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**Latvia University of Life Sciences and Technologies  
Faculty of Food Technology**

**FOODBALT 2023  
16th Baltic Conference  
on Food Science and Technology**

**“TRADITIONAL MEETS  
NON-TRADITIONAL IN FUTURE FOOD”**

**Abstract Book**

**Jelgava  
May 11–12, 2023**

# FOODBALT 2023

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# FOODBALT 2023

Dear participants,

Welcome to the sixteenth FOODBALT conference established by professor Petras Rimantas Venskutonis in 2006. Since then, it has been organized in Kaunas, Tallinn and Jelgava attracting researchers from many countries outside Baltics. We are glad that numerous PhD students take the chance to present their work along with established researchers.

In FOODBALT 2023, researchers from 11 countries will present their latest scientific achievements in 8 sessions, comprising three key lectures, 34 oral presentations and 68 pitch presentations. The main topics include: Trends and Innovations in Food Science and Technology; Valorisation of Co-products, Non-traditional Ingredients, and Food Waste; Consumer's Preferences and Food Choices; Challenges in Nutrition Science; and Other Topics of Food Science and Technology.

The abstracts submitted indicated that quality research in food science often requires a multidisciplinary team. Thus, many studies were completed by partners from various departments of the same institution, by partners from different research institutions of the same country, by multinational researcher teams and also in partnership with industry.

We believe that you will enjoy and have benefit from attending the 16th Baltic Conference on Food Science and Technology "TRADITIONAL MEETS NON-TRADITIONAL IN FUTURE FOOD" held in Jelgava on May 11th and 12th, 2023.

Dr.sc.ing. Martins Sabovics, Dean of the Faculty of Food Technology



# FOODBALT 2023

## FOODBALT 2023

### 16th Baltic Conference on Food Science and Technology “TRADITIONAL MEETS NON-TRADITIONAL IN FUTURE FOOD”

#### Programme

#### May 11, 2023

8<sup>30</sup>-9<sup>30</sup> Registration Hall of Aula, LBTU main building

9<sup>30</sup>-9<sup>45</sup> **OPENING** Rector of LBTU **Irina Pilvere**, Dean of the LBTU Faculty of Food Technology **Mārtiņš Šabovics**

#### Session I Room Aula, *LBTU main building*

**Moderators:** **Sirli Rosenvald**, Center of Food and Fermentation Technologies, Estonia  
**Mārtiņš Šabovics**, Latvia University of Life Sciences and Technologies, Latvia

9<sup>45</sup>-10<sup>25</sup> **KEY LECTURE Sirli Rosenvald**, *Center of Food and Fermentation Technologies, Estonia, The proteins of the future*

10<sup>25</sup>-10<sup>40</sup> **O1 – Ū. Luhila**, K. Laos, T. Paalme *Ice binding proteins from psychrophilic bacteria - characterization and applications in food*

10<sup>40</sup>-10<sup>55</sup> **O2 – M.-L. Tammik, K.-L. Vimm** *Gelling properties of proteins in meat analogs*

10<sup>55</sup>-11<sup>10</sup> **O3 – I. Rutka**, R. Galoburda, J. Galiņš, A. Galiņš *Bio-active compounds in bee drone larvae after freeze-drying*

11<sup>10</sup>-11<sup>25</sup> **O4 – E. Bartkiene**, V. Bartkevičs, A. Santini, V. Lele, V. Starkute, E. Zokaityte, D. Klupsaite, P. Zavistanaviciute, E. Tolpeznikaite, E. Mockus, E. Mozuriene, R. Ruijbs, D. Cernauskas, F. Özogul, R. P. F. Guiné, K. J. Domig, J. M. Rocha *Sourdough lactic acid bacteria – from food industry by-products and alternative food stock valorization to neurotransmitters production*

#### 11<sup>25</sup>-12<sup>00</sup> Pitch presentations

**P1 – A. Taivosalo**, I. Stulova, M.-L. Kütt, T. Kriščiunaite, T. Gimaeva, M. Tamm *Determination of potential allergenicity of commercially available whey protein hydrolysates with LC-MS*

**P2 – H. Saar**, K. Adra, T. Kriščiunaite, H. Vaikma *Rheological and sensory characterization of plant-based yoghurt analogues to describe the texture of products using instrumental parameters*

**P3 – A. Łobacz**, J. Kowalik, N. Wąsowska, J. Tarapata, J. Żulewska *Application of cricket flour in yoghurt production*

**P4 – A. Grava**, R. Galoburda, J. Zagorska *Potential of legumes in the development of plant-based yogurt*

**P5 – A. Kaleda**, K. Talvistu *Salt can improve fibrousness in extruded plant-based high-moisture meat analogs*

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- P6** – M. Darewicz, M. Pliszka, J. Borawska-Dziadkiewicz, A. Iwaniak, P. Minkiewicz *Oat kernel proteins as a source of antioxidant peptides*
- P7** – A. Iwaniak, M. Darewicz, M. Hryniewicz, P. Minkiewicz *Food-derived proteins as the sources of sensory peptides based on computer prediction*
- P8** – M. Alas, M. Kriisa *Fermentation of pea protein matrix for the development of plant-based cheese*

12<sup>00</sup>-12<sup>45</sup>LUNCH

## Parallel Session II Room 182, 1<sup>st</sup> floor, LBTU main building

Moderators: Laura Jūrienė, Kaunas University of Technology, Lithuania

Tatjana Ķince, Latvia University of Life Sciences and Technologies, Latvia

12<sup>45</sup>-13<sup>00</sup> **O5** – I. Jurevičiūtė, D. Leskauskaitė, M. Keršienė, V. Eisinaite *Effect of κ-carrageenan on the physical and rheological properties of heat-induced pea protein gels*

13<sup>00</sup>-13<sup>15</sup> **O6** – I. Lignicka, A. Graci, R. Galoburda *Physico-chemical and sensory properties of extruded breakfast cereals made of brown pea and oat*

13<sup>15</sup>-13<sup>30</sup> **O7** – K. Ozoliņa, S. Muižniece-Brasava *Legume consumption patterns, preferences, and prospects among the population in Latvia*

13<sup>30</sup>-13<sup>45</sup> **O8** – E. Andersone-Trēziņa, T. Ķince, L. Tomsone *Germination impact on phenolic content and antioxidant activity of beans*

13<sup>45</sup>-14<sup>15</sup> **Pitch presentations**

**P9** – J. Leveckytė, V. Kitrytė-Syrpa *Optimization of pressurized ethanol extraction of common dandelion (*Taraxacum officinale* L.) flowers*

**P10** – O. Šataitė, M. Pukalskienė, P. R. Venskutonis *Phenolic profile and antioxidant activity of honeysuckle (*Lonicera caerulea*) berry pomace*

**P11** – E. Juzėnaitė, M. Pukalskienė, R. Maždžierienė, P. R. Venskutonis *Pectin recovery from black currant pomace physio-chemical functional variations based on methyl-esterification*

**P12** – I. Pocevičienė, P. R. Venskutonis, L. Jūrienė, R. Baranauskienė *Characterization of mechanically fractionated black currant pomace and its supercritical CO<sub>2</sub> extraction products*

**P13** – L. Jūrienė, V. Morkūnienė, P. R. Venskutonis *Application of response surface methodology for the optimization of Pressurized liquid extraction of cherry pomace*

**P14** – R. Grabauskaitė, L. Jūrienė, R. Kazernavičiūtė, P. R. Venskutonis *Fractionation of berry seeds and pomace using green high-pressure extraction methods*

**P15** – J. Jovaišaitė, L. Jūrienė, A. Pukalskas, P. R. Venskutonis *Extraction of valuable lipophilic compounds from *Vincetoxicum* species*

**P16** – A. Petrikaityte, M. Pukalskienė, R. Kazernavičiūtė, P. R. Venskutonis *Optimizing the extraction of bioactive components from sea buckthorn (*Hippophae rhamnoides* L.) pomace and development of antioxidant-enriched mayonnaise*

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## Parallel Session III Room Silver Hall, *LBTU main building*

**Moderators:** Jonas Damašius, Kaunas University of Technology, Lithuania

Sandra Muižniece-Brasava, Latvia University of Life Sciences and Technologies, Latvia

12<sup>45</sup>-13<sup>00</sup> **O9** – R. Ruska, S. Muižniece-Brasava, S. Sazonova, L. Berga, I. Laukalēja-Broka, J. Ķīvīte *Packaging analysis for a sustainable future*

13<sup>00</sup>-13<sup>15</sup> **O10** – A. Taha, F. Casanova, A. Stirkė *Effects of pulsed electric field on the structural and emulsifying properties of dairy proteins*

13<sup>15</sup>-13<sup>30</sup> **O11** – K. Eryasar-Orer, E. B. Olutas, S. Karasu-Yalcin *Investigation of biosurfactant production of yeasts from food origin*

13<sup>30</sup>-13<sup>45</sup> **O12** – K. Kārklīņa, L. Ozola *Evaluation of pine cone syrups and changes of physical parameters during storage*

13<sup>45</sup>-14<sup>15</sup> **Pitch presentations**

**P17** – A. Jaruševičienė, J. Damašius *Morphology of different laminated biocomposites suitable for food packaging*

**P18** – R. Alksnis, I. Alsiņa, L. Dubova, T. Harbovska, M. Dūma *Non-destructive detection of tomato maturity*

**P19** – V. Kočetkovs, S. Sazonova, S. Muižniece-Brasava, J. Ķīvīte *Analysis of packaged egg product shelf life after opening*

**P20** – I. Bernāte, M. Šabovics *Effect of ozone on Enterobacteriaceae spp. in seeds of alfalfa, wheat grain and sprouts*

**P21** – D. Dagtė, R. Živirdauskienė, M. Keršienė *Effect of ozonation on shelf life of French dessert cannelés liquid dough*

**P22** – K. Laos, K. Eha *Effect of thermal treatment on the rheological properties of carrageenan gels*

**P23** – H. Lang, K. Saarniit, R. Kuldjärv *The effect of transition to a more energy-effective processing regime on the shelf-life of lingonberry-blueberry-rye puree*

**P24** – N. Konkubaeva, A. Kulmyrzaev, A. Deydiev, R. Galoburda *Determination of the shelf life of puffed wheat "badyrak vanilla" and "badyrak with whey"*

14<sup>15</sup>-14<sup>45</sup> **COFFEE BREAK HALL OF AULA**

## Key Lecture Room Aula, *LBTU main building*

14<sup>45</sup>-15<sup>25</sup> **KEY LECTURE.** Eystein Oveland, Institute of Marine Research, Norway, NMKL and validation of methods for food analysis – Examples from determination of vitamins using LC-MS/MS

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## Parallel Session IV Room 182, 1<sup>st</sup> floor, *LBTU main building*

**Moderators:** Eystein Oveland, Institute of Marine Research, Norway

Liene Ozola, Latvia University of Life Sciences and Technologies, Latvia

- 15<sup>30</sup>-15<sup>45</sup> **O13** – E. Pasečnaja, D. Začs *Method developement for the determination of per- and polyfluorinated compounds in food*
- 15<sup>45</sup>-16<sup>00</sup> **O14** – D. Fedorenko, M. Jansons, R. Pavļenko, Z. Bērziņa, V. Bartkevičs *The quantitative analysis of pyrrolizidine alkaloids in food products using Nanoflow liquid chromatography mass spectrometry*
- 16<sup>00</sup>-16<sup>15</sup> **O15** – D. Lazdiņa, I. Ciproviča, D. Segliņa *Japanese quince seed protein extraction using different defatting methods*
- 16<sup>15</sup>-16<sup>50</sup> **Pitch presentations**
- P25** – K. Eryasar-Orer, E. B. Olutas, S. Karasu-Yalcin *Influence of carbon sources on biosurfactant production by *Cyberlindnera fabianii**
- P26** – A. Arslan, E. Yalçın, D. Ermişer, A. Güneş *Protein and total starch contents of milling fractions of buckwheat grown in different locations of Türkiye*
- P27** – U. Krakauskaitė, M. Syrpas *Evaluation of colour stability of purified phycocyanin extracted from *arthrospira platensis* after complexation with food-grade polysaccharides*
- P28** – R. Ołędzki, T. Lisowska, A. Tiupova, M. Villanueva, J. Harasym *The change in antioxidant activity characteristics of buckwheat flour after microwave supported heat-moisture treatment*
- P29** – A. Zhogoleva, H Lang, S. Rosenvald *Key odour-active compounds in cooked salmon*
- P30** – G. Deveikaitė, R. Žvirdauskienė *Isolation and characterization of pigments from pigment-producing microorganisms extracted from environment and their antibacterial activity*
- P31** – R. Al Akiki Dit Al Mazraani, M. Syrpas *Pressurized liquid extraction of bioactive compounds from *Parmotrema perlatum*: Optimization and analysis*
- P32** – M. Dūma, I. Alsiņa, L. Dubova *Phytochemicals in tomatoes*

## Parallel Session V Room Silver Hall, *LBTU main building*

**Moderators:** Catia Martins, University of Aveiro, Portugal

Zanda Krūma, Latvia University of Life Sciences and Technologies, Latvia

- 15<sup>30</sup>-15<sup>45</sup> **O16** – K. Jakobson, A. Kaleda, T. Kriščiunaite *Does surface morphology of plant-based protein powders influence sensory perception?*
- 15<sup>45</sup>-16<sup>00</sup> **O17** – R. Ołędzki, J. Harasym *Effects of selected thermal treatments on the bioactive and textural properties in bell peppers*
- 16<sup>00</sup>-16<sup>15</sup> **O18** – A. Silva, C. Martins, S. M. Rocha *Can hop terpenic volatiles have impact on beer volatile profile?*

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## 16<sup>15</sup>-16<sup>50</sup> Pitch presentations

- P33 – A. Pisponen**, S. Taimalu, H. Andreson *The effect of the ratio of lactic acid bacteria and yeasts in kvass fermentation*
- P34 – R. Riekstiņa-Dolģe, Z. Krūma**, L. Tomsone *Effect of honey origin and yeast type on the bioactive compounds in mead*
- P35 – S. Ribeiro**, T. Tavares, I. Furtado, R. Silva, A. Rudnitskaya, F. S. S. Rogerson, F. Alves, S. M. Rocha *Mapping of volatile compounds from Port wine fortification spirits: A step forward on the route of sustained innovation*
- P36 – S. Puišele, I. Dabiņa-Bicka**, Z. Krūma *Production of spirit from Jerusalem artichokes*
- P37 – V. Minelgaitė**, M. Syrpas *Evaluation of physicochemical, phenolic profile and antioxidant capacity changes of kombucha during fermentation*
- P38 – J. Jagelavičiūtė**, D. Čižeikienė, L. Bašinskienė *Effect of cranberry pomace on smoothie properties for the development of functional beverage*
- P39 – V. Kreicbergs, M. Dūma**, B. Ozola, V. Miķelsone *Biologically active compounds in wild and cultivated cranberries and blueberries*
- P40 – L. Tomsone**, R. Galoburda, M. L. Ngouemazon *Texture evaluation of edible pearls filled with natural juice*

## 18<sup>30</sup> Departure for conference dinner

## 19<sup>00</sup>–22<sup>00</sup> CONFERENCE DINNER (departure to Jelgava at 22<sup>15</sup>)

## May 12, 2023

### Parallel Session VI Room 182, 1<sup>st</sup> floor, LBTU main building

Moderators: Carmela Lamacchia, University of Foggia, Italy

Evita Straumīte, Latvia University of Life Sciences and Technologies, Latvia

- 8<sup>30</sup>-8<sup>45</sup> **O19 – R. Mūrniece**, E. Stalidzāns, I. Dabiņa-Bicka, R. Galoburda, I. Cinkmanis, D. Kļava *Application of mathematical modelling as a tool in the use of rye malt to balance the quality of rye flour*
- 8<sup>45</sup>-9<sup>00</sup> **O20 – S. Reidzāne**, I. Grāmatiņa, R. Galoburda, V. Komašilovs, A. Zacepins, A. Bljahhina, T. Kince, A. Traksmāa, D. Kļava *Hull-less barley sourdough bread: Composition of polysaccharides and technological characteristics*
- 9<sup>00</sup>-9<sup>15</sup> **O21 – X. Suo**, L. Moriconi, L. Peverini, A. La Terza, E. Vittadini *Application of acorn flour in leavened bread products*
- 9<sup>15</sup>-9<sup>30</sup> **O22 – M. Chiodetti, E. Carini** *The effect of sorghum flour (Sorghum bicolor [L.] Moench) on bread staling: From macroscopic to molecular properties*
- 9<sup>30</sup>-9<sup>25</sup> **O23 – M. Chiodetti**, S. Monica, E. Bancalari, B. Bottari, E. Carini *Effect of selected lactic acid bacteria fermentation on sorghum techno-functional properties*

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- 9<sup>45</sup>-10<sup>00</sup> **O24** – **C. Lamacchia**, B. La Gatta, M. Rutigliano, F. Dilucia, M. T. Liberatore, R. Caporizzi *Effect of grape pomace powder on the fresh tagliatelle gluten network and sensory properties*
- 10<sup>00</sup>-10<sup>45</sup> **Pitch presentations**
- P41** – **A. Mariševa**, I. Beitāne *The study of technological properties of amaranth, amaranth-buckwheat, and amaranth-oat pasta*
- P42** – **T. Lisovska**, M. Villanueva, A. Orkusz, J. Harasym *High moisture microwave treatment modulates functional and pasting characteristics of buckwheat flour*
- P43** – **T. Lisovska**, M. Villanueva, F. Ronda, A. Orkusz, J. Harasym *High moisture microwave treatment modulates functional and pasting characteristics of teff flour*
- P44** – **M. Riškus**, J. Jagelavičiūtė, L. Bašinskienė *Protein enrichment of wheat bread using defatted hazelnut and walnut meal as by-products*
- P45** – **E. Straumīte**, I. Kņūtina *Evaluation of wheat bread quality with legumes blends*
- P46** – **F. Vurro**, C. Summo, G. Squeo, F. Caponio, A. Pasqualone *The use of durum wheat oil in the preparation of focaccia: tradition, innovation, and sustainability*
- P47** – I. Skrabule, L. Rābante-Hāne, I. Dimante, **I. Taškova**, S. Sviatchenko *The impacts of nitrogen use efficiency of potato genotypes on environmentally friendly raw material production for starch processing*
- P48** – **V. Šterna**, E. Sokolova, I. Taškova, I. Skrabule, I. Dimante *Potato cultivars with elevated protein content – promising source of novel food*
- P49** – **S. Sudheer**, S. Hussain, T. Heinsalu, R. Bhat *Valorisation of agro-industrial biomass for the cultivation of edible mushrooms*

## **Parallel Session VII Room Silver Hall, LBTU main building**

**Moderators:** **Ivi Jõudu**, Estonian University of Life Sciences, Tartu, Estonia

**Inga Šarenkova**, Latvia University of Life Sciences and Technologies, Latvia

- 8<sup>30</sup>-8<sup>45</sup> **O25** – **S. Sabuņeviča**, J. Zagorska *Organic milk as medium for lactic acid bacteria growth: A review*
- 8<sup>45</sup>-9<sup>00</sup> **O26** – **I. Jõudu**, A. Sats, T. Jairus *Composition, quality and valorisation possibilities of transition milk*
- 9<sup>00</sup>-9<sup>15</sup> **O27** – **M. P. Totaro**, G. Difonzo, F. Caponio, A. Pasqualone, C. Summo *Reformulation approaches to reduce the use of nitrates and nitrites in ripened sausages*
- 9<sup>15</sup>-9<sup>30</sup> **O28** – **S. Juchniewicz**, W. Kopec *Influence of ultrasound assisted extraction on the molecular, rheological and technological characteristics of actomyosin*
- 9<sup>30</sup>-9<sup>45</sup> **O29** – **L. Varnaitė-Kapočė**, V. Eisinaitė, D. Leskauskaitė *Characterization of different structured food-grade double-emulsion formulations*

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9<sup>45</sup>-10<sup>00</sup> **O30** – E. Aus, R. Kuldjārv, A. Meikas, H. Vaikma, M. Junusova *Chemical, metagenomic and sensory differences in kimchi fermented in industrial and laboratory scale*

## 10<sup>00</sup>-10<sup>45</sup> **Pitch presentations**

**P50** – J. Kowalik, A. Łobacz, J. Tarapata, J. Żulewska *Fermented dairy beverages of selected milk ingredients*

**P51** – I. Stulova, K. Adra, M.-L. Kutti, L. Kiiker *Effect of aging time on the rheological properties of the plant-based ice cream mix*

**P52** – V. Sarv, K. Kerner, P. R. Venskutonis, G. Rocchetti, P. P. Becchi, L. Lucini, A. Tānavots, R. Bhat *Evaluation of rowan fruit pomace ingredients in meatballs by conventional quality characterization and UHPLC-QTOF-MS based untargeted metabolomics with multivariate data analysis*

**P53** – K. Kerner, R. Kazernavičiūtė, I. Jöudu, A. Tānavots, P. R. Venskutonis *Effect of different blackcurrant seed ingredients on the quality of pork meatballs*

**P54** – K. M. Ruus, R. Kuldjārv, H. Vaikma *A study to find a possibility to soften bones of Baltic herring and Baltic sprat with acetic acid and hydrochloric acid*

**P55** – D. Nurvafayeva, D. Berdiyeva, R. Tashmanov, S. Ishniyazova, N. Muminov, Z. Saidmuradova, A. Tursunov *Study of the use of apple pomace as food supplement*

**P56** – C. P. Costa, S. Patinha, A. Rudnitskaya, S. A. O. Santos, A. J. D. Silvestre, S. M. Rocha *Sustainable valorization of Sambucus nigra L. berries: From crop biodiversity to nutritional value*

**P57** – D. Malenica, L. S. Maciel, K. Herodes, M. Kass, R. Bhat *Sustainable utilization of apple pomace and oat bran pomace for development of livestock feed*

**P58** – K. Safarov, O. Achilov, U. Karshiev, S. Nasimov *Influence of probiotic preparation on meat productivity and meat quality of broiler chickens and rabbits*

## 10<sup>45</sup>-11<sup>15</sup> **COFFEE BREAK HALL OF AULA**

### **Session VIII**                      **Room 182, 1<sup>st</sup> floor, LBTU main building**

**Moderators:** Tetiana Lisovska, Wrocław University of Economics and Business, Poland  
Ilze Laukalēja-Broka, Latvia University of Life Sciences and Technologies, Latvia

11<sup>15</sup>-11<sup>55</sup> **KEY LECTURE** Andrejs Ērglis, *Institute of Cardiology and Regenerative Medicine, University of Latvia, Latvia, Food, health, technology transfer and science*

11<sup>55</sup>-12<sup>10</sup> **O31** – A. Beluško, L. Aumeistare, K. Majore, I. Ciproviča *Bioactive compounds in human milk of mothers living in Latvia*

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- 12<sup>10</sup>-12<sup>25</sup> **O32** – **S. Aleksejeva**, A. Krasikova, I. Ciproviča, L. Meija *Effect of buttermilk polar lipids on plasma lipid profile: A pilot study*
- 12<sup>25</sup>-12<sup>40</sup> **O33** – **R. Kuldjārv**, A. Jagomāe, L. Kiiker, A. Jõelegt, S. Pihelgas *Dietary intervention study conducted with fiber rich functional and sustainable smoothie made using leftover apple pomace from apple cider industry*
- 12<sup>40</sup>-12<sup>55</sup> **O34** – **L. Zemļicka**, E. Straumīte *A review – Quantitative and qualitative indicators of factors affecting the sensory perception of coffee*
- 12<sup>55</sup>-13<sup>45</sup> **Pitch presentations**
- P59** – R. P. F. Guiné, **D. Kļava**, Z. Krūma, E. Straumīte, S. G. Florença, O. Anjos, I. Djekic, C. Chuck-Hernández, M. Matek Sarić, E. Bartkiene, N. M. Boustani, M. Papageorgiou, J. M. F. Baro, M. Korzeniowska, M. Černelič-Bizjak, M. Tarcea, E. Damarli, V. Ferreira *Consumer perception about edible insects' relation with environment and sustainability*
- P60** – **M. N. G. Ibrahim**, A. Aav, I. Jõudu *The prospective effect of pure α-amylase utilization in the production of functional high quality oat drinks*
- P61** – **J. Grinberga**, I. Beitāne *Alternatives to fructose for the development of products for patients with diabetes*
- P62** – **L. Plociņa**, I. Beitane *The importance of fatty acids in mental health*
- P63** – **L. Jansone**, Z. Krūma, E. Straumīte, S. Kampuse *Dehydrated sauerkraut juice as a salt alternative in food*
- P64** – **S. Īriste**, B. Batare, G. Krūmiņa-Zemture, I. Beitāne, S. Sazonova *Hygienic assessment of sanitary facilities in catering establishments*
- P65** – **K. Jusys**, I. Jurevičiūtē, V. Eisinaitē, D. Leskauskaitē, A. Šipailienē *Influence of sea buckthorn pomace (*Hippophae rhamnoides* L.) on the functional properties of surimi*
- P66** – **R. Riekstiņa-Dolģe**, M. Eglīte, G. Krūmiņa-Zemture *The issues faced by school meal providers*
- P67** – **V. Yevlash**, N. Murlykina, O. Aksonova, S. Gubsky *Capabilities of wild plant *Salicornia europaea* application in food technologies*
- P68** – **L. Huseynli**, C. Hald, C. Dawid, K. Vene *Identification of bitter off-taste compounds in sunflower press cake using sensomics approach*

## 13<sup>45</sup>-14<sup>00</sup> CLOSING OF CONFERENCE

**SESSION I**  
**PROTEINS: NEW SOURCES AND**  
**NON-TRADITIONAL APPLICATIONS**

## THE PROTEINS OF THE FUTURE

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Animal protein production is inefficient and with a large environmental footprint which results in a need to find alternative sources of protein to feed the growing population by satisfying the craving for meat while keeping in mind the environmental impact and economical feasibility. There are multiple approaches that are developed in parallel, each of them with its own strengths and limitations. Plant-based proteins are prominent in market readiness but there are still drawbacks to consumer acceptance regarding the taste and nutritional aspects. There is a constant look for different new plants that could be used for protein production and would bring some beneficial economic or techno-functional properties. Also, the circular economy approach and exploitation of different leftovers and sidestreams for protein production are of high interest. The highest investments are going to the cultured meat developments which are struggling with economics, scalability, and legislative aspects. Now, when the use of specific insects is allowed also in Europe the developments in this field are also continuing. Finally, fermentation as a promising technology either as precision fermentation or single-cell proteins is getting its momentum and is being seen as one of the possibilities to also address food security and land use limitations. The fermentation-derived protein market is being expected to achieve the fastest growth rates in the alternative protein space. There are also social aspects like consumer acceptance influencing the uptake of any new technology and despite the technological advancements that will affect the success of any of the solutions.

**Keywords:** alternative proteins, fermentation, plant-based, cultured meat, insects

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## ICE BINDING PROTEINS FROM PSYCHROPHILIC BACTERIA: CHARACTERIZATION AND APPLICATIONS IN FOOD

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Ice-binding proteins (IBPs) are polypeptides produced by organisms living in cold environments to prevent ice crystal growth or recrystallization. Several food-spoiling microbes can grow at refrigerator temperatures (2–6 °C), therefore temperatures close to or below zero are preferred for long-time storage. However, decreasing the temperature to the melting point is challenging as it might cause freezing damage due to time-spatial temperature fluctuations.

A solution to the problems related to ice formation in chilled and frozen products might be the addition of IBPs. Our collaboration partner has recently screened 60 psychrophilic bacterial cultures, isolated and found a strain (*Pseudomonas fluorescens*) capable of secreting IBPs. The main goal is to investigate the potential of using *Pseudomonas fluorescens* IBPs to improve frozen foods' quality and storage time. For that purpose, the growth and excretion of IBPs by the respective strain of *Pseudomonas* are characterized, the protein is isolated, its DNA and protein sequence are established, and the mechanisms of action in food storage conditions are evaluated.

Preliminary experiments have shown that the protein is stable at various temperatures and in the neutral pH range. The strain requires organic nitrogen to produce IBPs and the addition of L-asparagine or L-proline to the culture broth appears to have a positive effect on the production of IBPs. The incorporation of *Pseudomonas fluorescens* culture broth containing IBPs improved the quality of frozen wheat dough stored at –20 °C for eight weeks. It exhibited higher yeast survival rates and better yeast vitality. Additionally, the bread prepared from the frozen dough had better specific volume, porosity, and softness. Although additional experiments should be conducted, this shows that the protein has the potential to be used to improve the quality of frozen dough products.

**Keywords:** ice-binding proteins, frozen storage, ice recrystallization inhibition, frozen dough

**Acknowledgments.** This study was supported by RESTA 12.

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## GELLING PROPERTIES OF PROTEINS IN MEAT ANALOGUES

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Plant-based meat alternatives have gained significant attention in recent years as a sustainable and healthy alternative to traditional meat products. Plant proteins are the main component of meat alternatives because of their functional properties, mainly gelling ability. One of the biggest challenges with meat analogues is that the texture changes dramatically during cooling, including the juiciness and cohesiveness of the product. Recently, various new protein isolates have reached commercialization, thus functional properties of these proteins in plant-based burger were studied.

Texture Profile Analysis (TPA) and Sensory Analysis with trained panel of nine assessors were conducted. Soy, rapeseed, potato, yeast, and egg white protein was studied and compared to a reference burger patty to investigate the influence of gelling properties on the sensory attributes.

Our study demonstrated that results between TPA and sensory assessment coincided in several measured attributes. Hardness, springiness, and chewiness were measured the highest in samples with egg white, potato, and soy protein. Sensory analysis indicated that, compared to a reference sample, potato and egg white protein had the greatest effect on springiness, hardness, and cohesiveness, simultaneously reducing the moistureness of the burger patty. Overall, the plant protein powders had mainly a positive effect on the texture of the plant-based burger patty by increasing the juiciness and cohesiveness.

**Keywords:** meat analogues, gelling, sensory analysis, texture profile analysis, plant proteins

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## BIO-ACTIVE COMPOUNDS IN BEE DRONE LARVAE AFTER FREEZE-DRYING

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In biological beekeeping, an actual problem is limiting the spread of *Varroa* mite without using harmful chemicals. Removing bee drone larvae from the hive can significantly reduce the spread of *Varroa* mite in the bee colony. In recent years, bee drone larvae, as a beekeeping by-product, have been increasingly studied as an alternative protein source, but relatively little research has been done on the vitamins, hormones and other important bioactive compounds found in product, and the available information is often questionable. Drone larvae were freeze-dried to preserve biologically active substances. The aim of the study was to determine the content of vitamins, prohormones and 10-hydroxy-2-decenoic acid (10-HDA) in the samples of bee drone larvae. Drone larvae contained large amounts of water-soluble B-group vitamins, such as thiamine (B1), riboflavin (B2), niacin (B3), choline (B4), and pantothenic acid (B5). Ascorbic acid (C) and prohormones were also found. The 10-hydroxy-2-decenoic acid (10-HDA) was not found in bee drone larvae because the larvae were separated from their cells during collection and not squeezed out in the liquid form thus the admixture of royal jelly in the larval samples was negligible.

**Keywords:** brood homogenate, bee pupae, Apilarnil, honeybee products

**Acknowledgments.** This research was funded by Latvia University of Life Sciences and Technologies (LBTU). Project name: Processing of bee brood homogenate (Z51).

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## SOURDOUGH LACTIC ACID BACTERIA – FROM FOOD INDUSTRY BY-PRODUCTS AND ALTERNATIVE FOOD STOCK VALORIZATION TO NEUROTRANSMITTERS PRODUCTION

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Sourdough is a complex ecosystem, where lactic acid bacteria (LAB) and yeasts are dominant organisms. LAB isolated from sourdough can be employed as a biotechnological starters to improve the safety and functionality of food and feed, to provide added value and to increase safety of food industry by-products, to design synthesis of functional molecules in fermentable substrates, and to moderate the technologies for safer alternative stock (*e.g.*, insect flour) incorporation to the main food (*e.g.*, bread) formulas. Sourdough contains a wide range of LAB, which metabolic activity strongly affects the characteristics of the fermentable substrates. The addition of starter cultures under controlled conditions is a highly prospective technology for sustainable feed preparation. Metabolites of the LAB as well as viable LAB cells in fermented feed material leads to desirable changes in animal microbiota, better health and production quality. Additionally, the high-functionality fermented feed can be produced by applying sourdough LAB for the food industry by-product valorization. Also, fermentation with sourdough LAB greatly contribute not only to the flavour, aroma, and texture of the final product but also to functional molecules synthesis, *e.g.*, galactooligosaccharides can be synthesized from the dairy industry by-products containing lactose; gamma-aminobutyric acid can be produced from the substrates containing L-glutamic acid (*e.g.*, Spirulina). This type of bioconversion is a very promising technology for food and nutraceutical production. Finally, our works showed, that sourdough LAB application in industry is extremely broad: from food industry by-products and alternative food stock valorization to neurotransmitter production.

**Keywords:** lactic acid bacteria, by-products, fermentation, functional molecules, safety

**Acknowledgements:** The authors gratefully acknowledge COST Action 18101 SOURDOMICS—Sourdough biotechnology network towards novel, healthier and sustainable food and bioprocesses (<https://sourdomics.com/>; <https://www.cost.eu/actions/CA18101/>), and is supported by COST (European Cooperation in Science and Technology) (<https://www.cost.eu/>). COST is a funding agency for research and innovation networks.

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## DETERMINATION OF POTENTIAL ALLERGENICITY OF COMMERCIALY AVAILABLE WHEY PROTEIN HYDROLYSATES WITH LC-MS

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Hypoallergenic formulas containing hydrolyzed protein are intended for use by infants to prevent cow's milk protein allergy. The degree of hydrolysis of epitopic areas determines the residual allergenicity of whey protein hydrolysates (WPH). However, only amino acid-based infant formulas (IF) are considered entirely nonallergenic. The aim of this study was to investigate four commercially available WPH with different degree of hydrolysis (H1–H4) for potential allergenicity applying liquid chromatography mass-spectrometry (LC-MS) analysis of water-soluble peptides. Additionally, the molecular weight distribution of proteins and peptides in WPH was measured by size-exclusion ultra-performance liquid chromatography (SE-UPLC). Based on the peptide coverage and peptide-length distribution profiles, WPH showed different extent of hydrolysis: extensively (H1 and H2), partially (H3), and slightly hydrolyzed WPH (H4). Altogether, numerous peptides related to 44 specific IgE-binding epitopes from  $\beta$ -lactoglobulin and 2 – from  $\alpha$ -lactalbumin were found in all WPH regardless of their extent of hydrolysis. Sequence-based identification of specific peptide composition is a reliable method to detect IgE-binding epitopes, which aids to discover the allergenicity of protein hydrolysates in IF.

**Keywords:**  $\beta$ -lactoglobulin; cow's milk allergy; IgE-binding epitopes; peptidomics; whey hydrolysate

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## RHEOLOGICAL AND SENSORY CHARACTERIZATION OF PLANT-BASED YOGHURT ANALOGUES TO DESCRIBE THE TEXTURE OF PRODUCTS USING INSTRUMENTAL PARAMETERS

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In this work, the textural properties of commercial yoghurt analogues were described through rheological measurements and sensory evaluation. The aim was to find the rheological parameters that describe the specific characteristics of products and to correlate them with sensory parameters such as sliminess, creaminess, wateriness, etc.

From the rheological measurements of the yoghurt analogues, certain characteristics emerged that could describe the positive and negative attributes of the samples. Viscosity and flow curves revealed that the curves of negative reference samples (products described as "slimy") were less dependent on shear rates. Based on the data of the flow curves and the results obtained from the amplitude test, the samples described as "slimy" start to flow first. Samples with undesirable textural properties were weaker and less deformable. The frequency sweep test distinguished the samples with negative and positive characteristics the best showing that the "slimy" samples had a higher slope of  $G'$  vs. frequency and a smaller  $G''/G'$  ratio in the entire frequency range, also indicating instability and the possibility for syneresis.

This preliminary study showed the potential to distinguish yoghurt analogues with certain textural attributes by using rheological measurements. Based on the given results, it could be possible to characterize various texturizing ingredients in the development of prototype products with desired sensorial properties using instrumental analysis.

**Keywords:** rheology, plant-based, texture, sensory analysis

**Acknowledgements.** This study is supported by ERDF and Estonian Research Council via project RESTA16.

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## APPLICATION OF CRICKET FLOUR IN YOGHURT PRODUCTION

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Despite the high nutritional value of edible insects and the growing interest in using them as food, the consumption of food with edible insects in Europe is still low. In the present study, the possibility of using cricket flour in yoghurt production was investigated. A basic physico-chemical analysis of the yoghurts was carried out, during which the pH, titratable acidity and whey syneresis were determined. To determine the microflora of the yoghurts, a microbiological analysis was performed using the traditional plate method. A sensory analysis (appearance, odour, consistency, flavor, general assessment) was also carried out, during which the necessity of flavour additives in the yoghurts was investigated and their quantity determined. On the basis of the analyses, it was found that the yoghurts with cricket flour had an adequate pH value, as well as acceptable titratable acidity. However, the addition affected the syneresis, increasing the amount of whey separated. The results of microbiological analyses showed that the microbiological quality of the yoghurts tested was satisfactory, but the predominance of *Streptococcus salivarius* ssp. *thermophilus* bacteria, was noted. Sensory tests showed the need for fruit additives to mask the intense taste and smell of crickets. Yoghurt with 1% cricket flour and 25% fruit additives (berry and strawberry flavour) received the highest sensory rating.

**Keywords:** edible insects, yogurt, sensory evaluation

**Acknowledgments.** Project financially supported by Minister of Education and Science in the range of the program entitled "Regional Initiative of Excellence" for the years 2019-2023, Project No. 010/RID/2018/19, amount of funding 12.000.000 PLN.

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## POTENTIAL OF LEGUMES IN THE DEVELOPMENT OF PLANT-BASED YOGURT

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The main challenges faced in the production of animal origin alternative products using legumes are the bitter taste and aroma of legumes, as well as the presence of anti-nutrients. In order to reduce taste of legumes and improve the nutritional and biological value of the products, fermentation may be applied as the solution. The development of lactic acid bacteria in a legume-based substrate and its effect on the quality of fermented products is insufficiently studied and practically not represented in Europe. Therefore, the aim of the study was to develop a plant-based yogurt. For the plant-based yogurt development yellow pea protein concentrate (ALOJA – STARKELSEN, Latvia) and isolate (ASNS, Latvia), brown pea, green pea and fava bean concentrates (ALOJA – STARKELSEN, Latvia), two starters – VEGE033 (DANISCO, Denmark) and YoFlex (Chr. Hansen Holding, Denmark), sugar (concentration in a product: 0, 1, 2, 3, 4, 5 %), potato starch (ALOJA – STARKELSEN, Latvia) were used. Fermentation was carried out at  $38 \pm 1$  °C till the pH reached  $4.5 \pm 0.1$ . Lactic acid bacteria count in all samples were more than  $10^7$  CFU mL<sup>-1</sup>. Regards the texture, the least gel like structure was observed for the alterative yogurt from fava bean protein concentrate, whereas the structure of other samples did not differ significantly. The yogurt viscosity decreased after fermentation compared to drink from legume concentrate/isolate before fermentation, which could be due to breakdown of starch inducted by lactic acid bacteria. Considering the organoleptic properties, the yogurt from pea protein isolate had the best taste and flavour.

**Keywords:** legumes, yogurt, plant-based, fermentation

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## SALT CAN IMPROVE FIBROUSNESS IN EXTRUDED PLANT-BASED HIGH-MOISTURE MEAT ANALOGS

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High-moisture meat analogs (HMMA) are typically produced from plant-based proteins using an extruder equipped with a long cooling die. Inside the extruder, protein powders are mixed with water, heated up to 160 °C, and the screws push the melted material into the die. The solidifying material inside the die stretches into long fibers that resemble meat. To better imitate meat fibrousness, the recipe and extrusion conditions must be optimized.

We developed three HMMA recipes based on combinations of proteins from (A) soy and wheat, (B) soy, wheat, and pea, and (C) wheat and pea. Extrusion conditions were optimized for each recipe. First, one HMMA was produced with tap water, then water was switched to a 1.5% sea salt solution. The changes were assessed visually by cutting the samples in half and using the texture profile analysis (TPA).

The texture of HMMAs with salt was less uniform and had fibers and layers that separated more easily thus enhancing similarity to cooked meat. However, the effect depended on the recipe. Sample C became the most fibrous, while sample B improved only slightly. TPA showed that samples A and C became softer and less chewy with salt, in contrast, sample B became significantly harder. To counter the loss of mechanical strength, 0.6% of KOH was added to sample C to increase pH. This significantly improved its mechanical strength while preserving some of its fibrousness.

Thus, the incorporation of salt can be a simple and cost-effective way of improving the fibrousness of HMMAs.

**Keywords:** meat analog, plant proteins, high-moisture extrusion, texture, fibrousness

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## OAT KERNEL PROTEINS AS A SOURCE OF ANTIOXIDANT PEPTIDES

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Oat proteins are considered as a reservoir of peptides with biological activities, including antioxidant peptides. Oat (*Avena sativa* L.) kernels are characterized by a high content of nutrients, such as proteins, fats, vitamins, and minerals. Our initial studies relying on the *ex vivo* hydrolysis of oat kernel proteins revealed the potential of these proteins as precursors of bioactive peptides. In this study oat kernel proteins were examined for their antioxidant activity via *in vitro* digestion. *In silico* part of the study was carried out using computation tools available in UniProt (<https://www.uniprot.org/>), BIOPEP-UWM (<http://www.uwm.edu.pl/biochemia/>), and METLIN (<https://metlin.scripps.edu/>) databases as well as Fragment Ion Calculator. According to INFOGEST method, the *in vitro* digestion procedure included the following steps: "oral" – 2 min, "gastric" – 2 hours, pH 3.0, "intestinal" – 2 hours, pH 7.0. Then, digests were analysed for their antioxidant activity. Next, they were used in a screening for antioxidant peptides. Based on the *in silico* systematic screening for antioxidant peptides, the amino acid sequences of biopeptides were identified in digests using LC-Q-TOF-MS/MS method. Digests of oat kernel proteins showed antioxidant activity. The intestine digest demonstrated the highest degree of antioxidant activity (ABTS = 96.27%; DPPH = 35.70%; FRAP = 23.02  $\mu\text{M}$  Trolox  $\text{mg}^{-1}$  of sample). The antioxidant fragments (i.e. Pro-Trp, Val-Trp), selected based on the results of *in silico* studies, were identified in the digests. According to our results, it can be concluded that oat kernel proteins are the source of peptides with antioxidative activity.

**Keywords:** antioxidant peptides, BIOPEP-UWM database, digestion, oat proteins

**Acknowledgments.** This study was funded by the National Science Centre, Poland (Project 2018/31/N/NZ9/01280) and supported by Minister of Education and Science in the range of the program entitled "Regional Initiative of Excellence" for the years 2019-2023, Project No. 010/RID/2018/19, amount of funding 12,000,000 PLN.

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## FOOD-DERIVED PROTEINS AS THE SOURCE OF SENSORY PEPTIDES BASED ON COMPUTER PREDICTION

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Hydrolysis of food proteins contributes to the release of biologically and functionally active peptides, including sensory (tastant) sequences. The latter are considered by consumers as undesired, especially when thinking about protein hydrolysates being the components of e.g. functional food. The aim of the study was the computer analysis of food-derived protein sequences being potential source of tastant peptides. Analyses included the following steps: elaboration of the profiles of potential sensory activity of proteins as well as the computer simulation of hydrolysis of proteins to generate tastant/bioactive peptides. The selected plant and animal protein sequences (derived from oil and leguminous plants, crops, milk, fish, and meat) were taken for the bioinformatic analysis using the sub-database of sensory peptides and amino acids – BIOPEP-UWM available at: <https://biochemia.uwm.edu.pl/biopep-uwm> [as of February 2023]. The profile of potential sensory activity of protein was defined as the location and type of sensory peptide(s) in a protein chain. The computer simulation of hydrolysis of proteins was performed using endopeptidases acquired from BIOPEP-UWM database. The results revealed that majority of peptides located in protein sequences were bitter. Moreover, the largest number of bitter peptides was present in milk and carp proteins (caseins and myosin, respectively). Ficin and papain potentially released the largest number of tastant peptides from all proteins analyzed. Some peptide tastants revealed biological potential as the dietary components supporting the metabolic syndrome prophylaxis. Our studies confirmed the suitability of selected bioinformatic tools in studying the proteins as the food components being the source of tastant/bioactive peptides.

**Keywords:** BIOPEP-UWM database, sensory peptides, food proteins, hydrolysis

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## FERMENTATION OF PEA PROTEIN MATRIX FOR THE DEVELOPMENT OF PLANT-BASED CHEESE

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Development of plant-based cheese alternatives is challenging due to the differences between animal and plant-based ingredients such as proteins and fats. Most of the commercial plant-based cheeses are mainly coconut-oil and starch based and the rest of them are nut and soy based, which are common allergens. A good alternative to nuts and soy are peas which have a high protein content and thus high biological value. Unfortunately, peas have distinctive off-flavours and aromas. Some techniques, such as fermentation with lactic acid bacteria have potential to reduce off-flavours and produce important aromatic and flavour compounds.

The aim of this study was to evaluate the technological and sensory potential of starter and protective cultures for the fermentation of pea protein mixtures. Commercial starter cultures were evaluated individually as well as in combination with protective cultures. In addition to the sensory evaluation (quantitative descriptive analysis), the aroma compounds (by GS-MS) as well as organic acids (by HPLC) and free amino acids (by UPLC) were determined. The aroma profile and sensory characteristics of the plant-based cheese products depend on the bacterial composition of the starter cultures. The results of free amino acids showed that samples with mesophilic cultures had higher glutamic acid content, which was associated with umami taste. More cheesy and buttery compounds were detected in the plant-based mixtures with selected thermophilic cultures. Combination of thermophilic cultures with protective cultures increased all levels of cheesy and buttery compounds like acetoin, diacetyl and 3-methylbutanoic acid.

**Keywords:** plant-based protein, fermentation, starter cultures, GS-MS

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**SESSION II  
APPLICATIONS OF LEGUMES;  
RECOVERY OF BIOACTIVE  
COMPOUNDS**

# FOODBALT 2023

## EFFECT OF $\kappa$ -CARRAGEENAN ON THE PHYSICAL AND RHEOLOGICAL PROPERTIES OF HEAT-INDUCED PEA PROTEIN GELS

**Ieva Jureviciute, Daiva Leskauskaitė, Milda Kersienė, Viktorija Eisinaite**

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This study aimed to investigate the physical and rheological properties of heat-induced pea protein hydrogels modified with different concentrations (0–0.6%) of anionic polysaccharide  $\kappa$ -carrageenan ( $\kappa$ -CR). Gelation of pea proteins in pea protein /  $\kappa$ -CR mixed gels was controlled by using different heat treatments at 80 °C and 95 °C. Gelation process was traced rheologically measuring the storage modulus  $G'$  and loss modulus  $G''$  during heating-cooling cycles. The results revealed that at the end of the cycle, compared to control samples that did not contain  $\kappa$ -CR, storage modulus of the gel containing 0.6%  $\kappa$ -CR increased approximately 50 and 150 times for gels heated at 80 and 95 °C, respectively. Furthermore, gel firmness study revealed that the addition of polysaccharide increased the firmness of pea protein gels from 0.08 N (in samples without  $\kappa$ -CR) to approximately 2 N (in gels containing 0.6 %  $\kappa$ -CR). Even at small concentration (0.2%),  $\kappa$ -CR was effective in increasing water-holding capacity of pea protein gels to higher than 90 %. Taken together, these findings demonstrate that  $\kappa$ -carrageenan is effective in improving the properties of pea protein gel.

**Keywords:** pea protein,  $\kappa$ -carrageenan, gelation, rheology, water-holding capacity

**Acknowledgments.** This study was supported by Kaunas University of Technology.

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## PHYSICO-CHEMICAL AND SENSORY PROPERTIES OF EXTRUDED BREAKFAST CEREALS MADE OF BROWN PEA AND OAT

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Due to the nutritional and sustainability benefits, there is a growing demand for legume products; one of the ways to increase product variety is to use them in different ready-to-eat products. Higher protein and lower starch content in legumes compared to cereals typically used in extruded products may have an impact on physico-chemical properties of the final product. Besides, legumes have specific bitter and green flavour, which affects the overall liking of the product. The specific flavour can be decreased using additional ingredients and/or different technological processes. This study investigated impact of brown pea and oat flour proportion, additional ingredient, and technological process on the extruded ring and pillow physico-chemical and sensory properties. Results showed that breakfast cereal type, ingredient content and processing method did not have a high impact on product bulk density, expansion ratio, water solubility index, and colour. Extruded pillows had higher moisture content and higher water activity than extruded rings. Products with less brown pea had higher crunchiness, lower hardness, and lower water absorption index. Sensory evaluation showed that panellists preferred extruded pillows due to their texture. However, extruded rings received higher overall liking. Greeny and bitter aftertaste was more noticeable for samples without sugar, yet it did not affect overall liking significantly. It can be seen that brown pea has the potential to be used as a raw material in different breakfast cereal production. However, further studies on improving product physico-chemical and sensory properties should be made by adjusting product recipes and selecting a proper technological process.

**Keywords:** twin-screw extrusion, breakfast cereals, brown pea, oat

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## LEGUME CONSUMPTION PATTERNS, PREFERENCES, AND PROSPECTS AMONG THE POPULATION IN LATVIA

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In the last decades, the demand for plant-based proteins has increased rapidly because of the limited supply of animal protein and its rising cost, as well as increased awareness of the impact of animal consumption on the loss of biodiversity, climate change, and freshwater depletion. The study analyzed legume consumption patterns in Latvia by investigating consumer perceptions, knowledge, and intentions to change their consumption practices of legumes. The study "Legume consumption patterns in Latvia" was carried out among 776 respondents, 89% of whom were women and 11% men. The average age of the participants was 46.3 years. Latvian consumers recognized that the inclusion of legumes in restaurant menus has a positive effect on the environment (63%) and allows them to eat healthier (91%). The inclusion of legumes in the diet is most influenced by taste, quality and known origin. Among the respondents, the choice of legume consumption is uniform. 66% of respondents regularly consume canned legumes. On the other hand, semi-finished legume products are regularly chosen by only 17%. In terms of increasing the consumption of legumes, there are still significant barriers related to insufficient awareness of the possibilities of legume use. It is essential to diversify the availability of legumes to increase their consumption. Respondents indicated allergic reactions after consuming legumes, which can be reduced by diversifying their processing. Consumption of legumes in Latvia is not optimal. A large number of consumers consume canned pulses. Measures like educating consumers on the possibilities of using legumes and diversifying the availability of legumes may potentially increase legume consumption in Latvia.

**Keywords:** consumption of legumes, practice, preferences

**Acknowledgments.** This research was funded by the project "Develop in the food market competitive creams from roasted legumes, by applying appropriate packaging, which would be able to ensure a longer storage period, without applying special storage conditions, while maintaining its sensory and physical properties." project N° VP-V-2022/77

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## GERMINATION IMPACT ON PHENOLIC CONTENT AND ANTIOXIDANT ACTIVITY OF BEANS

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Pulses are an excellent alternative to animal protein in human diet. Whole bean seeds have complex chemical structure with wide range of bioactive constituents, e.g., phenolic compounds with well-known antioxidative properties. Germination is a low-cost and widely used bio-process method that can cause increases in phenolic compound amount and antioxidant activity. The aim of the current study was to estimate the impact of germination conditions (time and temperature) on the content of total phenolic compounds (TPC) and antioxidant activity (DPPH\*, reducing power) of four colorful (red and orange pinto beans, barlotti beans in cranberry red and one white common bean variety) *Phaseolous vulgaris*, harvested in year 2022 in Latvia. White common beans from the local market as a control sample were analysed. Pulse grains were sorted and soaked in tap water (ratio 1:5) for  $12 \pm 1$  h at  $22 \pm 2$  °C. After soaking, beans germination was performed at 24 and  $48 \pm 1$  h in the dark at  $20 \pm 1$  °C and  $25 \pm 1$  °C,  $80 \pm 2\%$  relative air humidity; the total phenolic content and antioxidant activity have been determined using standard methods. The results of the current research showed a significant impact of germination time and germination temperature on the antioxidant activity of phenolic compounds in analysed bean samples.

**Keywords:** pulse grains, varieties, bioactive compounds

**Acknowledgments.** This research was supported by the framework of the project 'Legumes as alternative for extruded pasta obtaining' funded and implemented by the program "Strengthening of scientific capacity at LBTU".

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## OPTIMIZATION OF PRESSURIZED ETHANOL EXTRACTION OF COMMON DANDELION (*TARAXACUM OFFICINALE* L.) FLOWERS

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Common dandelion (*Taraxacum officinale* L.) has been traditionally used for various medicinal purposes, including as a natural diuretic, to support liver function, and to treat digestive problems. *T. officinale* flowers is of particular interest, since those contain a variety of biologically active compounds, such as flavonoids, phenolic acids, sesquiterpene lactones, and polysaccharides, exerting strong anti-inflammatory, antioxidant, and anti-cancer properties.

The purpose of this study was to obtain valuable antioxidant constituent-rich fractions from *T. officinale* flowers by pressurized ethanol extraction (PLE-EtOH). Central composite design and response surface methodology were employed to investigate the effect of selected PLE-EtOH parameters (temperature, extraction time per one cycle and number of cycles) on PLE-EtOH yield, *in vitro* antioxidant activity, total flavonoid, and  $\beta$ -carotene content. From 12.8 to 29.8 g 100 g<sup>-1</sup> of polar fraction was obtained within the selected PLE-EtOH operability region (40–80 °C, 5–15 min per cycle, 1–3 cycles). The produced extracts proved to have particular *in vitro* antioxidant activity (TPC: 40.6–54.5 mg GAE g<sup>-1</sup> extract; TEAC<sub>CUPRAC</sub>: 59.3–115.9 g TE g<sup>-1</sup> extract), and high content of  $\beta$ -carotene (2.5–6.4 mg  $\beta$ -carotene g<sup>-1</sup> extract). Such dandelion flower PLE-EtOH extracts could find multipurpose applications in the food, pharmaceutical, nutraceutical, and cosmetics industries, for example developing dermatological phytopreparations (lotions, creams, or ointments) to soothe skin irritation or inflammation.

**Keywords:** *Taraxacum officinale* flowers, pressurized ethanol extraction, *in vitro* antioxidant activity, total flavonoids,  $\beta$ -carotene

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## PHENOLIC PROFILE AND ANTIOXIDANT ACTIVITY OF HONEYSUCKLE (*LONICERA CAERULEA*) BERRY POMACE

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Effective processing of fruit and berry pomace may generate valuable functional ingredients for developing food products with higher amounts of different dietary polyphenols and other health-beneficial phytochemicals. Honeysuckle berries are rich in vitamins, polyphenolic compounds (anthocyanins, iridoids, phenolic acids and flavonoids), saponins and sugars. The aim of this study was to investigate the phenolic composition of honeysuckle berry pomace extracts by traditional and advanced extraction methods. Triacylglycerols, anthocyanins and other phenolic compounds, iridoids, organic acids, monosaccharides were performed by ultra-performance chromatography (UPLC) coupled with a time-of-flight mass spectrophotometer (Q-TOF). Saponin content was determined by the UV spectrophotometric method.

The main identified triacylglycerols were 1-linoyl-2-linoyl-3-linoylglycerol (LLL), 1-oleoyl-2-linoyl-3-linoylglycerol, 1-oleoyl-2-oleoyl-3-linoylglycerol, 1-palmitoyl-2-linoyl-3-linoylglycerol, 1-palmitoyl-2-linoyl-3-oleoylglycerol. For instance, the main triacylglycerol LLL varied from 33.84% to 59.10% in EtOH and H<sub>2</sub>O extracts. Honeysuckle pomace presented six anthocyanins; cyanidin-3-glucoside was identified as the main anthocyanin. Monosaccharides such as fructose and glucose were predominant sugars in all honeysuckle berries extracts. The main organic acids, iridoids and phenolics were citric acid, chlorogenic acid, quercetin-3-rutinoside. Loganic acid, loganic acid-7-O-pentoside, alpigenoside, quercetin hexoside, kaempferol/luteolin hexoside, and luteolin-3-rutinoside were identified in the obtained extracts. The quantitative determination of citric acid showed an interval from 107mg to 171 mg g<sup>-1</sup> extract. In general, honeysuckle is a good source of dietary antioxidants and may be a promising functional ingredient for increasing nutritive value and also may be used as a functional powder for the manufacture of cosmetics, food supplements and etc.

**Keywords:** Honeysuckle berries pomace, cyanidin-3-glucoside, citric acid, chlorogenic acid, quercetin-3-rutinoside, loganic acid

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## PECTIN RECOVERY FROM BLACK CURRANT POMACE PHYSIO-CHEMICAL FUNCTIONAL VARIATIONS BASED ON METHYL-ESTERIFICATION

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Black currant berries are usually processed into jams, juice etc. leaving large amounts of waste (approx. 30%) that could be processed into food ingredients such as pectins for other applications.

The aim of this study was to isolate pectin from black currant pomace by hot acid and enzyme assisted hydrolysis to obtain pectin with varying degree of methyl esterification (DM), that is, high methoxyl (HM) and low methoxyl (LM) and determination of the physio-chemical, rheological, and functional properties of isolated pectin.

During present study, the enzymatic extraction of pectin from black currant pomace has been shown to achieve higher yield of pectin (31.5%), while pectin obtained by hot acid hydrolysis – 19.4%. Both types of obtained pectin was structurally and morphologically different owing to varying conditions of extraction. Pectin obtained by hot acid hydrolysis exhibited better emulsifying properties and viscosity than pectin obtained by enzyme-assisted hydrolysis. The emulsifying properties including the emulsifying capacity (EC) and emulsifying stability (ES) of isolated pectin were examined in O/W emulsion system. For instance, hot-acid extraction obtained pectin has better emulsifying capacity properties (64.04%) than pectin isolated by enzyme hydrolysis (18.6%).

This study provided structural information of different method obtained black currant pectin and how different extraction method impact pectin structural and technological properties.

**Keywords:** pectin, hot-acid, enzyme-assisted, black currant

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## CHARACTERIZATION OF MECHANICALLY FRACTIONATED BLACK CURRANT POMACE AND ITS SUPERCRITICAL CO<sub>2</sub> EXTRACTION PRODUCTS

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After the process of berry juice extraction, the resulting solid residue (pomace), retains significant amounts of bioactive compounds. Unfortunately, pomace is often discarded as a waste, leading to the loss of valuable nutrients. The objective of this research was to conduct a comprehensive investigation into the chemical composition and volatile compounds found in dried black currants pomace, and to determine the changes in composition that occur as a result of supercritical CO<sub>2</sub> extraction (scCO<sub>2</sub>E). The raw material was mechanically separated into two distinct fractions, namely the skins/residual pulp and seeds. Moisture, protein, fat, fiber, sugars and headspace volatile compounds were determined for each fraction. The scCO<sub>2</sub>E was carried out at 60 °C and 45 MPa during 120 min. The highest yield of lipids was obtained from the seeds, 15.66% and 18.29% by scCO<sub>2</sub>E and Soxhlet-hexane, respectively. Conversely, the skins yielded significantly lower lipid content, with only 4.42% and 5.21% obtained using the same extraction methods. The extraction process resulted in an increase in the percentage content of sugar, fiber and protein in the pomace after scCO<sub>2</sub>E. The volatile compounds were analyzed using Headspace solid-phase microextraction (HS-SPME) coupled to gas chromatography-mass spectrometry (GC-MS). In the process of lipid extraction, a portion of the volatile compound is co-extracted and eliminated along with the extract. The extracted lipid fraction has potential applications in the food and cosmetic industries. Meanwhile, the residual defatted material still retains valuable nutrients such as proteins and sugars, rendering it suitable for downstream processes including fermentation.

**Keywords:** scCO<sub>2</sub>E, blackcurrant, pomace, volatile compounds

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## APPLICATION OF RESPONSE SURFACE METHODOLOGY FOR THE OPTIMIZATION OF PRESSURIZED LIQUID EXTRACTION OF CHERRY POMACE

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In recent years, the sour cherry (*Prunus cerasus* L.) has been a very popular fruit in the world. Cherry consumption has a positive effect on prevention of cardiovascular, Alzheimer's and inflammatory diseases, improves appetite, and lowers blood pressure. All these beneficial advantages of sour cherries are due to the high content of bioactives such as anthocyanins, polyphenols, and proanthocyanidins. Today, cherries are consumed as fresh fruits or used for the production of wine, juice, and jam; they can be dried or processed into other products. Cherry juice generates large amounts of pomace, most of which are currently discarded as waste. Therefore, there is an urgent need for cherry pomace valorisation studies for their conversion into ingredients of higher added value. The aim of this study was to optimise the pressurized liquid extraction process (PLE) to recover valuable polar fractions from cherry pomace residues after supercritical fluid extraction with carbon dioxide (SFE-CO<sub>2</sub>). A response surface methodology based on a central composite design was used to determine the effect of extraction time and temperature on the selected response factors. Total extraction yield, total phenolic content (TPC), ABTS radical scavenging activity, oxygen radical scavenging capacity (ORAC), and proanthocyanidins content were chosen as responses. The highest yield (29.61%) was obtained at the highest temperature and time (120 °C and 45 min), while the highest ABTS (125.42 mg TE g<sup>-1</sup> of extract) and TPC (47.17 mg GAE g<sup>-1</sup> of extract) were obtained at 60 °C and 30 min. The proanthocyanidins dominated in the extract obtained at 90 °C and 30 min. Taking into account all observed responses, the extraction process was optimised and validated. Therefore, the results obtained in this study may be promising for the recovery of bioactive compounds from defatted cherry pomace by PLE.

**Keywords:** cherry pomace, pressurized liquid extraction, antioxidant capacity, response surface methodology

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## FRACTIONATION OF BERRY SEEDS AND POMACE USING GREEN HIGH-PRESSURE EXTRACTION METHODS

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An efficient management of biomass remaining after berry processing gained a lot of attention in the recent years due to their nutritional and other valuable properties. High-value ingredients obtained after biorefining berry pomace are finding application in food, cosmetic and pharmaceutical fields. The aim of this work was to isolate valuable fractions from strawberry, blackberry and elderberry seeds as well as rowanberry pomace by supercritical CO<sub>2</sub> (SFE-CO<sub>2</sub>) and pressurized liquid (PLE) extractions. The highest lipophilic fraction yield by SFE-CO<sub>2</sub> was  $14.28 \pm 0.18\%$  obtained from elderberry seeds. PLE with ethanol and water mixture (70:30) yielded 20.61–47.29% of polar extracts. Tocopherols and phytosterols were determined in lipophilic fractions after Soxhlet extraction. Total phenolic content (TPC) by Folin-Ciocalteu method and antioxidant activity by ABTS<sup>•+</sup> scavenging and cupric reducing antioxidant capacity (CUPRAC) assays were investigated of the obtained polar fractions. The highest TPC was determined in strawberry seed PLE extract ( $92.18 \pm 3.90$  mg GAE g<sup>-1</sup>), while blackberry seed PLE extract exhibited the best radical scavenging and CUPRAC values. TPC, ABTS<sup>•+</sup> and CUPRAC values were also evaluated in raw berry seeds and pomace as well as in the residues after each extraction by Quencher methodology. It can be concluded that fractionation of strawberry, blackberry and elderberry seeds and rowanberry pomace by high-pressure extraction enables obtaining the extracts containing valuable bioactive components and possessing antioxidant properties.

**Keywords:** berry by-products, supercritical CO<sub>2</sub> extraction, pressurized liquid extraction, antioxidant capacity

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## EXTRACTION OF VALUABLE LIPOPHILIC COMPOUNDS FROM *VINCETOXICUM* SPECIES

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Swallow-wort (*Vincetoxicum*) is an herbaceous, perennial, climbing plant native to Europe, North America and Asia. Swallow-wort have diuretic and laxative properties and a powder made from the roots is said to accelerate wound healing. It must be stressed that swallow-wort is a poisonous plant, which in large doses can affect the nervous, vascular and cardiac systems. However, there is very little detailed scientific information on these plants.

The aim of this work was to determine chemical composition of three *Vincetoxicum* species leaves; to evaluate the yields obtained by supercritical fluid extraction with carbon dioxide (SFE-CO<sub>2</sub>) and traditional Soxhlet extraction, characterize the extracts and evaluate their antioxidant capacity. *V. hirundinaria*, *V. nigrum* and *V. luteum* were defatted by SFE-CO<sub>2</sub>. The lipophilic extracts were analyzed by different methods. Triacylglycerols (TAGs) were analyzed by ultra performance liquid chromatography (UPLC), while the total chlorophyll and carotenoid contents were measured by spectrophotometric method. Antioxidant activity was evaluated by using different *in vitro* antioxidant capacity assays: the DDPH assay and the Oxygen Radical Absorbance Capacity (ORAC) assay. Total phenol content was measured by *Folin-Ciocalteu* method.

The yields of lipophilic fractions recovered by SFE-CO<sub>2</sub> were 1.3–1.7%, while those obtained by Soxhlet varied from 1.7 to 2%. Linoleic, linolenic, oleic and palmitic acids were major fatty acids in the extracted triacylglycerols. The concentration of carotenoids and chlorophylls varied between different species. The extracts obtained by different extraction methods were characterized by their antioxidant potential. It can be concluded that extraction by supercritical fluid extraction with carbon dioxide can extract valuable bioactive compounds from leaves of different *Vincetoxicum* species.

**Keywords:** *Vincetoxicum*, chemical composition, supercritical CO<sub>2</sub>, antioxidant capacity

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## OPTIMIZING THE EXTRACTION OF BIOACTIVE COMPONENTS FROM SEA BUCKTHORN (*HIPPOPHAE RHAMNOIDES* L.) POMACE AND DEVELOPMENT OF ANTIOXIDANT-ENRICHED MAYONNAISE

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Sea buckthorn pomace is rich in high-value biologically active compounds, which can provide functional properties for food products and pharmaceuticals. The aim of this study was to provide evidence for the valorisation of sea buckthorn pomace to obtain functional ingredients such as carotenoids, tocopherols and sterols that can find a potential applications while producing value-added products. Optimum conditions for supercritical carbon dioxide extraction (SFE-CO<sub>2</sub>) were determined based on Response surface methodology (RSM). Central composite design was used to optimize the SFE-CO<sub>2</sub> extraction conditions (pressure, temperature, time and modifier ethanol) to extract bioactive compounds. Proximate analysis of dried sea buckthorn pomace was performed by AOAC (moisture – 925.10; minerals – 900.02; crude protein – 960.52; crude fat – 920.39) official procedures. Total content of carotenoids was evaluated by UV – visible spectrophotometry. While content of tocopherols and phytosterols were determined by ultra-performance liquid chromatography – quadrupole time-of-flight mass spectrometry (UPLC-Q-TOF-MS). Mayonnaise with sea buckhorn extract (concentrations 0.5%, 0.75%) produced by optimum conditions in order to improve its stability during storage (0; 14; 28 day) at room temperature. After RSM analysis, the optimal SFE extraction conditions for sea buckthorn pomace were: extraction temperature 35 °C, pressure 39 MPa with 5% ethanol as extraction modifier, and 2 h of extraction time. Under these conditions obtained yields were 14.39 g 100 g<sup>-1</sup> DW, carotenoids (175.92 mg 100 g<sup>-1</sup>), α-tocopherol (72.46 mg 100 g<sup>-1</sup>), and ergosterol (76.37 mg 100 g<sup>-1</sup>). The developed process in this study is environmentally-friendly, and can be adopted for producing natural bioactive pigments for potential food industry applications. Some of the interesting results of obtained mayonnaise enriched with sea buckthorn pomace CO<sub>2</sub> extracts will be presented.

**Keywords:** sea buckthorn, supercritical fluid extraction, carotenoids, tocopherols, sterols

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**SESSION III  
INNOVATIVE TECHNOLOGIES AND  
PACKAGING FOR SHELF-LIFE  
EXTENSION**

# FOODBALT 2023

**PACKAGING ANALYSIS FOR A SUSTAINABLE FUTURE**

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The amount of packaging has significantly increased in the world and in Latvia in the recent years, and it continues to increase every year. Forecasts show that the amount of packaging produced will even continue to grow, reaching 276,000 tons in Latvia in 2035, which means an increase of 14%. According to forecasts, in the future the amount of plastic will also increase by 23%, reaching 53,000 tons in 2035. A large part of the packaging consists of food packaging, because nowadays packaging is an essential element of the process of selling food products. The purpose of the research was to summarize and analyze the types of polymer packaging materials currently present in the Latvian market, their sustainability and inclusion in the circular economy cycle. The research was carried out both by analyzing the documentation attached to the packaged products and by researching product packaging in supermarkets. As the results show, most of the packaging materials currently available in the Latvian market are not recyclable; often there is an excessive amount of packaging used. A significant part of the packaging consists of multi-layer packaging materials, which cannot be recycled, for which alternatives need to be sought. It is important to mention that plastic packaging can be divided into three large groups in terms of recycling: films or soft packaging, containers and bottles. Each of these groups has a different maturity in the circular economy cycle. It should be noted that, depending on the types of packaging, 60–70% of packages can be found with a symbol that identifies the type of plastic used. It is important that a detailed research analysis of packed products allow evaluating the overview of the situation of packaging materials in Latvia, considering the basic principles of the design strategy, in order to find solutions, how, after using the packaging, to turn the generated waste into resources, considering the principles of sustainability.

**Keywords:** packaging, sustainability, circular economy, plastics

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## EFFECTS OF PULSED ELECTRIC FIELD ON THE STRUCTURAL AND EMULSIFYING PROPERTIES OF DAIRY PROTEINS

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Pulsed electric field (PEF), as an emerging eco-friendly technology, has been used in the food industry for the inactivation of enzymes and microorganisms. PEF was also utilized to change the structural and techno-functional properties of food proteins. This abstract represents our latest studies on the applications of PEF on milk proteins. The first study aimed to investigate the effects of PEF-assisted glycation of bovine serum albumin (BSA) and soluble potato starch on the emulsifying performance of BSA/starch conjugates. The physicochemical and emulsifying properties of the BSA/starch conjugates were investigated. PEF at 3.5–5.7 kV cm<sup>-1</sup> decreased the fluorescence emission intensity of BSA/soluble starch conjugates. Furthermore, PEF-treated (3.5–5.7 kV cm<sup>-1</sup>) BSA/soluble starch conjugates had better emulsifying properties (lower droplet size of emulsions) and protein solubility compared to native BSA and untreated BSA/soluble starch mixtures. The aim of the second study was to examine the effects of PEF treatment (0–30 kV cm<sup>-1</sup>) on the structural properties of casein micelles (CSM). At 10 kV cm<sup>-1</sup>, PEF treatment caused a significant increase in the particle sizes, absolute  $\zeta$ -potential, turbidity, and surface hydrophobicity values while a decrease in the solubility (%) of CSMs was observed. Moreover, the results of Fourier transform infrared spectroscopy (FTIR) analysis confirmed that PEF treatment influenced the particle sizes and improved the protein solubility of CSMs. Moreover, the deconvolution analysis of the Amide I region (1600–1700 cm<sup>-1</sup>) of FTIR spectra showed that PEF treatment reduced the  $\alpha$ -helix content but increased the  $\beta$ -sheet of CSMs. Raman spectra confirmed that PEF treatment > 10 kV cm<sup>-1</sup> buried tyrosine residues in a hydrophobic environment and the decrease in the  $\alpha$ -helix was also proved.

**Keywords:** pulsed electric field, secondary structure, protein-polysaccharides interaction, casein micelles, bovine serum albumin

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## INVESTIGATION OF BIOSURFACTANT PRODUCTION OF YEASTS FROM FOOD ORIGIN

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Biosurfactants, bio-based surface-active compounds produced by microorganisms, have majorly surface reduction activity due to the presence of both hydrophobic and hydrophilic moieties. Biosurfactants found numerous applications in several industries from petroleum, food and cosmetics to pharmaceutical. In this study, the biosurfactant production capacities of 142 food originated indigenous yeast strains were evaluated by using four different screening methods. For this aim, firstly hydrocarbon overlay and tween 80 agar tests were done and on the basis of these results, 44 strains including species of *Metschnikowia pulcherrima* (11), *Wickerhamomyces anomalus* (3), *Saccharomyces cerevisiae* (3), *Cyberlindnera fabianii* (2), *Geotrichum silvicola* (2), *Torulaspora delbrueckii* (1), *Trichosporon asahii* (1), *Debaryomyces hansenii* (1), *Candida lusitanae* (5), *Candida famata* (6), *Candida tropicalis* (3), *Candida parapsilosis* (1), *Candida valida* (1), *Candida kefyr* (1), *Candida zeylanoides* (1), *Candida guilliermondii* (1) and *Candida lipolytica* (1) were found to be potential strains. Then, the oil spreading test confirmed biosurfactant production of 13 yeast strains among the 44 yeasts which had oil spreading results larger than 1 cm clear zone diameter. As a next step of the screening, the surface tensions of only 6 (3 strains of *W. anomalus*, 2 strains of *G. silvicola* and a *Cyb. fabianii* strain) of 13 yeasts, which gave the largest diameters between 1.7–6 cm were measured. The maximum reduction in the initial surface tension of the fermentation medium was achieved to be  $38.12 \pm 0.06$  mN m<sup>-1</sup> by the biosurfactant produced from *Cyb. fabianii* MIAU-1 and therefore this yeast was introduced as a novel biosurfactant producing strain.

**Keywords:** biosurfactant, yeast, surface tension, *Cyberlindnera fabianii*

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## EVALUATION OF PINE CONE SYRUPS AND CHANGES OF PHYSICAL PARAMETERS DURING STORAGE

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There is an increasing demand for natural and healthy food products that play a multifunctional role in human diet. Pine cone syrup has long been known and used for its medicinal purposes. As part of the research, a syrup was developed from pine cones, which can be used not only in cases of colds, but also in everyday life. The aim of the research was to prepare and evaluate different pine cone syrups using brown and white sugar and analyse their physical parameter changes during storage. Syrups were characterised by volatile compounds and their changes depending on the type of sugar used as well as by analysing content of soluble solids, pH, viscosity and titratable acid during storage. A total of 33 volatile compounds were detected in syrup made with white sugar (SWS) and 36 in syrup with brown sugar (SBS). Of the compounds detected, the sample SWS was characterised more by compounds giving a pine and resinous aroma, while sample SBS was characterised by a pine and citrus aroma. The determination of the soluble solids content of the syrups, irrespective of the sugar chosen, by one-factor analysis of variance ( $p > 0.05$ ), in sample SBS  $63.2 \pm 0.6$  Brix% and in sample SWS  $62.7 \pm 0.6$  Brix% on average, is in line with the legislation (62 Brix%) for the soluble solids content of syrups. No significant difference was found between sample pH, which for both samples was 3.5. Sample SBS on average had a higher viscosity ( $0.102 \pm 0.001$  Pa s) than sample SWS ( $0.09 \pm 0.001$  Pa s) and it was noticed that sample became more viscous during storage.

**Keywords:** titratable acid, volatile compound, brown sugar, viscosity, conifer syrup

**Acknowledgements:** LBTU Innovation and Technology Transfer Centre Vaucher No. VP-V-2022/46 "Create and develop product recipes from pine cones and buds - in product groups - syrup, jam, marmalade".

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## MORPHOLOGY OF DIFFERENT LAMINATED BIOCOMPOSITES SUITABLE FOR FOOD PACKAGING

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Recently, interest in environmentally friendly as well as biodegradable food packaging has increased. One of the solutions could be the development of laminated cellulose biocomposites with different polysaccharides. Cellulose fibre is a natural plant-derived biopolymer that is receiving more and more interest in food packaging due to its low cost, availability, and sustainability. Polysaccharides such as pectin, agar, and starch are non-toxic, biodegradable, and biocompatible, and are therefore widely used in the food industry.

Therefore, the aim of this research was to produce laminated cellulose/pectin, cellulose/agar and cellulose/starch biocomposites by the solvent casting method and analyse their morphology. The surface of biocomposites was analyzed by using optical microscope and a scanning electron microscope (SEM). Additionally, pictures of contact angle with water drop were taken and mechanical characteristics were evaluated of the prepared cellulose biocomposites.

Analysis of the obtained surface images of the cellulose/pectin biocomposites showed that pectin gave the biocomposite a brown colour, the cellulose/agar biocomposites a light yellow colour, and the cellulose/starch a white colour. The intensity of the colour increases with increasing concentration of polysaccharide. SEM images proved that 5% of pectin solution is not suitable for fully covering cellulose fibres, while for agar and starch this concentration is suitable. Mechanical characteristics revealed that the cellulose/pectin biocomposites are stronger compared to other polysaccharide biocomposites and its contact angle is the highest. In conclusion, laminated cellulose/pectin biocomposites without plasticiser glycerol have potential for developing food packaging material.

**Keywords:** cellulose, food packaging, pectin, agar, starch

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## NON-DESTRUCTIVE DETECTION OF TOMATO MATURITY

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Tomatoes (*Solanum lycopersicum*) are the most widely grown vegetable fruit in the world with an important contribution to a healthy diet. They are consumed in diverse ways: raw or cooked while still maintaining their nutritive value. The taste of a tomato can range from sweet to acidic, and can vary depending on the variety of tomato and maturity stage. Visible and near infrared spectroscopy is rapid, convenient and low cost method for detection of fruit quality. The aim of the study is to evaluate the suitability of non-destructive methods for detecting the maturity of tomatoes. Tomatoes were grown in a commercial greenhouse "Mežvidi" of Ltd "Latgale vegetable logistics" and harvested at five stages of ripeness (green, breaker (physiological maturity), turning, light red / yellow (commercial maturity), red/orange (full ripen) were used in experiments. Three tomato varieties orange 'Bolzano F1', red-fruited 'Encore' and brown-fruited 'Chokomate F1' were analysed. Content of carotenoids (lycopene, carotene), chlorophylls, acidity and soluble solids are analysed biochemically. Taste index and maturity index were calculated using soluble solids content and acidity. Reflectance spectrums (350–2500 nm) were obtained with spectroradiometer RS-3500. The results proved that the best indicator of ripeness is the color of the fruit. It is impossible to objectively determine the taste of the fruit by non-destructive methods. Non-destructive methods are suitable for single-colored fruits ('Bolzano' and 'Encore'), but for the brown-fruited tomato variety, where the color is determined by both lycopene and chlorophyll, it is more difficult to identify the degree of ripeness. Indices for determining fruit maturity have been developed.

**Keywords:** lycopene, carotene, Brix, tomato colour, spectroradiometer

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## ANALYSIS OF PACKAGED EGG PRODUCT SHELF LIFE AFTER OPENING

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Eggs are perishable and consumed in large quantities, mainly fresh. If the egg producer is unable to sell the eggs within 14 days, then they must be served in another form - pasteurised liquid egg, pasteurised liquid egg white or pasteurised liquid egg yolk. After pasteurisation followed by immediate packaging and without added preservatives, the products are given a new best before date of 30 to 40 days. According to the product manufacturer, the packaging indicates that the product can be stored at  $4 \pm 2$  °C for 24 to 48 hours after opening. The aim of this study was to test how long it takes for an egg-based product without added preservatives, packaged in biodegradable packaging, to lose its shelf-life after opening at  $4 \pm 2$  °C.

The three egg products selected for the trial were 'Mass from egg', 'Mass from egg white' and 'Pancake batter'. Samples were analysed on total plate count (TPC), pH and colour changes during storage. Standard methods were used. The results showed that the egg products lost their quality 78, 84 and 87 h after opening by exceeding the maximum permissible limit of  $1 \times 10^6$  CUF g<sup>-1</sup> for TPC. The pH and colour of the samples did not show significant differences during storage. The experimental results show that pasteurised liquid egg products without added preservatives, packaged in biodegradable packaging, can be stored at a  $4 \pm 2$  °C till 69 to 81 hours after opening the packaging depending on the type of product.

**Keywords:** egg mass, pancake batter, total plate count, biodegradable packaging

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## EFFECT OF OZONE ON *ENTEROBACTERIACEA* SPP. IN SEEDS OF ALFALFA, WHEAT GRAIN AND SPROUTS

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Seeds and grains are not only a basic component of the agricultural system, but also an integral part of the food basket. Cereal products alone account for half of the world's food consumption. The sprouts of various seeds have gained a lot of attention among consumers due to freshness, crispness and germination, as a cheap and simple process. Warm and moist germination conditions are ideal for the growth of microorganisms. This raises food safety concerns.

The aim of this study was to determine the effect of ozone on *Enterobacteriaceae* spp by treating alfalfa (*Medicago sativa*) seeds and wheat (*Triticum aestivum*) grain with ozone gas and rinsing with ozonated water during germination. VRBG (Violet Red Bile Glucose Agar) medium was used to detect *Enterobacteriaceae* spp. Dry seeds and wheat grain were treated with ozone gas at 20 ppm for 10 minutes, and during germination, seeds and grains every 12 hours were rinsed with ozonated water in a flow-through, where the concentration of ozone in the water was 2.0 mg L<sup>-1</sup>. Rinsing with ozonated water was performed for 20, 40, 60 minutes. Untreated alfalfa seeds and wheat grain were used as controls. When evaluating samples of alfalfa seeds, *Enterobacteriaceae* spp. was not detected in dry seeds and in the washing water of untreated seeds, but in the washing water of seeds planted with ozone gas, 2.6 log CFU g<sup>-1</sup> was found. After 12 hours of soaking, it increased to 5.5 log CFU g<sup>-1</sup>. After 24 hours of germination and rinsing with ozonated water, as well as after 7 days of storage at 4 ± 2 °C, *Enterobacteriaceae* spp. was detected in all samples at an average of 8.0 log CFU g<sup>-1</sup>, regardless of the duration of rinsing. When evaluating the wheat grain samples, *Enterobacteriaceae* spp was already detected in dry grains on average up to 0.5 log CFU g<sup>-1</sup>, gradually increasing to 5.5 log CFU g<sup>-1</sup> in soaked grains, after 24 hours of germination it already reached 7.5 log CFU g<sup>-1</sup> in both control and ozone-treated samples, but after 7 days of storage, 6.5 log CFU g<sup>-1</sup> was found.

**Keywords:** grains, germination, seeds, *Enterobacteriaceae* spp.

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## EFFECT OF OZONATION ON SHELF LIFE OF FRENCH DESSERT CANELÉS LIQUID DOUGH

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It is popular to supply ready-made raw semi-finished products to the market, but there are longer storage challenges, especially if it is a liquid dough. Ozone is a powerful disinfectant and is of interest to food scientists, because it can be used to disinfect food and preserve it for longer time.

The aim of the study was to evaluate the effect of ozone on the shelf life of Canelés dough.

The dough was prepared according to a traditional recipe, all the ingredients of which can be purchased at the supermarket. Two types of dough were made, for the production of which ozonated and non-ozonated flour was used. Later, these doughs were poured into sealed sterile 200 mL vials and one part of doughs was ozonated by passing ozone directly into the vials for 5 minutes. Four types of dough were prepared in 10 replicates for the tests. All samples were stored at  $4 \pm 2$  °C in a refrigerator. Microbiological tests, pH measurements and Canelés baking were performed, once a week, for 6 weeks. The conducted studies show that ozone treatment did not extend the shelf life of liquid dough. Both ozonated and non-ozonated dough deteriorated during storage and became unsuitable for baking: after 2 weeks of storage Canelés from non-ozonated dough deformed during baking, while Canelés from ozonated dough had a more runny consistency. After three weeks, the ozonated dough Canelés stuck to the moulds, and after 4 weeks, none of the doughs were suitable for baking and all the doughs had an unpleasant smell. Non-ozonated dough went mouldy.

**Keywords:** flour dough, ozone, shelf-life, microbiology

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## EFFECT OF THERMAL TREATMENT ON THE RHEOLOGICAL PROPERTIES OF CARRAGEENAN GELS

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Carrageenans are sulphated polysaccharides obtained from red seaweeds. They play an important role due to their gelling, thickening and stabilizing properties, which are widely used in the food, cosmetics and pharmaceutical industries. In the commercial process of carrageenans, heat is generally employed during extraction and drying that can affect the polysaccharides' functional properties. Therefore, the aim of this study was to investigate the thermal treatment (75–115 °C for 15 minutes) on the rheological behaviour of  $\kappa$ -,  $\kappa/\lambda$ -,  $\iota$ - carrageenan and furcellaran gels.

All studied polysaccharides showed a storage modulus ( $G'$ ) vs. frequency dependence and can be categorized as a typical physically cross-linked network gel. No changes in gel strength values were observed with 2.5% (w/v)  $\kappa$ -,  $\kappa/\lambda$ -,  $\iota$ - carrageenan gels during thermal treatment. However, 2.5% (w/v) furcellaran formed thermally unstable gels as the gel strength was decreasing with increasing the treatment temperature. The melting and gelling temperatures were decreasing with increasing the heat treatment temperature for all carrageenans while furcellaran was most affected by thermal treatment.

**Keywords:** carrageenan, gel properties, rheology

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## THE EFFECT OF TRANSITION TO A MORE ENERGY-EFFECTIVE PROCESSING REGIME ON THE SHELF-LIFE OF LINGONBERRY-BLUEBERRY-RYE PUREE

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Environmentally sustainable production is becoming a relevant topic for both consumers and producers. Reducing the energy consumption in the production phase helps to achieve a lower ecological footprint. The aim of this research was to evaluate the effect of switching from resource-intensive heat treatment (108 °C, 27 min) to a more economical pasteurization process (93 °C, 9 min) on the shelf-life and quality of lingonberry-blueberry-rye puree. Room-temperature and accelerated shelf-life test (ASLT) were conducted with lingonberry-blueberry-rye puree samples, processed with different heat-treatment regimes. The second aim of the research was to validate an ASLT model for the product. During both shelf-life tests, anthocyanins and total phenolic content (TPC) were analyzed. The initial results showed that samples with higher temperature treatment contained lower amounts of anthocyanins and TPC. The content of anthocyanins in both shelf-life tests decreased immediately after first analyzed point (on average 74.5%) and by the end of the test, it was equal for samples from both heat treatment regimes. These changes were also confirmed with colorimetric analysis, showing a rapid change in color after first analyzed point. Sensory analysis showed minimal differences between samples from both heat treatment regimes and minimal changes were found throughout both storage tests. Therefore, the use of pasteurization process can be recommended. ASLT was carried out on the assumption that the aging factor is  $Q_{10}=3$ . An exact  $Q_{10}$  value was calculated for this product, based on the reaction rates of the main quality changes observed during both storage tests. It was found that an ASLT with lingonberry-blueberry-rye puree or similar products should be carried out with  $Q_{10}=2.7$ .

**Keywords:** accelerated shelf-life tests, sustainable production, phenolic compounds, sensory analysis

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## DETERMINATION OF THE SHELF LIFE OF PUFFED WHEAT "BADYRAK VANILLA" AND "BADYRAK WITH WHEY"

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Puffed grains made from whole grains of wheat, corn or rice are ready-to-eat breakfast cereals, which do not require additional preparation. Sweet-coated puffed wheat has become very popular among consumers. Two recipes for puffed grain coatings were developed – puffed grain with vanilla flavour "Badyrak vanilla" (BV) and puffed grain with whey "Badyrak with whey" (BMS). The addition of whey enriched the product with vitamins B<sub>1</sub>, B<sub>2</sub> and B<sub>6</sub>, as well as essential amino acids. In the application of coating, oil was used. Deterioration of oil may be limiting factor for shelf life of the developed products. Therefore, the aim of this study was to determine the changes in the acid value of lipids during storage to establish the shelf life of sweet-coated puffed wheat grains. The products were packaged in the sealed pouches of metallized polypropylene (MetPP), 30 g each. The acid value was studied monthly according to the standard GOST R 52466-2005 in products during their eight month storage. The studies were carried out at different storage temperatures (20±2 °C, 4±2 °C, and minus 18±1 °C). Literature studies and organoleptic evaluation of puffed wheat allowed setting limiting acid value at 4.0 mg g<sup>-1</sup> of fat. When acid value exceeded the limit, the overall organoleptic quality was reduced, primarily due to the changes in aroma and the appearance of an unpleasant aftertaste. The increase of acid value was storage temperature dependent. The highest acid value after eight-month storage was established for samples stored at 20±2 °C, being 4.5 mg g<sup>-1</sup> of oil for BV and 5.2 mg g<sup>-1</sup> of oil for BMS. The study allowed recommending 4-month shelf life for "Badyrak with whey" and 5 months for "Badyrak vanilla".

**Keywords:** puffed wheat, food concentrates, whey, acid value

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**SESSION IV**  
**FOOD CHEMISTRY: METHOD**  
**DEVELOPMENT AND APPLICATIONS**

# FOODBALT 2023

## NMKL AND VALIDATION OF METHODS FOR FOOD ANALYSIS – EXAMPLES FROM DETERMINATION OF VITAMINS USING LC-MS/MS

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NMKL was established in 1947 as a Nordic organization with the aim of developing and standardizing methods and procedures for food analysis. Our recent revitalization led to the Baltic countries joining in 2022 and our name was changed to Nordic-Baltic Committee on Food Analysis (<https://www.nmkl.org>). I will present an overview of ongoing work in the NMKL groups for Microbiology, Chemistry, Sensory and NordVal International. Validation is required when developing and/or establishing an analytical method in the laboratory, and participation in proficiency testing is an obligatory quality assurance when achieving accreditation is needed. To be standardized, methods should also be validated in an interlaboratory study ensuring compliance of results across different laboratories. I will introduce the principles in validation of analytical methods based on our NMKL procedures and present two mass spectrometry methods as examples. Mass spectrometry in terms of LC-MS/MS is a powerful analytical tool in modern vitamin analyses enabling discrimination and quantification of different vitamin forms. The first example is the already available method NMKL 204 “Total folate in food by LC-ESI-MS/MS. Quantification of 6 folate vitamers”. The second example is an LC-ESI-MS/MS method for simultaneous analysis of the vitamins B1, B2, B3 and B6 being developed and validated in line with NMKL procedures at the Institute of Marine Research. In conclusion, NMKL provides a platform for knowledge sharing and quality assurance for developing methods and procedures for food analysis in the Nordic-Baltic region by utilizing our network of experts from both governmental and private institutions.

**Keywords:** NMKL, method validation, LC-MS/MS, vitamins

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## METHOD DEVELOPEMENT FOR THE DETERMINATION OF PER- AND POLYFLUORINATED COMPOUNDS IN FOOD

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Per- and polyfluorinated alkyl substances (PFASs) comprise a large group of anthropogenic chemicals, which are ubiquitous environmental contaminants. In 2020 European Food Safety Authority (EFSA) concluded that perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluorohexanesulfonic acid (PFHxS) and perfluorooctanesulfonic acid (PFOS) can cause developmental effects and may have adverse effects on serum cholesterol, the liver, the immune system, and birth weight. EFSA considered the effects of PFAS on the immune system as the most critical and established a group tolerable weekly intake (TWI) of 4.4 ng kg<sup>-1</sup> b.w.<sup>-1</sup> per week for the sum of these four PFASs. Recently, the European Commission has established maximum levels for PFASs in certain foods, focusing on limits for priority four PFASs. Therefore, more sensitive analytical methods or improved analytical protocols should be applied to ensure the analysis of PFASs at occurrence levels that comply with the newly established EFSA TWI of 4.4 ng kg<sup>-1</sup> b.w.<sup>-1</sup>

An improved analytical methodology allows to determine 14 PFASs along with four priority components using HPLC-Orbitrap-MS. Based on Guidance document the following analytical performance criteria were verified – analytical recovery, linearity, limit of quantification (LOQ), precision and trueness, and estimation of measurement uncertainty (MU). Analytical recovery for four priority PFASs were in range 80–120%, while for short and long chain compounds recovery is in range 70-135%. The linearity over the concentration range of 0.5–500 pg µL<sup>-1</sup> was observed for selected PFAS with correlation coefficients ≥0.995, while trueness and precision were in range 3–7% and 1–8%, respectively. LOQ values for PFASs were 0.01 µg kg<sup>-1</sup> w.w. except for long chain representatives which LOQ values were 0.50 µg kg<sup>-1</sup> w.w. The observed performance characteristics of the method demonstrated that it fulfils specified requirements from the Guidance Document on Analytical Parameters for the Determination of Per- and Polyfluoroalkyl Substances (PFAS) in Food and Feed.

**Keywords:** food safety, fluorinated contaminants, high-resolution mass spectrometry

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## THE QUANTITATIVE ANALYSIS OF PYRROLIZIDINE ALKALOIDS IN FOOD PRODUCTS USING NANOFLOW LIQUID CHROMATOGRAPHY MASS SPECTROMETRY

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Pyrrrolizidine alkaloids (PAs) are a group of widespread chemical compounds exhibiting genotoxic and carcinogenic effects that are found in flora, such as *Fabaceae*, *Boraginaceae*, and *Asteraceae* plant families. In this study, a novel sensitive method for the determination of PAs in foods was developed employing nanoflow liquid chromatography-Orbitrap mass spectrometry combined with simple and fast sample preparation procedure.

The occurrence study of PAs in food products available on the Latvian market was carried out, including samples of tea ( $n=15$ ), honey ( $n=40$ ), herbal tinctures ( $n=15$ ), and milk ( $n=10$ ). Some of the honey and tea samples contained quantifiable levels of PAs well below the maximum limit of  $200 \mu\text{g kg}^{-1}$  set in Commission Regulation (EU) 2020/2040, except for one herbal tea sample that had a total PA concentration of  $215 \mu\text{g kg}^{-1}$  mainly in the form of *N*-oxides.

Additionally, the screening analysis included MS<sup>2</sup> screening for fragment ions commonly produced by PAs during collision-induced dissociation and a highly selective  $\text{C}_6\text{H}_8\text{N}^+$  fragment ion could be used as a target fragment ion for PA detection and discovery, which has been demonstrated by the analysis of contaminated samples.

**Keywords:** pyrrolizidine alkaloids, nano-LC-MS, suspect screening, Orbitrap

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## JAPANESE QUINCE SEED PROTEIN EXTRACTION USING DIFFERENT DEFATTING METHODS

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Seeds, including those of *Rosaceae* fruits, are most commonly processed for oil production; however, the press-cake can be a valuable source of proteins. The aim of the research was to evaluate Japanese quince (*Chaenomeles japonica*), a relatively uncommon fruit crop, seeds as a source of functional protein after oil extraction.

Protein was extracted under alkaline conditions after a variety of defatting methods (CP: cold-pressing, SFE: supercritical fluid extraction, CP with subsequent SFE, and solvent extraction using hexane) as well as from undefatted seeds, after which the protein pellets were lyophilized. Protein content was determined using the Kjeldahl method ( $N_{\text{almond}} = 5.18$ ), fat content (solvent extraction oil yield expressed as fat content in the sample) was determined as well in undefatted and defatted seed flour.

Significant differences between differently defatted samples were observed in protein yield, purity, and recovery. Unprocessed seed fat content was  $11.75 \pm 0.13\%$ , while in the defatted samples:  $6.40 \pm 0.06\%$  (CP),  $5.32 \pm 0.15\%$  (SFE) and  $0.90 \pm 0.47\%$  (CP-SFE), hexane-defatted samples were defatted fully. Protein content in unprocessed seeds was  $19.86 \pm 0.08\%$ , protein content in protein extracts ranged from  $66.18 \pm 0.8\%$  in CP to  $84.02 \pm 0.04\%$  in SFE flour. The protein extract yield was highest in hexane-defatted samples ( $12.54 \pm 0.13\%$ ) and lowest in CP-SFE flour ( $11.08 \pm 0.20\%$ ).

Defatting improved the protein extract purity, but did not have a significant positive effect on protein extract yield. Defatting also improved protein recovery.

**Keywords:** pome fruit, technological protein, residue, by-products

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## INFLUENCE OF CARBON SOURCES ON BIOSURFACTANT PRODUCTION BY *CYBERLINDNERA FABIANII*

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Biosurfactants are surface-active molecules produced by various microorganisms. Fermentation media composition plays a key role in biosurfactant production and it could be enhanced when both lipophilic and hydrophilic carbon sources, such as glucose and fatty acids, are used in the media. In this research, each of glucose, fructose, sucrose and glycerol were used by their combination with several vegetable oils (sunflower, hazelnut, rapeseed, corn, cottonseed, and olive) for production of biosurfactant by *Cyberlindnera fabianii* MIAU-1. The total 24 experiments were conducted in shake flasks and the most suitable substrates for the production were selected based on the results of surface tension reduction (STR) of the media. The minimum and maximum STR values of the medium containing glucose and its combination with oils were between 19.44–26.57 mN m<sup>-1</sup>. These values were 15.91–23.73 mN m<sup>-1</sup> and 13.26–26.55 mN m<sup>-1</sup> for fructose and sucrose containing media, respectively. Overall, the highest STR results were taken in the media composed of glucose-sunflower oil, glucose-hazelnut oil, glucose-corn oil and sucrose-hazelnut oil, which were about 26–26.50 mN m<sup>-1</sup>. In addition, the minimum STR was found to be 8.49 mN m<sup>-1</sup> for the glycerol and cottonseed oil containing medium. In general, the medium composed of glucose and sunflower oil was chosen based on being more economic and accessible for biosurfactant production. These results revealed that food wastes such as fruit and vegetable peels rich in sugars and waste frying oil could have considerable potential for the biosurfactant production by *Cyb. fabianii* strain.

**Keywords:** biosurfactants, carbon source, surface tension, food waste

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## PROTEIN AND TOTAL STARCH CONTENTS OF MILLING FRACTIONS OF BUCKWHEATS GROWN IN DIFFERENT LOCATIONS OF TÜRKİYE

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Buckwheat, which is a pseudocereal, is a gluten-free product. It has high nutritional content and physiological benefits. The physicochemical and functional properties of buckwheat starch, such as swelling, gelatinisation, pasting, retrogradation, are influenced by the milling process. Buckwheat seed consists of hull, bran, endosperm and germ. The aim of this research was to find out the effect of milling process on protein and starch contents of milling fractions of native buckwheats collected from the different locations of Türkiye. The buckwheat cultivar of *Güneş cv.* was collected from 8 different locations of Türkiye in the harvest year of 2021 and the buckwheat cultivar of *Aktaş cv.* collected from Konya location was used for checking. After conditioning, they were roller-milled (Bühler) into the fractions of coarse bran, fine bran, break flour and reduction flour. Buckwheats were also rotor-milled using a high-speed ultra centrifugal mill (Retsch) for gaining wholegrain buckwheat flours. The break flours, reduction flours and wholegrain flours obtained from each location and cultivar were analysed for determining the protein and total starch contents on dry weight basis. The nitrogen contents were determined using Kjeldahl method. Total starch contents were determined spectrophotometrically using Megazyme total starch assay kit. The highest protein (%N×6.25) contents were found in the reduction flours followed by wholegrain flours. The highest total starch contents were achieved with the break flours followed by the reduction flours. The protein and starch contents of break and reduction flours of buckwheats were completely different from the same fractions of roller-milled wheat.

**Keywords:** buckwheat, milling fractions, wholegrain, protein, total starch

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## EVALUATION OF COLOUR STABILITY OF PURIFIED PHYCOCYANIN EXTRACTED FROM *ARTHROSPIRA PLATENSIS* AFTER COMPLEXATION WITH FOOD-GRADE POLYSACCHARIDES

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Phycocyanin is a blue-coloured phycobiliprotein found in cyanobacteria with great potential to be used as a natural colourant in the food industry. The use of this dye is limited since phycocyanin is relatively unstable, affected by temperature, pH, and light exposure, as well as extraction and purification. This study aimed to obtain a high-purity extract of phycocyanin and evaluate the use of food-grade polysaccharide complexation to improve the stability of the blue colour under different storage conditions. Towards this, various extraction conditions (time, extraction solvent, biomass to solvent ratio) and conventional extraction techniques such as homogenisation, freeze-thaw and maceration were evaluated for their ability to recover phycocyanin from *Arthrospira platensis* biomass. The highest phycocyanin yield was obtained after homogenisation with phosphate buffer (0.1M, pH 7) for 45 minutes (37.01 mg g<sup>-1</sup> DW, purity 0.82), while maceration with phosphate buffer (0.1M, pH 7) for 2 hours resulted in lower yield (30.73 mg g<sup>-1</sup> DW) but showed the highest purity extract (1.35). Further extract purification was performed, and using activated carbon resulted in the highest level of purification, with the final purity reaching 2.58 (food-grade). Afterwards, the phycocyanin-rich extract was complexed with food-grade polysaccharides (xanthan gum, iota-carrageenan) to evaluate its stability under different storage conditions (temperature, packaging, light exposure, heat treatment). Phycocyanin stability was improved with additives, with xanthan gum showing the most significant effect on the stability of phycocyanin content throughout storage. Conclusively, adding polysaccharides to phycocyanin solutions can potentially improve colour stability over storage time.

**Keywords:** phycocyanin, spirulina, cyanobacteria, extraction, stability

**Acknowledgments:** The mentorship fund of the Kaunas University of Technology supported this study.

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## THE CHANGE IN ANTIOXIDANT ACTIVITY CHARACTERISTICS OF BUCKWHEAT FLOUR AFTER MICROWAVE SUPPORTED HEAT-MOISTURE TREATMENT

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The use of microwaves for the physical modification of flours and starches is a fast and more effective alternative to conventional hydrothermal treatments that is still poorly studied. In this study, microwave treatments were carried out with buckwheat flour, which is a gluten-free pseudocereal flour notable for its high protein content and its phenolic and antioxidant compounds. Hydrothermal treatments (HMT) can be applied to food through a wide variety of procedures. The application of microwave radiation (MW) has been increasing. MW energy has the characteristic of being a non-ionizing energy whose foundation lies in the rapid alternation of high-frequency electromagnetic fields within the products, producing temperature increase, due to the friction between the molecules, which quickly orient themselves towards these electromagnetic fields. The studied factors were buckwheat flour origin, humidity of the samples before the treatment and exposure time to microwaves. Taking two types of Polish buckwheat flours (controlled variety and commercial flour), their initial moisture was adjusted to 20% and 30% and then two microwave treatment times were tested. The microwave treatment also had a significant effect on the functional (viscometric profile) and technological properties (water absorption capacity, oil absorption capacity, water absorption index, and swelling power) of flours but negative on the total content of polyphenols, soluble polyphenols and antioxidant activity. However, the effect was positive on the insoluble polyphenols, getting a greater extraction of them, if compared with samples of untreated flour.

**Keywords:** buckwheat flour, microwave radiation, functional properties, antioxidant activity

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## KEY ODOUR-ACTIVE COMPOUNDS IN COOKED SALMON

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The current study is a part of the Good Food Institute (GFI) research grant targeted to decode and recreate the aroma of salmon. There is a lack of information regarding the key molecules that give salmon its characteristic flavour, which gives a starting point to mimic it in fish alternative products. The objective of the current study was to create a list of the most relevant aroma-active molecules in cooked salmon using solid-phase microextraction (SPME) followed by gas chromatography-olfactometry (GC-O) analysis.

More than 50 odour-active compounds were registered by GC-O assessors in the cooked salmon samples; and 20 of them possessed modified frequency ratings (MF) higher than 30%. We will also obtain quantitative data on compounds with high MF scores to perform the recombination studies with standards to reproduce the cooked salmon aroma.

It was found that unsaturated aldehydes with fatty, green notes and trimethylamine with fishy note contribute mostly to the distinctive salmon aroma profile. The unsaturated aldehydes such as (E,E)-2,6-nonadienal, (E,E)-2,4-decadienal, (E)-2-nonenal and (Z)-4-heptenal are derived from lipid oxidation processes. In salmon, the main fatty acids are unsaturated oleic (C18:1) and linoleic (C18:2) acids. The next step of the research would be to investigate the correlation of the single polyunsaturated fatty acids on the salmon model odour profile.

Advanced knowledge of the aroma profile of cooked salmon could improve understanding of how to optimize the aroma and taste of fish alternatives.

**Keywords:** salmon, GC-olfactometry, aroma-active compounds

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## ISOLATION AND CHARACTERIZATION OF PIGMENTS FROM PIGMENT-PRODUCING MICROORGANISMS ISOLATED FROM ENVIRONMENT AND THEIR ANTIBACTERIAL ACTIVITY

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In the food industry, there is always a demand for food products, which are colourful and have attractive appearance, also has nutritional and health-enhancing properties to attract the attention of consumers. Synthetic pigments are widely used in various industries, including food, textiles, cosmetics, and pharmaceuticals. Although synthetic pigments are more attractive and widely used in the global market, they can cause many side effects such as hyperallergenicity, carcinogenicity and other toxicological problems. Recent studies have revealed that microorganisms are a promising source of natural colours, and they have attracted the attention of the industry, as the production of new, safe, easily degradable, environmentally friendly pigments with no adverse effects is becoming more and more relevant.

The aim of the work was to isolate pigmented microorganisms from environmental samples, select fermentation conditions, isolate pigments from microorganisms and check their antimicrobial activity and other properties.

Pigments have been isolated from various sources such as soil, food waste, flour, etc. Growth parameters of pigment-producing microorganisms such as growth temperature, pH, tryptone and NaCl salt concentration in the medium were optimised to evaluate pigment production. After fermentation, the pigments were isolated by cell lysis with an ultrasonic bath and solvent extraction. During the research, five types of pigments were extracted from six investigated microorganisms. The properties of the extracted pigments, such as antimicrobial activity, were investigated.

Microorganism dyes are not only environmentally friendly, but it can also satisfy the need for visually appealing colours and enrich foods with beneficial properties. Due to their unique properties, microorganism derived pigments can be used as food dyes and as food supplements.

**Keywords:** pigments, microorganisms, isolation, fermentation

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## PRESSURIZED LIQUID EXTRACTION OF BIOACTIVE COMPOUNDS FROM *PARMOTREMA PERLATUM*: OPTIMIZATION AND ANALYSIS

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*Parmotrema perlatum* (family *Parmeliaceae*), also known as Black stone or stone flower, is a lichen found in the Southern and Northern hemispheres and is utilized as a spice in India and China. Although it is documented that many lichen-derived substances possess a broad spectrum of bioactivity, studies on characterization and especially the recovery of bioactive components utilizing sustainable extraction technologies are relatively scarce. This study evaluated pressurized liquid extraction (PLE) as a sustainable technique for recovering lichen-specific functional components. Firstly, liquid chromatography with tandem mass spectrometry (LC-MS/MS) indicated that lichen extracts were characterized by lecanoric-, gyrophoric- and usnic acid. In that direction, a central composite design and response surface methodology was used to assess the effect of extraction parameters, including solvent (ethyl acetate-ethanol), time (15–45 min) and temperature (40–120 °C) on the recovery of the three main components, chosen as response factors. The highest concentrations for lecanoric- (ca. 350 mg g<sup>-1</sup> of extract), gyrophoric- (ca. 287 mg g<sup>-1</sup> of extract), and usnic acid (ca. 60 mg g<sup>-1</sup> of extract) were observed with ethyl acetate. Analysis of variance indicated that, the extraction temperature was a critical factor, with high recoveries recorded under mild conditions (40–50 °C). Furthermore, lecanoric and gyrophoric acid extraction was favored by short extraction times, whereas usnic acid required more extended extraction periods. After numerical optimization under the selected constraints and considering all observed responses, the optimal extraction conditions were (pure ethyl acetate, 45 °C, and 24 min), under which all quadratic models were validated. Besides targeted substances, LC-MS/MS data revealed the occurrence of other depside and dibenzofuran derivatives. Conclusively, this study highlights the high efficiency of PLE in recovering rapidly fractions with high concentrations of the targeted bioactive molecules under mild conditions.

**Keywords:** *Parmotrema perlatum*, usnic acid, lecanoric acid, gyrophoric acid, pressurized liquid extraction

**Acknowledgments.** The mentorship fund of the Kaunas University of Technology supported this study.

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## PHYTOCHEMICALS IN TOMATOES

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Tomatoes (*Solanum lycopersicum*) are well known fruit fortified with health-promoting phytochemicals, where phenolics (phenolic acids and flavonoids) and carotenoids (lycopene,  $\alpha$ -, and  $\beta$ -carotene) are the main bioactive compounds present in ripened tomatoes. The aim of the present study was to evaluate chemical composition of different size and color tomatoes. Chemical composition – content of lycopene,  $\beta$ -carotene, soluble solids, total phenolics and flavonoids were determined in tomato cultivars grown in plastic film greenhouse during winter season with additional LED lighting (results 2019–2021 year). The study examined six varieties of tomatoes – ‘Forticia’ F1 – red, average mass of fruits 135.7 g, ‘Encore’ F1 – red (87.16 g), ‘Diamont’ F1 – red (105.7 g), ‘Strabena’ F1 – red cherry (18.25 g), ‘Bolzano’ F1 – yellow (61.76 g), ‘Chocomate’ F1 – brown (69.5 g). UV spectrophotometer UV-1800 was used for the absorbance measurements, the content of soluble solids content (the degree Brix) was measured with a refractometer. The obtained results showed that there were significant differences in the mean values between analysed parameters according to the colour and size of tomato fruit. The content of lycopene differed as follows: red cherry>red>brown>yellow, but content of  $\beta$ -carotene: red cherry>red> yellow> brown. The content of soluble solids changed from 4.57 Brix° (red varieties) till 7.5 Brix° (red cherry). The content of phenolic compounds was by 27.6%, 26.4% and 10.4% more in cherry tomatoes than brown, red and yellow tomatoes, respectively. The highest content of flavonoids was determined in yellow tomato variety and the regularity is as follows: yellow >brown>red cherry>red.

**Keywords:** lycopene, phenolics, flavonoids, tomatoes colour

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**SESSION V**  
**TRENDS AND INNOVATIONS IN**  
**PLANT-BASED PRODUCT**  
**DEVELOPMENT**

## DOES SURFACE MORPHOLOGY OF PLANT-BASED PROTEIN POWDERS INFLUENCE SENSORY PERCEPTION?

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Feeding the growing population of the world and sustainability are major drivers for food ingredient and food producers. Therefore, the use of alternative proteins in food is a major trend in the food industry. Plant proteins are high-potential alternatives for animal proteins but unfortunately, most plant-based protein powders are not well soluble and may be perceived as gritty or grainy in liquid dairy alternatives. Our previous instrumentally and sensorially measured particle size analysis (PSA) had revealed the lack of a clear connection between the instrumental and sensory results for particles < 200  $\mu\text{m}$  (D90) indicating that other particle properties like shape and surface roughness need further exploration. According to this, the aim of our current study was to explore the morphology of the plant-based protein powder particles using scanning electron microscopy (SEM). Considering the former PSA and sensory analysis results, five plant-based protein powders were selected for the SEM study including one oat and four pea samples. The samples were prepared as 6% water dispersion, which were heated for 15 minutes at 85 °C, cooled down in an ice-water bath, vitrified and lyophilized. SEM analysis revealed that large particles, which were not detected sensorially were also smooth and round, while sensorially coarse ones were more irregularly shaped and porous. For future work, it is recommended to correlate the SEM results with the production process of the plant protein powders with the aim to produce the best suited products for liquid dairy analogues.

**Keywords:** plant proteins, scanning electron microscopy, particle morphology, sensory analysis, particle size analysis

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## EFFECTS OF SELECTED THERMAL TREATMENTS ON THE BIOACTIVE AND TEXTURAL PROPERTIES IN BELL PEPPERS

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Because of the impact of high temperature, unprocessed plant raw materials acquire different bioactive properties and their organoleptic qualities, such as elasticity or hardness, are changed. The aim of the study was to investigate the effect of selected thermal methods such as cooking, steaming, microwave or grilling on the total antioxidant capacity (TAC) and the content of polyphenolic compounds in red, yellow and green bell peppers. The TAC was analysed for both fresh and treated thermal bell peppers. Thermal treatments were performed in standard times for individual methods in consumer use.

In methanol extracts, the antioxidant potential was assessed using the DPPH, ABTS and FRAP methods, as well as the content of polyphenols using the Folin-Ciocalteu method. All methods of thermal treatment caused significant ( $p \leq 0.05$ ) changes in the TAC and in the total polyphenol content in bell peppers. The TAC was reduced the most by microwaves and traditional cooking (hot water). The greater reduction of the total polyphenol content was observed in bell peppers, which has undergone traditional cooking. The smallest changes in the antioxidant activity and the content of polyphenolic compounds were observed in bell peppers subjected to steam cooking.

All analysed bell pepper colour varieties were also texturally tested using the double bite test. The conducted analyses showed significant changes in the elasticity and hardness of the analysed bell peppers because of the use of appropriate methods of thermal treatment. Reducing the elasticity and hardness of the tested bell peppers was observed to the greatest extent because of the microwave process. On the other hand, the steam cooking process caused the smallest changes in the elasticity and hardness of the tested bell peppers.

**Keywords:** thermal treatments, bell peppers, antioxidants, polyphenols, hardness

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## CAN HOP TERPENIC VOLATILES HAVE IMPACT ON BEER VOLATILE PROFILE?

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The development of new and distinctive beers is a trend that daily challenges brewers. Consumers' engagement is related to beer aroma characteristics that are essentially associated with its volatile components. In fact, hops (one or blended hops, per beer) have been used to provide beer bitterness and/or aroma, which had led to a diversity of beer styles. Despite brewers' empirical knowledge about hops impact on beers sensory characteristics, the chemical information on this impact is restricted to few components. Thus, the main objective of this work was to disclose the relation between hop or blended hops on beer terpenic composition, using a methodology based on headspace-solid phase microextraction (HS-SPME) combined with comprehensive gas chromatography – mass spectrometry with time-of-flight analyser (GC×GC-ToFMS). In this work, eight hop varieties and six beer styles were studied.

A total of 102 and 72 terpenic compounds were identified, in hops and beer, respectively. There was a significant increase of new identified compounds comparing with reported data, namely: from 44% (Nugget hop) to 61% (Mosaic hop) in hops, and for beers, new identified volatiles varied between 46% (Pilsner) to 83% (Belgian dark strong ale). To disclose the relation between hop or blended hops on beer terpenic composition, a reconstruction of the beer volatile composition was performed using only hops data according to their percentage used in each beer style. A similar clustering was achieved between the beers data and the reconstructed beer volatile composition using hops data, which allows inferring that the beers terpenic profile is modulated by the terpenic composition of the respective hops. Therefore, this methodology may be further used as a tool to predict hops impact on beer sensorial characteristics (e.g. citrus, woody, or floral aromas).

**Keywords:** beer, hops, terpenic volatile composition, aroma compounds, advanced chromatographic methodology

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## THE EFFECT OF THE RATIO OF LACTIC ACID BACTERIA AND YEASTS IN KVASS FERMENTATION

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Kvass is non-alcoholic beverage, produced from rye malt or dried rye bread by natural fermentation. Traditionally, yeasts participate in the fermentation of kvass, but the addition of various lactic acid bacteria (LAB) allows accelerating the fermentation process and adding unique taste and aroma to kvass. The aim of this research was to compare physicochemical and sensory characteristics of kvass fermented in different combinations of *Sacharomices cerevisiae* and LAB strains.

The kvass mash was made using special bread produced for making kvass and beer. Baker's yeast and three commercial LAB strains were used to ferment the mash. The ratio of yeasts and bacteria was as follows: 100% yeasts; 50% yeasts:50% bacteria; 20% yeasts:80% bacteria and 100% bacteria. The pH, soluble solids ( $^{\circ}\text{Bx}$ ), titratable acidity (TTA,  $\text{g L}^{-1}$ ) and flavor characteristics of the kvass samples were analyzed after 12, 14 and 16 hours of fermentation.

The results showed that kvass fermented only by yeasts was over-fermented and had a bitter, unpleasant taste, and conversely, kvass fermented by LAB alone was sweet and almost unfermented. In terms of sensory properties, the most acceptable beverages were obtained in both 50:50 and 20:80 combinations of yeasts and bacteria, while the taste and physicochemical properties depended significantly on the bacterial strain used in the fermentation. In conclusion, the physicochemical parameters of kvass are more influenced by the selection of LAB strains and less by the ratio of LAB and yeasts.

**Keywords:** kvass, fermentation, acidification, lactic acid bacteria

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## EFFECT OF HONEY ORIGIN AND YEAST TYPE ON THE BIOACTIVE COMPOUNDS IN MEAD

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Mead is a type of wine made from honey and water, and its quality can vary depending on several factors, such as honey origin and yeast type. The quality of the honey used to make mead is crucial to its overall taste and aroma. Locally-sourced honey is generally preferred for making mead. The aim of research was to evaluate effect of honey origin and yeast type on the quality of mead. Must was prepared using honey, water and Japanese quince juice. In the first stage of the research five types of yeasts were tested, namely, Uvaferum CM (Eaton), Lalvin EC1118™ Lalvin ICV K1-V1116™, Lalvin 71B™ (Lallemand) and M05 Mead yeast (Mangrove Jack's). In the second stage honey of different origin, namely, buckwheat, linden, rapeseed, spring flower, heather, vetch, and multifloral were tested. Mead was fermented for four weeks and for all samples the total phenol and flavonoid content, and antiradical activity was evaluated. The total highest phenols content was presented by a sample fermented with Lalvin ICV K1-V1116™ whereas the lowest for sample fermented with Mead yeast. Total phenol compounds are an important ingredient in honey wines as they promote sensory and qualitative properties such as taste, aroma and astringent taste. The highest flavonoid content was in sample fermented with Lalvin 71B™ yeast, whereas the highest antiradical activity was determined in samples fermented with Mead yeast and Lalvin 71B™. Significantly higher phenol content was determined in samples made from buckwheat honey. Mead is a source of bioactive compounds and selection of honey and yeast type is significant for increasing mead bioactivity.

**Keywords:** honey, yeast, mead, phenol, antiradical activity

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## MAPPING OF VOLATILE COMPOUNDS FROM PORT WINE FORTIFICATION SPIRITS: A STEP FORWARD ON THE ROUTE OF SUSTAINED INNOVATION

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Port wine is a fortified wine produced in the Douro Appellation (Portugal) under very specific conditions resulting from natural and human factors. Its intrinsic aroma characteristics are modulated upon a network of factors, such as fortification with grape spirit (*ca.* 77% v/v ethanol). The grape spirit comprises roughly one fifth of the total volume of this fortified wine, thus it is a potential contributor to the global quality of this beverage, including the aroma notes. Nonetheless, the information about the influence of the grape spirit on the final aroma of Port wine, as well as the grape spirit volatile composition, are extremely limited. This work intends to perform an in-depth mapping of grape spirits VOCS and to generate new data that may contribute for molecules' identification, by using multidimensional gas chromatography. To fulfill this goal, the experimental parameters of a methodology that combines the two-dimensional comprehensive gas chromatography-mass spectrometry with time-of-flight analyser (GC×GC-ToFMS) with a solid phase microextraction technique (SPME) were optimized to promote the best extraction efficiency and chromatographic separation. To test the applicability of this methodology, a set of grape spirits were analysed, which allowed the detection of hundreds of volatiles. This study adds further insights unveiling the complex nature of the grape spirits chemical volatile data, through the identification of compounds not yet determined in these matrices. These novel data may be useful in the production of Port wines that promote novel sensorial experiences, respecting tradition and quality of this highly recognized fortified wine.

**Keywords:** gas chromatography, microextraction technique, grape spirit, Port wine

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## PRODUCTION OF SPIRIT FROM JERUSALEM ARTICHOKES

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Jerusalem artichoke (*Helianthus tuberosus*) is a root vegetable that is native to North America and has a sweet, nutty flavour with a slightly crunchy texture. Jerusalem artichokes are a good source of dietary fiber, potassium, iron, and thiamin. They are also a prebiotic food containing a high amount of inulin, typically ranging from 16% to 20% of the total weight of the root. High content of carbohydrates shows its potential as raw material for spirit production. The aim of current research was to evaluate Jerusalem artichoke as a raw material for spirit production.

Fresh Jerusalem artichoke roots were crushed and juice was extracted and fermented using two yeasts appropriate for fast fermentation process – Turbo Carbo Yeast (Browin) and Turbo Rum yeast (Browin). For mash before fermentation pH, titratable acidity, soluble solids were analysed. During fermentation process changes in density were evaluated. Distillation process was performed using bubble cap plate column. After distillation, part of samples were filtered using charcoal to remove impurities and improve taste and aroma. For all samples ethanol content, volatile compounds were determined using GC and sensory evaluation was performed. Initial soluble solid content of Jerusalem artichoke juice was 19 Brix, and it was fermented up to 9% of ethanol with Rum yeast that provided also better sensory properties. After distillation aroma was specific and sharp, whereas filtration reduced total peak area of volatiles significantly.

Jerusalem artichoke is potential plant for production of neutral spirit without any distinct flavour, but it can still have a slight sweetness and the mouthfeel of spirit is described as smooth, velvety.

**Keywords:** distillation, spirit, Jerusalem artichokes, volatiles

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## EVALUATION OF PHYSICOCHEMICAL, PHENOLIC PROFILE AND ANTIOXIDANT CAPACITY CHANGES OF KOMBUCHA DURING FERMENTATION

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Kombucha is a slightly sweet, tangy, and effervescent fermented beverage that has recently become popular due to its reported health advantages. However, more research is needed to understand these potential benefits fully. This study aimed to determine the physicochemical and bioactive compound changes and the total antioxidant capacity of black tea kombucha during fermentation. The pH and total acidity were evaluated during sixteen fermentation days. As could be expected, pH reduced from an initial  $4.70 \pm 0.03$  to  $2.86 \pm 0.03$  while total acidity increased from  $0.60 \pm 0.04$  to  $11.62 \pm 0.20 \text{ g L}^{-1}$ . High performance liquid chromatography in tandem mass spectroscopy (HPLC-MS/MS) was successfully developed to analyze the changes of target constituents (carbohydrates, organic acids, phenolic compounds), resulting in the detection of twenty-four compounds. HPLC-MS/MS results further verified that lactic and acetic acid content increased as fermentation progressed. Sucrose content decreased, while changes in the most abundant phenolic substances revealed different patterns. The total phenolic content (TPC) and antioxidant capacity were evaluated with the Folin-Ciocalteu method, ABTS radical scavenging and CUPRAC assays. During fermentation, the TPC increased from  $525 \pm 3$  (day 0) to  $721 \pm 2 \mu\text{g GAE mL}^{-1}$  (day 16<sup>th</sup>). In the ABTS assay, the capacity of kombucha increased from  $1527 \pm 146$  to  $1767 \pm 35 \text{ mg TE mL}^{-1}$  by the 9<sup>th</sup> day, then decreased to  $1467 \pm 123 \text{ mg TE mL}^{-1}$  by the 16<sup>th</sup> day. In contrast, no significant changes in the antioxidant capacity were observed in the CUPRAC assay. Understanding and analyzing physicochemical and bioactive compound changes in kombucha during fermentation can help develop kombuchas with higher bioactive potential and improve knowledge on the kombucha fermentation process.

**Keywords:** kombucha tea, fermentation, bioactive compounds, antioxidant capacity

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## EFFECT OF CRANBERRY POMACE ON SMOOTHIE PROPERTIES FOR THE DEVELOPMENT OF FUNCTIONAL BEVERAGE

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Nowadays, the consumption of food products, which are ready to use and contain bioactive compounds, such as dietary fiber, has been increased. Smoothies are smooth consistency beverages, which usually contains fruit or fruit juice. These beverages may also be a suitable matrix for incorporation of probiotics. Cranberry pomace is a good source of dietary fiber and can be used to produce novel foods. Nevertheless, pomace may negatively influence the products' properties and acceptability. Enzymatic hydrolysis can be used to modify their dietary fiber composition and technological properties. The aim of this study was to evaluate effect of enzymatically hydrolyzed cranberry pomace on smoothie properties and probiotic bacteria (*Bifidobacterium animalis*) viability during 28 days of storage at 4 °C.

Two types of smoothies containing 5% of enzymatically treated cranberry pomace and one smoothie without pomace (control) were prepared from banana (10%), apple juice (30%), water (55%) and supplemented with *Bifidobacterium animalis*. Pomace was hydrolyzed using commercially available Novozyme A/S (Denmark) enzymes: Viscozyme® L and Celluclast® 1.5L. The addition of enzymatically treated pomace affected pH, titratable acidity, colour, sensory properties and reducing sugar content of smoothies. The control smoothie and smoothie prepared with pomace hydrolyzed with Celluclast® 1.5L showed higher counts of *B. animalis* not only at the end of storage, but also after *in vitro* digestion and can be used as vehicle of these probiotic bacteria during digestion.

The obtained results suggested the feasibility of incorporating enzymatically treated cranberry pomace as dietary fiber supplement for formulation of functional beverages containing probiotic bacteria.

**Keywords:** functional beverages, cranberry pomace, probiotics

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## BIOLOGICALLY ACTIVE COMPOUNDS IN WILD AND CULTIVATED CRANBERRIES AND BLUEBERRIES

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Blueberries and cranberries are among the best sources of biologically active compounds - flavonoids, anthocyanins, phenolic acids, and vitamins. The chemical composition of berries varies depending on the variety, growing conditions, stage of ripening, etc.

The aim of research was to determine and compare the content of total phenols, flavonoids, anthocyanins, vitamin C, soluble solids, and total acidity in wild and cultivated cranberries and blueberries. Berries were obtained from the local market in a stage of full ripeness. Spectrophotometer was used for the absorbance measurements, the content of soluble solids was measured with a refractometer, the content of vitamin C and total acidity – volumetrically.

The obtained results showed that the content of total phenols in cultivated cranberries was twice as high as in cultivated blueberries. The calculations showed a significant difference in polyphenol groups. The relative proportion of flavonoids changed as follows: wild blueberry < cultivated blueberry < wild cranberry < cultivated cranberry and a similar relationship was observed regarding anthocyanins. It means that phenolic acids dominate in cranberries, while flavonoids and anthocyanins are important in blueberries despite the origin. The content of vitamin C and soluble solids was by 42% and 40.2% more in cultivated blueberries than in wild blueberries, respectively. It was found that total acids in wild cranberries were on average six times higher than in blueberries. In general, we can conclude, that the most significant differences were found between chemical composition of wild and cultivated blueberries.

**Keywords:** phenolics, flavonoids, anthocyanins, berries

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## TEXTURE EVALUATION OF EDIBLE PEARLS FILLED WITH NATURAL JUICE

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There is a trend towards a healthier and more nutritious diet. Fruits and berries are a valuable source for this purpose. It is possible to obtain an innovative and interesting product for the consumer if fruit or berry juice is included in an edible casing.

The aim of this study was to develop edible pearls filled with natural berries juice having texture comparable to the commercial samples from market.

The hardness and elasticity of five natural berries juice pearls (with currant, blackcurrant, chokeberry, raspberry and apple juices in various combinations) were studied. Calcium chloride, sodium alginate and xanthan gum were used as coating material in the encapsulation process. The results were compared with two commercial samples.

The obtained results showed that apple-chokeberry juice pearls had a significantly harder texture than the commercial samples. On the other hand, the elasticity parameters of the analysed samples were not significantly different from the commercial samples.

The hardness and elasticity of our experimental pearls were in the same range (hardness 9.30–17.85 N and elasticity 0.16–0.22 mm) as the commercial pearls (hardness 8.05–11.75 N and elasticity 0.15–0.21 mm). This shows that pearls developed in the current study are equivalent to the commercial samples. In future research, it would be valuable to carry out a sensory evaluation to understand the consumer's opinion.

**Keywords:** edible coating, hardness, elasticity, natural juice

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**SESSION VI  
INNOVATIONS IN USE OF FLOURS  
AND POTATOES**

## APPLICATION OF MATHEMATICAL MODELING AS A TOOL IN THE USE OF RYE MALT TO BALANCE THE QUALITY OF RYE FLOUR

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Rye grain and flour quality are highly variable within one variety, depending on ripening and harvesting conditions. Starch quality and endogenous enzyme activity are essential indicators of rye flour baking properties. Optimum quality indicators for rye flour are Falling number (FN) 160–200 s, maximum viscosity 400–600 BU. To ensure the quality raw materials for bread production, rye unfermented malt is used as an enzymatic additive. Malt activity is characterised by Diastatic Power (DP), which may vary around DP 120–450. The aim of the work was to predict the amount of rye malt required to balance the quality of rye flour by modelling baking properties.

Rye flour with different enzymatic activities (FN 210, 262, 346 s) was used to develop the mathematical model. Five rye malt samples with DP 170, 179, 261, 362, and 408 were used, and malt was added in the amounts of 0.5, 1.0, and 1.5%. In total 45 samples were analyzed for the rheological and textural properties, the Falling Number, and  $\alpha$ -,  $\beta$ -amylase activity.

The enzymatic activity of  $\alpha$ -amylase for different malt samples ranged from 45 to 174 U g<sup>-1</sup>, whereas the  $\beta$ -amylase activity was 8.62–17.1 U g<sup>-1</sup>.

Adding less active malt (DP 120) at 1.5% concentration can achieve similar effect to the case when adding more active malt (DP 362, DP 408) in a lower concentration – 0.5%. The developed model will allow accurate determination of the malt amount addition required, thus reducing raw material consumption and costs.

**Keywords:** rye flour, rye unfermented malt, enzymatic activity, diastatic power, mathematical modelling

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## HULL-LESS BARLEY SOURDOUGH BREAD: COMPOSITION OF POLYSACCHARIDES AND TECHNOLOGICAL CHARACTERISTICS

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Hull-less barley flour is a highly valuable raw material containing unique nutrition composition with a high content of proteins, starch and non-starch polysaccharides. Hull-less barley flour can be used for the fermentation of sourdough. The starch and non-starch polysaccharides (NSP) of the grain transform during processing and affect bread's chemical and physical characteristics. The aim of the study was to determine the content of glucans, mannans and fructans, total dietary fiber (TDF), and analyze their changes in hull-less barley and wholegrain wheat breads in comparison to their content in flour, as well as to characterize the impact of polysaccharides on the hardness, specific volume, and porosity of bread. To perform an experiment hull-less barley bread and wholegrain wheat bread were fermented in three ways: fermented with spontaneous hull-less barley (SHB) sourdough, germinated hull-less barley (GHB) sourdough and fermented with yeast. When using hull-less barley sourdough, the content of  $\beta$ -glucans in the wholegrain wheat bread increased twofold. Principal component analysis showed that wholegrain wheat breads with GHB sourdough had higher content of starch, NSP and pronounced hardness. Higher content of the TDF together with higher specific volume and porosity differentiate wholegrain wheat bread fermented with yeast from other breads studied. Hull-less barley bread fermented with SHB sourdough was characterized by higher starch and TDF content, but fermented with GHB sourdough – by higher total glucans and NSP. A decrease of the content of total glucans,  $\beta$ -glucans, mannans and fructans was observed during processing of bread.

**Keywords:** hull-less barley, hull-less barley sourdough, non-starch polysaccharides,  $\beta$ -glucans, fructans

**Acknowledgements.** This study was supported by Latvia University of Life Sciences and Technologies program project G14 “Biologically active compound content in the developed barley bread» and project No. 8.2.2.0/20/1/001 “LLU Transition to a new funding model of doctoral studies”.

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**APPLICATION OF ACORN FLOUR IN LEAVENED BREAD PRODUCTS**

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The fruits of oaks (*Quercus* spp.), commonly known as acorns, represent a forgotten and sustainable food source that deserves attention because of its interesting composition in terms of various bioactive compounds. Acorn flour (AF) applications in leavened products is currently limited. This work aimed to investigate the physical-chemical characteristics of acorn and wheat flours, the dough making potential of their mixtures, and the effect of acorn flour (0–50%) on bread quality (volume, texture, moisture).

Acorn flour (AF) contained 56% carbohydrates, 6.6% protein, 6.0% fiber and 20.1% fat. AF had higher water (69.6%) and oil holding capacity (45.5%), higher gelatinization temperature (72 °C), and lower peak viscosity (324 BU, visco amylograph) than wheat flour (WF). AF and WF mixtures were able to form a workable dough up to 20% substitution (Farinograph analysis) with increased water absorption, development time and comparable stability as compared to WF. AF addition to wheat in bread enhanced bread crumb hardness, darkness, moisture content, and decreased specific volume and cohesiveness. Shelf-life analysis (7 days, 25 °C) revealed, as expected, increasing hardness and decreasing cohesiveness of all samples with storage time. AF addition accelerated hardening and retarded cohesiveness loss of bread crumb during storage. Addition of an extra 3% water in bread formulation increased dough development time and stability, resulting in a softer bread with higher specific volume.

This work illustrated the possibility of using up to 20% AF for producing bread products with a structured dough, indicating an interesting application of AF in leavened products.

**Keywords:** acorn, dough, bread, shelf-life

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## THE EFFECT OF SORGHUM FLOUR (*SORGHUM BICOLOR* [L.] MOENCH) ON BREAD STALING: FROM MACROSCOPIC TO MOLECULAR PROPERTIES

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Sorghum is a cereal of a great interest due to its climate resilience and valuable nutritional profile (high content of bioactive compounds). The inclusion of sorghum flour in staple foods such as bread is a strategy to improve breads nutritional value but, at the same time, a technological challenge. Bread staling assessment is an important task to assess the quality of sorghum-composite breads. To date, the literature on this topic is scarce. Therefore, the aim of this work was studying the staling process (over 7 days of storage) in conventional wheat bread (STD) and breads in which 10 (S10), 20 (S20) and 30% (S30) of wheat flour was substituted with sorghum flour. Bread staling was studied considering macroscopic (specific volume, texture, moisture content and water activity), mesoscopic (freezable water content and retrograded amylopectin) and molecular ( $^1\text{H}$  NMR molecular mobility) properties. An increase of hardness and a reduction of specific volume, cohesiveness and springiness were found in S-breads. Moreover, both a higher freezable water content and  $^1\text{H}$   $T_2$  mobility (for the population at highest mobility), and a lower  $^1\text{H}$  FID mobility (for the population at lowest mobility, related to rigid starch domain) were found in S-breads. The presence of the biopolymers such as kafirin proteins, fiber, and poorly accessible starch, may have weakened the solids-water interactions in fresh S-products. These changes were evident during all storage time. Alternative strategies could be applied to improve sorghum bread quality and stability during storage, such as fermentation with proteolytic and exopolysaccharides-producing lactic acid bacteria strains.

**Keywords:** sorghum, composite bread, staling,  $^1\text{H}$  NMR mobility, thermal properties

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## EFFECT OF SELECTED LACTIC ACID BACTERIA FERMENTATION ON SORGHUM TECHNO-FUNCTIONAL PROPERTIES

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Sorghum is a climate-resilient, gluten-free crop with a high presence of bioactive components. However, sorghum proteins (kafirins) are highly hydrophobic and poorly digestible. Moreover, sorghum starch is trapped in the protein matrix and has poor technological performances. Consequently, the formulation of good quality leavened bread with sorghum flour is challenging. Fermentation is a sustainable biotechnology that can improve the nutritional and technological functionalities of cereals. This study aimed to evaluate the effect of fermentation of sorghum flour with lactic acid bacteria (LAB) strains (*Lactobacillus delbruekii* subsp. *bulgaricus*, *Lactocaseibacillus casei*, *Leuconostoc* spp.), which were selected according to their proteolytic, flavour and exopolysaccharides (EPS)-producing activities. To assess the growth capacity of bacteria on sorghum flour, the sourdough's pH, total titratable acidity, and bacterial count were analysed. Colour and antioxidant activity by DPPH assay were also analysed. The sourdough's rheological properties, thermal properties by differential scanning calorimetry and proton molecular mobility by  $^1\text{H}$ NMR, were evaluated. All LAB strains showed excellent growth capacity on sorghum substrate, reaching values of up to  $10^9$  CFU  $\text{g}^{-1}$ , and pH between 4.0 and 4.3. The samples showed a pH-induced colour change, probably affecting the phenolic compound, with an increase in  $a^*$ ,  $b^*$  and  $L^*$  values, with a resultant change from a greyish to a more pinkish colour. Fermentation changed the gelatinization properties of the samples and showed an increase in viscosity probably due to changes in the protein and starch fractions, and the possible production of EPS. These results demonstrate that the fermentation with the LAB strains studied may be a potential strategy to improve sorghum-based bread.

**Keywords:** sorghum, fermentation, functional properties, lactic acid bacteria

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## EFFECT OF GRAPE POMACE POWDER ON THE FRESH TAGLIATELLE GLUTEN NETWORK AND SENSORY PROPERTIES

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Grape pomace contains significant amounts of substances that can be considered beneficial to health indicating that this grape by-product has a great potential to be used as functional ingredient in different kinds of food. Pasta is a traditional cereal-based product, which represents a suitable product for the addition of nutrients because it is accepted worldwide due to the low cost, easy production and sensory attributes. From a technological point of view, the exclusive use of durum wheat semolina ensures some desirable parameters in the cooked pasta, such as good texture, resistance to surface disintegration, and retention of a firm structure. Thus, the replacement of semolina presents a major technological challenge. To the best of our knowledge, no studies of the impact on the quality of the gluten network of pasta fortified with grape pomace powders have been found in literature. The objective of the present work was to evaluate the incorporation of grape pomace powder in the preparation of fresh tagliatelle pasta. On this basis, we studied the effect of the replacement of semolina, with two different amount of grape pomace powder (5 and 10%) on fresh tagliatelle pasta protein polymers, by size-exclusion high performance liquid chromatography (SE-HPLC) in order to gain a better understanding of possible interactions at the molecular level. The polymeric protein extractability and disulphide bonds of the tagliatelle samples were evaluated as predictors of the pasta sensory properties and the chemical quality was also analysed.

**Keywords:** grape, pomace, pasta, gluten network, sensory quality

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## THE STUDY OF TECHNOLOGICAL PROPERTIES OF AMARANTH, AMARANTH-BUCKWHEAT, AND AMARANTH-OAT PASTA

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Amaranth flour is a valuable raw material with a unique chemical composition; however, it is gluten-free, which significantly affects the technological properties of the product. The study aimed to evaluate the technological properties of amaranth, amaranth-buckwheat, and amaranth-oat pasta in comparison with wheat semolina pasta. Eight samples were analyzed: control - wheat semolina pasta, amaranth flour pasta (100%), amaranth and buckwheat or oat flour blend pasta with a flour ratio of 85:15, 70:30, and 50:50. Beetroot powder for colour and plantain powder as a binder were added to all pasta samples. As part of the study, the water absorption capacity (WAC), the boiling time, and the colour before and after cooking were determined. The lowest WAC was determined for amaranth pasta, which was  $1.65 \pm 0.01 \text{ g g}^{-1}$ , while amaranth-buckwheat and amaranth-oat pasta had a higher WAC: from  $1.77 \pm 3.02 \text{ g g}^{-1}$  to  $2.02 \pm 0.01 \text{ g g}^{-1}$  in amaranth-buckwheat pasta, and from  $1.67 \pm 0.01$  to  $1.95 \pm 0.01 \text{ g g}^{-1}$  in amaranth-oat pasta, however, WAC was significantly lower compared to the control sample -  $2.8 \pm 0.02 \text{ g g}^{-1}$ . The boiling time for amaranth, amaranth-buckwheat, and amaranth-oat pasta was between 12–14 min, which is significantly longer compared to the control sample – 8 min. The highest  $L^*$  and  $b^*$  values were shown by the control sample ( $80.06 \pm 2.06$  and  $23.10 \pm 4.60$ ), while the lowest  $L^*$  value was for the amaranth-buckwheat pasta in the ratio 50:50 ( $50.91 \pm 1.27$ ), however, the  $L^*$  value significantly decreased for all samples after boiling. The  $b^*$  value decreased for the control sample, while it increased for the amaranth, amaranth-buckwheat, and amaranth-oat pasta after boiling. Thanks to the beetroot powder, amaranth, amaranth-buckwheat, and amaranth-oat pasta showed a high  $a^*$  value, but the colour was not stable during boiling.

**Keywords:** buckwheat, oat, water absorption capacity, colour, boiling time

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## HIGH MOISTURE MICROWAVE TREATMENT MODULATES FUNCTIONAL AND PASTING CHARACTERISTICS OF BUCKWHEAT FLOUR

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One of the pseudocereals, which could be used as a functional gluten-free alternative is buckwheat. Therefore, there is a considerable interest in buckwheat for the production of nutraceutical preparations; it is considered to have potential for “functional food” development as it can provide health benefits beyond basic nutrition. However, buckwheat is not only used to improve the nutritional profile of products, but also to improve their physical and sensory quality, especially in the gluten-free products. Buckwheat do not contain any gluten-type proteins, which results in serious technological problems in buckwheat-based bread manufacturing. Heat-moisture treatment (HMT) is used for improving of poor functional properties of native starch and is particularly favourable for food applications. Several studies have demonstrated that HMT significantly alters the molecular structure and physicochemical properties of chestnut, corn, rice, potato, and sorghum starches. The main objective of the study was to analyze the impact of microwave radiation in the conditions of preset initial moisture content at 20% and 30% and heated for 4 or 8 min in cycles of MW exposure/rest of 20/40 s for Polish and Spanish buckwheat varieties. The viscometric profiles of flours in correlation to techno-functional properties of hydration, and colour characteristic of flours were assessed. The important factor influencing the changes was initial moisture content. The more pronounced effects were observed for 30% of initial moisture and 8 min treatment. The peak and final viscosities were lowered. Heating resulted in changes in pigmenting by lowering luminosity and hue and increasing chroma.

**Keywords:** buckwheat flour, microwave radiation, functional properties, pasting properties

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## HIGH MOISTURE MICROWAVE TREATMENT MODULATES FUNCTIONAL AND PASTING CHARACTERISTICS OF TEFF FLOUR

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Teff (*Eragrostis tef*) is an annual grass native to Ethiopia. Teff has an attractive nutrition profile, high in dietary fibre, iron, protein and calcium. Being minor cereal, it is considered gluten-free what creates wide range of possibilities for its usage. Recently its cultivation has started also in Europe, especially Spain. There are several different varieties of teff, but the differentiation based on cultivar name/number is more pronounced in country of origin (Ethiopia), while in Europe is the colour – white or brown, which distinguishes the cultivars. Physical treatments are being considered as alternatives to improve the technological properties of various gluten-free flours. Heat-moisture treatment (HMT) is used for improving of poor functional properties of native starch and is particularly favourable for food applications. Compared to conventional HMT processes, the use of microwave radiation (MW) has been proven to be one of the most attractive treatments due to its low cost and high efficiency in heat transmission. MW treatment has also demonstrated a capability to modify the functionality of the flours. The following study assessed the impact of microwave radiation in the conditions of pre-set initial moisture content of 20% and 30% and heating for 4 or 8 min in cycles of MW exposure/rest of 20/40 s for white and brown Spanish teff varieties. The colour changes and techno-functional properties of hydration characteristics correlated with viscometric profile were evaluated. The important factors impacting the differences were initial moisture content and the variety of teff. The viscometric curves were smoothen revealing higher stability of the paste.

**Keywords:** teff flour, microwave radiation, functional properties, pasting properties

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## PROTEIN ENRICHMENT OF WHEAT BREAD USING DEFFATED HAZELNUT AND WALNUT MEAL AS BY-PRODUCTS

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Bread is a staple food and consumers are looking for a product that not only tastes good, but also has a benefit, for instance – protein enriched bread. Bread, made using wheat flour (WF), mostly contains carbohydrates and some protein. A part of WF can be replaced by other flours with high protein content resulting in protein enriched bread. To increase protein content, researchers add pulse flour, nuts, protein isolates. Nuts are rich in unsaturated fatty acids, high-quality proteins, carbohydrates, and other bioactive molecules (e.g., phenolic compounds, vitamins). With the increasing market need of nut lipids, large amounts of defatted nut meal as by-product is produced. However, defatted nut meal is usually used as forage or fertilizer resulting in a waste of high-quality protein. It is essential to improve the utilization and the economic value of the defatted nut meal to encourage the development of nut industry. There is not much information about using defatted nut meal to increase protein levels in bread. Therefore, the main objective of this study was to evaluate the influence of addition of defatted hazelnut meal flour (HMF) and walnut meal flour (WMF) on WF technological properties and bread quality. Comparative study was carried out using defatted lupine flour (LF). The amounts of additives for bread fortification (17% WMF, 22% HMF, and 25% LF) were chosen so that the bread could be labelled as a "high protein" product according to the Regulation (EC) No 1924/2006 on nutrition and health claims made on foods. The results showed that the addition of tested products increased water holding capacity (WHC) and water binding capacity (WBC) of WF but had no significant effect on oil holding capacity (OHC). HMF and WMF had the highest WHC, HMF – also the highest WBC. Regarding gel hydration properties, HMF and WMF had higher water solubility index (WSI) but lower water absorption index (WAI) than WF. All additives increased the hardness of WF dough and bread (mostly LF and HMF), while 3% gluten addition significantly reduced the hardness of both dough and bread. In terms of sensory evaluation, bread with addition of WMF was the preferred bread by the consumers, while the bread with the addition of LF was the least liked.

**Keywords:** bread, protein, lupine, hazelnut, walnut

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## EVALUATION OF WHEAT BREAD QUALITY WITH LEGUMES BLENDS

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Wheat bread has been one of the staple foods around the world for thousands of years, widely consumed in daily diet. Eating bread provides energy because it contains carbohydrates, fibers, proteins, vitamins, minerals and biologically active compounds. Legumes are a type of plant-based food that includes beans, lentils, peas and chickpeas. According to the World Health Organization (WHO), legumes are an essential part of the daily diet, providing a cheap, sustainable intake of protein, carbohydrates, fibre, minerals and vitamins. The aim of this research was to evaluate quality of wheat-legume bread depending on ingredients used.

In the research, 16 different flour blend samples for bread with bean, fava bean and brown pea flour and brown pea protein concentrate were prepared. Legume flour and brown pea protein concentrate was added in the amount of 5–25%. For bread samples following quality parameters – moisture, colour, texture, baking loss, and nutritional value were analyzed.

The moisture content of wheat bread with legume flour was significantly affected by both the type and quantity of added legume, which is indirectly related to the water-binding capacity of the flour and the proportion of water added. The colour of the crumb of the analysed wheat bread samples with different types of legumes was significantly affected by the type and amount of added legumes – total colour difference ( $\Delta E$ ) was between 0.69–9.30. The addition of 5–15% pea protein concentrate to wheat flour did not significantly affect ( $p>0.05$ ) the hardness of bread samples, whereas the addition of fava bean, bean and gray pea flour significantly affected ( $p<0.05$ ) the hardness of bread.

**Keywords:** bread, grey pea, fava bean, pea protein concentrate, quality

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## THE USE OF DURUM WHEAT OIL IN THE PREPARATION OF FOCACCIA: TRADITION, INNOVATION, AND SUSTAINABILITY

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Focaccia is an Italian garnished flat bread, which is differently topped according to regional taste and availability. However, its constant peculiarity is the high amount of oil added to the dough and on the surface, which influences its chemical, physical and sensory properties.

This work, with the aim of improving the nutritional features of focaccia, proposed the use of an innovative oil, namely durum wheat oil, and evaluated its effects, in comparison with olive oil and sunflower oil.

Durum wheat oil was rich in PUFAs ( $60.5 \pm 0.06\%$ ), nevertheless, the focaccia with durum wheat oil was more resistant to oxidation than the one prepared with sunflower oil. These results were due to the higher content of antioxidants, principally tocotrienols, in durum wheat oil ( $1020 \text{ mg kg}^{-1}$ ) than in sunflower oil ( $70.2 \text{ mg kg}^{-1}$ ). However, focaccia with olive oil was the most resistant to oxidation, due to the abundance of MUFAs ( $72.5 \pm 0.1\%$ ) and phenols ( $81.5 \pm 3.2 \text{ mg GAE kg}^{-1}$ ) in the starting oil. The determination of volatile compounds mirrored these observations, especially in terms of markers of lipid oxidation, as confirmed also by the sensory analysis. The compression test (TPA) showed that durum wheat oil and olive oil determined lower values of hardness, and chewiness than sunflower oil, probably due to their content of diacylglycerols ( $4.49 \pm 0.04\%$ ,  $3.53 \pm 0.06\%$  and  $1.93 \pm 0.15\%$ , respectively).

Durum wheat oil could represent an alternative to the oils currently used, combining tradition, innovation, and sustainability, in a circular key.

**Keywords:** flat bread, focaccia, durum wheat oil, milling by-products

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## THE IMPACTS OF NITROGEN USE EFFICIENCY OF POTATO GENOTYPES ON ENVIRONMENTALLY FRIENDLY RAW MATERIAL PRODUCTION FOR STARCH PROCESSING

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Potato starch production in Latvia is increasing as demand for this product is growing due to the outstanding properties of potato starch, such as superior water binding capacity, good clarity and neutral flavour. The production of raw material using varieties with improved nitrogen use efficiency (NUE) is essential for optimal farming systems to reduce environmental pollution. The aim of this study was to detect the NUE of genotypes and to evaluate the impact of NUE on starch content in tubers (SC), tuber yield (TY) and starch yield (SY). The production of potato was evaluated in organic and integrated farming with three different nitrogen supplies over two years. The NUE of genotypes was estimated as the tuber dry matter yield per available nitrogen. The genotype impact on TY as partitioning of variance components (PVC) was 24 and 34% in all environments in 2020 and 2021, respectively. SC was mostly determined by genotype and PVC was 83 and 84% in 2020 and 2021, respectively. The impact of genotype on NUE was only 29 and 20% (PVC in 2020 and 2021), respectively. The relationship between TY and SC was not significant ( $p>0.05$ ) in both years, and NUE and SC correlated insignificantly ( $p>0.05$ ), with some exceptions. The correlation of SC and SY was significant ( $p<0.5$ ) and positive. NUE correlated positively and significantly with TY and SY. In conclusion, the raw material for potato starch processing was determined by TY, and SY was determined by SC. The higher NUE provided an increase in TY and SY but did not influence SC.

**Keywords:** potato, nitrogen use efficiency, starch content, starch yield, tuber yield

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## POTATO CULTIVARS WITH ELEVATED PROTEIN CONTENT – PROMISING SOURCE OF NOVEL FOOD

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Potato proteins are considered to be one of the most valuable plant origin foods for human consumption. One of the largest groups of potato proteins is patatine, which has high potential to be used in the food industry as a novel food with foaming and emulsifying properties and good health benefits. Since patatine content is strongly dependent on cultivar, it could be used in potato breeding programmes to create potato cultivars with elevated content to develop new products. Potato genotypes were evaluated by pure protein and patatine content in four management systems with different nitrogen (N) supplies for two years.

The results of this study showed that crude protein in tubers of different genotypes varied from 4.69 to 16.17% D. Pure protein varied from 3.5% to 8.31% DW. Patatin relative abundance (PTA) ranged from 1.65% to 50.8% of the pure protein. The highest PTA was found for cultivars 'Verdi' (36.9–50.8%), 'Rigonda' (21.9–23%), 'Lenora' (19.3–27.4%), 'Brasla' (19.1–27.6%), and 'Imanta' (22.5–30.2%). The PTA of these cultivars exceeded the average of the tested (19) genotypes in both years of the study, although the difference between the harvest years was significant ( $p < 0.05$ ). The plant available nitrogen amount in soil did not affect PRA significantly ( $p > 0.05$ ).

**Keywords:** protein, patatine, health benefits, potato genotypes

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## VALORISATION OF AGRO-INDUSTRIAL BIOMASS FOR THE CULTIVATION OF EDIBLE MUSHROOMS

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Agricultural biomass is rich in lignocellulose components and various types of nutrients. The disposal of this biomass causes serious environmental issues. There is always a high demand of discovering agricultural waste management methods which are cost-effective and contribute to lower environmental pollution. Mushroom cultivation is an approach that fulfills these requirements. The objective of this study is to utilize agro-industrial wastes from Estonia such as hardwood sawdust and pomace for growing different mushrooms and to find their nutritional composition. As a part of this study, the edible mushrooms *Hericium erinaceus* were cultivated on different combinations of hardwood sawdust with growth supplements. The yield of fresh mushrooms ranged between 300 to 500 gram per 2 kilogram and the biological efficiency was around 76.7%. The proximate analysis of *H. erinaceus* showed 1.14% total dietary fiber, 2.62% total protein, 88.3% moisture, and 1.79% ash. The total phenolic content and DPPH assay values were 394.4 mg (Gallic acid equivalent) and 132.9 mg (Trolox equivalent) per 100 g of the fresh mushroom samples, respectively. The study indicates that agro-industrial biomass is a good source to cultivate mushrooms and one of the promising waste valorisation methods.

**Keywords:** agro-industry, wastes management, nutritional, valorisation

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**SESSION VII**  
**TRENDS IN PROCESSING OF**  
**ANIMAL ORIGIN PRODUCTS**

## ORGANIC MILK AS A MEDIUM FOR LACTIC ACID BACTERIA GROWTH: A REVIEW

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In recent years the demand for fermented dairy products is fast growing. Lactic acid bacteria (LAB) are of the major interest in the food industry due to their ability to form the quality and functionality of the product. Significantly higher LAB cell count, as well as their bacteriocinogenic potential, is presented in fermented organic (ORG) products as yoghurt and kefir, than in their conventional (CONV) counterparts. Still there is a lack of information about possible explanation and evidence of ORG milk as a better medium for LAB growth. The aim of the current review was to summarize findings of research articles on the organic milk composition, to find out possible differences between organic and conventional milk, to provide a credible explanation about their influence on more intensive LAB growth in organic milk. Monographic method was used in this study. The composition of organic milk may have potential benefits for the development of LAB due to the higher concentration of vitamins, amino acids, peptides and long chain fatty acids in it.

**Keywords:** organic milk, yoghurt, substrate

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## COMPOSITION, QUALITY AND VALORISATION POSSIBILITIES OF TRANSITION MILK

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The purpose of this article is to provide an overview of the results of the first stages of the project, which evaluated the composition and quality of milk from the 2<sup>nd</sup> to 5<sup>th</sup> postpartum milkings and developed a methodology for the determination of Ig concentration in the transition milk.

The levels of protein, dry matter and immunoglobulins in the transition milk highly correlated and decreased with each milking. Immunoglobulin levels (g kg<sup>-1</sup>) were 47.88, 30.69, 15.86, and 10.09 for the second, third, fourth, and fifth milkings, respectively. The strong correlation between the Brix of the milk and the levels of immunoglobulins allows selection of the milk used for preparation of the preparation on the basis of the Brix, easily determinable on site.

In freeze-dried preparation/product, the IgG content above 40% is considered optimal/sufficient. The technology developed enables this criterion to be achieved, if the Brix of the original milk is over 15. Based on the content of immunoglobulins in the milk, milk from second and third milking with Brix >15 are suitable for the preparation of Ig preparation. The content of immunoglobulins in the milk of the fourth and fifth milkings is already so low that with proposed, relatively simple, technology it is not possible to achieve a sufficient content of IgG in the preparation.

**Keywords:** transition milk, immunoglobulins, concentration technology

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## REFORMULATION APPROACHES TO REDUCE THE USE OF NITRATES AND NITRITES IN RIPENED SAUSAGES

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Wastes and by-products from agri-food chain, such as olive leaves, may contain highly valuable bioactive substances. Several studies showed the positive impact of the addition of Olive Leaf Extract (OLE), rich in polyphenols, on the oxidative and microbial stability of several vegetable foods, while the application on meat-based products has been less studied.

In this study the addition of OLE to ripened sausages have been investigated in order to limit the amount of nitrates and nitrites, which cause the formation of N-nitroso compounds. Samples of sausages with different nitrates, nitrites and OLE ratios were produced and compared to a control containing the maximum levels of nitrates and nitrites defined by Reg. (UE) n. 1129/2011.

The obtained results showed that the replacement of nitrates and nitrites with OLE did not affect the hygiene and safety microbiological parameters. Using OLE at the highest dose ( $800 \text{ mg kg}^{-1}$ ), alone or in combination with nitrates and nitrites at the lowest dose ( $75 \text{ mg kg}^{-1}$ ), did not cause any significant difference in moisture, pH, and  $a_w$  compared to control. The OLE addition further mitigated the pH increasement and positively influenced the textural parameters such as springiness and cohesivity. Colorimetric indices significantly depended on the addition of nitrates and nitrites, and yellowness was also influenced by the OLE. Accelerated oxidation stability tests highlighted the antioxidant effect of the extract.

**Keywords:** vegetable extract, by-products, additives, processed meat

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## INFLUENCE OF ULTRASOUND ASSISTED EXTRACTION ON THE MOLECULAR, RHEOLOGICAL AND TECHNOLOGICAL CHARACTERISTICS OF ACTOMYOSIN

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Efficient use of by-products can reduce environmental pollution and increase the added value of the meat industry. Protein-rich by-products, including bones or tendon fragments, can be an excellent source of protein such as actomyosin (AM), used in food production. AM is a valuable protein in terms of technology and nutrition. In this work, attention was paid to checking the effect of the use of ultrasound (US) on the improvement of extraction efficiency and the influence of the ultrasonic process on the technological and rheological properties of AM. AM protein was obtained by washing turkey meat with a high content of connective tissue, KCl, and K-phosphate buffer pH 7.0 twice, with modifications in the form of ultrasound. Actomyosin was obtained in buffers of different salt compositions and ionic strength. The resulting solutions were analyzed for protein content, and protein recovery; tested using dynamic oscillatory thermorheology to determine the modulus  $G'$  and  $G''$ . The particles were examined by Fourier Transform Infrared spectroscopy (FTIR) and the molecular weight by high-performance liquid chromatography (HPLC analysis using polarized light, refractometric and viscometric detectors. Actomyosin gels were also prepared and tested for their ability to water-holding capacity.

Ultrasonic modifications of the AM protein recovery process increase yield by up to 33%. Studies of dynamic oscillatory thermorheology, storage modulus  $G'$  and loss modulus  $G''$ , demonstrate that the actomyosin denaturation process occurs at higher temperatures in ultrasound treated samples. It has been also found that the ultrasonic process has a positive impact on the water-holding capacity of AM gels, this could be the basis for the application of this method in the industry.

**Keywords:** actomyosin, ultrasound, extraction, turkey, poultry

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## CHARACTERIZATION OF DIFFERENT STRUCTURED FOOD-GRADE DOUBLE-EMULSION FORMULATIONS

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The use of double-emulsion formulations in the food industry is a promising strategy to encapsulate and protect active substances, such as flavours, nutrients, probiotics, and to modify the texture and sensory properties of foods. However, the stability and quality of these formulations depend on various factors, such as the choice of ingredients, the processing conditions, and the storage conditions. In this study, we investigated the characteristics of water-in-oil-in-water emulsions structured in various ways (gelled external water phase with whey protein isolate and calcium chloride, gelled oil phase with carnauba wax and combination of both). The rheological features showed that all samples were gel-type structures with thixotropic behaviour. Viscosity curves indicated that while increasing the shear rate, the viscosity was decreasing in all double emulsions. The texture and the particle size of all samples differ – the firmest sample ( $0.69 \pm 0.03$  N) with the largest particles ( $D_{3,4} = 13.08 \pm 0.57$  nm) was observed in emulsion with gelled external water and oil phases. Besides that, the stability determined by the centrifugation method revealed that the most stable emulsion ( $1.25 \pm 0.13\%$ ) was with the gelled external aqueous phase, while the least stable was the emulsion with gelled oil phase ( $26.73 \pm 3.65\%$ ). The lipid oxidation was determined with p-anisidine and the value was ranging between  $142.60 \pm 5.22$  to  $220.95 \pm 2.54$ . To sum up, the characterization of different structured food-grade double-emulsion formulations was carried out in this study. The results showed that the emulsion characteristics were strongly affected by the type of structural materials and formation method.

**Keywords:** double emulsion, whey proteins, rheology, particle size, texture

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## CHEMICAL, METAGENOMIC AND SENSORY DIFFERENCES IN KIMCHI FERMENTED IN INDUSTRIAL AND LABORATORY SCALE

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Kimchi is a traditional Korean dish of fermented vegetables. It has gained popularity globally because of its organoleptic and nutritional properties. Moreover, Asian food consumption is on the rise in Europe and in Estonia. Therefore, an Estonian company specializing in vegetable farming has a plan to start producing kimchi in addition to sauerkraut.

The aim of this study was to compare kimchi fermented on industrial scale and in laboratory to understand how the environment affects fermentation processes and whether the differences between kimchi are due to raw material or rather fermentation conditions.

In the industry four different kimchis were made, 100 kg each. From each kimchi 4 kg were transported to the laboratory and divided into two batches. In both conditions the kimchis fermented for 14 days. For the analyses, samples were taken at seven time points when chemical, metagenomic and sensory analysis were conducted.

The results showed that microbiological community was similar in samples from both environments meaning that the main effects come from raw materials and the impact from the environment was less significant. The environment however affected the speed of the processes where the kimchi fermented in laboratory achieved optimal fermentation stage faster. Similar conclusions can be drawn from the results of sensory and chemical analysis. With this study we also found the optimal fermentation time.

Overall, we found that vegetable fermentation laboratory scale trials can be successfully transferred to the industrial scale.

**Keywords:** kimchi, fermentation, metagenomic analysis, sensory analysis, industrial scale

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## FERMENTED DAIRY BEVERAGES WITH ADDITION OF SELECTED MILK INGREDIENTS

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The aim of the study was to produce the fermented dairy beverages from skimmed milk (SM) with addition of membrane separation products of milk, probiotic starter cultures (*Bifidobacterium animalis* ssp. *lactis* BB-12 and *Lactobacillus acidophilus* LA-5) and  $\beta$ -galactosidase enzyme. Twelve combinations of fermented dairy beverages were manufactured using skim milk (SM), microfiltration permeate (PMF), microfiltration retentate (RMF) with probiotic strains BB-12 or LA-5, with or without addition of  $\beta$ -galactosidase. The ceramic MF membranes with 0.1  $\mu\text{m}$  pore diameter were used for separation. The number of *Bifidobacterium* was checked using TOS agar with selective supplement (MUP), while the number of *Lactobacillus* was determined using selective Rogosa agar. The following sampling plan was applied for microbial enumeration: after 24 hours of incubation at 37 °C, and after 168, 264, and 576 hours of storage at 6 °C. The beverages based on PMF and RMF enhanced the survival of probiotic bacteria during cold storage. The beverage RMF +  $\beta$ -galactosidase constituted the best environment in terms of probiotic bacteria survival. The initial number of *Bifidobacterium* was 8.17 log cfu mL<sup>-1</sup>, which decreased to 7.95 log cfu mL<sup>-1</sup> after 24 days of storage. In case of *Lactobacillus* the number of microorganisms was 9.57 and 8.44 log cfu mL<sup>-1</sup>, respectively. The beverage PMF without  $\beta$ -galactosidase supported growth of *Bifidobacterium*. An increase in the number of these microorganism was observed from initial number 7.42 to 8.65 log cfu mL<sup>-1</sup> after 24 days. The beverage based on SM and PMF with  $\beta$ -galactosidase did not support the growth of probiotic bacteria. The production of dairy beverages based on membrane separation products creates the possibilities for new product development with functional properties, comprising living probiotic cells, serum proteins, micellar proteins, mineral salts.

**Keywords:** probiotics, microfiltration,  $\beta$ -galactosidase

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## EFFECT OF AGING TIME ON THE RHEOLOGICAL PROPERTIES OF THE PLANT-BASED ICE CREAM MIX

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Over the past years, the adoption of a plant-based diet has been a growing trend and the demand for non-dairy products has increased. This rising tendency has also led to demand for plant-based ice-creams (PBIC), but scientific information regarding its technological features during production is scarce. Choosing suitable plant proteins as an alternative for milk proteins is a critical step due to their different functional properties such as low solubility, emulsifying and foaming properties. PBIC manufacture involves a two-step process: ice-cream mix preparation followed by ice-cream manufacture. Transformation an aqueous ice cream mix to a semi-solid foam structure, directly relates to the quality of final product. The aim of this research was to prepare ice-cream mixes using different plant protein source, investigate the effect of aging time on the rheological properties of mixes and compare them to dairy ice cream mix. The results showed that the viscosity of the dairy ice cream mix changed little and was stable after 96 h of aging time, having final viscosity of 452 mPa s. The viscosity of ice cream mix made with fava bean protein increased four times during aging ranging from 532 to 2293 mPa s. The viscosity of ice cream mixes made with pea or hemp proteins increased also, 2.5 or 3.3 times, respectively. This study demonstrated the importance of the plant proteins properties, which can affect the viscosity of the mixtures as the aging time prolongs. Additionally, overall sensory attributes of PBIC made with different plant proteins were evaluated and general acceptance of all ice-creams was confirmed.

**Keywords:** plant-based ice cream, plant protein, aging time, rheology

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## EVALUATION OF ROWAN FRUIT POMACE INGREDIENTS IN MEATBALLS BY CONVENTIONAL QUALITY CHARACTERIZATION AND UHPLC-QTOF-MS BASED UNTARGETED METABOLOMICS WITH MULTIVARIATE DATA ANALYSIS

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Recent studies on pomace valorization revealed the possibility of obtaining valuable ingredients for foods. In this study, rowanberry pomace (2%-AC) defatted with supercritical CO<sub>2</sub>, its EtOH/water extract (1%-E) and extraction residue (2%-R) were tested in meatballs. The samples were packaged under modified atmosphere (70% N<sub>2</sub> and 30% CO<sub>2</sub>) and stored at 4 °C. The lowest cooking loss was achieved, when the meatballs contained mainly fiber-rich 2%-R. Only in case of 1%-E, the pH of meatballs was significantly lower compared to the control sample, on the 6<sup>th</sup> day. During the same period, 2%-AC and 1%-E containing higher amount of bioactives decreased the yellowness (b\*) of meatballs. The meatballs with 1%-E demonstrated the highest DPPH radical scavenging capacity. The untargeted metabolomics approach (UHPLC-QTOF-MS followed by multivariate statistics) was applied for evaluation of the of pomace ingredient effect on the meatball chemical composition during storage, particularly for tracking oxidation related compounds. Preliminary data indicate that some metabolites, which may be related to the oxidation, such as 4-hydroxy-2-nonenal, hexanoylcarnitine and 6-hydroxypentadecanedioic acid were accumulated in the control sample at higher concentrations. The untargeted metabolomics demonstrated the opportunity for evaluating the effects of pomace ingredients, which may delay oxidation processes of meat.

**Keywords:** *Sorbus aucuparia* berry pomace, food metabolomics, lipid oxidation, antioxidants, meat quality

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## EFFECT OF DIFFERENT BLACKCURRANT SEED INGREDIENTS ON THE QUALITY OF PORK MEATBALLS

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The application of agri-food by-products, containing antioxidant phytochemicals, in meat products is gaining popularity to improve the overall quality, inhibit oxidation processes and formation of carcinogenic compounds in processed meat. Blackcurrant (BC) pomace is rich in antioxidants, particularly anthocyanins, and therefore may be promising ingredient for meat products. The aim of this study was to evaluate the effect of ground BC seeds and their residues after supercritical CO<sub>2</sub> (BC-ASC) and hydroethanolic (BC-EH) extractions on the quality parameters of pork meatballs, which were prepared with 1, 3, and 5% w/w of BC ingredients, packed under modified atmosphere and stored 1, 3 and 6 days at 4 ± 1 °C. BC ingredients increased the content of fibre and reduced cooking loss of meatballs in a dose dependent manner. The effect on product colour was also evident, particularly in case of adding BC-EH and BC-ASC. Thus, the lightness (*L\**) of meatballs decreased, while their redness increased (*a\**) due to the presence of dark coloured anthocyanins in blackcurrant. BC ingredients had slight effect on pH, while water activity was similar for all samples and storage days. In conclusion, the results showed that BC seed ingredients are potential fibre-rich materials to be used in meat products improving the overall quality and increasing nutritional quality related health benefits.

**Keywords:** *Ribes nigrum* L. seeds, pork meatballs, meat quality, antioxidants

**Acknowledgments.** This study was supported by the European Union's Horizon 2020 research and innovation program project ERA Chair for Food (By-) Products Valorisation Technologies of Estonian University of Life Sciences—VALORTECH (grant agreement No 810630).

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## A STUDY ON SOFTENING BONES OF BALTIC HERRING AND BALTIC SPRAT WITH ACETIC ACID AND HYDROCHLORIC ACID

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Baltic herring and Baltic sprat are some of the most common species of fish in the Baltic Sea. Due to their low price and small size, these fish are suitable for making breaded fish. So far, the problem has been the sharp and hard bones if using dressed fish.

The aim of the work was to find a regime to soften the bones of Baltic herring and sprats and make them more acceptable for people. Experiments with hydrochloric acid and acetic acid were carried out. Acetic acid was not suitable for softening bones, hydrochloric acid however had a positive impact. Different regimes were tested to find out the optimum processing time and concentration to process both species that were caught at different seasons. The results of our research showed that Baltic herring caught in the autumn had the strongest bones and needed 2.5 + 2.5 h to be processed in 1.5% hydrochloric acid and in 3% sodium carbonate for neutralization. Baltic herring caught in spring had to be processed for 1.5 + 1.5 h, respectively. Sprats had no such differences in bone hardness and both, spring and autumn sprats were processed for 1 + 1 h, respectively.

Selected regimes were tested on an industrial scale and produced sensorially acceptable fish products and bone softening effects. The processed fish were breaded and heat-treated, packaged in gas environment. As a result, a regime for softening bones was created and positively tested.

**Keywords:** Baltic sprat, Baltic herring, bone softening, hydrochloric acid, acetic acid

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**STUDY ON THE USE OF APPLE POMACE AS FOOD SUPPLEMENT**

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The main sources of dietary fiber in the diet of a modern person, along with grain product processing, are vegetables and fruits. Apple pomace is rich in dietary fiber. In the work, technological studies were carried out to identify the optimal amount of additives from apple pomace, substituting a part of minced meat, in order to enrich dishes with dietary fiber.

We prepared the flour dish "Manty with meat" and "Cabbage rolls". Apple powder was added to minced meat in the amount of 5, 10 and 15%, reducing the amount of meat. In order to study the effect of apple powder additives on organoleptic indicators, nutritional and biological value, studies of the chemical and amino acid composition were carried out and chemical "Skor" of the studied and control samples. Studies have shown that the use of apple powders in manti fillings, in addition to minced meat, lead to an increase in the dry matter content in raw and prepared dishes by 5, 8 and 12%, respectively, compared with control (traditional) samples. In cabbage rolls with apple nutritional supplement fiber content increased by 6.2% compared to control sample. The effectiveness of the use of apple pomace in the organization of dietary nutrition was shown.

**Keywords:** apple pomace, fiber, diet food

**Acknowledgments.** We thank the employees of the restaurant "Kabobcha" and the production association "Agromir", who provided the conditions for the research work: preparation of national dishes and supply of apples pomace, (July-November 2022). We express our sincere gratitude to all those who helped and supported us in carrying out this research work.

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**SUSTAINABLE VALORIZATION OF *SAMBUCUS NIGRA* L. BERRIES:  
FROM CROP BIODIVERSITY TO NUTRITIONAL VALUE**

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Improvement of dietary and ecological biodiversity, namely by exploring autochthonous varieties, is a key point to the construction of a more sustainable food system and planetary health. However, the environmental sustainability continues to face huge challenges, reflecting the importance of achieving a better understanding about the functional role of biodiversity in ecosystems. Thus, the main objective of this research was to contribute to the sustainable valorization of *Sambucus nigra* L. berries through a comprehensive approach to evaluate the effects of elderberry's cultivar, harvest year, and plantation field on the physicochemical composition of berries. Moreover, the nutritional value of elderberry juice and respective dried pomace was determined. This complementary information is of huge utility for the rational and, as much as possible, integral use of elderberries. The harvest year, followed by field and the interaction of harvest × field, accounted for the highest impact on the berry's physicochemical parameters, indicating the importance of the combined impact of the macro- and mesoclimate conditions on plant metabolism. Elderberry juice and dried pomace are a good source of carbohydrates (ca. 12 and 82%, respectively) and have low amounts of fat (≤2.5%), making them low-energy foods. Dried pomace may also represent a potential alternative source of vegetal protein (ca. 6%).

**Keywords:** *Sambucus nigra* L., elderberry, proximate composition, nutritional value, food products

**Acknowledgments.** This work was developed within the scope of the projects LAQV-REQUIMTE (UIDB/50006/2020 and UIDP/50006/2020), CICECO (UIDB/50011/2020, UIDP/50011/2020 & LA/P/0006/2020), financed by national funds FCT/MEC (PID-DAC) and the project SambucusValor, PDR2020-101-031117, Parceria Number 146/Iniciativa Number 341, supported by the COMPETE Operational Programme (COMPETE 2020) under the PORTUGAL 2020. FCT is also acknowledged for the research contract under Scientific Employment Stimulus to S. Santos (2021.03348.CEECIND).

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## SUSTAINABLE UTILIZATION OF APPLE POMACE AND OAT BRAN POMACE FOR DEVELOPMENT OF LIVESTOCK FEED

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Annually, 1.3 billion of tons food waste is produced worldwide. Vegetal waste (VW) makes 2/3 of this amount. Due to current disposal solutions, this waste contributes significantly to environmental pollution. Recent years have seen several novel waste management strategies, including sustainable utilization of vegetal wastes for the development of animal feed. VW represents an alternative to the current feed material due to its rich bioactive compounds content. This study included an evaluation of apple pomace and oat bran as animal feed supplements. Following analyses were undertaken: proximate analyses, metabolizable energy and protein, mineral, vitamin, fatty acid and amino acid content. Regarding the influence of extraction parameters: time, volume of solvent and temperature on amino acid content, only the mass was a statistically significant parameter. Apple pomace showed small amount of crude protein but a high content of crude fibre, comparing to oat bran which had high crude protein content but low amount of crude fibre. Oat bran showed significant amount of iron and zinc. 37 amino acids were detected in both samples. Apple pomace showed low amounts of amino acids compared to oat bran, except for cysteine. High amount of numerous amino acids was detected in oat bran.

**Keywords:** vegetal waste, animal feed, circular economy, sustainability

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## INFLUENCE OF PROBIOTIC PREPARATION ON MEAT PRODUCTIVITY AND MEAT QUALITY OF BROILER CHICKENS AND RABBITS

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In conditions of intensive development of poultry and rabbit breeding, poultry and rabbits are mainly kept in closed, limited cages, as a result of which contact with the source of beneficial microbes is disrupted. Probiotics prepared from natural sources and their use in industrial poultry and rabbit breeding is one of the topical issues in solving food security. The probiotic increases the efficiency of nutrient absorption, suppresses pathogenic microflora in the intestine, stimulates the growth of beneficial intestinal microflora, increases meat and egg productivity, improves the taste and nutritional quality of products. We have technologically developed probiotics from our own strains of *Bacillus subtilis*. The experiments were carried out on 36 Hykole rabbits and 120 Ross-308 broiler chickens. Rabbits of the experimental group from the age of one month and broiler chickens of the experimental group from the age of one day with drinking water were given a liquid probiotic at a dose of 1 mL ( $1.0 \times 10^9$  CFU / CFU) per 1 liter of water for 7 days in a row, food in all groups for rabbits and for chickens there was a standard economic and factory, weighing of live weight was carried out every 5 days before slaughter. Broiler chickens were slaughtered at 32 days of age, rabbits at 61 days of age. The mass of carcasses in the experimental group of broiler chickens, on average for each carcass, was 120 grams more than in the control ones, and in rabbits of the experimental group, on average, for each carcass, it was 90 grams more than in the control ones. The results of tasting the broiler chicken broth (color, smell, taste, and consistency) average in the experimental group  $8.88 \pm 0.03$  points or 16.9% more than in the control group, this proves that the taste and nutritional quality is improving.

**Keywords:** probiotic, *B. subtilis*, broiler, rabbit, meat

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**SESSION VIII**  
**CHALLENGES IN NUTRITION AND**  
**SENSORY SCIENCES**

# FOODBALT 2023

## BIOACTIVE COMPOUNDS IN HUMAN MILK OF MOTHERS LIVING IN LATVIA

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Human milk contains numerous bioactive compounds including oligosaccharides (HMOs). HMOs are particularly interesting compounds in human milk due to their structural and concentration diversity, as well as HMOs studies in Latvia are very scarce.

This study aimed to analyze the oligosaccharides in human milk and their influencing factors from mothers living in Latvia. Forty exclusively breastfeeding women (23 mothers of boys and 17 mothers of girls, aged 21 to 40 years) participated in the study. The participants filled out a questionnaire with questions about breastfeeding and completed a three-day food diary. Data about birth weight and length of the child, the place of residence, smoking habits and parity were collected. Prior to the study, approval from Riga Stradins University Ethic Committee was received (NR. 22-2/521/2021). The concentration of oligosaccharides was analysed on a Shimadzu High-performance liquid chromatography (HPLC) system equipped with refractive index detector (RID).

The concentration of carbohydrates in human milk was variable (lactose concentration was  $7.50 \pm 0.33 \text{ g L}^{-1}$ , glucose  $0.04 \pm 0.05 \text{ g L}^{-1}$ , galactose  $0.02 \pm 0.02 \text{ g L}^{-1}$ , lactulose  $0.04 \pm 0.02 \text{ g L}^{-1}$  and 4-galacto-lactulose  $0.74 \pm 0.51 \text{ g L}^{-1}$ ), the birth weight, length, residence of mother did not affect the concentration of oligosaccharides in human milk. The factor smoking before pregnancy showed a close correlation with 4-galacto-lactulose concentration. However, the research is still ongoing and to draw conclusions it is necessary to analyze a larger number of samples.

**Keywords:** human milk, oligosaccharides, 4-galacto-lactulose, galactose, glucose

**Acknowledgements.** This research is funded by “Strengthening Research Capacity at the Latvia University of Life Sciences and Technologies” project (NR. Z53) “Bioactive components in human milk and its association with maternal diet”.

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## EFFECT OF BUTTERMILK POLAR LIPIDS ON PLASMA LIPID PROFILE: A PILOT STUDY

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Serum lipids are impacted by hormonal changes in women throughout their life cycle. Serum lipid profile changes contribute to an increased risk of cardiovascular diseases. Dietary polar lipids (PLs) can impact the lipid profile and cardiovascular health. The goal of this study was to determine the effect of buttermilk consumption on plasma lipid profile. The randomised clinical trial included eight perimenopausal women aged 45 to 55 (mean [SD] age: 48.1 [2.9] years) with a moderately high low-density lipoprotein cholesterol level (LDL-C level (mean [SD] LDL-C level: 3.53 [0.32] mmol L<sup>-1</sup>) and stable weight (mean [SD] weight: 74.3 [17.9] kg) over the previous six months without lipid-lowering therapy. The intervention group (n = 4) consumed 250 mL (50 mg PLs) of buttermilk daily for 28 days, along with their regular diet and exercise. The control group (n = 4) was advised not to change their lifestyle. The enzymatic colour reaction method was used for plasma lipid measurements and the hexokinase method for plasma glucose estimation before and after the trial. The approval from Riga Stradins University Ethics Committee was received (Nr. 2-PĒK-4/513/2022) prior to the study. After 28 days of the trial, the intervention group showed a decrease in LDL-C level (mean [SD] LDL-C level change: -0.18 [0.65] mmol L<sup>-1</sup>). Conversely, there was an increase in LDL-C level (mean [SD] LDL-C level change: 0.09 [0.51] mmol L<sup>-1</sup>) in the control group. The pilot study showed that the consumption of buttermilk might improve the plasma lipid profile of perimenopausal women with a moderately high LDL-C level.

**Keywords:** buttermilk, polar lipids, dairy, cholesterol, perimenopause

**Acknowledgements.** This study was supported by the program “Strengthening Research Capacity in the Latvia University of Life Sciences and Technologies” project “The study of buttermilk polar lipids”.

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## DIETARY INTERVENTION STUDY CONDUCTED WITH FIBER RICH FUNCTIONAL AND SUSTAINABLE SMOOTHIE MADE USING LEFTOVER APPLE POMACE FROM APPLE CIDER INDUSTRY

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Sustainability and environmentally friendly production are the key elements in The Farm to Fork Strategy that aims to reduce the environmental and climate impact. An important task is to reduce the leftovers to the minimum in every step of food production. Every year there is more than 5 million tons of apple pomace leftover from apple juice industry. Most of that goes to landfill, although it is nutritious material, e.g., containing different carbohydrates and dietary fibers. Our aim was to maximize the separation of edible part of apple pomace and use obtained apple puree to create smoothies with enriched fiber content. We tested different fibers and fiber mixes in *in vitro* study to find best possible recipe for the smoothie that would support the diversity of gut microbiome. Development and testing phase ended with successful prototype that contained 1/3 of apple puree obtained from apple pomace and complex dietary fiber mix. We also created low-fiber smoothie as placebo product for our dietary intervention study. Dietary intervention study lasted 11 weeks, 39 participants. Our results from dietary intervention study showed that consumption of high fiber smoothie influenced the human gut microbiome, blood lipid characteristics and general well-being of participants. We saw reduction of bacteria associated with overweight or inflammation (e.g., *Coprococcus comes*, *Dorea*, *Ruminococcus torques*), and increase of active fermentative bacterium (*Lachnospira*). The results from blood lipid analysis showed decrease in low-density lipoprotein (LDL) and non- high-density lipoprotein (non-HDL) cholesterol. Overall, our dietary intervention study showed the beneficial effects of prototype smoothie consumption.

**Keywords:** dietary intervention study, apple pomace, dietary fibers, microbiome, functional smoothie

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## A REVIEW – QUANTITATIVE AND QUALITATIVE INDICATORS OF FACTORS AFFECTING THE SENSORY PERCEPTION OF COFFEE

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An assessment of the supply of coffee on the market allows concluding that the information provided to consumers on the expected sensorial characteristics of coffee varies between producers. It does not provide confidence in the basis of this information; thus, it can give consumers an ambiguous idea of the expected sensory properties of coffee – taste notes - bitterness, sweetness, aroma, body, and degree of roast.

The aim of the study was to analyze scientific research and provide a summary of the sensory properties of coffee, factors influencing consumers' choice of coffee, and consumer perception evaluation methods used in the study of the sensory properties of coffee.

Consumer perceptions and interpretations of the indications provided by coffee producers describing the expected sensory spectrum of coffee are highly subjective and influenced by various, multiple aspects. It is also observed that manufacturers do not always provide data to consumers based on the objective measurements. Perception of professional experts as well as consumers is possible to determine by using CATA (Check all that Apply) and RATA (Rate all that Apply) methods what give a profile of intensity and characteristics of various sensory properties of coffee samples. In scientific research the effect of different coffee brewing methods, grind size, water quality and temperature, and other factors to sensory perception are mentioned. Influence of these factors on coffee sensory properties are evaluated using SCA (Speciality Coffee Association) approved method, descriptive methods, Ranking test and Time intensity method.

Consumers base their choice on subjective, not always justified ratings, preconceptions about the expected taste of coffee.

**Keywords:** coffee, sensorial characteristics, perceptions, interpretations

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## CONSUMER PERCEPTION ABOUT EDIBLE INSECTS' RELATION WITH ENVIRONMENT AND SUSTAINABILITY

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The interest in adopting more sustainable diets can be a driver for consumers to engage the consumption of edible insects, even in countries where they are not culturally accepted as food. This work aimed to study the perceptions and knowledge of consumers in different countries towards edible insects and their relation with environment and sustainability. The present investigation was based on a questionnaire survey (11 questions) and this descriptive cross-sectional study was carried out on a non-probabilistic sample of 7221 participants from 14 countries. The participants in the survey revealed high knowledge (over 50%) about the sustainability issues related with edible insects as food. The sociodemographic variables education, sex and age are influential, by decreasing order of importance. Regarding living environment, rural areas have the lowest percentage of informed participants. Comparing countries, statistically significant differences were observed for all questions, making this the most important predictor for information about sustainability of edible insects. This is expected, having in mind that cultural influences are highly variable among the set of countries included in the study, with a high number of European countries, but also with Latin American countries like Mexico or Brazil, or Middle East countries like Turkey or Lebanon.

**Keywords:** edible insects, protein alternative, sustainability, consumer

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## THE PROSPECTIVE EFFECT OF PURE $\alpha$ -AMYLASE UTILIZATION IN THE PRODUCTION OF FUNCTIONAL HIGH QUALITY OAT DRINKS

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The objective of present research was to investigate the potential effect of utilizing pure  $\alpha$ -amylase in the production of functional, highly stable oat drink rich in  $\beta$ -glucan and soluble nutrients. The pure  $\alpha$ -amylase (PA) treatment was carried out for the oat slurry containing 16% oat flour and compared to commercial  $\alpha$ -amylase containing a mixture of  $\beta$ -glucanases. The  $\beta$ -glucan was measured by the enzymatic McCLEARY method, the total solids (TS), total soluble solids (TSS) estimated by the degree of Brix ( $^{\circ}\text{Bx}$ ), separation rate, particle size distribution, foaming capacity and stability, and the cold storage stability of the final oat drinks (ODs) were analysed. Differential sensorial assessment was conducted by trained assessors panel based on the triangle test. The incorporation of PA produced OD rich in  $\beta$ -glucan ( $0.40 \text{ g } 100 \text{ mL}^{-1}$ ). Compared to the non-pure  $\alpha$ -amylase treatment, ODs treated with pure  $\alpha$ -amylase had significantly ( $p < 0.01$ ) higher contents of TSS by  $1.5 \text{ }^{\circ}\text{Bx}$ , and TS by  $0.29\% \text{ (w/v)}$ . The stability parameters including the separation rate and the particle size  $d_{4,3}$  values decreased by  $8.39\% \text{ h}^{-1}$  and  $1.5 \text{ } \mu\text{m}$ , respectively, which resulted in noticeable stability of OD products for 7 days in the cold store. ODs with higher  $\beta$ -glucan content had significantly ( $p < 0.01$ ) higher viscosity ( $r = 1.000$ ), foaming capacity ( $r = 0.953$ ) and foaming stability ( $r = 0.992$ ). The ODs produced with PA had significantly distinctive sensorial properties, thickness, and stickiness mouthfeel with a slightly brownish colour. Results from previous studies demonstrate the potential effects of including PA in OD processing for increasing its stability and health benefits.

**Keywords:** pure  $\alpha$ -amylase, oat drink, stability, functional product,  $\beta$ -glucan

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## ALTERNATIVES TO FRUCTOSE FOR THE DEVELOPMENT OF PRODUCTS FOR PATIENTS WITH DIABETES

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In food production to reduce product glycemic index, glucose and sucrose are substituted with fructose, which does not rapidly increase the sugar level in the blood. However, increased fructose intake can cause the development of obesity, metabolic syndrome, and alcohol-free fatty liver disease. The aim of the research was to evaluate the studies on possible fructose alternatives that would be of natural origin, suitable for food production, and would not affect sugar level in the blood.

In the scientific literature, three possible alternatives to fructose can be identified, namely stevia, thaumatin, and polyols. Stevia is a sweet plant rich in nutrients with a favorable impact on the human body, i.e., it decreases glucose level in the blood, and yields antibacterial and antioxidative effects. The negative aspect of stevia is the bitter aftertaste that is reduced by adding fructose. Thaumatin is a sweet protein that keeps stability up to 120 °C and endure pasteurization and high-temperature sterilization. Thaumatin may add a liquorice taste to the product. Polyols are low-calorie sweeteners that naturally appear in fruit, vegetables, mushrooms, and seaweed. Polyols have a low glycemic index that is attributed to lipogenesis delay, the lower necessity for insulin, and small sugar level change after a meal.

The results have shown that the evaluated fructose alternatives have a high potential for the development of products for patients with diabetes, however, there are needed studies to evaluate their impact on technological and sensory features, as well as their influence on glucose level in blood.

**Keywords:** fructose, stevia, thaumatin, polyols, diabetes

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## THE IMPORTANCE OF FATTY ACIDS IN MENTAL HEALTH

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Nutrition plays a vital role in brain development and mental health, whereas fatty acids play a particularly important role. The aim of the study was to analyze the scientific literature on the importance of fatty acids in mental health.

Patients with mental health problems have lower blood levels of omega-3 fatty acids and lower levels of docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA). A deficiency of omega-3 fatty acids leads to functional impairment of nerves and changes in the structure or function of membrane-bound enzymes, protein receptors, and ion channels. Taking 600–2000 mg of EPA and DHA per day reduced depressive symptoms. Positive effects were also observed with alpha-linolenic acid 1 g a day or 0.75 mg to 1 g a day EPA and DHA. Study shows that taking omega-3 fatty acids together with antipsychotic medication improves the Hamilton Depression Rating Scale. The Commission of the European Food Safety Authority states that consuming EPA and DHA up to 5 g per day does not pose a health hazard for 16 days. Cohort studies have shown an association between moderate intake of the omega-6 polyunsaturated fatty acids (PUFA), linoleic acid and a lower risk of cardiovascular disease, while a high intake of saturated fatty acids was associated with increased anxiety scores.

Studies clearly show the beneficial effects of fatty acids on mental health, so it would be important to develop new products with an appropriate fatty acid composition to supplement the diet of people with mental diseases.

**Keywords:** mental health, fatty acids, omega-3, EPA, DHA

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## DEHYDRATED SAUERKRAUT JUICE AS A SALT ALTERNATIVE IN FOOD

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The awareness of high NaCl consumption is rising, and the alternative ways and methods of its reduction in processed foods are studied. The most common are substitutes, replacers, like potassium or calcium chloride, or enhancers, like monosodium glutamate. Also, a variation in NaCl particle size, its encapsulation, and controlled release to ensure the salty mouthfeel. One way of substituting NaCl is by adding naturally salty plant-based foods, like seaweed or dehydrated sauerkraut juice (DSJ). DSJ contains 12% of NaCl, a combination of minerals, phenolic compounds, and 103 mg 100 g<sup>-1</sup> vitamin C. The aim of this study was to investigate dehydrated sauerkraut juice as a salt alternative in experimental salad dressings. The evaluation of salt content in commercially available salad dressings was performed to set the content for experimental dressings, and the minimum of 1.3 g 100 g<sup>-1</sup> was found to be too salty, therefore, it was reduced to 0.8; 0.5 and 0.2 g 100 g<sup>-1</sup>. For the experimental salad dressings with DSJ, volatile compounds were determined and sour, grassy aromas with almond notes were identified. Sensory descriptive tests distinguished sweet, sour, salty tastes, and also garlic, mayonnaise and yogurt. Sensory, rate-all-that-apply tests comparing the control sample (with salt) and DSJ samples with the reduced content of salt equivalent were carried out. There were significant differences in the overall liking of samples, but the experimental samples with DSJ and the reduced salt equivalent were rated higher than the control samples; therefore, DSJ may be a salt alternative in food applications.

**Keywords:** dehydrated sauerkraut juice, NaCl replacer, substitute

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## HYGIENIC ASSESSMENT OF SANITARY FACILITIES IN CATERING ESTABLISHMENTS

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Guests consider the sanitary facilities (SF) of catering establishments to be the most dangerous in terms of hygiene. During the Covid-19 pandemic, companies paid special attention to their cleanliness. The aim of this study was to assess the hygiene of catering establishments' SF based on microbiological assessment and visual inspection of SF.

Two research methods were used: microbiological analyses in the SF of six catering establishments; a questionnaire for the guests of catering establishments.

Three microbiological assessments were carried out on the surfaces of the SF of six Jelgava catering establishments that are most frequently touched by guests: toilet bowl cover; water flush button; soap dispenser and SF door handle. No enteric bacteria were detected in the samples collected in 2021. However, in the February and April 2022 samples, when the number of guests in the catering establishments was much higher, enteric bacteria were detected in two samples.

A survey was carried out using *Google Forms* from 31 March to 21 April 2022. 183 guests of catering establishments aged between 15 and 50 took part. The results of the survey showed that before and during the Covid-19 pandemic, guests' habits towards visiting catering establishments have changed. Contingency analysis was used to process the survey data.

Enteric bacteria are most commonly found on the lid of the toilet bowl in the SF of catering establishments. Guests of catering establishments consider clean and well-maintained SF as a strong indicator of high quality in catering establishments in general. The 'higher status' of catering establishments is not a guarantee of microbiologically cleaner SF, but reflects a misguided (stereotypical) perception of guests.

**Keywords:** catering establishments, sanitary facilities, hospitality

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## INFLUENCE OF SEA BUCKTHORN POMACE (*HIPPOPHAE RHAMNOIDES* L.) ON THE FUNCTIONAL PROPERTIES OF SURIMI

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Surimi products are well-considered by consumers as high-protein, low-fat and ready-to-eat fish products. Various food additives are added to surimi products to enhance the properties and nutritional value of the surimi gel. In recent years, both food researchers and the industry have been trying to use berry pomace as a dietary fibre additive in various foods. There is some research on the effect of dietary fibre on the formation of surimi gel, however, it is insufficient and currently, surimi products are not enriched with dietary fibre. The general objective of this study was to evaluate the influence of sea buckthorn pomace (SBP) on the protein interactions, texture and water-holding capacity (WHC) of surimi, as these properties are among the most important for the formation of surimi gel.

Research results indicate that surimi contains mainly hydrophobic ( $8.15 \pm 1.45\%$ ) and hydrogen ( $15.58 \pm 0.53\%$ ) bonds. The addition of SBP to the surimi reduced the number of hydrophobic and hydrogen bonds to  $1.63 \pm 1.33\%$  and  $8.86 \pm 1.89\%$ , respectively. However, the addition of SBP increased the hardness of the gel ( $2.44 \pm 0.19$  N), as compared to surimi gel without SBP ( $1.35 \pm 0.15$  N). Fortification of surimi with the SBP resulted in an increase of WHC (93.68 to 97.01%).

In conclusion, SBP, which is a by-product of berry juice processing, is applicable to improve the properties of surimi gel. Thus, SBP can be used for the enrichment of surimi products with dietary fibre. Moreover, these research results are promising for the production of higher value-added surimi-based products.

**Keywords:** surimi, sea buckthorn, pomace, protein bonds, gel

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## THE ISSUES FACED BY SCHOOL MEAL PROVIDERS

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The quality of meals can directly affect children's health and growth. The Latvian school lunch program aims to provide hot lunches for students and it follows strict Latvian government guidelines of low salt and sugar, no fried or processed food meal plans. The catering industry of the public sector is facing significant economic challenges, as well as its operation is affected by the regional reform that took place in Latvia. The aim of the study was to evaluate the most important challenges and obstacles of service providers – entrepreneurs and municipalities in the provision of school lunches. In the study, a survey of entrepreneurs, school management, and representatives of the municipality was carried out. The results of the study showed that the majority of school catering services are provided as an external service (45.8%), the service is provided by both the external service and the municipality (37.5%) and the service is provided by the municipality (16.7%). The main risks in the provision of school lunches are the rapid rise in prices and insufficient state/municipal funding (45.62%), the decrease in the number of students (29.8%), the lack of qualified labor (22.8%) and pandemic restrictions (14%) etc. For some municipalities, the school lunch is perceived as a big financial pressure. The understanding of the availability and quality of the catering service is insufficient, municipal co-financing differs within the framework of the municipalities and rural territories and is different for individual social groups.

**Keywords:** school lunch, service providers, important challenges and obstacles

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## CAPABILITIES OF WILD PLANT *SALICORNIA EUROPAEA* APPLICATION IN FOOD TECHNOLOGIES

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Global food security concerns are driving the search for new sustainable food sources and spurring interest in the use of edible wild plant materials. The latter include *Salicornia* as a source of salt and nutrients such as dietary fibers, polyphenols, flavonoids, and minerals, including selenium, magnesium, sodium, chlorine, manganese, chromium, iron, copper, potassium, calcium, and others. These nutrients determine the valuable functional and technological properties and organoleptic characteristics of finished products. Important for creating new foods with *Salicornia* are emulsifying properties, improving texture, salty taste, colour formation, and increasing yeast efficiency.

The subject of the study was the development of a dietary supplement "Solevit Mg" from the wild plant *Salicornia*. The aerial parts of the plant of the species *Salicornia europaea* L., collected in the south of the Kherson region, Ukraine, in August-October 2020 were taken as samples for the study. Convective drying was used because the technological features of this process make it possible to preserve the properties of the original product. The drying kinetics of this plant in various modes was studied, which made it possible to optimize the parameters of the production process of a dietary supplement in the form of a powder.

The results of the proximate composition were as follows: protein 22.10%, fat 2.65%, carbohydrates 31.5%. Chemical analysis confirmed the content of minerals and vitamins in the dietary supplement. The use of the additive by partial replacement of salt in the technologies of wheat bread and cheese snacks were evaluated.

**Keywords:** *Salicornia europaea*, bread, salt

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## IDENTIFICATION OF BITTER OFF-TASTE COMPOUNDS IN SUNFLOWER PRESS CAKE USING SENSOMICS APPROACH

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The sunflower (*Helianthus annus* L.), a member of the *Asteraceae* family, is cultivated as a crop worldwide for human and livestock consumption. The primary application of sunflower is oil production, and it is the third most widely cultivated oil seed crop in the world, with a production volume of 57.26 million tons. Throughout the oil production process, a large amount of sunflower press cake accumulates, which contains proteins, cellulosic fibers, lignins, phenols, and minerals. The sunflower press cake contains 28–42% of protein, and this high protein value makes the sunflower press cake potential source of global protein demand.

The bitterness in sunflower press cake could limit its usage as protein alternative despite being a sustainable and economical alternative to animal protein. However, understanding the underlying reasons for this bitterness could lead to the access of new sources of protein. To identify the specific compounds responsible for the bitter taste in sunflower press cake, an activity-guided sensomics approach was employed.

The successful application of sequential solvent extraction, solid-phase extraction, High Performance Liquid Chromatography (HPLC), Taste Dilution Analysis (TDA) and <sup>1</sup>H NMR, <sup>13</sup>C NMR measurements allowed identification of key bitter off-taste compounds. The TDA revealed that two fractions had the most bitter taste, and subsequent identification of those fractions showed that phenolic compounds and lipid oxidation products were the major contributors to the bitterness of sunflower press cake. Lipid oxidation products such as trihydroxyoctadecenoic acid, dihydroxyoctadecenoic acid, hydroxyoctadecadienoic acid and their isomers, as well as stearic acid, were identified as the bitter off-taste compounds in sunflower press cake.

**Keywords:** sunflower, bitter taste, fatty acids, sensomics, taste dilution analysis

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