioxide (CO<sub>2</sub>) concentration and solid-state lighting on antioxidant and nutritional properties of red leaf 'Multired 4' and green leaf 'Multigreen 3' baby leaf lettuce (*Lactuca sativa* L.) was investigated. The 500 ppm and 1000 ppm CO<sub>2</sub> concentrations and the module of four-component light-emitting diode-based (LED) illumination were used. Plants were cultivated in controlled conditions, in peat substrates for 30 days from sowing to harvesting. 21/17 °C day/night temperature and 16 h photoperiod was maintained. Total photosynthetic photon flux density (PPFD) generated by LEDs was maintained at 300 μmol m<sup>-2</sup> s<sup>-1</sup>: blue (455nm), red (638nm, 669nm), far-red (731nm). Our results demonstrate that elevated CO<sub>2</sub> concentration in combination with solid-state lighting significantly increased the amount of ascorbic acid. Meanwhile, the decrease of total anthocyanin concentration in 'Multigreen 3' and the DPPH free-radical scavenging capacity in 'Multigreen 3' and 'Multired 4' were observed. The increase of α and β tocopherol accumulation was found in 'Multigreen 3', whereas the significant decrease of all tocopherol isomers observed in 'Multired 4'. According to our results, the increase of ascorbic acid content in green leaf lettuce was associated to the accumulation of tocopherol homologues. The significant increase of carbohydrates under elevated CO<sub>2</sub> was observed in 'Multired 4', however it had no significant effect on the content of photosynthetic pigments. The carotenoid content under elevated CO<sub>2</sub> concentration was significantly lower in 'Multired 4' lettuce. In summary, the enhanced CO<sub>2</sub> concentration changed concentrations of antioxidant compounds and carbohydrate accumulation in baby leaf lettuce grown under solid-state lighting depending on the lettuce variety.

**Keywords:** ascorbic acid, carbohydrates, chlorophyll, DPPH, phenols, tocopherol.

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## THE INFLUENCE OF SOLID STATE FERMENTED SAVORY PLANTS OF THE GENUS *Satureja* (*montana* AND *hortensis*) WITH CERTAIN LACTOBACILLI ON THE QUALITY AND SAFETY OF MINCED MEAT PRODUCTS

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The main focus in this study was to investigate the effects on the quality and safety of minced meat products treated by addition of *Satureja montana* and *Satureja hortensis*, fermented by different lactic acid bacteria (LAB) strains that produce bacteriocin-like inhibitory substance (BLIS).

For the herbs fermentation several different LAB (*Pediococcus acidilactici* KTU05-7, *Pediococcus pentosaceus* KTU05-8, *Pediococcus pentosaceus* KTU05-9, *Lactobacillus sakei* KTU05-6, *Pediococcus pentosaceus* KTU05-10) and different fermentation conditions (solid state fermentation (SSF) and fermentation in liquid medium) were used. The mass fraction of fermented herbs in the minced meat formula was 3.5 and 7.0 %.

We found experimentally that *Satureja Montana* and *Satureja hortensis* fermented with LAB contained more L(+) lactic acid than D(-) lactic acid. The concentrations of biogenic amines in all analysed minced meat products were far below levels causing a health risk. We also found that the addition of *Satureja Montana* and *Satureja hortensis*, fermented by different LAB strains have a positive impact on the organoleptic and technological parameters of the minced meat products.

We conclude that the use of SSF with different LAB's of *Satureja Montana* and *Satureja hortensis* allows to enrich minced meat products with lactofermented herbs and increase the organoleptic and technological parameters of minced meat products with less biogenic amines.

**Keywords:** minced meat products, solid state fermentation, lactobacillus, *Satureja montana*, *Satureja hortensis*.

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## INFLUENCE OF FREEZING ON THE PHYSICOCHEMICAL PROPERTIES OF CONCENTRATED EMULSIONS STABILIZED BY WHEY PROTEINS AND CHITOSAN

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The use of aminopolysaccharide chitosan in the food industry is related to its functional properties and physiological activities. Chitosan was shown as good thickener and stabilizer as well emulsifier in emulsions. Oil-in-water emulsions often are destroyed by freezing, and that can have limitations for their use in some food applications.

The objective of this study was to evaluate the effect of freezing on the properties of concentrated (40 % (w/w)) oil-in-water emulsions prepared with rapeseed oil and stabilized by whey protein isolate (4 % (w/w)) and chitosan (0.1–0.5 % (w/w)).

The samples of freshly prepared emulsions were held for 1 day, 2 weeks and 1 month at +6 °C, -8 °C and -18°C before being thawed to room temperature and analyzed. The emulsions were characterized by particle size distribution (laser diffraction spectrometer), apparent viscosity and thixotropy (stress controlled rheometer), amount of free oil (solvent extraction) and bulk observation of the samples.

Results showed that the increasing amount of chitosan in oil-in-water emulsions lead to gradual increase in the emulsions active acidity, particle size, apparent viscosity and thixotropy. It can be noticed that emulsions were highly stable on ageing at +6 °C and -8 °C, showing only small increase in particle size and free oil amounts measured after thawing. All emulsions held at -18°C and thawed were destabilized and showed considerable oil phase separation.

**Keywords:** emulsions, chitosan, whey proteins, freezing.

## ANTIBACTERIAL ACTIVITY OF PHENOLIC ACIDS AGAINST FOODBORNE PATHOGENS

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The purpose of the work was to define antibacterial properties of five phenolic acids (benzoic, chlorogenic, gentisic, caffeic, p-coumaric) against four foodborne bacteria pathogens: *Staphylococcus aureus* A-529, *Listeria monocytogenes* 17/11, *Escherichia coli* O 26 152/11 and *Salmonella* Enteritidis 322/11. Bacteria strains were clinical isolates and were purchased from Polish National Institute of Hygiene. Phenolic acids were purchased from Sigma-Aldrich.

The experiment consists on determining minimal inhibitory concentration  $\text{mg}/\text{cm}^3$  (MIC) and minimal bactericidal concentration  $\text{mg}/\text{cm}^3$  (MBC) of the phenolic acids. Minimal inhibitory concentration was determined on Mueller-Hinton liquid medium (Merck, Germany) with macrodilution method. Each test-tube was inoculated with culture suspension, cell density  $10^7/\text{cm}^3$ . The samples were incubated at  $37^\circ\text{C}$  for 24 hours. Growth was observed as turbidity of medium. Minimal bactericidal concentration was determined on Mueller-Hinton Agar medium (BTL, Poland) with plate method. The plates were incubated at  $37^\circ\text{C}$  for 24 hours. After incubation the number of colonies was counted.

Minimal inhibitory concentration and minimal bactericidal concentration of benzoic acid were equal for all tested strains and observed at  $1,25 \text{ mg}/\text{cm}^3$  and  $2,5 \text{ mg}/\text{cm}^3$ .

MIC and MBC of chlorogenic acid for *Staphylococcus aureus* were observed at  $5.0 \text{ mg}/\text{cm}^3$  and  $10.0 \text{ mg}/\text{cm}^3$  and for *Listeria monocytogenes* at  $0.62 \text{ mg}/\text{cm}^3$  and  $10.0 \text{ mg}/\text{cm}^3$ . For Gram-negative strains MIC and MBC were equal and defined at  $10.0 \text{ mg}/\text{cm}^3$ .

Gentisic acid showed antibacterial activity (MIC) at  $5.0 \text{ mg}/\text{cm}^3$  for *Staphylococcus aureus* and  $2.5 \text{ mg}/\text{cm}^3$  for the rest of strains. MBC for *Staphylococcus aureus* and *Salmonella* Enteritidis were equal and observed at  $5.0 \text{ mg}/\text{cm}^3$ . MBC for *Escherichia coli* and *Listeria monocytogenes* were equal as well and defined at  $2.5 \text{ mg}/\text{cm}^3$ .

For caffeic acid MIC and MBC for Gram-negative strains were the same and defined at  $2.5 \text{ mg}/\text{cm}^3$  and  $5.0 \text{ mg}/\text{cm}^3$ . For Gram-positive strains antibacterial activity was stronger and observed at  $0.31 \text{ mg}/\text{cm}^3$  (MIC),  $0.63 \text{ mg}/\text{cm}^3$  (MBC) for *Staphylococcus aureus* and  $0.31 \text{ mg}/\text{cm}^3$  (MIC),  $2.5 \text{ mg}/\text{cm}^3$  (MBC) for *Listeria monocytogenes*.

MIC and MBC of p-coumaric acid were the same for all tested strains and came to  $2.5 \text{ mg}/\text{cm}^3$  and  $5.0 \text{ mg}/\text{cm}^3$ .

Summing up Gram-positive strains were more sensitive on phenolic acids than Gram-negative strains. *Listeria monocytogenes* was the most sensitive among all tested bacteria.

**Keywords:** phenolic acids, MIC, MBC, foodborne pathogens

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## EFFECT OF RYE AND WHEAT BRAN EXTRACTS ON THE STABILITY OF BEEF MEAT BURGERS

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The oxidation of lipids leading to rancidity is one of the most important changes during food storage and production (Melton, 1983; Rosmini et al., 1996). The acceptability of a food product depends on the extent to which this deterioration has occurred. Therefore, some criteria for assessing the extent of oxidation are required. The aim of this study was to determine the influence of rye and wheat bran extracts on the stability of beef meat burgers by monitoring the microorganisms, gas composition, pH, organoleptic properties, instrumental colour, metmyoglobin ratio, hexanal and thiobarbituric acid reactive substances (TBARS). Six different samples of beef meat burgers were prepared: control, with 0.4 % rye and wheat bran methanol extracts, with 0.4 % rye and wheat bran acetone extracts and commercial. All samples were packaged with MAP (30 % CO<sub>2</sub> / 70 % O<sub>2</sub>) and storage at 4 °C for 14 days.

The oxygen was decreasing (from 75.6 % to 37.8 %) and carbon dioxide was increasing (from 14.8 % to 53.8 %) during 14 days and this indicated on the bacteria growth. The lowest activity of microorganisms was in commercial burgers. However, activity of microorganisms did not have significant effect to burgers with rye and wheat bran extract. The minimum pH had control (5.11±0.01) and beef burgers with 0.4 % methanol rye bran extract (5.35±0.03) (day 14). Characteristics of meat color (L\*, a\* and b\*) were measured by spectrophotometer using CIELab space. Red colour was better preserved in commercial burgers throughout the storage, while wheat bran methanol extract was superior in colour comparing to other samples. Metmyoglobin ratio results were in agreement with instrumental colour measurements. The lowest % of metmyoglobin was found in commercial burgers followed by burgers with 0.4 % methanol wheat bran extract, meaning that the colour of these samples was better preserved. The slowest formation of oxidation products (hexanal and TBARS) during storage were found in the commercial beef, followed by the samples with 0.4 % methanol wheat bran extract. It may be concluded that the extract of wheat bran, obtained with methanol was the most efficient in perserving burgers of beef meat during storage. Physicochemical properties of this extract were also superior comparing with others extracts.

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**Keywords:** *lipid oxidation, rye bran, wheat bran, beef meat burgers.*

## NOVEL EXTRUDED PROBIOTIC FEED FOR RABBITS

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The well-being of pets is closely related to their feeding. In addition to providing nutritional value, food composition influences the intestinal microflora and may lead to or prevent gastrointestinal disorders. The pet food industry predominantly uses extrusion to manufacture dry pet foods. Desirable effects of extrusion comprise increase in palatability, destruction of undesirable nutritionally active factors and improvement in digestibility and utilization of proteins and starch. Conventional dry pet foods are characterized as having a moisture content of 15% by weight or less, with a typical value of around 8%-10% by weight (Dzanic, 2003). Typical extruded rabbit food contains 50%-75% grains and cereal products, 10%-18% protein, 3-5% lipids, and raw fiber 8-12%. The first step for the production of dry pet foods is raw materials grinding, batching, and mixing of the dry ingredients. Next step is adding water, about 10% by weight and extrusion, where pet food is cooked at about 120°C and shaped. Then pet food is cooled and dried. The new trend in pet foods is to add probiotic bacteria to their products. Prebiotics and probiotics, though, are much more than trendy additives. Probiotic beneficial bacteria provide functionality to the pet's diet that will help keep them strong and healthy. However many commercially available probiotic pet foods do not contain suitable strains of bacteria and the levels are insufficient (Weese and Martin, 2011).

High quality pet probiotics have at least following important properties: the correct strains of bacteria beneficial for pets, not people; the ability to survive the acidic environment of pet's stomach and small intestine; product stability under normal storage conditions.

The purpose of this study is to develop novel extruded probiotic feed for rabbits. In order to achieve longer shelf life of product probiotic bacteria are infused by vacuum into product which is promising alternative to widely used coating method. The mixtures of two to three from ten commercial probiotic strains are used. They include strains from *Enterococcus* spp., *Lactococcus* spp., *Lactobacillus* spp., *Bifidobacterium* spp., and *Saccharomyces* spp.

In order to evaluate the survival of probiotics in extruded feed we developed the gastrointestinal tract simulator imitating conditions in rabbit's stomach and small intestine. This model is based on the single bioreactor and the simulated parameters are temperature, pO<sub>2</sub>, pH profile, bicarbonate and bile secretion control in small intestine and the holding-time of food in upper gastrointestinal tract. Although the ultimate model for testing the viability of probiotic bacteria is the living being, the gastrointestinal simulator is an efficient tool for screening experiments and for selection of most resistant probiotic strains to rabbit's gut environment. In addition, quick results and reasonable handling expenses make it an attractive solution in development of novel probiotic products.

The project is carried out with the support of PRIA (Estonian Agricultural Registers and Information Board), Measure 1.7.1-New products, production methods and technologies development cooperation.

**Keywords:** pet food, extrusion, probiotics, gastrointestinal tract simulator, rabbit

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## SENSITIVITY OF *CAMPYLOBACTER JEJUNI* TO BLACK, RED CURRANT, CHERRY AND GOOSEBERRY HYBRID JUICE

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The objective of the study was to determine the sensitivity of *Campylobacter* to plant materials. The disease of campylobacteriosis is usually caused by *C. jejuni*, a gramnegative, spiral shaped bacterium. *C. jejuni* grows at microaerophilic conditions under the oxygen concentrations 3-5 % and carbon dioxide concentrations 2-10 %. *C. jejuni* are susceptible to drying, heating, cooling. The growth of these bacteria is inhibited by acidic medium and disinfectants. The infectious dose is 1.000-10.000 bacteria, although 400-500 bacteria can be enough to infect humans. The common [routes of transmission](#) for the disease-causing of *Campylobacter* are these: consumption of insufficiently heat-treated meat products, unpasteurized [milk](#), polluted water.

The sensitivity of *C. jejuni* culture to currant, gooseberry and cherry hybrid juice was determined by agar diffusion method. The antimicrobial activity of all investigated hybrids juice was determined by using the juice concentrations of 100 %, 50 % and 10 %. A 50 µl of investigated juice was added to the hollows in agar medium. The antimicrobial effectiveness was evaluated by formation of inhibition zones of tested cultures.

100 % juice of all investigated hybrids inhibited the test strain of *C. jejuni*. The most active antimicrobial against *C. jejuni* was gooseberry juice which resulted in inhibition zones up to 16 mm. Currant juice resulted in the different diameter of inhibition zones (the average value was 15 mm). *C. jejuni* were the most resistant to cherry hybrid juice. 10 % hybrid juice was completely ineffective against *C. jejuni*. The most of investigated hybrid juices at 50 % concentration inhibited the growth of *C. jejuni* and resulted in small inhibition zones, only 50 % juice of two cherry and one currant hybrid did not show any inhibitory effect against *C. jejuni*. The obtained results with *C. jejuni* were compared with results of other bacteria cultures. The growth of *Listeria monocytogenes* and *Bacillus cereus* was inhibited by all the juices and their mortars; *Staphylococcus aureus* and *Kocuria rhizophila* were resistant to the mortars of some juices. Gram-negative bacteria *Salmonella Typhimurium* and *Escherichia coli* were sensitive to the tested preparations, although inhibition zones were lower under effects of currant, gooseberry and cherry hybrid juice.

*C. jejuni* were more resistant to currant, gooseberry and cherry hybrid juice than other investigated bacteria. Currant, gooseberry and cherry hybrids are known for good antimicrobial activity, their juices inhibited the growth of Gram-negative and Gram-positive bacteria.

**Keywords:** Currant, cherry, gooseberry hybrids, juice, antimicrobial properties.

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## THE EVALUATION OF FLAVOUR CHANGES DURING RIPENING TIME ON EXTRA HARD CHEESE “DŽIUGAS“ BY ELECTRONIC NOSE

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Cheese is a popular food due to diversity in its application, nutritional value and good flavour. Especially, its flavour is one of the key attributes for the consumers and product quality. Cheese flavour formation mostly occurs during cheese ripening and extra-hard cheeses are unique in their varieties depending on the ripening time. For example, Lithuanian extra hard cheese “Džiugas“ made from cow milk, according to their ripening time, have unique flavour profiles. Recently, electronic nose have been shown to be valid instrument, which is applicable in many fields of food for the aroma comparisons. So, the main aim of the present study was to evaluate the flavour changes during ripening on extra hard cheese “Džiugas“ by electronic nose.

Flavour changes of the cheese samples were analyzed by electronic nose after 12, 18 and 36 months ripening. The principal components (PCA) analysis was used to describe cheese volatiles changes. The obtained results showed that the mixtures of aroma compounds were successfully discriminated. The qualitative study indicated that cheese flavour was different between all analyzed cheese samples depending on the ripening time.

In conclusion, electronic nose showed flavor changes during ripening and generally it is suitable instrument for cheese flavor analyses.

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**Keywords:** dairy products, hard cheese, ripening, electronic nose.

## COMPARISON OF DIFFERENT EXTRACTION METHODS FOR ISOLATING PHENOLIC COMPOUNDS FROM LOVAGE (*LEVISTICUM OFFICINALE* L.) LEAVES AND STEMS

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Lovage (*Levisticum officinale* L.) is a perennial herb belonging to the *Umbelliferae* family, and its seeds, leaves and roots (fresh, powdered and as essential oils), are commonly used in Europe in foods and beverages due to their flavouring and medicinal properties. Several methods can be applied to improve extraction yield and reduce the loss of functional compounds from the food matrix. Ultrasound-assisted extraction (UAE) has great potential in food production and during sonication the cavitation process causes the swelling or breakdown of cell walls, which allows high diffusion rates. Microwave-assisted extraction (MAE) causes molecular movement and rotation of liquids with a permanent dipole leading to a very fast heating of the solvent and the sample, offering advantages such as improved extraction efficiency, reduced extraction time and low solvent consumption.

The aim of the current research was to determine the best method for obtaining extracts with high antiradical activity from lovage leaves and stems

Fresh leaves and stems of lovage were collected in Latvia, in July 2012. Plant materials were washed, homogenized, and subjected to extraction procedures with different solvents, methods and duration. Conventional and Soxhlet extraction were performed with eight different solvents: n-hexane (HE), ethyl acetate (EA), diethyl ether (DI), 2-propanol (PR), acetone (AC), ethanol (95%) (ET), ethanol/water/acetic acid (80/20/1 v/v/v) (EWA), and ethanol/water (80/20 by volume) (EW), but UAE and MAE were performed with ET. Conventional extraction was performed with a magnetic stirrer for 1h at room temperature, but Soxhlet extraction was performed in a classical Soxhlet apparatus for 2h. UAE was performed at a frequency of 25kHz for 15 to 18000 seconds. MAE was performed using 900 W microwave power for 15 to 90 seconds.

The total phenol content (TPC) and total flavonoid (TF) content of the lovage extracts were determined according to the Folin-Ciocalteu spectrophotometric method and colorimetric method, respectively. Antioxidant activity of the plant extracts was measured on the basis of scavenging activities of the stable DPPH<sup>·</sup> and ABTS<sup>·+</sup> radicals and reducing power.

Results of multivariate dispersion analyses showed that extraction duration, solvent, method and lovage part are all significant factors affecting TPC, TF, DPPH<sup>·</sup>, ABTS<sup>·+</sup> and reducing power ( $p < 0.05$ ). All analysis of lovage leaves and stems using Soxhlet extraction with ET and EW showed the highest results. Extraction method is crucial in extraction of phenolic compounds, and it was observed that optimum extraction duration for phenolic compounds varies with free radical scavenging activity. In the current research, eight solvents with different polarity were used, and they can be arranged as follows (starting from more nonpolar solvents): HE < EA < DI < PR < AC < ET < EWA < EW. From selected solvents the lowest polarity is for hexane, but the highest for EWA and EW. Obtained results showed that TPC generally increased with the increasing polarity of a solvent. It was also observed an increase in antioxidant scavenging activity with increased solvent polarity.

Analysis of the phenolic compounds and free radical scavenging activity in lovage leaf and stem extracts showed differences depending on extraction method, solvent and part of plant used. The most suitable solvents are ET and EW, the best method is Soxhlet extraction, and the best of the two lovage parts chosen for this study is the leaf.

**Keywords:** ABTS, DPPH<sup>·</sup>, lovage, reducing power, TFC, TPC.

## ANTIOXIDANT PROPERTIES AND PHYTOCHEMICAL COMPOSITION OF *CHAMAEMELUM NOBILE* (L.) ALL. AT VARIOUS PLANT VEGETATION PHASES

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Natural ingredients isolated from various medicinal and aromatic plants may be valuable alternatives for synthetic food additives, which have become undesirable by the consumers. Flavonoids, coumarins, phenolic acids and procyanidins isolated from Roman chamomile were reported as bioactive components possessing strong antioxidant and antimicrobial activity.

The aim of this study was to investigate the antioxidant activity and phytochemical composition of Roman chamomile (*Chamaemelum nobile* L.) collected in Lithuania at various plant vegetation phases. The samples were prepared after hydrodistillation of essential oil (EO) in a Clevenger-type apparatus. Distillation residues were separated into liquid and solid fractions. Liquid fraction was freeze-dried, while the solid one was dried and further extracted with acetone. The freeze dried water extracts (WE) and deodorized acetone extracts (DAE) were tested for their antioxidant activity (AA) by using DPPH<sup>•</sup>, ABTS<sup>•+</sup> radical scavenging, Folin-Ciocalteu, ferric reducing antioxidant power (FRAP) and oxygen radical absorbance capacity (ORAC) assays. The composition of phenolic compounds was analysed by UPLC/ESI-QTOF-MS and seven caffeoylquinic acid derivatives were identified in the *Chamaemelum nobile* extracts. The total amount of phenolic compounds (TPC) was measured with Folin-Ciocalteu reagent using gallic acid as a standard and expressed in gallic acid equivalents (GAE). The highest TPC amounts were in WE, which varied from 50.1 to 143.2 mgGAE/g depending on the growth phase, while in DAE it was from 19.6 to 93.9 mgGAE/g and in the EO only from 7.9 to 13.4 mgGAE/g. The ORAC values measured for DAE were from 886 to 1827 µmol trolox equivalents (TE)/g, while for WE they were from 2825 to 4596 µmolTE /g.

Consequently the antioxidant activity of water extracts was stronger than that of deodorized acetone extracts. The extracts isolated during beginning of flowering, full flowering and in the end of flowering phases were stronger antioxidants compared to other growth phases.

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**Keywords:** *Chamaemelum nobile*, antioxidant activity, phenolics, growth phases, caffeoylquinic acid

## INFLUENCE OF BIODEGRADABLE PACKAGING ON THE QUALITY CHARACTERISTICS OF FROZEN SPINACH

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Synthetic polymers are the most common packaging materials used for food staff. However, the increase of the use of synthetic polymers led to serious ecological problems because of the difficulty of waste disposal. One of the main objectives of industries is the reduction of environment pollution due to the plastic packaging materials. Therefore many studies have been done in order to develop innovative recyclable and/or biodegradable materials suitable for food products. The aim of this work was to study the influence of biodegradable/compostable packaging on the quality characteristics of frozen spinach. For this purpose the samples were stored in three different films: polyethylene monolayer (PE), PE with a specific additive for the increase of its biodegradability (PE+ADD), biodegradable/compostable film (B/C), at three different temperatures (-8, -18, -28 °C) for several months. Ice distribution (using computer vision system (CVS) for image analysis), water content and the ascorbic acid content were analysed in frozen spinach.

Obtained results did not evidence significant differences on spinach stored in traditional and new packaging materials (biodegradable/compostable).

As expected, the storage temperature significantly influenced product quality characteristics, giving rewarding results when the samples were stored at -18 and -28 °C. The image analysis technique showed a different level of re-crystallization and ice redistribution (bound to the different water mobility in the system) at the different storage temperatures investigated.

The ascorbic acid content decreased with storage time proportionally to the storage temperature adopted, probably because of residual enzymatic activity.

**Keywords:** spinach, frozen, biodegradable packaging, AA content

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## IDENTIFYING THE FLAVOR AND AROMA PROFILES OF BASIL USING QUANTITATIVE DESCRIPTIVE SENSORY AND INSTRUMENTAL ANALYSIS

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The aim of the work is to study the effect of processing (drying, freeze-drying, heat treatment, and freezing) on the taste and aroma of basil (*Ocimum Basilicum* L). A lexicon and references were developed to describe the sensory flavor characteristics of basil. Gas-chromatography/mass-spectrometry and GC-Olfactometry were applied to determine the key aroma-active compounds. An innovative approach using *front-face*-fluorescence spectroscopy for fingerprinting was also tested. Principle Component Analysis was used to classify and group data gathered using different methods. Samples were acquired from different regions (Egypt, California, Peru, France, Sweden, and Estonia) and were either processed by the producer or in our facility. The following compounds were identified as having the strongest impact on aroma: methional (potato), 1-octen-3-ol (mushroom), eucalyptol (eucalyptus), benzene acetaldehyde (honey, sweet), linalool (jasmine), eugenol (sweet), methyl eugenol (clove),  $\alpha$ -caryophyllene (sweet), 10.21 unknown (pepper), beta-pinene (hay) and 6.57 unspecified sesquiterpene (dried pea). Estragole (anise) was present in three sample types (*Frozen Swe*, *Heat treated Eg* and *Freeze-dried*), but it seemed to be dependent on the cultivar rather than the method of processing. All methods confirm that the origin of the plant has a greater influence on the flavor profile than the method of processing. Frozen samples and fresh basil had very similar flavor profiles with "mint", "sweet", "citrus", and "fresh" characteristics. Dried basil has less intensive aroma, with only "hay-like" odor increasing with the temperature treatment. The taste profile of *Freeze-dried* samples more similar to fresh and frozen samples; however, its aroma profile is more similar to dried samples. Employing *front-face*-fluorescence spectroscopy to fingerprint the samples proved to be a rapid and cost-effective technique that can either supplement or replace sensory analysis in quality control applications.

## ANTIOXIDANT ACTIVITY OF METHANOLIC EXTRACTS OF LOVAGE (*LEVISTICUM OFFICINALE* KOCH.)

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Oxidative stress induced by the excessive production of free radicals and reactive oxygen species is associated with many diseases. It is assumed that plant origin natural antioxidants might reduce adverse effects of oxidative stress, therefore they have been in the focus of many studies worldwide.

Lovage (*Levisticum officinale* Koch.) is an aromatic and medicinal herb possessing characteristic earthy, celery-like flavour. It is cultivated in many European countries and has been used for various applications such as perfumery, foods, medicines, and others.

The aim of this study was to evaluate antioxidant properties of methanolic extracts isolated from different anatomical parts of lovage. Methanolic extracts were prepared in the accelerated solvent extraction apparatus ASE-300 from the residues remaining after supercritical fluid extraction with carbon dioxide and accelerated solvent extraction with acetone of ground plant material by using 70 % concentration methanol as a solvent.

Antioxidant potential of methanolic extracts isolated from different lovage anatomical parts was studied by using different *in vitro* assays such as ABTS•+ (2,2'-azinobis-(3-ethylbenzothiazoline-6-sulfonic acid cation radical), DPPH• (2,2-diphenyl-1-picrylhydrazyl radical) radical scavenging, ORAC-Fluorescein (oxygen radical absorbance capacity), and total phenolic content measured by the Folin-Ciocalteu method.

It was determined that the highest radical scavenging capacity possessed lovage leave's extracts, for instance trolox equivalent antioxidant capacity measured by ABTS<sup>•+</sup> was 542 – 614 μmol Trolox g<sup>-1</sup> whereas in stem and root extracts it was approx. 3 and 8 times lower.

**Keywords:** lovage (*Levisticum officinale* Koch.), methanolic extracts, accelerated solvent extraction, antioxidant activity, total phenolic content.

## COMPARISON OF ANTICARCINOGEN CONTENTS IN CHOSEN CONVENTIONAL AND ORGANIC VEGETABLES

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Many studies led in recent years in Europe indicate that ecological vegetables may contain more of the valuable for human health bioactive compounds than those from conventional farms. It is also commonly stated that ecological food is of better quality than the conventional. Even the term “healthy food”, however questioned by the professional, shows the feelings of consumers and their expectations. Therefore, the aim of this work was the comparison of some natural, proved anticarcinogen contents in chosen vegetables being their good sources.

The compounds taken into consideration in the study were quercetin in yellow and red onion,  $\beta$ -carotene in carrot, lycopene in tomato, glucosinolates in broccoli, white cabbage and cauliflower, allicin derivatives in garlic,  $\alpha$ -tocopherol and tocopherol acetate in white cabbage, L-ascorbic acid in broccoli, calcium in white cabbage, and zinc and selenium in garlic. The samples were vegetables available for consumers on the Warsaw market at the time of analyses. The influence of tillage type (ecological, conventional) of investigative material was studied. Quantitative and qualitative analysis were executed with the help of standard chromatographic methods (GC-MS and HPLC-DAD).

Basing on the investigations performed it is not possible to affirm unambiguously, that the kind of tillage (ecological and conventional) has influenced in essential way and one-way the content of chemopreventers in studied vegetables available from ecological and conventional shops in Warsaw. Good sources of natural anticancerogens were among tomatoes, garlic, broccoli and cauliflower from ecological tillages, but white cabbage grown with conventional methods.

**Keywords:** ecological vegetables, chemoprevention, anticancerogens, carotenoids, vitamins, chromatographic methods

## THE CONTENT OF SELECTED BIOLOGICALLY ACTIVE COMPOUNDS IN FLAX SEEDS (*LINUM USITATISSIMUM* L.) AND ITS PRODUCTS

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The aim of the study was to perform the comparison of selected biologically active compounds content as well as antiradical activity of flax seeds extracts as well as flax seeds products (brown and golden flax seeds, defatted ground seeds, roasted flax and petals of flax).

The study presents the characteristics of basic chemical composition of flax seeds and its products including dry matter, total proteins, fat and ash contents. Soluble proteins were analysed by means of spectrophotometry at  $\lambda=750$  nm, available thiol groups content in a reaction with 2,2'-dithiobis (5-nitropyridin) at  $\lambda=386$  nm, total polyphenols with the Folin-Ciocalteu's reagent at  $\lambda=700$  nm and phytic acid at  $\lambda=510$  nm. Determinations of fatty acids profile using GC-MS method and the content of  $\gamma$ -tocopherol with the use of HPLC were also performed. Antioxidant activities of the investigated products' extracts toward DPPH• stable radicals were measured applying the spectrophotometric method ( $\lambda=517$  nm).

It has been proven that flax seeds and its products are a good source of minerals, protein and fat with dietary beneficial fatty acids composition. Unprocessed seeds and petals contained substantial quantities of  $\alpha$ -linolenic acid in the range 42-48%, while defatted and roasted flax seeds 60-69% of linoleic acid. The investigated products had a high content of phytic acid and available thiol groups. The content of  $\gamma$ -tocopherol in flax seeds and its products were highly dependent on fat content. Thereby, defatted flax showed significantly lower level of this compound (3.3 mg/100 g) in comparison with the other products (9.5 - 13 mg/100 g). Moreover, acetone extracts of the analyzed products were distinguished by a considerably higher capacity of radicals scavenging DPPH• than hexanoic and PBS buffer extracts.

**Keywords:** flax seeds, phytate, thiol groups,  $\gamma$ -tocopherol, fatty acids, antioxidant properties