

## **O.1**

### **Development of indirect acoustic methods and techniques for complex evaluating of extrudate structures**

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The porosity and structure of extrudates of rye and buckwheat mixture have been evaluated using different indirect methods: (1) acoustic transmission and an acoustic spectrometer in the low frequency range (10-30 kHz) and (2) acoustic echolocation and an acoustic level meter. The rye and buckwheat mixture extrudates (0-40 % of buckwheat) were produced by single and twin screw extrusion.

The results show that the acoustic transmission gives a high correlation ( $R^2 = 0.893$ ) between the amplitude of penetrated acoustic signal ( $A_p$ ) and mechanical strength of the extrudates determined by texture analyzer. Also high relationships between  $A_p$  and the structure parameters: density, expansion index and the diameter of pores were apparent ( $R^2$  ranged from 0.897 to 0.979). Acoustic echolocation gives additional information on the swelling parameters of extrudates: swelling dynamic –  $V_d$  and degree of swelling –  $V$ . The determined swelling parameters ( $V_d$  and  $V$ ) correlated well with the structural parameters, analysed by the instrumental methods.

The performed experiments with both extruders proved, that the varied amount of buckwheat in extrudate composition allowed to produce products with a different quality of texture – from snacks (crispy, easily chewed) till breakfast cereals (less crispy, crusty, with longer chewiness). The swelling dynamics of rye extrudates like snacks was the most intensive. Extrudates with 20 % buckwheat additive compared with rye extrudates had better swelling properties and more homogeneous structure. Extrudates with the 40 % of buckwheat flour underwent a long unbroken not interrupted swelling process and kept its structure during the whole process.

The acoustic transmission in combination with the acoustic echolocation is an excellent tool to give information of both texture of end products and the processes during extrusion. Non-destructive character, rapid and simple the acoustic transmission method can be recommended for both laboratory and industrial application and could be successfully used as an on-line process and quality control tool.

## O.2

### **Effect of alcohol concentration, reducing and heating on prolamin extraction**

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Alcohol soluble protein fraction of wheat, barley and rye is responsible for the harmful immune response on people with gluten intolerance. Therefore, people with gluten intolerance need to avoid products that may contain these proteins. Wheat is the main contaminant in most gluten-free food products. Therefore wheat proteins and peptides involved in immune response have been studied in many publications. However, in oat products, the other two cereal candidates, barley and rye, are occasionally main contaminants too.

Barley and rye are closely related to wheat and, therefore, their proteins have many similarities to wheat proteins. However, some important differences exist between the protein fractions of these three cereals. If these differences are not taken into account, they may cause errors to the analysis results when determining the total gluten content of the sample.

Based on the revised Codex standard from November 2007, an immunological method should be used for the quantitative determination of gluten in foods. Two immunological ELISA methods for gluten detection are commercially available. These methods have been developed to detect wheat gluten proteins and difficulties have occurred in quantifying barley proteins. Celiac harmful proteins are commonly extracted with 40% or 60% ethanol for the immunological assays. These conditions were efficient for wheat prolamins, but not necessarily best for barley and rye prolamins.

The aim was to find extraction conditions that were suitable for celiac harmful proteins of all of the three cereals. In this study, the extraction efficiencies of ethanol, 1-propanol and 2-propanol in varying alcohol concentrations were compared in respect of the total protein content of the extracts and their protein composition. In addition, the need of reducing and heating of the samples during extraction was studied. It could be concluded that the differences between cereals causing errors in analysis results could be eliminated with suitable extraction.

### **O.3**

#### **Wheat flour reactivity and agglomeration mechanisms: contribution of particles physical properties (size & shape)**

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Wheat flour powder reactivity is defined as particles ability to react under exterior constraints (water adding or mechanic/thermal energy contribution). This includes wheat flour particles behavior during agglomeration process after adding and mixing with water, which results in crumbly dough formation. Particles reactivity is considered in regard with “Intrinsic Characteristics” of flour particles. This study aims to study, how particle properties affect powder reactivity, and secondly, the reactivity mechanism involved in agglomeration process for two different types of cereal products (pasta & noodles). Intrinsic characteristics of wheat flour particles are size distribution, shape distribution, roughness, and chemical surface composition. Two wheat flour powders were prepared by milling durum wheat, and soft wheat. Particle size distribution was carried out by laser diffraction method. Digital Image Processing (DIP) method is applied to estimate particle shape factors; after dispersion onto a glass plate, and acquiring a set of 500-1000 image of each sample by Microscope LEICA. This reveals a lot of shape factors such as (perimeter, sphericity, elongation ratio, etc.). The results obtained establish a fundamental method to characterize wheat flour particles, and suggest further exploration of its potential use in various powders application.

## **O.4**

### **Characterisation of isolated Emmer and Einkorn starches**

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Emmer and einkorn were one of the earliest domesticated forms of wheat. Today they are only seldom cultivated. To increase the variety of raw materials old crops are now rediscovered and analysed for potential uses in food processing. To characterise isolated emmer and einkorn starch the main components and the functional properties were analysed. Starch was isolated from emmer and einkorn in pilot scale by using the tabeling method. The amylose (Megazyme testkit), protein (Kjeldahl) and fat (Soxleth) content of the starch was measured. The functional properties water binding capacity, swelling power, solubility and transmittance (spectrophotometer) of the starch and the freeze-thaw stability (freezing starch gels at  $-7^{\circ}\text{C}$  overnight, thawing at  $30^{\circ}\text{C}$  for 2h, four cycles), viscosity (Brabender viscograph) and hardness (Texture Analyser TA-XT2i®) of emmer and einkorn starch gels were analysed. The amylose content was higher in einkorn starch than in emmer starch. The protein and fat content of emmer starch was lower, suggesting that the cleaning and isolation process was more successful than in einkorn starch. Isolated emmer starch showed a higher solubility, a higher water binding capacity but a lower swelling power compared to einkorn starch. The freeze-thaw stability of einkorn starch was higher as shown by lower syneresis values. The peak viscosity, viscosity at  $30$  and  $95^{\circ}\text{C}$  and the setback profile of einkorn starch was higher than that of emmer starch. The transmittance of the einkorn starch gel decreased faster than that of the emmer starch gel during 5 days. The hardness of the emmer starch gel was higher at the first day than that of the einkorn starch gel. The increase of the hardness during one week storage at  $4^{\circ}\text{C}$  was higher in the einkorn starch gel.

## O.5

### **Purification and hydrolysis of wheat gliadin subgroups**

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Commercial wheat gluten is the protein rich by-product of the wheat starch industry. As a result, wheat gluten is available in large amounts and at relatively low cost. Due to its insolubility at neutral pH, wheat gluten use is limited. Enzymic hydrolysis of wheat gluten may broaden its field of applications. Wheat gluten can be hydrolyzed into peptides with foaming and emulsifying properties. Gluten peptides may also have bioactive properties such as blood pressure regulating and opioid effects. However, there is lack of insight into fractionation methods to extract these peptides from hydrolysate mixtures. Moreover, successful fractionation methods may lead to increased insights in the structure-function relationship of these peptides.

A 60 % ethanol soluble fraction of wheat gluten containing the gliadins was separated with an optimized semi-preparative reversed phase HPLC method to gliadin fractions. Gliadin was successfully fractionated in  $\omega$ -,  $\alpha$ - and  $\gamma$ -gliadin.  $\alpha$ -Gliadin was collected in two separate fractions.  $\omega$ -Gliadin yield was much lower than that of  $\alpha$ - and  $\gamma$ -gliadin. The purified fractions were hydrolyzed using Alcalase, a mixture of serine-peptidases. Size-exclusion HPLC and reversed phase HPLC revealed a complex mixture of peptides. Gliadin fractions were then hydrolyzed using a single enzyme with known cleavage action.

## **P.1**

### **Effect of extrusion on the functional properties of barley, maize and rice as brewing adjuncts**

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Worldwide the brewing industry is becoming more competitive and is constantly looking for ways and means as to improve beer quality and decrease manufacturing costs. Recently a considerable interest is noticed to apply extruded products as brewing adjuncts. In this study, the effect of the with 30% and 50% water moistened raw material on the functional properties (water solubility index – WSI, water absorption index – WAI and degree of starch gelatinization – DG) of barley, maize and rice extrudates were investigated. Extruded samples were prepared using a one-screw extruder (amount of blades - 3, screw speed – 190 rpm, screw strain – 120Nm). The saccharification test was also performed under mashing conditions to evaluate the suitability to use these cereals as replacement for malted barley. In this test, industrial enzyme preparations as Fungamyl 800L (fungal  $\alpha$ -amylase), Ceremix Plus M6 (bacterial  $\alpha$ -amylase,  $\beta$ -glucanase,  $\beta$ -xylanase and neutrase) and AMG 300L BrewQ (heat stable glucoamylase) were used. The performed study revealed that functional properties of extrudates are strongly related to the cereal type and the amount of water added before extrusion. The higher the amount of water (50%) the higher the WSI, and the lower the WAI. The highest WSI (10.1%) and WAI (2.13g/g) were demonstrated by barley extrudates. Meanwhile, the lowest values of these parameters were observed on rice extrudates, (3.04% and 0.63g/g, respectively). The highest DG was observed in maize (98.7%). The fastest saccharification was noticed in extruded barley. Barley starch was fully degraded after heating at 63°C, for 5min. The longest saccharification process was in extruded maize, which took 90 minutes. Also it was noticed that Fungamyl 800L better acts on extruded maize and Ceremix Plus M6 – on extruded rice, but both enzyme preparations act the best on barley. AMG 300L BrewQ was used as an auxiliary enzyme in composition with Fungamyl 800L and Ceremix Plus M6. Saccharification was faster in extruded maize (70 min.) and rice (60 min.), when AMG 300L BrewQ was used. Different extrusion parameters had no effect on the saccharification process.

## **P.2**

### **Starch, sugar and fat, major components determining the final textural properties of biscuit**

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One of the important features of a biscuit is the texture. The texture will depend on the formulation and the cooking regimes used, but a key factor is the component that forms the main matrix that links the different elements together. Starch is the major structural element in many foods, but it is often considered to be an ‘inert filler’ in biscuits, with the fat or sugar playing the structuring role. This poster shows the typical amounts of starch retaining the amylopectin order for a range of commercial biscuits. Differential scanning calorimetry indicated a narrow range of temperatures for starch gelatinisation (peak 65.2 – 67.3 °C) and a range of enthalpies (2.65 – 4.58 J/g of biscuit). It also shows the physical characteristics of model biscuits where the sugar level and fat type (butter and palm oil) have been altered. The densities of these biscuits were greater than commercial samples, but they had similar fracture strength. The palm oil samples were less hard than the biscuits made with butterfat. Rapid Visco Analyser results indicate that there is no cold water swelling for the samples, but care is required so that samples are matched for starch levels when considering peak and final viscosities. In the test biscuits there were no evidence of remaining sugar crystallinity from the lower sugars sample (17%). However, at 22% sugar some crystallinity remains. Starch amylopectin packing is evident in all samples as indicated by X-ray, microscopy and differential scanning calorimetry. Understanding the interaction between ingredients, particularly starch and its conversion, and these roles in forming the texture of foods is essential if foods are to be successful in the market place, and can be developed as “better for you” products.

### **P.3**

#### **Possibility of obtaining new extruded products from selected rye flour characterized by higher content of healthy compounds**

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Extrusion cooking technology is widely used in the food industry. Cereals breakfast and snack type foods are nowadays very popular due to their taste and most of all the dietetic value. Extrusion of cereals causes increase of the quantity of soluble dietary fiber (SDF) in raw material. According to present knowledge rye is very good material to produce functional food, nevertheless it is used rather rarely in extrusion cooking technology. Rye grain contains several components which may have important role in nutrition, dietetic, prophylactic and prevent of some civilization's diseases development. Besides relatively high amount of dietary fiber (especially soluble fraction of pentosans and  $\beta$ -glucans) and easy available protein it contains also phenolic acids and lignans (SECO, MAT) which belongs to phytoestrogens. It is also good source of some vitamins (B-group), as well as mineral compounds. Most of these components are located in outer kernel layers and in germ and they are removed during milling process. The aim of this study was to obtain new extruded products from rye flour containing considerably higher amount of some healthy compounds than commercial flour. In the first stage of research enriched rye flour (ERF) was selected from passage and commercial rye flour. The choice was done on the basis of chemical composition of these flours. ERF contained about two times higher amount of pentosan and  $\beta$ -glucan and 3 to 6 times SECO and MAT in comparison with commercial rye flour. Before extrusion ERF was fermented with lactic acid bacteria. Chemical composition, physical properties as well as sensory evaluation for ERF extrudates were performed. Extrusion and fermentation process caused almost two times increased of soluble pentosans. The amount of phytoestrogens in extrudates was lower about 20-40% in compared to raw material (ERF), but still considerably higher than in commercial rye flour (about two times for SECO and almost four times for MAT). Lactic acid fermentation improved both crispness and expansion ratio of extrudates. Results obtained in this study shows that ERF might be used as a raw material for production of extruded functional food.

## **O.6**

### **Incorporation of high fibre ingredients into gluten-free bread.**

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Gluten-free (GF) breads tend to be purely starch-based and in general are nutritionally poor; hence their enrichment with dietary fibres is imperative. The objective of this study was to examine the effects of the addition of high fibre ingredients to a GF bread formulation, based on rice flour, potato starch, skimmed milk powder and hydrocolloids. Five different fibres, apple fibre (AP), oat bran (OTF), oat bran containing 10% beta-glucan (BG10), oat bran containing 15% beta-glucan (BG15) and oat fibre (OTG) were examined at 5 and 10 % (flour basis) addition levels. The consistency of the GF batters was standardized using fundamental rheological tests (single frequency). Standard baking tests such as bake loss (%), specific volume (ml/g), crust colour ( $L^*$ ), crumb moisture (%) and image analysis were measured. The staling properties of the breads were determined using texture profile analysis over a 5-day period.

Results showed, for all the GF batters, a significant increase in the level of water with increasing fibre ( $P < 0.05$ ). With regards to the baking characteristics, significant differences were found between the control GF (no fibres) and the fibre containing GF bread ( $P < 0.05$ ). Furthermore, significantly higher bake loss and crumb moisture values were found for each fibre ( $P < 0.05$ ). Correlations were detected between crumb moisture and cohesiveness after 5 days of storage ( $R = 0.83$ ,  $P < 0.05$ ). The specific volume was significantly improved for BG10, BG15 and OTF at 5% and 10%. In comparison, the AP (5%) and AP (10%) exhibited significantly lower specific volumes ( $P < 0.05$ ). Significantly lower crumb hardness values, with the exception of AP (5%) were found for the fibre containing GF breads over 5 days in comparison to the control ( $P < 0.05$ ). The most promising results were found for the OTF (10%), OTF (5%) and BG10 (10%) GF breads. Overall, it can be concluded that the addition of fibres enhanced the quality of the GF breads by decreasing their crumb staling.

## **O.7**

### **A model approach based on gluten-starch blends reveals the role of gluten in a pound cake system**

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In bread, gluten is the structural element that makes up the basic framework. For cake, most authors agree that the development of a gluten network in the batter is limited, due to the high levels of fat and sugar. However, this does not need to imply that the gluten is functionally inert. In order to evaluate the role of gluten protein in cake making, gluten-starch blends with different ratios of gluten to starch were tested in a pound cake formula. Gluten concentrations were related to differences in cake batter properties, changes during baking and final cake quality. Batter viscosity and cake height were monitored during baking. Pound cake quality indicators included cake volume, texture and crumb structure. Furthermore, the protein population in cakes was studied by size-exclusion high performance liquid chromatography. The viscosities of batters made from gluten-starch blends in the otherwise standardised formula increased with their gluten content. The absorption capacity of flour protein provides batter viscosity and capacity to retain expanding air nuclei and to ensure the uniform dispersion of the ingredients. Increasing gluten levels in the cake recipe led to a more extended oven spring period and thereby to desired product volumes. Cakes with a starch content exceeding 92.5% in the gluten-starch blend suffered from substantial collapse during cooling and had a coarse crumb with a solid gummy layer at the bottom. Image analysis showed statistical differences in numbers of cells/cm<sup>2</sup>, cell to total area ratio and mean cell area ( $P < 0.05$ ). Mean cell area as well as cell to total area ratio were the highest for cakes with the lowest density and highest gluten levels. Relative sodium dodecyl sulfate (SDS, 2.0%) buffer (pH 6.8) extractabilities of protein from cakes baked with the different gluten-starch blends, decreased with gluten content and were strongly correlated with the intensity of collapse. Taken together, the results teach that protein gives the cakes resistance to collapse, resulting in desirable volumes and an optimal grain structure with uniform cell distribution.

## **O.8**

### **Gluten-starch blends provide insight into the role of gluten in sugar-snap cookies**

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Cookies are baked products which generally contain three major ingredients (flour, sugar and fat) and only low final water contents. Good quality cookies have large spread, a tender bite and a uniform surface cracking pattern. While it is clear that flour proteins have a pronounced role in cookie making, there is no consensus in literature about their role and influence on cookie quality.

This work deals with the impact of gluten and the underlying mechanism in cookie dough setting. To that end, an approach based on model mixtures of gluten and prime starch was used to investigate the effects of both gluten and starch on cookie quality.

Higher gluten levels in gluten-starch blends decreased dough piece weight, its density, stickiness and hardness. Starch did not gelatinize in the cookie making process. The largest spread in the oven was obtained when no gluten was added to the recipe. However, this yielded cookies of unacceptable structure, and pointed to gluten as the structure carrying moiety. Higher gluten contents increased spread onset time, decreased cookie spread but generally had little impact on set time. Additional water lowered spread onset time and likewise had no statistically significant impact on set time. The results showed that the final cookie diameter greatly depends on the spread onset time which itself depends on the amount of water available to the non gluten constituents in the system. Size-exclusion high performance liquid chromatography showed that, during baking, proteins aggregated. This indicated that, during baking, the added gluten acquired the mobility necessary to interact, or stated differently, that it was not in a glassy state. However, because increasing levels of gluten increasingly decreased the relative level of water available to itself, and because the set time, and, hence, the set temperature, did not depend on the gluten level, we concluded that cookie dough setting is not determined by its passing through an ‘apparent’ glass transition. Notwithstanding the above, more protein aggregation went hand in hand with less spread.

## O.9

### **Bio-Competence Centre of Healthy Dairy Products**

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Bio-Competence Centre of Healthy Dairy Products (CC) is a private company, established by the Estonian companies and universities with main goal to study the possibilities of biotechnological altering of milk production and biotechnological processing of milk, dairy products as well as milk-based products with additional bioquality by co-operation with Universities and Enterprises. The implementation of results of planned research helps to increase the innovativity and competitiveness of Estonian dairy industry.

The implementation of results of planned research could help to increase the innovativity, competitiveness, and resources of Estonian dairy industry.

The shareholders of the company are the University of Tartu, the Estonian University of Life Sciences, Starter Ltd., Dairy Co-operative E-Milk and Animal Breeders' Association of Estonia.

There are two development orientations:

1. To improve raw milk composition through feeding and breeding strategies with the aim of producing milk of *high quality* for manufacturing dairy products of additional value;
2. Healthy milk products with anti-infectious and anti-allergic probiotics developed by using biotechnological methods.

Synergy benefits are expected to materialize as the biotechnological competence is integrated with agriculture and food industry. CC's projects combine the efforts of cattle breeders and geneticists, animal feeding scientists, microbiologists, milk technologists, nutritionists and biochemists, to cover the entire chain of production of milk, starting from cattle breeding up to making healthy milk products.

We have got a good insight from EU experts for our first halftime research plan and results and now waiting for final evaluation.

Now we prepare a new application form and new research plan for the next 7 year (starting 2009) and looking for new ideas and new consortium partners who are interested in our research and are interested to contribute the products.

The reason why we are interested of this workshop is that there will be cooperation with baking industry in the next 7 years project.

#### **Competence, training and services provided by CC:**

- **Keywords:**
- Functional food
- Food products with improved bio-quality
- Food microbiology, food antioxidants, oxidative stress
- Safety assessment
- Probiotics and prebiotics
- Anti-infectious and anti-allergic food products
- Improved milk coagulation (MCP)
- Genetic evaluation of MCP
- **Products and Services Provided:**

- Probiotic and prebiotic food
- Safety assessment
- Trainings in the science-based feeding of animals; science-based human nutrition and supplements
- Competence in the field of food microbiology, food antioxidants, oxidative stress
- Performing biochemical and microbiological analyses
- Clinical testing of products
- FFA determination
- Determination of rennet coagulation properties of raw milk
- Consultations (raw milk quality, rennet coagulation properties, nutrition, functional food)
- **Areas of cooperation:**
- Applied biotechnological research on dairy starters and new probiotic bacteria of human origin
- Milk composition and quality
- Factors influencing milk composition and technological property by animal feeding
- Genetic and phenotypic estimation of milk rennet coagulation properties and methods of generating a population of cattle producing milk with modified coagulation properties;
- Probiotics and diseases
- Bioactivities of food products (oxyresistance, etc.)

## **O.10**

### **Study of rye bread staling**

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The aim of the work was to characterize the staling of rye bread in comparison with wheat bread. Wide angle X-ray diffraction and <sup>13</sup>C cross polarization magic angle spinning nuclear magnetic resonance (<sup>13</sup>C CP MAS NMR) were used to investigate changes in crystallinity of starch during processing and storage of bread. Relative crystallinity of starch in rye bread during 2 weeks storage increased from 14.05% to 23.55%, while in wheat bread the increase was more intensive and rapid - increasing from 16.17% to 45.26%. In <sup>13</sup>C CP MAS NMR spectra the peak corresponding to disordered amylopectine 97 ppm appears with the baking and disappears with the storage. Also, during storage the intensity of peaks C-6 61 ppm decreases and that of 63 ppm increases. In parallel to the spectroscopic studies the change in rheological properties of fresh bread was studied using a Physica 301 MCR rheometer and TA-XT2 texture profile analyzer. Crumb storage modulus (G') and hardness demonstrated four fold for rye bread and five fold for wheat bread increase after 7 days of storage. Water activity of measured bread did not show significant change during 7 days. The heat flow of bread measured by TAM III Thermal Activity Monitor (Thermometric) decreased quickly during first 5 h after baking while increase in crystallinity could not be observed by spectroscopic methods. After that the heat flow decreased slowly approaching zero level in 4-6 days. The results different measurements demonstrated that staling is correlated well with starch crystallization and was quicker for wheat bread compared to sour rye bread.

## **O.11**

### **Characterisation of functional properties of cereal flours in crispy tempura**

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Cereals are grown for many purposes; crop varieties, seasonal variation and milling technologies result in compositional and functional variability which is relevant to the food coating industry. Cereal flours are major constituents of tempura batters and determine many characteristics of the finished product including crispiness and glossiness. Trials were conducted on tempura batter systems to determine the effect of varying the type of wheat and maize flours on the quality of deep-fat-fried chicken nuggets. Basic tempura batters were formulated with water, flour, starch, seasoning and leavening agents. Processing and quality parameters including batter viscosity, batter pick-up and sensory scores of coated (and deep-fried) chicken nuggets were determined. Batter viscosity (flow-cup) changed with the flour types used and this in turn affected the quality of the coating. Flour viscosity was correlated to both batter-pickup and adhesion quality and was closely linked to the application properties of the batter to substrates. Also batter viscosity affected appearance and final texture of nuggets (including crispiness). The results of this study suggest the need for a detailed investigation into the functionality of wheat and maize flours as they are applied within commercial tempura batter systems. Criteria for selection of optimum flours and formulations for tempura batters need to be better understood. Further research into the interactions between various batter ingredients, including their shear-resistance and interaction with substrates, should allow better predictions of final product performance. Also this information should allow millers to optimise specifications for manufacturing flour for tempura applications, thus enabling industry to produce crisp and glossy coatings more consistently.

## **P.4**

### **The effects of barley flour addition on wheat bread quality**

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The health related importance of soluble fibres such as  $\beta$ -glucan has long been recognised; it has been shown that  $\beta$ -glucan has a positive effect on glycaemic insulin and cholesterol responses and also acts as a probiotic. Due to its high soluble fibre content and nutritional significance, barley has become a desirable food for human consumption. In these preliminary trials, breads were produced from two barley flour sources; whole barley flour (WBF) and pearled barley flour (PBF). In this preliminary trial a 100% wheat flour control bread formulation was replaced with WBF or PBF at 30, 50, 70 and 100% levels. The breads produced were evaluated for volume, colour, texture, moisture and crumb grain (using the C Cell bread imaging system). The starch pasting properties and fundamental rheological aspects of the blends were also assessed. Crust colour ( $L^*$ ; darkness) of the loaves was found to differ significantly ( $P < 0.05$ ). In particular, loaves containing 100% WBF and PBF were shown to be significantly lighter in colour ( $L^* = 75$ ) than the control ( $L^* = 47$ ). Crust colour was not found to be significantly affected by the type of barley used. Increasing the levels of barley in the formulations resulted in loaves with decreasing volumes ( $P < 0.05$ ). Loaf volume was also found to be affected by the type of barley flour used ( $P < 0.01$ ), with PBF producing breads of a lower volume than WBF breads. Crumb moisture differed between treatments ( $P < 0.05$ ) with the higher barley-containing breads having a drier crumb. Breads containing PBF did have a higher moisture content than those with WBF, however ( $P < 0.001$ ). Texture profile analysis of the bread slices showed that breads containing higher ratios of barley were firmer than the control wheat bread ( $P < 0.05$ ). WBF breads, were significantly harder ( $P < 0.01$ ) than PBF breads. WBF breads were also shown to be significantly more springy ( $P < 0.001$ ) and more chewy ( $P < 0.01$ ) than breads produced from PBF. Fundamental rheological testing of the doughs, and  $\beta$ -glucan analyses are continuing.

## **P.5**

### **The influence of different potato pectin fractions on the quality of mixed rye bread**

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The research was carried out to investigate the influence of pectin fractions isolated from potato dietary fiber (DF) concentrates (commercial potato insoluble fibers – PIF and soluble fibers – PUF) on the quality of mixed rye bread. A method for extraction of pectin from PIF (Pe-PIF) and PUF (Pe-PUF) that includes hot water extraction from the vegetable tuber under weak acidic conditions of pH 4.5 was used. Gel filtration was developed for determination of molecular weight (MW) of polysaccharides. A high performance capillary electrophoresis (HPCE) method was used for the quantitative analysis of the monosaccharide's components of the polysaccharide obtained from potato DF. The bread baking tests were carried out by using 5 % Pe-PIF or Pe-PUF of the quantity of wheat flour. The control bread has been baked without the additives. The bread quality was evaluated by using the Stivens-LFRA texture analyzer and the acoustic spectrometer. The amplitude of the penetrating acoustic signal (Ap) through the sample by an optimal frequency of 22,793 kHz was applied by the latter method. Also the standard methods for the evaluation the specific volume and porosity of crumb has been carried out. The obtained results showed that the yield of Pe-PIF and Pe-PUF was, respectively 12,6 % and 13,8 %, and their average MW - 716 kDa and 764 kDa. The common monosaccharides from both pectin fractions were glucose (Pe-PIF – 1,895 g/100g; Pe-PUF – 1,754 g/100g), galactose (Pe-PIF – 0,337 g/100g; Pe-PUF – 0,553 g/100g) and galacturonic acid (Pe-PIF – 0,868 g/100g; Pe-PUF – 1,617 g/100g). The baking test showed the differences in quality of bread with different pectin fractions. The highest specific volume (3,09 cm<sup>3</sup>/g), the best porosity of crumb (67,34 %), the lowest hardness of crumb (175 SPV), the highest value of Ap (0,2098 SPV) and lightest colour using Pe-PUF with higher MW and higher amount of galacturonic acid has been determined. Bread with the latter pectin fraction had also the most prolonged shelf-life. The other pectin fraction (Pe-PIF) with the smaller MW and the lower amount of galacturonic acid demonstrated almost the same results as the control bread but had a longer shelf-life like the Pe-PUF bread. So, the potato pectin fraction and especially of Pe-PUF could be used as to improve the quality of mixed rye bread.

## **O.12**

### **The influence of enzymes to the antimicrobial activity of bacteriocins produced by lactic acid bacteria**

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Bacteriocins produced by lactic acid bacteria have arisen a great attention as a novel approach to control fungal and bacterial spoilage in foods. In a previous study five lactic acid bacteria strains belonging to *Lactobacillus* and *Pediococcus* species were isolated from spontaneous Lithuanian sourdoughs and were found to produce novel bacteriocin-like substances. Moreover these strains will be used for the production of saccharificied fermentation media, consequently their interaction with enzymes is relatively significant.

The aim of this study was to evaluate the effect of four different baking enzymes: hemicellulase, lipase, amyloglucosidase, amylase (DSM Food Specialties, the Netherlands) on the inhibitory activity of five bacteriocins produced by lactic acid bacteria (LAB) isolated from spontaneous Lithuanian sourdough effective against *Bacillus subtilis*.

The bacteriocins studied disclosed an inhibitory effect against spore germination as well as vegetative cells of *B. subtilis*, the predominant species causing ropiness in bread. The possibility that antibacterial activity of bacteriocins might be lost after treatment with enzymes used for baking purpose was examined. The tested hemicellulase, lipase, amyloglucosidase and amylase enzymes exhibited a very low influence upon antimicrobial activity of most of these bacteriocins produced by LAB isolated from Lithuanian sourdough when used at normal baking concentrations or even higher.

This study suggests a possible application for these LAB strains producing bacteriocins in the sourdough baking industry in order to control *B. subtilis* spore germination and vegetative growth.

## **P.6**

### **Microflora characterization of rye meal sourdough**

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Almost all spontaneous sourdough cultures, especially those that have been maintained for a long time, contain both lactic acid bacteria (LAB) and yeasts. In literature there are no data about investigations of Latvian traditional rye meal sourdough microflora. The main purpose of the current research was to characterize the traditional Latvian spontaneous rye meal sourdough microflora. The dynamics of total plate count, as well as LAB and yeast plate count was determined. Changes of pH and titrated acidity were observed using standard methods. There are three stages of sourdough preparation in 72 hours totally; the renewal of sourdough was realized each 24 hours. As results of our experiments show, the pH value decreased during sourdough fermentation process approximately 1.8 times and reached pH 3.8 as a result of intensive development of microorganisms. Initial content of LAB was by 34% lower than yeast content. During the first stage of sourdough preparation, the content of LAB increased substantially by 54% but the changes of yeasts content were not relevant. Opposite results were observed in the changes of LAB and yeast content during the second stage of sourdough preparation: the content of LAB decreased insignificantly, but the content of yeasts decreased by 11%. In the third stage of sourdough preparation the changes of LAB were not significant but the content of yeasts increased by 33%. As a result the spontaneous rye meal sourdough contain by 7% more yeasts than LAB and possess a preferable rye bread aroma.

## **P.7**

### **Enrichment of cereal products with tempeh – fermented legume seeds**

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Tempeh is a traditional Indonesian food, made from soaked, cooked and then fermented by the mould (mainly *Rhizopus oligosporus*) soybean seeds. Highly nutritious properties and diarrhoea curial by tempeh are relatively wide described in the literature, but this product is not popular in Europe. The aim of this study was to evaluate the possibility of enrichment of cereal products by adding temeph. For tempeh production bean seeds (*Phaseolus vulgaris* variety Igołomska) and soy seeds (*Glycine max* variety Noviko) were boiled 5 minutes, dehulled, and boiled again 20 minutes for bean and 40 minutes for soybean and inoculated by spores of *Rhizopus oligosporus* NRRL 2710. The material was placed in Petri dishes and fermented at 37°C for 16 and 20 hours (bean and soybean respectively). The fresh tempeh products were added on wheat dough at the amount in 10, 25 and 50 % whereas dried tempeh was used in extrusion process in the amount of 10 and 25 %. After that the quality of the products were estimated by consumers. Thirty people group evaluated taste, flavour, colour and texture of obtained breads and extrudates. Extrudates were additionally estimation by texture analyzer TA-XT2i. In the breads with the highest addition of tempeh the consumer evaluation were significantly lower. Products supplementation by soybean tempeh resulted in higher estimation of colors, taste and texture, while bean tempeh improved flavor. Quality of breads with tempeh was slightly lower in comparison with traditional wheat bread. The extrudates sensory quality estimation was similar to bread – extrudates with addition of tempeh were characterized slightly lover evaluation in comparison with typical corn extrudates. The correlation between the texture evaluations by consumers and the work cut appointed by the texture analyzer were highly significant.

Bread can by enriched with nutritional tempeh product to the amounts below 25 % without considerable decrease of its quality. Tempeh in the extrusion process may create products with new organoleptic value.

## **O.13**

### **Reactive oxygen species (ROS) –induced degradation of cereal $\beta$ -glucan**

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Cereal  $\beta$ -glucan is a food polysaccharide in connection with health related benefits. In solution the linear  $\beta$ -glucan behaves as a partially stiffened random coil molecule, which results in high viscosity. The rheology is closely related to the health benefits, which has led to an increasing interest to use cereal  $\beta$ -glucan as a hydrocolloid in liquid and gel-like foods. Since the rheological properties are a fundamental factor in the functionality of oat and barley ingredients, the stability of molecular weight and size of  $\beta$ -glucan has to be profoundly understood during food processing and storage. It is known, that molecular weight is often reduced in processed foods, and this is generally attributed to enzymatic, acid or physical stress based hydrolysis. However, in a number of foods related systems, the decrease in viscosity or in extractability cannot be fully explained by these mechanisms of  $\beta$ -glucan degradation. We demonstrate that ROS (OH-radicals), such as those produced in Fenton reaction, where oxygen, metal and an electron donor are needed as reagents. In the present study a well known Fenton-type pro-oxidant, ascorbic acid (AA), was used as an electron donor because it is widely used in cereal foods. The viscosity of barley  $\beta$ -glucan solution (0.7 % w/w, 98% purity) reduced from 160 mPas to 20 mPas in two hours after AA/ionic iron treatment and the molecular weight was reduced from 520 kDa to 35 kDa (after four days cold storage), but the viscosity of a control treated with ionic iron remained constant. The viscosity loss due to AA/ionic iron addition was nearly totally inhibited by an OH<sup>•</sup>-scavenger and oxygen depletion. This clearly showed the role of ROS in the degradation. In an oat bran extract (no enzyme activity), where all the copassengers are available, the effect of AA on the viscosity was more pronounced. The extract, is well representative of aqueous foods, also shows spontaneous viscosity decrease in cold storage. We suggest that reductive copassengers of  $\beta$ -glucan participate in the degradation by ROS formation. Thus the role of naturally occurring as well as added compounds have to be understood in manufacturing novel  $\beta$ -glucan-rich foods.

## **O.14**

### **Health promoting aspects of pseudocereals in gluten-free research**

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The growing demand for gluten-free breads of high quality and high nutritional value has led to studying the baking qualities of the pseudocereal flours amaranth, buckwheat and quinoa. Pseudocereals are naturally gluten-free and are characterized by a high protein, fibre and micronutrient content. In this trial each of these flours replaced a portion of the rice flour (which is highly refined and not of a high nutritional quality) in a control gluten-free bread formulation (C) based on rice flour. Standard baking tests were conducted on the resulting breads. Nutrient analysis of the breads was also carried out. Total antioxidant capacity of all three pseudocereal grains, and buckwheat flour was determined by the DPPH method and the FRAP assay. Total phenol content was assessed by FCR assay. Loaf volumes were increased ( $P < 0.05$ ) for buckwheat (1.63ml/g) and quinoa (1.4ml/g) breads in comparison to the control (1.3ml/g). No difference in volume was found for breads containing amaranth. The crust colour of the loaves was significantly darkened following the inclusion of all pseudocereal flours ( $P < 0.01$ ). Crumb texture was significantly improved, with all pseudocereal-containing breads having a softer ( $P < 0.05$ ) and more cohesive ( $P < 0.01$ ) texture in comparison with the control. The C-Cell image analysis system revealed that the crumb grain of the breads with pseudocereals was improved. In particular, breads containing buckwheat had the highest number of evenly distributed cells, and the control had the highest number of holes. An overall increase in the nutrient content of all pseudocereal breads was observed. In particular, the protein, fibre and Mg levels significantly increased ( $P < 0.05$ ). Levels of total antioxidants in the buckwheat flour were significantly higher than the other samples. Antioxidant levels were significantly reduced (although still present for buckwheat breads) after baking, whereas those present in wheat breads were too low to measure. Similarly, significantly higher levels of total phenols were found in buckwheat flours and breads.

## **O.15**

### **Phenotypic correlations, GxE interactions and broad sense heritability analysis of grain and flour quality characteristics in spring bread wheats from Kazakhstan and Siberia**

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Grain and flour samples of 42 high latitude spring bread wheat genotypes from Kazakhstan and Siberia evaluated in a multi-location trial were analyzed for grain and flour quality-related characteristics and for grain micronutrient (Zn and Fe) concentrations. The genotypes generally showed high grain protein contents but low dough strength. Significant positive correlations were found between grain and flour protein content, gluten, gliadin, gli/glu ratio, Zn and Fe. Grain protein content correlated positively with grain hardness, flour ash content, sedimentation, and farinograph dough development time and stability. Grain Fe concentration associated positively with flour stability, water absorption and valorimeter value, suggesting that improvements in micronutrient concentrations in the grain does not impair flour strength. Only flour color (whiteness) and glutenin content (and the glu/gli ratio) showed negative relationship with contents of Fe and Zn in the grain. Interestingly, glutenin content correlated negatively with grain and flour protein; gluten content; mineral (ash, Zn, and Fe) concentration; gluten deformation index (IDK), arrival time, and stability. Conversely, gliadin showed strong positive correlations with grain and flour protein; gluten content; and mineral (ash, Zn and Fe) concentration. Gliadin also correlated positively with dough development time, stability time, and IDK. Environment and GxE interaction were found as sources of variation for many of the quality characteristics. This was reflected in low broad sense heritability (*H*) values for traits related to flour strength as IDK, stability and gliadin content. Breeding scenarios, including three locations with at least two replicates, are suited for the enhancement of most of the quality characters. Nevertheless, faster improvement of flour strength could be achieved if a larger number of locations were contemplated.

## **O.16**

### **Manipulation of the composition of wheat endosperm cell walls to improve nutritional properties**

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The major components of the dietary fibre consumed by humans are the cell walls of cereal endosperms. In wheat they account for 4-9% of the whole grain and comprise principally arabinoxylan, (1-3)(1-4) $\beta$ -glucan and smaller amounts of glucomannan and cellulose. We aim to manipulate the fibre composition to improve its contribution to colon function and reduction in serum cholesterol. A transgenic approach is used to manipulate the expression of selected enzymes in the pathway of  $\beta$ -D-glucan biosynthesis and to determine the impact of these modifications on the composition and properties of the cell wall.

Bioinformatics was used to identify rice homologues of Arabidopsis genes and corresponding ESTs of wheat. Sequences encoding putative glucan synthases were identified and wheat cDNA clones for candidate genes isolated using RT-PCR.

These cDNA sequences were used to design vectors for overexpression and RNAi constructs for gene knockout with biolistics into the wheat variety Cadenza. T1 embryos of transgenic lines were rescued and segregation ratios of transgenes determined.

Changes in cell wall polysaccharide composition resulting from down-regulation of genes, caused by RNA interference in the transgenic lines, were investigated. Enzymatic fingerprinting, a technique developed and used at the INRA laboratory, were used to analyze cell wall composition of the transgenic and control lines.

## **O.16**

### **Structural comparison of Arabinoxylans from two barley side-stream fractions**

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Barley husks and barley fibre are by-products from industrial process producing potable ethanol. Both barley fractions contain plenty of arabinoxylans, which could be utilized as a source of biopolymers. Arabinoxylans consist of a  $\beta$ -(1 $\rightarrow$ 4)-linked D-xylopyranosyl backbone with  $\alpha$ -L-arabinofuranosyl substituents attached at positions O-2, O-3 or both. The degree of substitution may change in different parts of the kernel. In general, the arabinoxylans in the outer parts of the kernel are less substituted than the arabinoxylans in the inner parts.

The aim of this study was to isolate arabinoxylans selectively using the enzymatic degradation of starch and protein and further extraction with saturated bariumhydroxide from barley by-products and to develop analytical methods for characterizing the isolated material. The main focus was in utilization of multi-detection size exclusion chromatography (HPSEC) method for molar mass and molecular size analysis of extracted arabinoxylans.

According to monosaccharide analysis, xylose and arabinose originated from arabinoxylans were mainly extracted with barium hydroxide indicating high specificity of barium hydroxide as an extractant. Arabinoxylan from barley fibre (BFAX) contained more arabinose and was thus more branched than arabinoxylan from barley husks (BHAX). Differences in branching were also clearly seen in <sup>1</sup>H NMR spectra. The molar masses ( $M_w$ ,  $M_n$ ) and intrinsic viscosities were obtained by HPSEC. The average molar masses of BFAX were higher than masses of BHAX. In addition intrinsic viscosity of BFAX was higher in comparison with BHAX which indicates the difference in molecular densities between two arabinoxylan samples.

## **P.8**

### **Effect of genotype and climatic condition on dietary fibre and Alkylresorcinols of wheat and rye**

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Dietary fibre and alkylresorcinols have been considered two major health protective components of cereals, concentrated mainly in the outer layers of kernel. Alkylresorcinols due to location and ease of analysing are also suggested as biomarker for estimating human intake of wholegrain foods. Wheat and rye make up most of cereal consumption in Europe, though dietary fibre ingestion is much below the recommended healthy level. Varieties with high amount of dietary fibre and alkylresorcinols are desirable for cereal foods.

The aim of the study was to examine the impact of genotype, weather condition and possible interactions on the variability of dietary fibre and alkylresorcinol content in wheat and rye. Since an indirect approach was applied for measuring dietary fibre basic grain components such as protein, ash, lipids, digestible starch and free sugars were also characterised. Water soluble grain components, their structure and viscous properties are responsible for the majority of healthy effects of dietary fibre, therefore, simple viscosity test was also used. Material for the study comprised of wholemeal samples represented by 24 winter and 2 spring wheat varieties and 5 rye varieties produced in the years 2005, 2006 and 2007 at Martonvásár, in Hungary. These varieties were selected from a wide range of cereal genotypes evaluated within the HEALTHGRAIN diversity screen. The three-year study showed that the amount of total dietary fibre in wheat and rye varieties tested was highly dependent on weather conditions while its viscous properties almost exclusively interacted with genotype.

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## **P.9**

### **Effect of genotype and location on dietary fibre and Alkylresorcinols of wheat and rye**

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The present study is continuation of tasks undertaken in the frame of the HEALTHGRAIN project and carried out to determine the influence of cultivation place on the content of major bioactive components i.e. dietary fibre and alkylresorcinols and the viscous properties of water grain extracts in selected wheat and rye genotypes. Since an indirect approach was applied for measuring dietary fibre basic grain components such as protein, ash, lipids, digestible starch and free sugars were also characterised. Material for the study comprised of wholemeal cereal samples represented by 24 winter and 2 spring varieties of wheat and 5 varieties of rye. All grain samples were produced in the same harvest year, 2007, in two distinct locations, Hungary and United Kingdom. The place of cultivation significantly affected all of the quality characteristics. Independent of cereal, conditions in the UK were favourable for starch and free sugars accumulation but poor for the rest grain components, except for extract viscosity. As compared to Hungary, wheat varieties harvested in the UK characterised with higher (by 27%) extract viscosity while ryes with much lower (by 84%). Susceptibility to sprouting of rye in humid and cold conditions might result in lower viscosity of water extract.

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