



C&E Spring Meeting

Consumer Driven Cereal Innovation: Where Science Meets Industry

MONTPELLIER, France, May 2-4 2007

- Consumer drivers
- Challenges to the industry
- Science and Technology

Main
Organisers



Locally
Organised by



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Dear Friends and Colleagues,

In this supplement to the CEREAL FOODS WORLD May-June issue, you will find the Cereals&Europe Spring 2007 meeting programme details and abstracts of all the presentations. For complete details regarding the meeting, visit www.cerealsandurope.net/. We were honoured to hold this meeting in Montpellier, France. It was the first European-based congress of AACC International: a congress focused on consumer needs for cereal-based products and how to best meet them via appealing innovations. Consumer needs are perhaps best summarized as the need for safe, healthy, and tasty foods: but that is easier said than done. With respect to safety, the food industry can already boast a long tradition of safeguarding an excellent reputation for cereal products. But how can one define “healthy”? How to distinguish fact from fiction? And if we can define how to best add health benefits to cereals products, we still need to please the consumer’s palate. Secondly, how to manufacture these products in a safe and cost effective way? All these questions were central to the meeting. This was a unique meeting for more than one reason: it was the first conference AACC International has organised in Europe; it was also a meeting, not only full of presentations and their related questions, but also of forming a common opinion: What are the key challenges that both science and industry are faced with? What are the next steps to best meet these challenges?

Cereals&Europe is the largest European organisation of R&D professionals in the cereal-based products area. In its 10 years of existence as the European Section of AACC International, it has aimed to disseminate cereal science and technology and to generate and stimulate networking within the cereal-based product R&D community in Europe. We hope that this conference is yet another opportunity to meet these goals!

We are extremely pleased with the tremendous support we received from the French cereals community. INRA, The National Institute for Agricultural Research, was especially involved in the organization of this meeting, because of its mission to conduct scientific research related to public health policy as well as out of its intention to support the development of the cereal sector. Arvalis-Institut du végétal, Passion Céréales, and AEMIC all gave their full support to this initiative. Major French companies as well as many others generously sponsored this undertaking as well. A special word of thanks also goes to the EU HEALTHGRAIN project for its support. Without all this help we would never have succeeded in making this happen. Thank you! Merci!

Rob Hamer, AACC International President

Joël Abecassis, Chairman Local Organising Committee

Peter Weegels, Chairman Cereals&Europe, Chairman Programme Committee

C&E Spring Meeting
Consumer Driven Cereal Innovation: Where Science Meets Industry
Le Corum Conference Center, Montpellier France

Wednesday, May 2, 2007

18.00–20.00 Welcome Reception
Presentation of Danone Biscuit and Cereal Foods Division Awards selected during the
6th European Young Cereal Scientists and Technologists Workshop
Exhibits and Poster Viewing

Thursday, May 3, 2007

8.00 Registration Open
8.30–13.15 Exhibits and Posters Open

Opening Plenary Session

8.30–8.50 Welcome Addresses:
Rob Hamer—President AACC International
François Houllier—INRA, Scientific Director Plant and Plant Products
Peter Weegels—Chairman C&E, Chairman Programme Committee

Invited Lectures:

8.50–9.20 Futures for the agri-industry. Nutrition & Health 2020—a scenario example
Peter Brown—Giract

9.20–9.50 Consumer attitudes towards healthy cereal products
Richard Shepherd—University of Surrey

9.50–10.20 Bringing cereal based foods back into the core of people's diet
Francesco Pantò—Barilla

10.20–10.40 Coffee Break

10.40–11.10 Effects of cereal foods on glucose and insulin metabolism: A nutria-genomics approach
Marjukka Kolehmainen—University of Kuopio

11.10–11.40 Diet, obesity, and genes in Europe: DIOGENES and other projects
John Blundell—University of Leeds

11.40–12.10 Consumer, cereals, and health: trends, fads, and reality
Julie Miller Jones—College of St. Catherine

12.10–12.40 Health benefits of whole grain products
Ron Madl—Kansas University

12.40–13.10 Cereal science and technology challenges for stronger nutrition and health consumer benefits
Moïse Riboh—Danone

13.15–14.15 Lunch – Posters and Exhibits Closed

14.15–18.00 Exhibits and Posters

19.30 Bus Departure to l'Abbaye de Valmagne for the Conference Dinner

Science Track

Consumer Insights and Nutritional Aspects of Innovative Cereal-based Products

Nutritional and Sensory Quality

Chair: Paul Colonna—INRA

Reporting: Richard Shepherd—University of Surrey

14.30–14.50 How to make good dough—Revitalising your product portfolio by understanding consumer needs
Pia de Wit—Unilever

14.50–15.10 Assessment of the suitability of a range of gluten-free cereals for their potential use in
gluten-free bread
Michelle Moore—University College Cork

15.10–15.30 Effect of lactic acid fermentation of barley whole meal on carbohydrate composition, anti-nutritional
factors, and digestibility
Stefan Sahlstrom—Matforsk

- 15.30–15.50 Structure-property relations in starch: Characterization and nutrition
Robert Gilbert—University of Queensland
- 15.50–16.10 Fructans in durum wheat: An opportunity for functional foods
Maria Grazia D'Egidio—CRA Roma
- 16.10–16.40 Coffee Break
- 16.40–17.00 (Bio)technical tools to tailor cereal flavour
Raija-Liisa Heiniö—VTT

Consumer Insights and Nutritional Aspects of Innovative Cereal-based Products

Physiology

Chair: Roel Vonk—University Medical Centre Groningen

Reporting: Kaisa Poutanen—VTT

- 17.00–17.20 In vivo digestive starch characteristics and post-prandial glucose kinetics of wholemeal wheat bread
Marion Priebe—University Medical Centre Groningen
- 17.20–17.40 The role of novel cellulose dietary fibers in controlling tissue lipid levels in high-fat fed hamsters
Maciej Turowski—The Dow Chemical Company
- 17.40–18.00 Health benefits of the functional cereal products supplemented with natural source of calcium and vitamin D
Alexey Korolev—Moscow Medical Academy

Technology Track

Better Processes for Better Nutrition

Chair: Klaus Lösche—TTZ Bremerhaven

Reporting: Roberto Ranieri—Barilla

- 14.30–14.50 New kneading process with oxygen-enriched water
Klaus Lösche—TTZ-Bremerhaven
- 14.50–15.10 Pre-fermented frozen dough. Impact of pre-fermentation on baking performance
Alain Le-Bail—ENITIAA-GEPEA
- 15.10–15.30 Controlling oat flake quality to meet consumer needs
Fred Gates—University of Helsinki
- 15.30–15.50 Technology of drinkable pro-biotic cereal suspensions (smoothies)
Hannu Salovaara—Avenly Oy Ltd
- 15.50–16.10 Development of new dry fractionation processes of wheat grain to address consumers' demand for healthy foods and ingredients
Xavier Rouau—INRA
- 16.10–16.40 Coffee Break

Bioactive Ingredients

Chair: José Berrios—USDA

Reporting: Peter Ashby—Cereal Partners Worldwide

- 16.40–17.00 Application of extruded wheat bran for added-value bread production
Loreta Basinskiene—Kaunas University of Technology
- 17.00–17.20 A new healthy and functional ingredient
Martijn Noort—TNO Quality of Life
- 17.20–17.40 Leveraging fibre characteristics to functionally improve food products
Rajen Mehta—SunOpta Ingredients Group
- 17.40–18.00 Flax: A versatile nutritional ingredient
John Smith—Quaker Tropicana Gatorade

Friday, May 4, 2007

8.00 Registration Open
9.00–12.30 Exhibits and Posters Viewing
17.00 Poster and Exhibit Take Down

Science Track

Cereals: Source of High Quality Nutrients

Regulation and Functional Nutrients

Chair: Robert Gilbert—University of Queensland

Reporting: Christophe Courtin—K.U.Leuven

9.00–9.20 Functional oat fractions for healthy and tasty products
Anu Kaukovirta—Norja-VTT

9.20–9.40 Insight in the anti-staling properties of a maltogenic amylase during bread making
Pedro Leman—K.U.Leuven

9.40–10.00 Insight into the impact of varying wheat flour associated xylanase levels in the arabinoxylan population in dough
Emmie Dornez—K.U.Leuven

10.00–10.20 Variation in rheological properties of dough enriched with untreated and treated dietary fiber-rich cereal fractions
Viorel Simac—Institute of Food Bioresources

10.20–10.40 Addition of bread wheat semolina to flour leads to preservation of starch granular structure during bread making
Fanny Leenhardt—INRA

10.40–11.10 Coffee Break

11.10–11.30 How to make a healthy high fibre bread with excellent taste
Daan Van Haaster—WUR

11.30–11.50 Impact of the new EU-food nutrition-health regulation on cereal R&D
Jan Willem van der Kamp—Healthgrain

Cereals: Source of High Quality Nutrients

Methodology

Chair: Maria Grazia d'Egidio—CRA Roma

Reporting: Rob Hamer—WCFS

11.50–12.10 Rapid acoustic screening of deoxynivalenol (DON) in grain
Grazina Juodeikiene—Kaunas University of Technology

12.10–12.30 Developments in the measurement of dietary fibre, available carbohydrates, and other components affecting food quality
Barry McCleary—Megazyme International

Technology Track

Product Quality

Product Texture and Quality

Chair: Bogdan Dobraszczyk—Reading University

Reporting: Mark Bason—Newport Scientific

9.00–9.20 Oxygreen® process, a new tool for the improvement of wheat grains and their products
Michel Dubois—Green Technologies

9.20–9.40 Interfacial properties of dough liquor from lipase modified dough
Henrik Lundqvist—Novozymes A/S

9.40–10.00 Water migration and molecular mobility in baked cakes during storage: An NMR investigation
Flore Le Grand—Cemagref

10.00–10.20 Impact of parboiling on the Maillard reaction in long-grain rice
Lieve Lamberts—K.U.Leuven

10.20–10.40 Towards a decision support tool for French bread making: Qualitative representation and expert-system shell for mixing
Hubert Chiron—INRA

10.40–11.10 Coffee Break

Product Quality

Shelf Life

Chair: Peter Köhler—Hans Dieter Belitz Institute

Reporting: Alain Le Bail—ENITIAA-GEPEA

- 11.10–11.30 Antifungal activity of sourdough and potential to reduce the level of calcium propionate in wheat bread
Fabio Dal Bello—University College Cork
- 11.30–11.50 Ingredients for improving frozen bakery products—an application which meets consumer and market needs
Inge Lise Povlsen—Danisco

Product Quality

Toxicology

Chair: Hamit Köksel—Hacettepe University

Reporting: Inge-Lise Povlsen—Danisco

- 11.50–12.10 Asparagine concentration and acrylamide formation potential in wheat flour as affected by sulphur fertilization
Peter Koehler—German Research Centre for Food Chemistry
- 12.10–12.30 Pesticide residues in post harvest treated wheat, barley, and their products
Umran Uygun—Hacettepe University
- 12.30–13.30 Lunch – Posters and Exhibits Closed
- 13.30–17.00 Exhibits and Posters
- 13.30–14.00 Special Exhibit and Poster Viewing Session

Closing Plenary Session

- 14.00–14.10 Presentation of the Puratos Great Taste and Wellness Awards, Selected During the C&E Spring Meeting

Invited Lectures:

- 14.10–14.40 Implications of the new EU legislation regarding health claims
David Richardson—DPR Nutrition
- 14.40–15.10 Research policy of the EU-Commission on cereals: Potential links with nutritional and health claims
Danièle Tissot—DG Research – European Commission
- 15.10–15.40 Coffee Break
- 15.40–17.00 Panel Discussions and Concluding Remarks
Rob Hamer—WCFS
Roberto Ranieri—Barilla
Paul Colonna—INRA
Kaisa Poutanen—VTT
Jean-Pierre Langlois-Berthelot—Arvalis-Institut du végétal
Peter Ashby—Cereal Partners Worldwide

I.1

Futures for the agri-industry. Nutrition & Health 2020—A scenario example. J. GOOSSENS (1). (1) Giract, Geneva, Switzerland.

Never has the agri-industry faced such important and fast changes as over the last 25 years. Moving away from its earlier key target i.e. improving efficiency and supplying the necessary quantities of food, the emphasis is rapidly shifting to supplying food products with improved taste, functionality and nutritional content and all these in a perfectly safe and also sustainable manner. In addition, the agri-industry is increasingly attracted by commercially interesting options to provide new renewable raw materials for the chemicals, pharmaceutical and bio-energy industries. These changes together with the globalization of its competitive environment and the growing regulatory pressure from authorities have exposed the industry more and more to consumer-related trends and issues. Be it nutrition and health, food safety, green chemicals, bio-energy or biotechnologies, the agri-industry has to increasingly balance ethical and long term issues in its strategy. The Future of Obesities (UK Foresight) project in which we participated clearly demonstrated the complex system of this issue alone. Adding the complexity of all the other changes, it becomes a daunting task for any player to come to grips with how all these uncertainties will play out in the future and hence what strategic options should be chosen. The example of the Nutrition & Health 2020 scenarios shows how one trend could shape the future of Europe. This in-depth analysis gives some insight on the fundamental change in European society depending on how the various stakeholders are anticipating their and society's future. It also illustrates the importance for stakeholders to better understand each other and together develop clear and more holistic visions in order to achieve a sustainable world for all in the future. Some participants in the N&H 2020 scenarios indeed saw this opportunity and engaged in the N&H Open Innovation Lab as the next logical step in the process, in which they jointly explored novel business concepts in the N&H field. If this is not enough pressure to cope with, the recent UN report on climate change lets us know that the time in which we can act is rapidly shrinking. So if we want to get it right for the future, the time to consider fundamentally new approaches is NOW.

I.2

Consumer attitudes towards healthy cereal products. R. SHEPHERD (1). (1) Department of Psychology, University of Surrey, Guildford, UK.

Against a background of increasing obesity and an increasing focus in the scientific community, in the media, among policy makers and the public on diet and health, cereal products occupy an important position in the diet. There are a number of potential health benefits from cereal products including mainstream refined cereal products, wholegrain products and potential future functional cereal products. In order to increase the consumption of both wholegrain and functional cereal products it is necessary to understand the views of consumers about such products. It is also important to understand how consumers think about different types of cereal products, ranging from staple foods such as bread through to cereal based snack foods. As part of the HEALTHGRAIN project (www.healthgrain.org) we have carried out a series of studies in the UK, Finland, Germany and Italy. Focus groups were followed up by quantitative surveys involving around 500 consumers in each of the countries. Although wholegrain products were rated more positively than refined cereal products in terms of healthiness, naturalness, being nutritionally balanced, filling and offering slow energy release, these effects were more pronounced for the Finnish sample but less so for consumers from the UK and Italy. Women were found to be more aware of benefits of cereal based foods than men, to be more health conscious and to expect less illness in later life caused by their eating habits. Women and older people were more willing to use cereal products produced to have specific health benefits (e.g. bread

containing added fibre). Perceived healthiness and pleasantness were the best predictors of willingness to use functional cereal products.

I.3

Bringing cereal based foods back in the core of people's diet. F.PANTO (1). (1) Barilla Fratelli, SpA, Parmalat, Italy.

Cereals are at the base of most traditional healthy eating patterns around the world. In today's habits they are still mainly relegated to white and refined products and often perceived as fuel only, not as a true important nutrient. Meat and animal proteins are considered as much more important in people's diets, with a potential detrimental effect on people's health. Re-introducing nutrient rich, wholesome and simply good cereal based foods into the diet, might not be an expressed consumer need, but it must be an important and necessary mission for us.

I.4

Effects of cereal foods on glucose and insulin metabolism: A nutrigenomics approach. M.KOLEHMAINEN (1), P.Kallio (1), D.E.Laaksonen (2), L.Pulkkinen (1), H.Mykkänen (1), L.Niskanen(2), M.Uusitupa(1), K.Poutanen (1)(3). (1)Food and Health Research Centre, Department of Clinical Nutrition University of Kuopio, Kuopio, Finland, (2)Kuopio University Hospital, Kuopio, Finland; (3)VTT Technical Research Centre of Finland, Espoo, Finland.

The pathogenesis of the metabolic syndrome is not well understood, but lifestyle, including diet, and genetic factors clearly interact in its development and progression. Whole grain and cereal fibre consumption have a strong inverse association with incidence of type 2 diabetes (T2DM) and cardiovascular disease. There is also suggestive evidence of the protective role of cereal foods with slow glyceic release on T2DM. Our aim is to examine the effects of long-term use of two dietary fibre-rich cereal diets differing in postprandial insulin responses, and to find potential physiological mechanisms underlying improved glucose metabolism. Subjects with impaired glucose tolerance were recruited to participate to 12-week dietary intervention with diets consisting of 25% of daily energy intake as a low-insulin response diet (rye-pasta) or high-insulin response diet (oat-wheat-potato). Gene expression profiles were determined from subcutaneous adipose tissue (AT) with Affymetrix™ Human Genome U133 plus 2.0 arrays. Glucose metabolism was investigated using oral glucose tolerance test. Improvement of first phase insulin secretion along with general down-regulation of gene expression in AT was found in rye-pasta group. Inversely, up-regulation of gene expression was detected in oat-wheat-potato group, including genes linked to stress response. Studies aiming to elucidate the mechanisms of the most interesting gene candidates in respect of carbohydrate modification have been started. Moreover, lipidomic analysis will be done in the near future. It is evident that dietary modifications induce changes at the levels of molecule, tissue and metabolites with effects on whole body physiology and disease pathogenesis. Using the systems biology approach to combine the results from these levels, it is possible to find early biomarkers and other factors for disease pathogenesis before the classical markers are being altered. In the long run it hopefully is possible to establish the role of cereal dietary modifications with a large impact on early disease prevention.

I.5

Diet, obesity and genes in Europe: DIOGENES and other projects.

J. BLUNDELL (1). (1) Chair of PsychoBiology, University of Leeds, Leeds, UK.

The Diogenes project has been developed in response to the epidemic of obesity in Europe which is accompanied by severe consequences for public health and huge economic costs. The goals of the project are to increase understanding of the processes – genetic, physiological, behavioural, nutritional and environmental – that generate or amplify the level of obesity, and to develop practical procedures that can be used to halt the epidemic and then to reverse it. The Diogenes project is truly pan-European and incorporates 29 partners in 14 European countries. Partners include 3 food industry multinationals, 5 SMEs together with research institutes and universities. The 5 year project started in January 2005 with a total budget of 20.1 million euros (14.5 million EU finding). The project is designed to enhance the science base and to yield considerable consumer benefits. There is a considerable nutritional dimension to the project which is of relevance to this meeting. Obese participants in 8 countries are enrolled in an 8 week weight loss phase using a VLCD; this is followed by a 6 month maintenance phase in centres in all 8 countries. The variables selected for the maintenance phase are the glycemic index and protein content of the diet. Consequently the project will assess the relative efficacy of different diets varying in protein content and CHO GI in preventing weight gain, regain and co-morbidities. The outcomes will also yield new food products and new dietary advice by diet/health professionals. In recent EU projects and international collaborative programmes we have been characterising individuals susceptible or resistant to weight gain in a weight inducing environment (EU QLK1-CT-2000-00515). We have identified features of susceptibility including a weak satiety response to fat (not to CHO), and a trait that reflects a strong preference for high fat foods (Blundell et al, 2005). Resistance to weight loss on a 12 week monitored exercise regime show an increased selection of dietary fat (King et al, 2006). A technique for measuring the strength of satiety generated by different foods (the Satiety Quotient) can predict long term weight control (Drapeau et al, 2005; 2007), and an innovative procedure for the hedonic evaluation of foods can distinguish between ‘liking’ and ‘wanting’ (Finlayson et al, 2007) and identify susceptibility to weight gain. These procedures provide the opportunity to assess the power of foods (and food ingredients) to provoke or prevent over-consumption, and to identify individuals who are most susceptible to overeating and weight gain. The Diogenes project will evaluate the efficacy of different diets to prevent weight regain after weight loss.

I.6

Consumers, cereals and health –trends, fads and reality.

J. M. JONES (1). (1) Nutrition and Food Science, College of St Catherine, Minneapolis, MN, USA.

Consumers have a love-hate relationship with carbohydrates. This ambivalence colors their thoughts on the health benefits of cereal foods. While a segment of consumers have embraced whole grain foods and the health advantages that they offer, others still eschew these foods as calorie laden, blood glucose and insulin raising, and nutritionally non-edifying. Continuing substantiation of associations linking ingestion of whole grains with a decrease in risk for diabetes, weight gain, coronary heart disease and diabetes and other conditions have failed to change the eating patterns

of many consumers, despite numerous products entering the market which are partially or totally whole grain. To add to the problem, consumers still have significant difficulty identifying whole grain products and often misidentify them. Many consumers are still unaware of the health benefits of whole grain and fortified cereal products, especially the important role of dietary fibre in cereal foods in helping to bridge the fibre consumption gap and in improving the glycaemic response. Health benefits of cereal foods along with strategies to help communicate these virtues to a public barraged with conflicting messaging will be proposed.

I.7

Health Benefits of Whole Grain Products.

R. L. MADL (1). (1) Bioprocessing & Industrial Value Added Programs, Grain Science and Industry, Kansas State University, Manhattan, KS, USA.

Health benefits of wheat bran as related to reduction of cancer risk are well known. Recent research has shown that additional components beyond fiber are present in wheat bran that contribute to suppression of cancer risk. Scientists from the departments of Biochemistry, Grain Science, and Human Nutrition at Kansas State University, and from the Dept of Physical Therapy at Wichita State University have joined forces to better understand these compounds. To date, a wide range of antioxidant activity has been observed within a sampling of over 100 specific cultivars. The antioxidant activity has been shown to transfer to blood in animals fed diets of the cultivars. This antioxidant activity has been correlated with colon tumor suppression in model animal systems. Components responsible for the cancer suppression effect may include orthophenolic compounds and lignans. Results will be shown and significance discussed.

I.9

Implications of the new EU legislation regarding health claims.

D. P. RICHARDSON (1). (1) DPR Nutrition, Croydon, Surrey, UK.

The new EU legislation on nutrition and health claims made on foods specifies in detail the conditions for their use, establishes a system for scientific evaluation of claims and creates European Community lists of authorised claims. The claims on foods will be broadly categorised into four groups: (1) ‘content’ claims listed in the Annex including nutrient content claims such as low fat, high fibre and reduced sugar, comparative claims and claims for ‘other substances’ with a nutritional or physiological effect; (2) health claims based on generally accepted scientific evidence under Article 13.1; (3) health claims based on newly developed scientific data and for those requiring IPR protection under Article 13.5; and (4) reduction of disease risk claims and claims referring to children’s development and health under Article 14. The substantiation of health claims will be accomplished by considering the totality of the available data and by weighing of the evidence. The new law also requires evidence of consumer understanding of the claim. This new legislation will impact significantly on cereal grain products and cereal-based ingredients with health claims, particularly in relation to scientific substantiation, consumer understanding and the development of nutrient profiles of a food or food category that may allow claims for products with desirable nutritional characteristics. Examples will include wholegrain health benefits, and oat beta-glucan and blood cholesterol lowering.

S.I.1.1

How to make good dough - revitalizing your product portfolio by understanding consumer needs. P. DE WIT (2), M. Arink (1). (1) SKIM Analytical, Rotterdam, The Netherlands, (2) Consumer Perception & Behaviour, UFHRI, Unilever, Vlaardingen, The Netherlands.

Unilever is vitally aware of the general trends that are affecting consumers' lives. The way consumers work and spend their free time, their use of media, attitudes and opinions are constantly evolving. As a result, their needs and product preferences are constantly changing. This not only applies to new products, but also to the more traditional and 'age-old' ones, such as bread. With such well-established traditional products in mind, a framework was created for new product development and positioning. This framework would successfully take account of relevant market trends and translate them into viable product concepts. A two-phase project was completed in the UK, Spain, Belgium and The Netherlands. We will show how this framework was established and, in combination with a rich blend of research methodologies, has enabled Unilever to conjure up new and fresh ideas for both the development and positioning of products within the bakery industry.

S.I.1.2

Assessment of the suitability of a range of gluten-free cereals for their potential use in gluten-free bread. M. M. MOORE (1), E. K. Arendt (1). (1) Department of Food and Nutritional Sciences, University College Cork, Cork, Ireland.

The suitability of white rice flour (WRF), brown rice flour (BRF), corn flour (CF), tef flour (TF), buckwheat (BW), sorghum (S) and oat flour (OF) for their potential use as ingredients for a gluten-free (GF) bread was assessed. Rheological tests on the batters and standard-baking tests on the resulting breads were carried out. Significantly higher elastic and complex modulus values were found for the OF, S and BW GF bread batters ($P < 0.05$). These bread batters exhibited more elastic properties similar to that of wheat dough than their counterparts. Furthermore significantly higher complex viscosity values were found for the OF and S GF bread batters, which rapidly decreased over time ($P < 0.05$). Baking tests revealed that the BRF, TF and BW breads yielded the highest loaf volumes ($P < 0.05$), lower bake loss and crumb hardness values ($P < 0.05$). Significantly lower crust colour values were found for the TF, BW, and OF breads indicating that these breads were darker in colour ($P < 0.05$). The hardness of all breads significantly increased over storage time ($P < 0.05$). Regarding the BW and OF GF breads, although high crumb hardness values were obtained, the rate of staling was less pronounced, when compared to the WRF, TF, CF and S GF breads. Fracture occurred only for most of the GF breads (BRF, TF, CF, S and BW) at day 2 and 5 with the exception of OF GF bread. From the results obtained in the current study, it can be concluded that the most suitable GF flours for use in the production of a good quality GF bread are OF, BRF and BW.

S.I.1.3

Effect of lactic acid fermentation of barley whole meal flour on carbohydrate composition, anti-nutritional factors and digestibility. S. SAHLSTROM (1), G. Skrede (1), O. Ahlstrom (2), K. Hjelme Connor (2) A. Skrede (2). (1) Matforsk, Aas, Norway, (2) Norwegian University of Life Science, Dept. of Animal Science, Aas, Norway.

Previous studies have shown that lactic acid fermentation of whole meal flour (WMF) barley may change the carbohydrate composition and the availability of nutrients for digestion and absorption. The levels of total dietary fibre and β -glucans were decreased by fermentation, while glucose

levels increased. The observed decrease in total β -glucans was mainly restricted to the soluble fraction. The changes in carbohydrate composition during fermentation were accompanied by increased digestibility of total carbohydrates in different model animals, e.g. Atlantic salmon (*Salmo salar*) and mink (*Mustela vison*). The present investigation was primarily undertaken to study the effects of lactic acid fermentation of barley WMF, using two different strains of lactic acid bacteria, on carbohydrate composition and contents of antinutrients such as β -glucans, α -amylase inhibitor activity, and phytic acid. Effects of fermentation on nutrient digestibility in mink were compared with effects of dietary enzyme supplementation (Porzyme 8100, Danisco). The fermentation reduced significantly levels of β -glucans, α -amylase inhibitor activity, and phytic acid. Fermentation with different strains of lactic acid bacteria had significantly different effect on total starch and total carbohydrate digestibility. The most efficient bacteria strain increased digestibility of total starch significantly from 68.8 to 83.0 %, and total carbohydrate from 44.5 to 58.8 %. A combination of fermentation and enzyme addition promoted a further increase in the digestibility of total carbohydrate to 66.1 %, but had no effect on digestibility of total starch beyond the effect of fermentation. In conclusion, lactic acid fermentation of barley WMF is a promising method to eliminate or reduce contents of inhibitors known to decrease nutrient availability in different species.

S.I.1.4

Structure-property relations for starch: characterization and nutrition. R. G. GILBERT (1), D. Konkolkewicz (2), A. Dona (2), J. Peate (1), A. Gray-Weale (2), M. Gaborieau (1), P. Castignolles (1). (1) Centre for Nutrition & Food Science, University of Queensland, Brisbane, Australia, (2) Chemistry School, University of Sydney, Sydney, Australia.

Two major nutritional issues in starch-based foods are glycemic index and resistant starch. The interplay of biological, chemical, and physical factors coupled with the ability to control the complement of biosynthetic enzymes using molecular biological tools requires synthesis-structure-property relationships of polysaccharides. Starch has a complex structure, with six hierarchical levels being identified, the lowest of which are chain length distribution, the distribution of branch points, the organization of the branched molecules to give amylopectin clusters and the organization of amylopectin and amylose into crystalline and amorphous lamellae. Six new interlinked techniques are described to characterize these structural levels. These are (1) a means of plotting size-exclusion chromatography (SEC) data of whole starch to reveal randomness in branching structure, (2) the means of quantitatively interpreting SEC data obtained using in-line viscometric detection, data hitherto uninterpretable for this and other hyperbranched polymers, (3) the means of relating the quantity by which SEC separates (the viscosity-related quantity termed the hydrodynamic volume) to the actual size of the starch molecule, (4) NMR quantification of kinetics of the dissolution of starch, (5) a solvent system and dissolution procedure which, used in SEC and other size-separation techniques, for the first time gives the full size distribution of a starch sample, including the very high molecular weight components that are not detected with current protocols, and (6) diffusion coefficients of enzyme-like probes in a starch sample, which mimics digestion. Data from this battery of new techniques provide a powerful new set of tools, which in turn provide a mechanistic basis for linking molecular architecture to material behaviour for starches, allowing rational selection of plant molecular breeding targets and polymer processing conditions for desired nutritional properties.

S.I.1.5

Fructans in durum wheat: an opportunity for functional foods. M. D'EGIDIO (1), M.A. Pagani, M.C. Casiraghi, R. Zanchi, C. Cecchini. (1) CRA-Istituto Sperimentale per la Cerealicoltura, Roma, Italy.

Cereal grains harvested at the milky stage produce raw materials with interesting functional characteristics, as they represent a profitable and suitable source of fructo-oligosaccharides (FOS). These low molecular weight polymers of fructose are non-digestible compounds classified as "pre-biotics" for their properties in maintaining gut health. The production of durum wheat with high FOS levels is related to environmental conditions and also to genetic variability. FOS accumulation in several wheat varieties grown in the same environmental conditions was reported. The production of basic foods (such as dried and fresh pasta, bread, cookies and breakfast cereals) enriched with immature durum wheat grain (IWG) meal was also investigated. All products were characterized by chemical (proximate composition) and nutritional parameters (FOS levels, dietary fibre and resistant starch content, *in vitro* starch digestibility). In comparison with the reference pasta products (100% semolina), the addition of 30 % IWG led to a 20% increase in FOS content, without producing relevant changes into the cooking quality. Nevertheless, cooking of dried pasta induced release of FOS into the cooking water, phenomenon which was very limited in fresh pasta samples as a consequence of its shorter cooking time. As regards the bakery- products enriched with IGW, our results underlined the FOS susceptibility to yeast hydrolytic activity, thus suggesting that IWG meal may be used best in chemically leavened products, as cookies. The integration with IWG meal promoted a significant decrease (10%) in *in vitro* starch digestibility in all the tested products, providing evidence for interesting nutritional effects of these products on glucose metabolism. Studies on the influence of IWG integration on glycemic index of pasta together with the actual pre-biotic effects of FOS are in progress.

S.I.1.6

(Bio)technical tools to tailor cereal flavour. R.L. HEINIÖ (1), J.Buchert (1), A. Kaukovirta-Norja (1), O.Myllymäki (1), K.Katina (1), P.Lehtinen (1), K.Poutanen (1)(2). (1) VTT Technical Research Centre of Finland, Espoo Finland, (2) University of Kuopio, Food and Health Research Centre, Department of Public Health and Clinical Nutrition, Kuopio, Finland.

Wholegrain products are regarded beneficial for health by reducing the risk of several chronic diseases. Certain cereal types have a typical flavour, which in some cases is not regarded attractive enough for consumers. The flavour of native, untreated grain is mild and bland. Generally, the cereal flavour forms during processing, especially in heat treatments. By applying different bioprocessing techniques the flavour and texture of the products may be adjusted into desired direction. Volatile and non-volatile compounds influence the perceived flavour directly or indirectly as flavour components or flavour precursors. Descriptive profiling is used to form a general view of the sensory characteristics in the product. To understand the chemistry behind the flavour, statistical multivariate techniques are used to relate sensory characteristics and chemical compounds. In this work the impact of germination, milling fractionation, sourdough technology and enzymatic treatments on cereal flavour formation and characteristics will be discussed. Germination-drying process was found to adjust effectively the perceived flavour and increase the flavour stability of oat. Sourdough fermentation increased the perceived sourness and flavour intensity, and the following heat-treatment induced the appearance of flavours and compounds originating from Maillard reaction. The fractions of rye kernel have their characteristic flavour: between the mild tasting endospermic part and the bitter tasting outermost bran fraction, a rye-like flavour without any obvious bitterness was observed. This fraction contains significant amounts of bioactive compounds, such as alkylresorcinols, lignans and phenolic acids. Enzymes were also investigated as tools to modify rye flour. As a result of protease treatment the intensive, bitter flavour of rye was increased indicating that certain small peptides and concomitantly released phenolic compounds had a role in the bitter flavour.

S.I.2.1

***In vivo* digestive starch characteristics and postprandial glucose kinetics of wholemeal wheat bread.** M. G. PRIEBE (1), R. E. Wachters-Hagedoorn (2), J. A. Heimweg (2), A. Small (3), T. Preston (3), H. Elzinga (2), F. Stellaard (2), R. J. Vonk (1). (1) Center of Medical Biomics, University Medical Center Groningen, Groningen, The Netherlands, (2)Dept.of Pediatrics, University Medical Center Groningen, Groningen, The Netherlands,(3) Stable Isotope Biochemistry Laboratory, Scottish Universities Environmental Research Centre, Glasgow, UK.

Based on the glycemic index and *in vitro* measurements, it is assumed that starch in wholemeal bread is rapidly digestible, which is considered to be a nutritional disadvantage. We characterized starch digestion of wholemeal wheat bread (WB) and postprandial glucose kinetics in healthy volunteers. In a crossover study 4 healthy men ingested either intrinsically ¹³C-enriched WB (133 g) or glucose (55 g) in water. Plasma glucose and insulin concentrations were monitored during 6 h postprandially. Using a primed continuous infusion of D-[6,6-²H₂] glucose, the rate of systemic appearance of glucose was estimated (reflecting glucose influx) and the endogenous glucose production calculated. The glucose influx rate after WB was comparable with that after glucose in the early postprandial phase (0–2 h) ($p = 0.396$) and higher in the late postprandial phase (2–4 h) ($p = 0.005$). Despite the same initial glucose influx rate the 0-2 h AUC of insulin after WB was 41% lower than after glucose ($P = 0.037$). Paradoxically endogenous glucose production after WB was significantly more suppressed than after glucose (0-2 h AUC: $p = 0.015$, 2-4 h AUC: $p = 0.018$). Starch in WB is partly rapidly and partly slowly digestible. Postprandial insulin response and endogenous glucose production after WB ingestion is not solely determined by the digestive characteristics of starch. Other components of WB seem to be involved and need to be identified.

S.I.2.2

The role of novel cellulose dietary fibers in controlling tissue lipid levels in high-fat fed hamsters. M. TUROWSKI (1), W. H. Yokoyama (2), S. K. Lynch (1). (1) The Dow Chemical Company, Midland, MI, USA, (2) USDA ARS, WRRRC, Albany, CA, USA.

Excessive intake of carbohydrates and fats, particularly saturated fats, such as those in baked cereal products, contributes to the obesity epidemic in developed countries. Obesity is a concern because it is associated with cardiovascular disease, diabetes, high blood pressure and other metabolic diseases. Nearly 25% of adult Americans have elevated blood cholesterol, a risk factor for heart disease. Cellulose-based polysaccharides are already used in a variety of foods (e.g. granola bars, bakery products, vegetable burgers, etc.) as functional additives; however, they have recently gained acceptance as essential ingredients of processed foods delivering dietary fiber health benefits. We describe innovative applications of selected cellulose-based fibers and new data from a hamster model of human lipid metabolism. Male Syrian hamsters were fed for three weeks with a hypercholesterolemic diet (20% wt/wt dietary fat). Diets contained fiber, either a control (MCC or Teflon®) or one of several experimental modified celluloses, such as hydroxypropyl methyl cellulose (HPMC), at 5% (wt) level. The average VLDL+LDL cholesterol and liver esterified cholesterol levels in plasma were lowered 20–40% and up to 80%, respectively. Body weight gain was lowered between 10 and 40%, while the weight of abdominal adipose tissue was reduced by 20 to 30%. Ingestion of modified celluloses resulted in a considerable increase in the excretion of bile acids, cholesterol metabolites (cholesterol, coprostanol) and total fecal fat. The major bile acids were found to be deoxycholic acid and lithocholic acid. Triacylglycerides (TAG) excretion was increased in feces from modified cellulose-fed hamsters, indicating that these fibers appear to prevent the TAG digestion/absorption. It is evident that certain modified celluloses demonstrate considerable efficacy in lowering lipid levels, reducing abdominal adiposity, thus contributing to the cardiovascular health benefits.

S.I.2.3

Health benefits of the functional cereal products supplemented with natural source of calcium and vitamin D. A. KOROLEV(1), E. I. Nikitenko(1). (1) Moscow Medical Academy named I.M. Sechenov, Russia.

Diet is known to influence bone health. A deficiency of calcium and vitamin D results in poor bone mineralization, low mass and architectural deterioration of bone (osteoporosis) that lead to bone fragility and enhanced fracture risk. Much evidence indicates that increasing intake combination of calcium and vitamin D can reduce bone loss and the risk of fracture. The present study was conducted to investigate the biological effect of calcium absorption from cereal products (from whole grain) supplemented with natural sources of calcium and vitamin D in growing male rats. The rats were fed diets containing traditional cereal products (control diet 1) and cereal products enriched calcium and vitamin D: diet 2 consisted of natural source of calcium (eggshell powder) and vitamin D, diet 3 consisted of calcium alginate and vitamin D. Calcium concentration in traditional cereal products was about 34 mg/100 g; in cereal products enriched calcium (groups 2 and 3) was maintained within approximately the same range of 130-150 mg/100 g (as in dairy products). There was no difference in overall activity level and body weight gain among the groups during observer's period. However, rats fed diet 2 and 3 had a significantly higher femoral bone mass whereas rats fed control diet, which can be accounted for the high calcium and vitamin D contents in rats fed experimental diets (groups 2 and 3) compared to the control one. As result of the present study is the demonstrated biological accessible calcium from cereal products consisted eggshell or calcium alginate with vitamin D. Thus, there is strong evidence to suggest that eating a variety of supplemented cereal products (as functional foods) is beneficial in the prevention and management of osteoporosis.

S.II.1.1

Functional oat fractions for healthy and tasty products. A. KAUKOVIRTA-NORJA (1), O. Myllymäki (1), H. Aro (2), V. Hietaniemi (2), P. Lehtinen (1), K. Poutanen (1). (1)VTT Technical Research Centre, Espoo, Finland, (2) MTT Agrifood Research Finland, Jokioinen, Finland.

Oat is a superior source of soluble fibre plus phytochemicals, unsaturated fatty acids and high-quality protein. The consumers are aware of the health-promoting properties of oat and the physiological effects of oat β -glucans are evident and well- documented, Different type of commercial β -glucan fractions are available on global market. However, even though the health-benefits of oat and especially its β -glucans are well-documented the use on oat has not been growing as much as could have been expected. Furthermore, the use of other potential oat fractions like oat protein, starch and also oil is only very limited at the moment. There are several reasons for that: 1) Oat β -glucans are technologically very challenging due to they ability to form sticky and slimy gels and they are not suitable for all applications without modification, 2) oat lipids are known to easily form rancid flavours due to high native lipolytic activity in oat and 3) the fractionation process of oat is not always technologically feasible and only some of the fractions have market potential. A novel fractionation process has been developed for oat in order to improve the technological and functional properties of oat fractions including different type of high fibre and protein fractions, oat starch, oat oil and polar lipid fraction. The benefits of these fractions and the feasibility of the process will be discussed. The applicability of these fractions in consumer products will be presented.

S.II.1.2

Insight in the anti-staling properties of a maltogenic amylase during bread making. P. LEMAN (1), H. Goesaert (1), J. Delcour (1). (1) Centre for Food and Microbial Technology (M2S), K.U.Leuven, Leuven, Belgium.

Bread recipes are commonly supplemented with amylases. Through their action, these enzymes provide reducing sugars which support yeast metabolism, improve crust color and reduce dough viscosity in the initial phases of baking, hence facilitating dough expansion. Some heat-stable amylases (including a *Bacillus stearothermophilus* maltogenic amylase, BStA) are also very effective in retarding bread staling, although their functionality is still poorly understood at present. It can be speculated that the positive effects of these enzymes result from the formed dextrans, and/or that the resulting amylose and amylopectin population has a changed crystallization or retrogradation behaviour. In the present work, our main objective was to increase insight in functionality of amylases, and thus starch, during bread making and staling. We analysed the influence of amylases (with different mode of action) during bread making and storage on bread firmness and the molecular properties of the starch polymers. The structure of the residual amylase (molecular weight) and amylopectin [β -amylolysis limit, average (CL), external (ECL) and internal (ICL) chain length] populations, and the dextrans formed were analysed by HPSEC and/or HPAEC. The impact of the BStA on the firming rate and on the starch polymers during breadmaking markedly differed from that of other amylases. Results are discussed in relation to the different bread staling models.

S.II.1.3

Insight into the impact of varying wheat flour associated xylanase levels on the arabinoxylan population in dough. E. DORNEZ (1), K. Gebruers (1), S. Cuyvers (1), S. Wiame (2), J. A. Delcour (1), C. M. Courtin (1). (1) Centre for Food and Microbial Technology (M2S), K.U.Leuven, Leuven, Belgium, (2) Ceres-Soufflet, Brussels, Belgium.

Xylanases, enzymes which hydrolyze the backbone of cell wall arabinoxylans (AX), can have a significant impact on cereal based processes and end products. Despite numerous reports dealing with added microbial xylanases in bread making, little is known about the impact of wheat flour associated xylanases. The objective of this work was therefore to gain insight in the variation in levels of wheat flour associated xylanase and in their impact on the AX population in dough. The variability in xylanase activity levels in industrial wheat roller milling streams was investigated using 54 flour fractions, 4 bran fractions and germ. These milling fractions were equally analyzed for standard parameters, such as ash and starch content. Bran fractions were significantly richer in xylanase activity levels than germ and, even more so, than flour fractions. Xylanase activity levels in the 54 flour fractions differed ca 15-fold and were positively correlated with ash and negatively with starch content. The impact of varying levels of xylanase activity in wheat flour on the AX population in dough was studied using eight of the 54 wheat flour fractions selected on basis of their xylanase activity levels. Solubilisation of AX during mixing was mainly due to mechanical forces as the levels of reducing xylose (RX) and solubilised AX (S-AX) formed during mixing were not correlated with the xylanase activity of the flour. However, the levels of RX and S-AX formed during fermentation were strongly correlated with the xylanase activity of the flour. These experiments demonstrate the impact of varying levels of wheat flour associated xylanase activity on the AX population in dough. They might assist the cereal based industry in a better understanding of wheat quality variation and, ultimately, help them to obtain higher quality intermediate end consumer products.

S.II.1.4

Variation in rheological properties of dough enriched in untreated and treated dietary fiber-rich cereal fractions. V.S.SIMAC (1), D.G.Bordei (2). (1) Dept. Research and Development, Institute of Food Bioreources, Bucharest, Romania, (2) Dept. Biochemistry and Technology, Fac. Food Science and Engineering, Dunarea de Jos University, Galati, Romania.

The variation in the rheological properties of white wheat flour dough upon supplementation with different percentages of bran, pollard (10 to 20%), and biochemically and hydrothermally treated bran (10 to 50%) was studied. Biochemical treatment of the bran consisted of a lactic acid fermentation, while the hydrothermal treatment was performed at optimal activity parameters of temperature (50-52°C) and acidity (pH 4.5-5.0) for phytase. Phytase activation was pursued to reduce phytic acid content of the bran, as phytic acid is an antinutritional compound, which binds mineral elements from food making them unavailable for digestion. By adding higher percentages of dietary fiber rich fractions, a lower level of extensibility was obtained. At the same time, the extensibility of the dough increased in time, both for the control sample and dietary fiber enriched dough. Maximum resistance of the dough was highest at the beginning of the test for the control (620 BU) and for the samples supplemented with untreated bran (498-624 BU). However, it decreased in time, resulting after one hour in lower values than all other samples (166 BU for control and 145-150 BU for untreated bran). The extensibility of the doughs supplemented with biochemically treated bran increase in time and decrease when bran percentage augment. In the case of biochemically treated bran, the maximum resistance, the maximum extensibility of the doughs and the maximum viscosity of the flour suspension were obtained using lactic acid as pH regulator, as compared to citric and acetic acid. By adding higher percents of dietary fibers, the flour suspension viscosity decreases too. The results are very important for obtaining new products enriched in dietary fiber, because the variation of rheological characteristics of the dough have to be taken into consideration in the design of a product containing new additives and in establishing the technological parameters of the corresponding production process.

S.II.1.5

Addition of bread wheat semolina to flour leads to preservation of starch granular structure during bread making. F.LEENHARDT (1), C. Rémésy (1). (1) INRA, centre Clermont-Theix, Gènes Champanelle, France.

Most bread produced worldwide is made from sieved wheat flour characterised by low-size particles and a low fibers and micronutrients content. Optimizing bread nutritional value requires the use of flour which still contains small parts of grain outer layers. Such flours can be obtained directly by stone milling or by supplementation of white flour with wheat fibrous milling by-products. The most widespread process is the addition of wheat midds that are the by-product of the conversion of semolina fractions into flour. Since durum wheat semolina is suitable for bread making and commonly used in some countries, we have recovered bread wheat brown semolina by suppressing the last steps of the milling process. Applied to common wheat cultivars (*Triticum aestivum*), such a process provides 40 to 45% of flour, about 40% of coarse semolina and 15% of fine semolina with an overall milling yield of 80%. The present study was set up to investigate whether such coarse flours could improve bread nutritional value. We have compared the nutritional density of brown flour obtained by midds on the one hand and by semolinas addition on the other hand and found similar fiber and micronutrient contents. The bread making value of such flours containing brown semolina is good especially with a step of autolysis prior to kneading. Secondly, the preservation of starch granules in such semolina wheat breads was studied. White flour and flour containing semolina were observed under scanning electronic microscopy. The presence of semolina seems to protect endosperm cells and was associated with cellular cluster formation. Bread making processes such as the French traditional process led to incomplete starch gelatinization since some starch granules were

still present among the gelling network. Through addition of semolina, the proportion of intact starch granules in the final product increased, which is favourable to improve the bread glycemic index. In conclusion, it would be interesting to simplify current milling processes to enhance the presence of semolina in sieved flours, improving both nutritional density and glycemic index of breads.

S.II.1.6

How to make a healthy, high fibre bread with excellent taste. D.VAN HAASTER (1), H.Schols (1), R.J.Hamer (1). (1) Food Chemistry Group, Wageningen University and Research Centre, Wageningen, The Netherlands.

Consumers more and more appreciate healthy benefits of high fibre foods. Unfortunately, with leavened wheat products like bread, it is difficult to meet both requirements at the same time. Adding large quantities of bran generally goes at the expense of volume and crumb structure leading to unpalatable bread. This effect of fibre is related to its negative effect on gluten structure and properties. The latter is important for dough properties as well as gas holding capacity and final crumb structure. Previous work has shown that this effect is both physical (e.g. water binding) and chemical. The chemical effect is mediated by ferulic acid moieties linking arabinoxylans from bran and endosperm to gluten proteins, thereby changing the ability of gluten to form the viscoelastic network required. The larger the number of these interactions, the smaller the amount of agglomerated gluten and hence bread volume. With the Health grain project a series of cereal bran fractions are produced to explore their potential health effects. In this study we have studied fractions prepared from two wheat varieties (Crousty, Tiger) for their ability to interfere with gluten agglomeration. For this purpose we use a custom made, gluten extraction device allowing small-scale tests (max 12 g flour/test). Gluten agglomeration was expressed as Gluten Yield (GY, total protein in gluten/total protein in flour). Cereal bran fractions (Peeling, Pearling, Aleuron 1, Aleuron 2, Fine bran < 200µm, Fine bran) were added to achieve 3% AX on flour basis. As a result, GY values were lower, ranging from 7-12%, with the flour control at 13%. Differences between fractions could not be explained by differences in AX branching, or AX content of the fraction, but could be explained by differences in Ferulic Acid content. With increasing Mono-Ferulic Acid content GY was decreased. With increasing Di-Ferulic Acid content GY was increased. The best results were obtained with the Peeling fraction. Our results further underline the importance of understanding the exact nature of this chemical interaction between AX and gluten. Such knowledge will help overcome the current quality problems related to the preparation of High Fibre bread.

S.II.1.7

Impact of the new EU-food nutrition-health regulation on cereal R&D. J. W. VAN DER KAMP (1). (1) TNO Quality of Life, Zeist, The Netherlands.

Consumer interest in healthy cereal products is resulting to a growing number of product launches and an even larger increase in health related statements on packaged products. The new EU Regulation on nutrition and health claims made on foods (EC 1924/2006), and related nutrition policies at national, EU and world wide level, may lead to significant reformulations of basic products – such as white bread and pasta – as well as a range of requirements for new health claims as well as other nutrition related statements. In the near future reductions by 20% or more will be likely to occur of salt/ sodium levels in bread below the classical 2g salt/ 100g flour level. Also, efforts can be expected to raise the content of fibre, vitamins and minerals in white bread and pasta to levels compatible with the “good source of” requirements in Regulation EC 1924/2006. Adoption of a new definition of dietary fibre in Europe may lead to requirements of scientifically demonstrating physiological effects of fibres not naturally occurring in foods, but, for instance, modified by action the many enzymes

used in bread making. Whereas in e.g. dairy products successes with health claims have been obtained with added ingredients, the major success story in the cereals area, whole grain products, is based on a naturalness, and no added ingredients. This, as well as the considerations above, may stimulate changes towards healthier cereal products by introducing new cultivars and by exploiting the natural 'goodness of grains', as is done in the HEALTHGRAIN project.

S.II.2.1

Rapid acoustic screening of deoxynivalenol (DON) in grain. G. JUODEIKIENE (1), L. Basinskiene (1), D. Vidmantiene (1), E. Bartkiene (2), W. de Koe (3). (1) Kaunas University of Technology, Kaunas, Lithuania, (2) Lithuanian Veterinary Academy, Kaunas, Lithuania, (3) NMCP/PUM, Wageningen, The Netherlands.

Mycotoxins in food and feed are considered important safety issues of growing concern. At least 60% of food intake of man and animal is cereal related. Since mycotoxins such as deoxynivalenol (DON) occur frequently in cereals in mean concentrations up to 10.000 µg/kg, the magnitude of the problem of contamination can be big. An estimated deoxynivalenol intake of e.g. the French consumer reveals a high exposure especially for children. The vectors contributing most to this exposure are cereal-derived products. Reasons for the EU to prioritize legislation and for a high cereal consuming countries as Lithuania to monitor cereal grains intensively to protect its consumers. DON is produced by species of *Fusarium* causing Fusarium Head Blight (FHB). It attracts worldwide attention because of the significant economic losses associated with their impact on human health, animal productivity, brewing processes and trade. The incidence of FHB is most affected by moisture at the time of flowering. A fight between plant and mould occurs resulting in the formation of the toxin and the grain will shrivel. Shriveled grains in a consignment indicates *Fusarium* invasion. Scientists determined a direct varying correlation coefficient between 0.80 and 0.96 in DON concentration and the percentage of fusarioses grains. A consignment of grain manifests itself as a porous mass. The more shriveled grain in the consignment the more DON and via this correlation the quantity of DON can be determined. With an acoustic spectrometer one

can measure the porosity of matter. The instrument is used to determine e.g. the texture/structure of bakery and extruded products and has been applied on samples of with DON contaminated grain with success. Because the technique is cheap, fast, non-invasive, quantitative and because it has in- and on-line possibilities it lends itself for high speed throughput monitoring. The performance characteristics meet those in EU legislation. It owes its accuracy not only because of the strong correlation but also thanks to less built up of variability's in compare with the chemical/instrumental reference methods. The method has been confirmed by HPLC and ELISA. Two instruments based on transmission of the acoustic signal have been developed and will be integrated in a next generation of equipment in which transmission and reflection functions play a key role. Possibilities for inter-laboratory validation will be discussed when a series of apparatus have been built.

S.II.2.2

Developments in the measurement of dietary fibre, available carbohydrates and other components affecting food quality. B.V. McCLEARY (1), S. Charnock (1), R. Lloyd (1), V. McKie (1), P. Rossiter (1). (1) Megazyme International, Ireland.

Biochemical approaches offer the solution to the measurement of a wide range of food components that affect the quality of the food. The advent of molecular biology allows the production of the required tools, highly purified and specific enzymes, to resolve these analytical challenges. In this presentation, I will discuss the work currently underway in our laboratories aimed at finding solutions to these problems. More specifically, a method for the integrated measurement of total dietary fibre and available carbohydrates will be described in detail. Also, an overview of our work in the application of molecular biology in the development of advanced methodology for the measurement of a range of food components including food acids (e.g. acetic, L-malic, L-lactic, phytic acid), sugars (D-fructose, D-glucose, D-mannose, D-galactose, and D-xylose), plus ammonia, sugar alcohols and sweeteners, will be given. Discussions will focus on very rapid, advanced methods for acetic acid, ammonia and a number of amino acids such as L-arginine, L-glutamine and L-asparagine.

Lectures – Technical

T.I.1

New kneading process with oxygen-enriched water. A. Hofmann (2), C. Creutz, D. Sikken, K. LOESCHE (1). (1) Bremerhavener Institut für Lebensmitteltechnologie und Bioverfahrenstechnik – European Institute of Baking Technology, Bremerhaven, Germany, (2) Emil Kemper GmbH, Rietberg, Germany.

Kneading the dough is one of the most important steps in the processing of bakery products. This step more than any other will determine the quality of the final baked goods. However, the complex nature of the product-process interactions makes it a difficult process to optimise. Nevertheless, major innovative steps have been recently carried out in the design and automation of the kneading processes, mainly focused in optimising the dough formation involved reactions. Within the frame of a collaborative project between the ttz-EIBT and the company Kemper (Rietberg, Germany), a novel Spiral kneader "Oxylator" has been developed. The new device is equipped with a special jet-hydration system contributing to a better dough formation and an optimal dough structure development. In combination to that, the innovative "Oxylator" incorporates a system for the oxygen-enrichment of the water feed, which provides faster dough formation and the creation of the desired rheological properties of the final dough (i.e. higher water binding levels, optimal plasticity without affecting the desired elasticity level, increased proofing stability and tolerance to ripening processes, enhanced freeze-thawing-stability). The benefits of the novel "Oxylator" kneading system are effective even for low quality flours and by using low quantities of improvers (reduction up to 50% is possible), which can lead

to economical compensations for producers. Consumers will benefit from these advantages having access to higher quality baked products with, at the same time, fewer additives.

T.I.2

Pre-fermented frozen dough. Impact of pre-fermentation on baking performance. A. LE-BAIL (1). (1) UMR GEPEA-CNRS 6144, Nantes, France.

Even though conventional baking permits to produce the highest quality, the food industry has developed alternatives to produce product that could be freshly baked in small "hot points" in down town area. The corresponding technologies called "Bake Off Technologies" (BOT) encompass several baking processes such as frozen dough, frozen partially baked breads, fully baked frozen breads or pre-fermented frozen dough. The concept of partially fermented dough appeared over the last decade on the market. The objective is ideally to have a product that may be transferred directly from the freezer to the oven; in such a case, the thawing and the baking is done in one shot. Intuitively, one may easily understand that the degree of fermentation before freezing plays an important role. Indeed, the structure of the dough, which is made of closed cells, will collapse during chilling and freezing due to gas contraction. This paper presents a brief literature review followed by an original unpublished experimental study on the impact of the pre-fermentation step and of the freezing rate in the case of pre-fermented dough. A crispy roll (French baguette) has been selected as a test product. No specific adjustment of the formulation has been done.

A total fermentation time of 2 hours has been chosen. Freezing was done after a pre-fermentation step which duration was in between 1h and 2 h. Freezing rate was either rapid or slow (air 4m/s and temperature of -20°C for slow and -40°C for rapid). It shows that a rapid freezing yield in higher bread volume. Other parameters such as cell structure, crust colour, dry matter in crumb and crust have been investigated to assess with more details the impact of the processing conditions. An outlook is proposed through the European Project "EU-FRESHBAKE" (2006-2009) which is supervised by the author of the paper. This EU project focuses on BOT and might find interest in frozen pre-fermented technology (<http://eu-freshbake.eu/eufreshbake/>).

T.I.3

Controlling oat flake quality to meet customer needs. F. K. GATES (1), T. Sontag-strohm (1), H. Salovaara (1). (1) Dept. Food Technology, University of Helsinki, Helsinki, Finland.

Oats are traditionally eaten as flakes, which are prepared from groats, the whole grain oat kernel. The light colour, soluble dietary fibre and other phytochemicals of oats make them potentially attractive to consumers. However, the uses of oats remain limited to mainly porridge, muesli, biscuits and to a lesser extent in bread. Consumption of oats in Europe has not increased as predicted. One reason for this could be the lack of variety and convenience in available oat based food products. The aim of this study was to investigate the influence of heat treatment on the quality of oat flakes. Oat flakes are mainly sold to consumers. Thus, the quality attributes of the flakes are relatively unimportant, and the specifications for oat products are relatively basic, when compared to those for wheat flour. In this study quality was measured as flake thickness, specific weight, strength, water absorption and amount of fine material produced. A laboratory scale process for steaming and flaking oats was developed. The influence of heat treatment on flake quality was studied using a factorial experimental design repeated in triplicate. Kilned and unkilned oat groats were steamed for 30 seconds and were then tempered at three temperature levels (80, 95, 110°C) and three tempering times (30, 60, 90 min) were used. Standard conditions were used for flaking and the roll gap was set at 0.4 mm. The effect of kilning was small, but a significant effect on specific weight was detected. Tempering conditions were shown to influence the specific weight, thickness and water absorption of oat flakes. Water absorption increased with oven temperature and tempering time. Surprisingly, under these conditions there was no correlation between water absorption and flake thickness. An improved understanding of the effect of processing on oat materials facilitates product development.

T.I.4

Technology of drinkable pro-biotic cereal suspensions (smoothies). H. O. SALOVAARA (1) (2), F.K.Gates (1). (1) Dept. Food Technology, University of Helsinki, Helsinki, Finland, (2) Avenly Oy Ltd, Helsinki, Finland.

Cereal-based products could challenge soy-products in the rapidly growing non-dairy yoghurt sector. Applying fermentation by pro-biotic lactic acid bacteria or bifido-bacteria provides additional health benefits in addition to the dietary fibre available for the cereal ingredient. The technology for spoonable oat-based yoghurt-type products has been applied industrially already for more than ten years, and the product has an excellent consumer response and is challenging other non-dairy yoghurts. Drinkable cereal-based pro-biotic nectars or smoothies open new technological challenges in terms of texture and stability. The paper handles with technological issues related to novel cereal-based smoothies of high beta-glucan content fermented with health promoting pro-biotic microbial starters.

T.I.5

Development of new dry fractionation processes of wheat grain to address consumers' demand for healthy foods and ingredients. J.Abecassis (1), C.Barron (1), M.Chaurand (1), Y.Hemery (1), V.Lullien-Pellerin (1), X.ROUAU (1). (1) UMR1208, Agropolymer Engineering and Emerging Technologies INRA, SupAgro,UM2,CIRAD, Montpellier, France.

Wheat grains are a potential source of bioactive compounds (fibres, micronutrients, phytochemicals) that are recognized as positive for consumers health. These compounds are mostly present in the outer parts of grains where they are encapsulated in cellular structures and partly co-localized with detrimental compounds. Grain outer parts are excluded from foods based on white flour, the mass product of the conventional milling process. There is however a demand for nutritionally enriched cereal ingredients and foods that remains attractive and tasty for the consumers and convenient for processors. New dry fractionation processes are being developed with the aim to exploit fully the potential of the grains, by including positive compounds and increasing their bio-accessibility and by excluding negative compounds from raw materials. To help the development, optimization and control of new processes as well as to deliver a more precise composition of the generated fractions, a system of reliable markers of the different grain tissues and sub-structures is developed based on biochemical or spectral analyses. Both whole grain fractionation to make enriched flours and miller's bran cracking to make cereal-based ingredients are investigated with the objective to improve the resolution of the processes (decrease the particle size and improve separation efficiency) in combining pre-treatments and advanced physical fractionation. In particular, the interest of innovative technologies as cryogeny and electrostatic sorting is evaluated.

T.II.1

Application of extruded wheat bran for added-value bread production. L. BASINSKIENE (1), S. Garmuviene (1), G. Juodeikiene (1) (1) Dept. Food Technology, Kaunas University of Technology, Kaunas, Lithuania.

Currently an increasing attention is given to the people's diet enriched with dietary fibre. This study is dedicated to investigate the application of new sources of dietary fibre - extruded wheat bran for increasing the nutritional value of wheat bread. Extruded bran was chosen for the positive nutritional and safety effects of the extrusion process, which include increased digestibility, destruction of anti-nutritional constituents, toxic substances, and micro-organisms. A different amount of extruded bran (5-20% of flour) was used in the experiments and compared with ordinary bran. Moreover, the abilities of xylanase from *Aspergillus* to improve the quality of bread have been investigated. Bran additions, in general, had pronounced effects on dough properties yielding higher water absorption and smaller extensibility in compare with those obtained without bran addition (control bread). The bran always decreased the bread volume and crumb porosity and changed texture properties. Extruded bran in compare with ordinary bran had higher water absorption and less negative effect for bread springiness and chewiness. Exploitation of xylanase considerably improved the rheological dough properties, bread quality and prolonged bread shelf life. Enzyme addition allowed increasing the amount of bran till 15% without negative effect on the bread sensory properties and acceptability.

T.II.2

A new healthy and functional ingredient. M. W. NOORT (1). (1) TNO Quality of Life, Zeist, The Netherlands.

Lactobacillus reuteri is able to produce glucans and fructans during fermentation. One of these glucans, α -1,4/1,6 glucan with a molecular weight of 40 MDa and a degree of branching of about 16%, appeared to be a satiation inducing agent and has a favourable effect on insulin and blood glucose levels in humans. The glucan is not degraded in the stomach and the jejunum, but is completely degraded in the colon. Due to its slow starch characteristics, this glucan may be an interesting health promoting component for bakery applications. Adding this glucan in a white bread recipe resulted in a higher bread volume compared to a reference without any bread improvers. This increase was not noticed using other polysaccharides like dextran or polydextrose. When stored during one week at 20°C, the bread with the added glucan appeared to have similar crumb softness as a bread with Novamyl™, amylase and glycerol mono stearate. DSC analysis showed that the improved crumb softness was not a result of a reduced amylopectin re-crystallization as is the case for Novamyl™. Possible explanations for the increased softness are: Influencing water migration between starch and gluten. Influencing the mechanical properties of the texture by influencing the micro structure. The results show that this healthy ingredient has beneficial functional properties for applying it in bakery products.

T.II.3

Leveraging fibre characteristics to functionally improve food products. R. S. MEHTA (1), C. Peterson (1), R. Mercier (1), M. Dineen (1), H. A. Zamora (2). (1) SunOpta Ingredients Group, Bedford, MA, USA, (2) SunOpta Ingredients Group, Cambridge, MN, USA.

Consumers' interest and awareness of the health benefits of dietary fiber continues to grow, resulting in the need to develop a variety of foods with higher levels of dietary fiber. Functional fibers are not completely understood and leveraged in food systems. The properties of different types of fibers were used to control food characteristics in a manner similar to approaches used in selecting appropriate starches and hydrocolloids. The impact of fiber type on functionality in some representative foods will be discussed. When bread dietary fiber content was increased to 2.5 g per 50 g serving, only one low water absorbing oat fiber had to be used. However, at the higher total dietary fiber level of 11 g per serving, five different fiber sources needed to be used including 2 oat fibers with different textural characteristics, a resistant starch, inulin, and red wheat bran. Gluten levels had to be increased and other formula changes were also necessary. Similar approaches were needed for incremental changes in bagel fiber levels. When formulating to provide high levels of dietary fiber (>5 g per serving), just using one fiber source dramatically affected bread and bagel volume and sensory characteristics. This proves that in order to maximize fiber levels in foods, multiple approaches have to be used to achieve desirable product characteristics.

T.II.4

Flax: a versatile nutritional ingredient. J. J. SMITH (1). (1) Quaker Tropicana Gatorade (QTG), Barrington, IL, USA.

Whole grain products have traditionally been associated with high nutritional value and have received considerable attention in the nutrition community. Consumers are also becoming aware of the importance of getting more whole grains in their diets while many food manufacturers are responding with an ever increasing number of whole grain offerings. An emerging challenge faced by the food industry is how to improve the nutrition of whole grains and create product differentiation. Flax is an ingredient that has tremendous nutritional potential for cereal products. The addition of flax to cereals provides a method for adding the benefits of omega three fatty acids. Additionally, flax is high in protein, fiber and

other significant nutritional components. This presentation outlines the nutritional value of flax and provides some examples for incorporating flax into grain-based products.

T.III.1.1

Oxygreen® process, a new tool for the improvement of wheat grains and their products. M. J. DUBOIS (1), A.G. Pernot (1), C. Coste (1). (1) Green Technologies, Goëmar, Saint Malo, France

The Oxygreen® process is a treatment of grains by ozone gas which takes place in the milling sequence, between grain-cleaning step and B1. The grains are treated homogeneously in a confined reactor by a rising flow of ozone. The remaining ozone is destroyed in a destruction unit at 350°C. The process is versatile and automated to modulate the effect of ozone in order to comply with technological, nutritional or sanitary aims. It has been approved by the French Food Safety Authority (AFSSA) as a processing aid (Nov 2003 and Sep 2004). A first industrial plant is just launched. The Oxygreen process enables a drastic reduction of contamination by microbiological and chemical contaminants (insecticides and mycotoxins). The pericarp of the wheat grain is separated from the grain as a new and clean product. The obtained pellicles can be used for many applications. Energy costs for crushing the bare grains are reduced. Milling process can be simplified, the flour global extraction rate is increased and fractions separation is improved. Oxidative enzymes are inhibited, but some maltose is produced. It is easier to obtain flours of good quality for baking, without any additive as ascorbic acid, α -amylase, or added gluten. Tenacity and tolerance of the dough and extensibility when shaping loaves are increased. Dough stickiness is reduced and CO₂ retention during the rising process is increased. Breads made with flours issued from Oxygreen process have a said "nutty" or "malty" taste. The crumb has a creamy colour due to the presence of natural wheat pigments not altered by enzymatic activity. Outer layers of the grains can be incorporated in the flour without sanitary risk. Milling fractions can be used mixed or separated. Their taste, colour and size are improved such as to be used in many cereal products. Oxygreen treated bare grains could be used directly in industrial preparations. For white flour, no modification of the glycemic index has been detected.

T.III.1.2

Interfacial properties of dough liquor from lipase modified dough. P. B. Arskog (1)(2), L. Erlandsen (1), R. Ipsen (2), P. Wilde (3). (1) Cereal Foods, Novozymes A/S, Bagsvaerd, Denmark, (2)Dept. Food Science, Faculty of Life Sciences, University of Copenhagen, Copenhagen, Denmark,(3)Institute of Food Research, Norwich, UK.

During recent years the use of lipases with activity towards polar lipids has increased rapidly and is today able to reduce the amount of dough stabilizing emulsifiers such as CSL, SSL and DATEM in bread recipes. The lipases modify the inherent flour lipids so that they are able to stabilize the dough better. One kilo of lipase is able to replace 100 to 1000 kg of emulsifier, lower transport and a storage cost in combination with lower treatment cost makes the application favourable. In addition to this it can also replace E-numbers from the ingredient list since enzymes are regarded as processing aids. Understanding the role of lipids in dough stabilisation is useful for developing even more effective lipases. Gas cells in dough are thought to be lined by a liquid film, containing surface active substances such as lipids and proteins, which may either stabilise or destabilise the air-water interface. The objective was to study how changes in lipid profile by adding lipases with different specificities influence the surface properties of dough liquor (DL) compared to emulsifiers. The composition and surface properties of DL isolated by ultracentrifugation have been characterised. HPLC of DL showed that lipases changed the lipid composition. Pendant drop technique was used to study surface properties of DL. Lipases with high activity on polar lipids decreased surface tension and elasticity more than DATEM and lipase mainly active on non polar lipids. SSL decreased surface tension mostly and increased the elasticity strongly. Baking trials

showed that lipases with high activity on polar lipids increased specific volume to the same extent as DATEM, while SSL and the lipase mainly active on non polar lipids gave less increase.

T.III.1.3

Water migration and molecular mobility in baked cakes during storage: an NMR investigation. F. LE GRAND (1), M. Cambert (1), F. Mariette (1). (1) Food Process Engineering Research Unit, Cemagref, Rennes, France.

Consumers can notice a recent diversification in commercial pastries, notably products with fillings. The quality changes and consequently the shelf-lives of these products depend on dynamic properties of water inside food. The staling process and molecular mobility of these heterogeneous systems are still unclear. Because consumers are more and more demanding on preserving foodstuff, it is a challenge to understand molecular mobility and chemical reactions during storage of pastries. Several studies, using Nuclear Magnetic Resonance relaxation analysis, also called NMR relaxometry, have studied the retrogradation of starch and the water behavior in simple matrices: bread, starch-sugar(s)-water solutions. However, few studies have described the mobility of molecules in complex systems, containing fat. The aim of this work was to investigate the water migration inside shell-shaped sponge cakes, called "madeleines", and the consequences on molecular mobility from NMR relaxation measurement during storage. After cooking, a large water gradient between crust and center was observed. The results showed that this gradient was influenced by the composition of the recipe. From a careful analysis of the NMR data we observed a fat gradient, superimposed with a gradient in molecular mobility. During storage, the system tended towards equilibrium of liquid distribution between center and crust, but molecular mobilities were still different. The results showed that center and crust did not have the same structure, neither the same behavior during staling. Diffusion coefficients of water were also measured by pulsed field gradient NMR during storage, independently for crust and center of cakes. This work is thus a new step into molecular dynamics understanding of amylaceous foodstuff, especially those with low humidity and high fat content. Because samples are real food products, this study will find a direct application in industry.

T.III.1.4

Impact of parboiling on the Maillard reaction in long-grain rice. L. LAMBERTS (1), I. Rombouts (1), Brijs (1), J. A. Delcour (1). (1) Molecular and Microbial Systems, K.U.Leuven, Leuven, Belgium.

Parboiling is a three step hydrothermal treatment consisting of soaking, steaming and drying. The color of rice changes from white to amber during parboiling. It was already shown that Maillard reactions were responsible for color changes, besides leaching out and migration of bran pigments into the endosperm and some enzymic browning. The objective of our study was to increase insights in the contribution of Maillard browning during parboiling of brown rice. Long-grain rice cultivars (Puntal, Cocodrie, XL8, Jacinto, Red rice) were soaked at 50°C for ca. 30min. The soaked brown rice was steamed for different times at different temperatures to obtain mildly, intermediately and severely parboiled rice. Colour measurements indicated that parboiling resulted in a decrease in brightness and an increase in yellowness and redness of brown and milled parboiled rice. In contrast, redness and yellowness of Red rice decreased after parboiling, while darkness, yellowness and redness of milled parboiled Red rice also increased with severity of parboiling conditions. Determination of sugars indicated that sucrose and maltose levels decreased after parboiling, while the glucose content depended on parboiling conditions and the fructose content increased with severity of parboiling conditions. The change in the levels of furosine, a Maillard reaction indicator, caused by parboiling depended on variety. The varieties Puntal and Cocodrie showed an increase with severity of parboiling conditions, while for XL8, Jacinto and Red rice

furosine levels decreased after severe parboiling. The content of lysine, a second Maillard reaction indicator, decreased with severity of parboiling conditions. This work demonstrate that Maillard reactions increased with severity of parboiling conditions and allow us to conclude that mainly Maillard browning is responsible for parboiled rice color.

T.III.1.5

Towards a decision support tool for French bread making: qualitative representation and expert-system shell for mixing. H.CHIRON (1), G. Della Valle (1), P.Roussel (2), A. Ndiaye (3). (1) INRA, BIA, Nantes, France, (2) PolyTec'h Paris-UPMC, Paris, France, (3) INRA, UMR-US2B, Bordeaux, France.

French bread making is a complex process of different sequential operations (mixing, proofing, shaping, baking...) that are not presently fully understood by scientific approach. Conversely, experts have developed much know-how which is not widely available. To fill this gap, a knowledge management approach is being built by a group involving technological experts, food and computer scientists. First, a qualitative model of the mixing process has been developed by analysing control variables of kneading and state variables of dough. Our goal is to be able to automatically predict the dough conditions using control variables, and to deduct the causes of dough faults from the state and control variables. The control variables are the linear speed difference between the bowl and the mixing arm; the dough overheating during the kneading process, which is qualitatively assessed (low, average, high); the measurement in UF (Farinograph unit) of dough consistency at the beginning of kneading; the dough temperature (°C) at the end of the kneading process. The control variables are heterogeneous and are the only parameters used in the assessment of the dough conditions at the end of the kneading process. The flour dough is described using eight state variables: smoothing velocity, smooth aspect, extensibility, stickiness, stability, consistency, elasticity and creamy colour. The calculus space is represented as a qualitative homogeneous symbolic space of seven elements with two elementary functions, four comparison operators and eighteen internal composition laws, representative of the French bread making domain. Seven abstract operations are used to represent the elementary cognitive operations of human experts. A symbolic vocabulary space has been defined to allow the integration of French bread making domain vocabulary. Using this knowledge representation, the developed qualitative model automatically calculates the bread making scores on the French AFNOR standard (AFNOR: NF V 03-716). Software has been developed in the CLIPS programming language as a mock-up of this model. In the first validation step, the accuracy of the representation by the human experts have been found satisfactory and yielded encouraging results on the similarity between the predicted and the obtained bread making scores on the AFNOR standard.

T.III.2.2

Antifungal activity of sourdough and potential to reduce the level of calcium propionate in wheat bread. L. A. Ryan (1), F. DAL BELLO (1), E. K. Arendt (2). (1) Dept. Food and Nutritional Sciences- Biotransfer Unit, University College Cork, Cork, Ireland, (2) Dept. Food and Nutritional Sciences, University College Cork, Cork, Ireland.

A number of methods are applied to prevent or minimise microbial spoilage of bread, e.g. addition of chemicals, irradiation, pasteurisation of packaged bread, or addition of sourdough. We have recently described the ability of sourdough fermented by a *Lactobacillus plantarum* strain to inhibit the growth of Fusarium species on wheat bread. In this study, two antifungal *L. plantarum* strains were used to ferment sourdough and the resulting sourdough was tested for inhibitory activity against spores of the fungi *Aspergillus fumigatus*, *Fusarium culmorum*, *Penicillium expansum*, or *Penicillium roqueforti*. Results were compared to sourdough fermented by a non-antifungal *Lactobacillus sanfranciscensis* strain as well as to chemical acidified dough. Challenge tests against the above mentioned

fungi were also performed using bread containing 20% sourdough. Results indicated that sourdough fermented by the two *L. plantarum* strains has the potential to increase the shelf life of wheat bread. An increase in shelf life was observed against all selected fungi, except for *P. roqueforti*. Recently the amount of chemicals allowed in the bakery industry, in particular of calcium propionate, has been reduced to a level which does not assure the safety of products. The second objective of this study was to investigate the synergistic effect of antifungal sourdough and reduced levels of calcium propionate against the above mentioned spoilage organisms. At the maximum level allowed (0.3% calcium propionate and 20% sourdough addition) a strong antifungal activity was observed against all selected fungi. Interestingly, under these conditions growth of *P. roqueforti* was clearly inhibited and a shelf life increase of 2 two days was observed when compared to the controls. Results of this study strongly indicate that a further reduction in the addition of chemicals may be achieved, if antifungal sourdough is added to the final bread.

T.III.2.3

Ingredients for improving frozen bakery products - an application which meets consumer and market needs. I. POVLSEN (1), D. Petersen (1). (1) Danisco, Brabrand, Denmark.

A Danisco consumer insight study observing the food-related behaviour of 15 consumers in 3 Western European countries led to the identification of currently unmet needs. These consumer insights coupled with Danisco's knowledge of ingredient functionality and key competences within food texture, appearance and taste resulted in value-adding solutions within par-baked and frozen bakery products. This presentation briefly describes the findings of the consumer study and elaborates on the functionality of different ingredients, which improve the quality of the frozen product. Using different emulsifiers, enzymes and hydrocolloids it is possible to create an industry tool box which stabilizes the dough matrix and controls ice crystal growth during storage thus increasing shelf life of frozen products from weeks to several months. In this work different analytical tools such as microscopy in the form of Confocal Laser Scanning Microscopy (CLSM), water distribution measurements and baking trials have been used to study the influence of the different functional ingredients on the dough formation, stability of the dough during storage and the quality of the final bakery product.

T.III.3.1

Asparagine concentration and acrylamide formation potential in wheat flour as affected by sulphur fertilization. M. Granvogl (1), H. Wieser (2), P. KOEHLER (2), S. von Tucher (3), P. Schieberle (1). (1) Chair of Food Chemistry, Technical University of Munich, Garching, Germany, (2) German Research Center for Food Chemistry, Garching, Germany, (3) WZW Center of Life Sciences, Institute of Plant Nutrition, Technical University of Munich, Freising, Germany.

White flours of the spring wheat cultivar "Star" grown in a laboratory scale at five different levels of sulphur fertilization (30, 60, 90, 120, and 150 mg per pot) were analyzed for the content of sulphur, nitrogen, free amino acids, and sugars. The results demonstrated that the content of free asparagine, the precursor of acrylamide, increased by a factor of 163 when sulphur supply had been reduced from 150 to 30 mg per pot. In contrary, the content of reducing sugars, which are also involved in acrylamide formation, increased only slightly by a factor of 2.7 at most. Flours were heated for 20 min at 170 °C and analyzed for the content of acrylamide and 3-aminopropionamide, the key intermediate in acrylamide formation. Both acrylamide and 3-aminopropionamide concentrations increased in dependence on the lowered sulphur supply. The concentration of acrylamide rose by a factor of 33 from 94 µg/kg to 3124 µg/kg whereas the concentration of 3-aminopropionamide increased by a factor of 190 from 0.4 mg/kg to 76.0 mg/kg with reducing sulphur supply. Similar results were obtained for crispbreads made from the different flours in a micro-scale baking test. In conclusion, wheat plants should be sufficiently supplied with sulphur during growing to avoid high concentrations of acrylamide in baked products.

T.III.3.2

Pesticide residues in post harvest treated wheat, barley and their products. U.UYGUN (1), H. Köksel (1). (1) Dept. Food Engineering, Hacettepe University, Ankara, Turkey.

Residues of pesticides in cereals are influenced by storage, handling and processing that occurs between harvesting of grain and consumption of prepared foodstuffs. In order to investigate residue levels of malathion and fenitrothion and their metabolites (malaoxon, isomalathion and fenitrooxon) during storage, milling and baking, malting, pesticide-free wheat and barley were treated with the insecticides. Residues were determined in wheat, bran, flour, white and bran bread at about one-month intervals during storage and in barley at about one-month intervals during storage and in malt produced from the barley stored at various times of storage. The highest amounts of insecticides and metabolites were present in bran and the least in white bread. Reduction of malathion residues was about 95% in wheat through milling to flour and about 82% in flour through white bread baking. In another study which was carried out in collaboration of Ministry of Agriculture and Hacettepe University on the effects of processing on residue levels of organophosphorus pesticide residues (malathion, fenitrothion, chlorpyrifos methyl and pirimiphos methyl) in post-harvest treated wheat and its products were also investigated. Residues of the pesticides were detected in wheat and bran, flour, cookies, semolina and spaghetti obtained from treated wheat at intervals of about a month. A multiresidue analysis was performed using GC equipped with a Nitrogen-phosphorus detector. The confirmation was performed by GC-MS. Residues of post harvest insecticide treatment on stored grains generally declined slowly. Processing into foods resulted in large or small losses according to the nature of process. The overall results of our investigations indicated that the behavior of residues in storage and processing could be predicted by using the physical-chemical properties of the pesticides.

S.1

Separation of protein subunits in Irish wheat flours using microfluidic technology to determine quality and potential end-uses of individual flours. L. M. REID (1), E. Gallagher (1). (1) Teagasc, Ashtown Food Research Centre, Dublin, Ireland.

Routine testing is carried out each year on wheat samples obtained from the Irish Government Department of Agriculture field trials throughout Ireland to assess the quality and potential end-uses for different varieties of wheat from the different trial locations. All samples are subjected to grain tests (moisture content, Falling Number value, protein content and hardness index), and some to more comprehensive testing (including baking) depending on the results from the grain tests. Microfluidic technology could potentially provide a rapid and less labour-intensive and time-consuming means of obtaining important structural information about the wheat samples. The objective of this study was to investigate the suitability of microfluidic technology to determine the quality and composition of wheat proteins in a variety of flour samples. Forty-eight wheat samples were obtained from six field-trial locations around Ireland and milled. A 2100 Bioanalyzer (Agilent Tech., Palo Alto, CA) was used to separate the proteins present. Results point to the potential for differentiating samples on the basis of wheat variety [e.g. hard wheat (having a high protein content) or soft wheat (having a low protein content)] and location of harvest, both key factors related to the properties of particular wheat flours. The results also correlated well with those obtained using the existing tests. It was found that the protein composition for hard wheat varieties such as Soissons and Cordiale may contribute to their suitability for breadmaking, as both these varieties exhibited a larger concentration of glutenin subunits than other varieties. Also, spring wheat varieties which are generally not used for bread-making – such as Raffles, contained much smaller amounts of glutenin subunits. These results indicate that by examining the protein composition of the wheat samples, greater information about the composition and potential end-uses of the individual samples will be obtained.

S.2

The wheat bugs (Insecta Heteroptera) in Spanish wheat samples, and their effect on flour rheological quality. T. MONLEON-GETINO (1), M. Goula (2), E. Gordún (3), K. Gibert (1). (1) Universitat Politècnica de Catalunya, Dept. Statistics, Barcelona, Spain, (2) Universitat de Barcelona, Dept. Animal Biology, Barcelona, Spain, (3) Universitat Politècnica de Catalunya, Dept. Food Industries, Barcelona, Spain.

The Sunn pest belong to genera *Eurygaster* and *Aelia*. Their feeding activity changes protein quality, due to an enzyme complex (proteases, lipases, alfa and beta amilases, and invertase) present in the bug's saliva. In Spain, the effects of Sunn pests cause important economic losses, either by crop reduction or by the resulting low quality flour, which impedes its commercialisation. As a consequence, damaged wheat must be mixed with high quality wheat, or the flour must be chemically treated to overcome baking defects. Our objectives were to update information on Sunn pests in Spain, to try to relate their presence to wheat damage, and to develop a model to minimize the consequences of that damaged. Samples studied were those taken for the annual inquiry of the quality of wheat, promoted by the Spanish Association of Cereal Technicians. Samples amount to 96.5% of the cropped area, and to 97.07% of the total production. The period of study covers the last ten years, and includes about 700 samples of soft wheat /year. The results show that about a 15% of the studied samples were infested by sunn pests, with an average density of 0.20 bugs/sample. In all, 7 species of Sunn pests were recorded, unevenly distributed among wheat varieties and geographic areas in Spain. *Aelia germari* and *A. rostrata* were considered the most harmful species. Alveographic %W after a 2 h repose show statistical significant differences ($p < 0,05$) when samples

with and without sunn pests are compared. Infested wheat samples have a high proteolytic activity, which may be a good indication to detect wheat samples affected by degradation. To help provide the wheat industry with a quick screening method at the reception of wheat samples, a computational model, based on artificial neural nets and logistic regression, has been developed. The model is based on entomological data, visible damage on wheat grains, and the usual analytical parameters. It may predict 78,33% of the cases ($> 25\%$ W at 2 h repose).

S.3

Frozen dough: mathematical modelling of interactions between yeast cells and the dough matrix. S. D. MILLER (2), R. J. Winger (1). (1) Institute of Food, Nutrition and Human Health, Auckland, New Zealand, (2) Riddet Centre, Massey University, Palmerston North, New Zealand.

The shelf life of frozen dough is limited by the decline of proofing power during storage, which is primarily due to a decline in the fermentation ability of yeast cells. Events prior to freezing impact heavily on shelf life, for example accidental fermentation due to delays on the factory floor can severely compromise storage stability. This research aimed to mathematically characterise yeast metabolite dynamics in dough during pre-freezing fermentation. A novel method for measuring sugars and ethanol in yeasted dough was developed and validated. Using this method the consumption of substrate and accumulation of ethanol during fermentation were measured and their stoichiometric relation with gas production (measured via Risograph) was calculated. Results suggested that the capacity of *Saccharomyces cerevisiae* cells for oxidative metabolism is not utilised during fermentation. The uptake of substrates and excretion of wastes in the micro-environment around a yeast cell was mathematically modelled using available experimental data. It was concluded that the rate of fermentation was limited by neither diffusion of substrates towards a yeast cell, nor diffusion of harmful waste-products away from a cell. The capacity of the cell to transport sugar across the cell membrane was thought to be the limiting step in fermentation. Mathematical models of sugar uptake from biotechnology and fermented food industries were evaluated for their applicability in dough. A good fit to experimental data was achieved with a model based on hyperbolic enzyme kinetic equations. This work showed that the mathematical modelling approach widely applied to other fermented foods is also useful in bakery research. The models developed here demonstrate how dough composition can be predicted, and provide a tool that can be used in optimising frozen dough processing conditions to produce a consistently high-quality product.

S.4

Does wheat gluten elasticity compare with elastin? Dynamic mechanical properties of wheat gluten over a wide frequency window. A. REDL (2), S. Guilbert (1). (1) INRA UMR IATE, Montpellier, France, (2) Tate & Lyle Europe N.V., R&D, Aalst, Belgium.

The underlying mechanism of wheat gluten elasticity is still of considerable challenge. Unlike rubber the elastic properties of wheat gluten are not inherent to the material itself, since pure wheat gluten acts as a brittle and rigid polymeric glass. Wheat gluten is only elastic in presence of water and/or other hydrophilic plasticizers such as glycerol. In this respect wheat gluten acts similar to other elastic proteins such as elastin or squid protein. In order to monitor the changes in elastic properties of wheat gluten from its dry and glassy to its hydrated and rubbery state the dynamic mechanical properties were measured at various hydrations. The so obtained mechanical spectra were then combined to master curves and modelled with a generalized Cole-Cole model which enabled to quantify the glassy and elastic modulus and the width of the transition region. The spectra extend over 20 logarithmic time decades and show the transition from

glassy to rubbery behaviour over a very wide time domain of 10-11 decades. Such a broad transition is very unusual when compared to other elastic polymers such as rubber but has been observed yet for elastin where a hydrophobic mechanism was proposed to explain its elasticity. In this work we discuss the possible implication of such a hydrophobic mechanism in gluten elasticity.

S.5

Comparison of predictions of baking volume using large deformation rheological properties. B. DOBRASZCZYK (1), B. Salmanowicz (2). (1) Department of Food Biosciences, The University of Reading, UK, (2) Institute of Plant Genetics, Polish Academy of Sciences, Poznan, Poland.

Three large deformation rheological tests were carried out on doughs made from a number of Winter wheat varieties grown in representing a broad spread in baking performance in order to assess their suitability as predictors of baking volume: the Kieffer dough extensibility system, the D/R dough inflation system and the 2g mixograph. Principal Components Analysis of the data clearly showed that protein content and protein quality are independent. The parameters most closely associated with baking volume were strain hardening index, bubble failure strain, and mixograph bandwidth at 10 min. Simple correlations with baking volume indicate that bubble failure strain and strain hardening index give the highest correlations, whilst the use of best subsets regression, which selects the best combination of parameters, gave increased correlations with $R^2=0.865$ for dough inflation parameters, $R^2=0.842$ for Kieffer parameters and $R^2=0.760$ for mixograph parameters.

S.6

Study of gluten network development in mixed batter dough: structural and biochemical modifications. F. AUGER (3)(2), A. Redl (3), J. Lefebvre (1), M. Morel (2) (1) INRA, BIA-PEPSI, Nantes France, (2) INRA-UMR IATE, Montpellier, France, (3) TATE & LYLE Europe N.V., Aalst, Belgium.

Wheat dough development, which influences the quality of bread, relies on the formation of the gluten network. In consequence, controlling the gluten network development could improve bread processing and formulation. Unfortunately in bread processing, the rate of dough development is fast and underlying mechanisms remain mostly unresolved. We reduced the rate of dough development by increasing dough water content. Mixing was performed on a planetary mixer with variable mixing speeds and flour/water ratios. Protein staining experiments revealed that the gluten network development relied on two successive processes. The first involved the formation and growing of microscopic gluten lumps and the second involved the formation of gluten strands of several millimeters length. The structural transition from gluten lumps to gluten strands was completely achieved at the optimal dough development time (t_{peak}). On a biochemical point-of-view, SE-HPLC analyses of proteins revealed that mixing induced the de-polymerization of SDS-insoluble glutenin polymers. The de-polymerization was found to reach completion at t_{peak}, irrespective of the mixing conditions used. During the mixing, the de-polymerization proceeded continuously according to a kinetics that did not reflect changes neither in the mixing curve nor in the gluten macroscopic structure within the dough. This work suggests that the de-polymerization of glutenin polymers is not a simple artefact and might signal a key underlying event, crucial for gluten network development in mixed dough. It also demonstrates that the relationship between the biochemical state of glutenins and dough rheology is far from being straightforward and that the micro-scale organization of dough constituents needs to be taken into account.

S.7

Optimization of extrusion cooking parameters for main commercial pulse legumes. J. J. BERRIOS (2), R.T. Patil (1), J. Pan (2). (1) CIPHET, Ludhiana, India, (2) USDA-ARS-WRRC, Processed Foods Research Unit, Albany, CA, USA.

Dry peas (*Pisum sativum*), Lentils (*Lens esculenta*) and garbanzo beans (*Cicer arietinum* L.) are main commercial pulse legumes that have great potential to be made into expanded snacks and food ingredients. Extrusion is used commercially to add value to cereals grains. However, with the exception of soybean, other legumes have not been used for the development of extruded food products. The objective of this study was to optimize different extrusion conditions in some physical and nutritional characteristics of dry peas, lentils, and garbanzo beans. The pulse legume seeds were reduced to flours and extruded at moisture content of 20, 24, and 20 percent, and 160 and 180 degree Celsius. A Leistritz Micro-18-GL twin-screw was used at a constant speed of 500 rpm. The values of average torque and die pressure increased directly as the moisture content of the flours decreased from 28 to 20 percent and as the temperature increased from 160 to 180 degree Celsius. Expansion ration of the different legumes also increased with a decrease in moisture and an increase in extrusion temperature. Extruded lentil demonstrated the greatest expansion ration, followed by dry peas, and garbanzo products. Extrusion processing improved significantly the texture and protein digestibility of the legumes under study, without affecting their proximate composition. The use of response surface regression analysis allowed the optimization of the extrusion cooking parameters studied. Also, extrusion processing demonstrated to be an effective way to add value to lentil, dry peas, and garbanzo beans by the production of nutritious, expanded snack-type extrudates.

S.8

Effect of the sowing date on physicochemical and functional properties of native starches extracted from European soft wheat. C. MASSAUX (3), J. Lenartz (1), M. Sindic (3), B. Bodson (2), G. Sinnaeve (1), A.Falisse (2), P.Dardenne (1), C. Deroanne (3). (1) Département Qualité des Productions agricoles, Centre wallon de Recherches agronomiques, Gembloux, Belgium, (2) Unité de Phytotechnie des Régions tempérées, Faculté universitaire des Sciences agronomiques, Gembloux, Belgium, (3) Unité de Technologie des Industries agro-alimentaires, Faculté universitaire des Sciences agronomiques, Gembloux, Belgium.

The influence of wheat sown dates (October and December) on the starch properties was evaluated. The results showed a significant impact of this factor for most of the studied varieties. Native starches were isolated by 'Batter' procedure from white flour extracted from European wheat varieties (*Triticum aestivum* L.) cultivated in the same phytotechnic conditions during several years (2002 to 2005). Starch purity was always higher than 97% and extraction yields were around 75-80% of total starch. Starch damages, evaluated by the Chopin SD4 method, were higher in the samples sowed in December and correlated with water absorption of flours, analysed by farinograph. The amylose content, measured by iodometric reaction, was inversely correlated with the granule size distribution, evaluated by laser-diffraction analyser. A higher amylose content and a lower contribution of the small granules (< 10 µm) to the total volume were observed with later sowing dates. Starch viscosity behaviour, characterised by micro visco-amylograph with alpha-amylases inactivation by 2mM AgNO₃ addition, also showed variations with the sowing dates. The starch viscosities measured at 95°C were always higher in the samples sowed in October. It is apparent from this study that starch properties were influenced by the wheat sowing date. These variations could lead to processing or end-products quality problems and must be controlled. Furthermore, an appropriate selection of the wheat sowing date could be valorized to emphasize the required starch properties in industrial end uses.

S.9

Compositional and technological changes of wheat during germination.

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Wheat kernels of the cultivar 'Tommi' were germinated for up to 192 h at 15, 20, 25 or 30 °C. Samples were taken at different stages of germination and were analyzed for the quantitative protein composition using an extraction/HPLC method, for folate vitamins using a stable isotope dilution assay and for soluble, insoluble and total dietary fiber using a gravimetric method. Gluten proteins were substantially degraded during germination. During the first stages of germination the degradation of glutenins was predominant, whereas longer germination times were required to degrade gliadins. The optimal temperature for gliadin degradation was 20 °C and that for glutenin degradation was 25 °C. omega 5- and omega 1,2-gliadins were less sensitive against proteolysis than alpha- and gamma-gliadins and LMW subunits of glutenin were less sensitive than HMW subunits. During germination a time- and temperature- dependent increase of total folate occurred. A maximum 3.6-fold concentration was obtained after 102 h germination at 20 and 25 °C including 5-methyltetrafolate as the major vitamin. The concentration of dietary fiber remained constant or decreased during the first 96 h of germination. Prolonged germination times of up to 192 h led to a substantial increase of total dietary fiber and to a strong increase of the soluble dietary fiber by a factor of 3, whereas the insoluble fiber decreased by 50%. The activity of proteases and alpha-amylase showed a time-dependent increase, which was substantially stronger for alpha-amylase (factor 300) than for proteases (factor 3). Compared to flour from non-germinated wheat all rheological parameters were inferior in the germinated material. The water absorption decreased by 10 %, the resistance to extension of the dough and the extensibility of the gluten decreased to about 50% of the initial value.

S.10

Cereal proteomics: interactions of Transglutaminase and buckwheat proteins.

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Application of Transglutaminase (TGase) on buckwheat (BW) flour has shown significant improvements on the baking performances of the flour by promoting protein networks. In this study, the impact of TGase on the protein fractions of BW flour was investigated in order to better understand the activity and specificity of the enzyme. Albumin, globulin, prolamin and glutelin fractions were extracted from the flour and incubated with TGase. Size Exclusion Chromatography (SEC), SDS-PAGE and two-dimensional (2D) gel electrophoresis were performed on each fraction. SEC showed that the albumin and globulin fraction of BW were extensively cross-linked by TGase and high molecular weight (HMW) protein aggregates could be detected. 2D gel electrophoresis performed on the different fractions confirmed that BW albumin and globulins were extensively cross-linked. Therefore, the improvements in the baking performances of breads based on TGase-treated BW flour are due to extensive cross-linking of albumin and globulins and the resulting formation of HMW protein agglomerates. Study financially supported by European Commission, 6th framework programme, project HEALTHGRAIN (FP6-514008).

S.11

Effects of flour particle size on the physicochemical, rheological and textural properties of dough. S. ALAMATIAN (1), S.A. Mortazavi (1), M. Karimi (2). (1) Dept. Food Science and Technology, Ferdowsi University, Mashhad, Iran, (2) Food Science & Technology, Research Center of Agriculture & Natural Resources, Mashhad, Iran.

Four local varieties of wheat including; *Alvand*, *Gascogen*, *Pishtaz* and *Sabalan* (belonging of *Mashhad* region) were milled by a laboratory roller mill and fractionated by sieving in five particle size of; <106, 106-125, 125-180, 180-500 and >500 µm were tested for their physicochemical, rheological and textural properties of dough. The results indicated that >500 µm fractions of the all varieties of flour had the highest levels of protein and >500 µm fractions of the *Gascogen* and *Pishtaz* varieties had the highest amounts of ash. The particle size showed a positive correlation with protein, ash and moisture contents ($p < 0.05$). Increasing the particle size of flour (from 106-125 µm fractions that 180-500 µm fractions) increased of dough firmness ($p < 0.05$) and compressive energy for dough, decreased of dough deformation at rupture. Rheological data indicated that for all varieties, increasing the particle size of flour (from 125-180 µm fractions to 180-500 µm fractions), resulted in increased water absorption, mixing time and stability of the dough.

S.12

Quantitation of the dilatancy of different starches: effects on the water holding capacity, the techno-functional properties of wheat dough.

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The unique properties of wheat dough are due to the gluten network, the areas of accumulated starch and the free water between the particles. Mechanical forces during dough making are responsible for the generation of these structures and for their shape. The present work tries to clarify the mechanisms of interaction between starch and gluten, which up to now had not been determined but considered to be important for the final dough properties. Maize, rice and A and B starch from wheat were purified by wet sieving. Synthetic flour was made with dried gluten and gelatine. Constant dough resistance of 0.24 N monitored by SMS-Kieffer micro extension tests was used. Thin sections of dough were analysed by light microscopy. With wheat starch A, the gluten structures were thick and the starch-filled gluten-free spaces between them were very large. The resulting maize dough was similarly structured, the spaces were smaller, the smallest were formed with starch B. Dough elasticity got almost lost with the small particles of wheat B-starch, with rice and with the mixture of maize and rice. For dilatancy measurements water was added to pure starches just to fill the space between the starch granules. Stress ramps between 10 and 10⁴ Pa in a Couette geometry modified in order to avoid wall slipping monitored pronounced dilatancy of the A-starch and maize with a sudden stiffening at approximately 10² Pa. Rice and B-starch showed no or little dilatancy, the mixture of maize and rice took an intermediate position. Comparing these results with the generated dough structures and the water binding visible by the dough surface properties, there is a possible explanation for the differing dough properties: dough volume increases during kneading starch exhibiting dilatancy, thus immobilizing additional free water. The dough resistance increases and more mechanical energy can be transmitted to the gluten particles (better "development of gluten").

S.13

Effect of cooking methods on the volatile compounds of cooked rice. J. LIU (1), S. Zhao (1), S. Zhang (1), Y. Xu (1). (1) College of Food Science and Technology, Huazhong Agricultural University, Wuhan, China.

Cooked rice is the main food in the world. Flavour is the most important sensory attribute of cooked rice. Many studies have been carried out on the volatile compounds of cooked rice, especially on kinds of rice, milling degrees, storage time and drying condition. Volatile compounds of cooked rice are produced during cooking, but few studies have been focused on the volatile compounds of cooked rice by using different cooking methods. The objective of the present work is to study the effect of different cooking methods on the volatile compounds of cooked rice. The volatile compounds from cooked rice, prepared in an open cooker, a pressure cooker and an electric rice cooker were extracted by solid phase micro-extraction and analyzed with gas chromatography-mass

spectrometry (GC-MS). A total of 92 volatile compounds were identified. These compounds were aldehydes, alcohols, hydrocarbons, ketones, acids, esters and heterocyclic compounds. Hydrocarbons and aldehydes were the most numerous among all compounds. Types of volatile compounds were obviously affected by the cooking method. The results of identification show that the main components were hexanal (11%) with an open cooker, but oleic acid (58%, 28%), and (E)-2-butenedioic acid diethyl ester (37%, 15%) largely dominated in the rice cooked in a pressure cooker and electric rice cooker respectively.

S.14

Effect of growth temperature on viscosity of soluble barley beta-glucan. K. ANKER-NILSSEN (1), S. Sahlstrom (2), A. Holtekjolen (2), A. Uhlen (1). (1) Department of Plant and Environmental Sciences, Norwegian University of Life Sciences, Aas, Norway, (2) Matforsk, Aas, Norway.

Beta-glucans are non-starch polysaccharides from cell walls of endosperm and aleurone cells in barley. Viscosity of beta-glucan is of great importance with regard to brewing, performance as animal feed and in human nutrition. The solution viscosity depends on the concentration of the solution, the molecular weight of the beta-glucans, the shear regime, temperature and solvent used. Eight different barley varieties were grown at different temperatures in controlled environment chambers. The content of total, insoluble and soluble beta-glucan was determined. The viscosity of the isolated and purified water extractable beta-glucans was measured by using a rheometer (cone and plate). Their molecular weights were measured using HPLC. Results showed that the total beta-glucan content in barley kernels, which varied between 3.8% and 7.4% on dry matter basis, did not change much with growth temperature. However, the ratio between soluble and insoluble beta-glucans was more dependent on temperature. Results further showed that the viscosity induced by isolated and purified water extractable beta-glucans was highly dependent of the growth temperature. In addition, variation in viscosity between different varieties was found. These results show the need to focus not only on the total amount of beta-glucans in barley, but also on their ability to affect the viscosity.

S.15

Build-up of gluten proteins during grain filling: the influence of environmental factors. A. UHLEN (1), A. Moldestad (1), K. Hollung (2), H. Grove (2), E. Mosleth Færgestad (2). (1) Department of Plant and Environmental Sciences, Norwegian University of Life Sciences, Aas, Norway, (2) Matforsk, Aas, Norway.

Environmental factors as temperature, nitrogen availability and watering influences the build-up of gluten proteins in wheat during grain filling. It is well known that the portion of the largest insoluble glutenin macropolymers play an important role in the baking quality of wheat. For wheat varieties, large variations in protein quality are seen between locations and between years. During a two years study, one wheat variety was grown under controlled environment to study the build-up of gluten proteins at temperatures relevant for wheat producing areas at higher latitude. Two temperatures, 15°C and 18°C, were applied during grain filling. Build-up of proteins was followed with analysis of changes in size distribution of the proteins during grain filling. Grains were harvested from 20 days after anthesis, to maturation. Two-dimensional electrophoresis coupled to mass spectrometry was used to identify proteins which changed during grain development. Larger proportions of insoluble polymeric proteins were obtained at 18°C compared to 15°C. Mapping of the proteins by 2D electrophoresis shows clear differences between wheat grown at the two temperatures during grain filling. The results show that the differences in temperature used in this study had a clear effect on the build-up of gluten proteins.

S.16

Reducing and crosslinking wheat seed storage proteins with thioredoxin h. A. ZAHID (1), J.F. Gabarrou (1), R. Cazalis (1). (1) Laboratoire d'Agrophysiologie, EI Purpan, Purpan, France.

Thioredoxin *h* (Trx *h*) are now well-known to be involved in the mobilization of storage proteins during germination. This present work investigates their crosslinking potentiality. *In vitro* interactions between three wheat Trx *h* and seed protein fractions were studied. Electrophoretic analyses show that Trx *h* can reduce some disulphides bridges in the protein fractions, especially in the gliadins and the glutenins as it was observed before. We observe above all that these reductases can crosslink proteins and generate polymers of high molecular weight. Moreover, these Trx *h* show different affinities with the proteins fractions. Trx *h2* differs from both others to have a third cysteine residue in the N-terminal domain of the protein, and it is the most reactive. We show that Trx *h3* interacts with the albumin and globulin fractions as well as the gliadins but has only little affinity with the glutenins. On the other hand, Trx *h1* shows affinity only with the gliadin and glutenin fractions. Analyses by western blot with antibodies against Trx *h* and glutenin subunit confirm these results. Interactions between the protein fractions and Trx *h2* mutants combined with monobromobimane labelled sulphhydryl groups of the protein fractions are analyzed. The roles of these Trx *h* in the crosslinking of proteins in the grain as well as their potential use in biotechnology are discussed.

S.17

Characterization of Bulgarian oat genotypes (*Avena Sativa L.*): grain yield and grain yield related characteristics. G. PANAYOTOVA (1), N. Tsenov (1). (1) Dobrudja Institute of Agriculture, Dept. Breeding and Genetics, Ruse, Bulgaria.

The present investigation is a part of an elaborate analysis of eleven naked spring oat genotypes and one hulled Bulgarian oat variety. The characterization of this group in terms of the main functional compounds related to nutritional quality was presented earlier (Panayotova, 2006). Here, the samples were characterized in terms of grain yield, 1000 grains weight and morphological characteristics, related to grain yield - panicle length, number of ears/panicle, number of grains/panicle and weight of grains/panicle. According to the trait weight of grains per panicle, four groups can be distinguished: low productive; average productive; productive; high productive. The results show that breeding lines of naked oat with good properties were developed: the highest and most stable yields by years are found for genotypes NS 2-7, NL23, NL221 - 274, NL213. Genotypes with high 1000 grain weights were NL71, NL213 and N2-7. High productivity of the panicle, connected with the number of grains per panicle was observed for NL222, NL213 and NL23.

S.18

Influence of temperature and relative humidity on the mechanical properties and grinding behaviour of wheat bran. Y. M. HEMERY (1), M. A. Pachéco (1), X. Rouau (1). (1) UMR IATE, INRA, Montpellier, France.

Wheat bran is composed of pericarp, seed coats, and aleurone layer with some remaining starchy endosperm, and is mostly used in animal feeding. However, its high nutritional potential could be better valorised in human nutrition. Aleurone cells, in particular, contain nutritionally interesting compounds, but their availability is limited by complex cell wall fibres. A drastic decrease of the bran particles size, by means of an ultra-fine grinding, may facilitate the cell walls breakage to make cells content more accessible. The mechanical properties of the bran are supposed to govern most of its behaviour during milling. To study the influence of moisture content and negative temperatures on bran mechanical properties, hand-isolated strips of whole bran were submitted to uniaxial tension tests, using Dynamic Mechanical Thermal Analysis, at various temperatures (-80°C to 25°C) and various relative humidity (bran moisture content ranging from 8

to 25% dm). Decreasing the bran temperature led to increasing its rigidity and brittleness, and a rise in its moisture content led to increasing its extensibility. Model grindings were then carried out to study the influence of temperature and moisture content on bran dissociation. Bran samples were ground at ambient temperature or in liquid nitrogen, for increasing time. The combined effects of variation of moisture content and conditioning at very low temperature have also been studied. The granulometry of ground samples was assessed by laser diffraction, and the state of dissociation of aleurone cells was evaluated by quantifying water-extractable phytic acid. Whatever grinding type, the amount of water-extractable phytic acid increased as the mean particle size decreased, showing the influence of granulometry on aleurone cells content accessibility.

S.19

Gelatinization and retro-gradation properties of acetylated corn starch studied by DSC. J. BABIC (1), D. Subaric (1), V. Pilizota (2), D. Ackar (1), M. Kopjar (2), N. Nedic Tiban (2). (1) J.J.Strossmayer University in Osijek, Faculty of Food Technology, Department of Carbohydrates and Confectionery Products, Osijek, Croatia, (2) J.J. Strossmayer University in Osijek, Faculty of Food Technology, Department of Technology of Fruit and Vegetable Processing and Preservation, Osijek, Croatia.

Non-modified starch has limitations in food industry applications such as high tendency toward retrogradation, low thermal resistance and shear resistance. Therefore starch is often modified in different ways to change and improve its performance. The aim of this research was to study the effect of acetylation on gelatinization and retrogradation properties of corn starch. Acetylation was carried out by treating corn starch with 4, 6 and 8 % (w/w) of acetic anhydride at room temperature (the percentages of acetyl group were 1.257, 1.739 and 2.212 %). Differential scanning calorimetry (DSC) was used to investigate gelatinization and retrogradation properties of acetylated corn starch. Studies were conducted on model solutions with starch concentration of 30 %. Starch suspensions were heated in a temperature range from 25 °C to 95 °C at heating rate of 10 °C/min. After gelatinization, samples were cooled and stored at 4 and 25 °C. The enthalpy of retrogradation was measured by DSC after seven and fourteen days of storage. It was observed that acetylated corn starches gelatinized at lower temperatures and had lower values of gelatinization enthalpy in comparison with native starch. Comparing to acetylated starches, native corn starch had significantly higher tendency of retrogradation after 7 and 14 days of storage at 4 and 25 °C.

S.20

Mechanism of gliadin-glutenin linking in bread baking. B. Lagrain (1), K. Brijs (1), J. A. DELCOUR (1). (1) Centre for Food and Microbial Technology (M2S), K.U.Leuven, Leuven, Belgium.

Heat treatment of wheat gluten proteins and the resulting changes in rheological properties are of considerable importance for the characteristics of baked products. The conformational changes induced by heat eventually lead to larger gluten protein aggregates with the formation of gliadin-glutenin bonds. The aim of the present study was to increase the insights in gluten protein polymerization during bread baking by the use of oxidizing (potassium iodate and bromate) and reducing (glutathione) agents. At different points during bread baking SDS-extractability and molecular weight distribution of the proteins were analyzed with SE-HPLC. Changes in specific gliadin and glutenin fractions were determined with RP-HPLC. In the baking phase glutenin became almost unextractable. Potassium iodate and bromate increased both α - and γ -gliadin extractability during baking. The effect of glutathione on α - and γ -gliadin extractability was less pronounced, but, at increasing concentrations, levels of extractable α - and γ -gliadins decreased after baking. It was concluded that during baking gluten polymerizes through a sulfhydryl- disulfide exchange mechanism. Oxidizing agents, besides their effect on dough rheology, hinder gliadin-glutenin linking during baking by reducing the level of free sulfhydryl groups, while addition of glutathione increases the level of gliadin to

glutenin covalent binding. These findings demonstrate that, besides the effect on dough rheological properties, redox agents also exert an effect during baking with a possible impact on final product quality.

S.21

Xylanase inhibitors bind to polysaccharides. E. FIERENS (1), K. Gebruers (1), C. M. Courtin (1), J. A. Delcour (1). (1) Laboratory of Food Chemistry and Biochemistry, K.U.Leuven, Leuven, Belgium.

Xylanases are often used to improve cereal processing and end product quality. In wheat bread making the use of these enzymes may result in higher bread volumes and improved loaf texture, while in the case of wheat gluten-starch separation they are used to increase gluten and starch yield and purity. Cereals contain xylanase inhibitors which have a strong impact on the functionality of xylanases. Up until now three types of xylanase inhibitors are purified from wheat, i.e. TAXI (Triticum aestivum xylanase inhibitor), XIP (Xylanase inhibitor protein) and TLXI (Thaumatococcus-like xylanase inhibitor). During the study of their inhibition kinetics, it became clear that these xylanase inhibitors, in addition to binding to xylanases, also bind to (arabino)xylan and other polysaccharides. Binding assays with the three known xylanase inhibitors and different polysaccharides such as xylan and beta-glucans confirm that they all three bind to a different extent to various polysaccharides. We can conclude that the binding is specific, as it still occurs in the presence of Tween and caseine. Like TLXI, several other thaumatococcus-like proteins also show binding to polysaccharides, and in addition they are also capable of hydrolysing these polysaccharides. TLXI, however, is not capable of cleaving the glycosidic bonds of the polysaccharides and like TLXI, TAXI and XIP also haven't any hydrolysing activity. These insights will contribute to the unraveling of the functionality of these xylanase inhibitors in plants and in cereal processing, and they will certainly be relevant for the study of the inhibition kinetics of the xylanase inhibitors when (arabino-) xylan is used as substrate.

S.22

Effects of genotype, harvest year, genotype-by-harvest year interactions and agronomic factors on the variability of wheat associated xylanases.

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Xylanases are enzymes which hydrolyze the backbone of cell wall arabinoxylans and which, in doing so, can have a significant impact on cereal based processes and end products. The xylanases associated with wheat kernels consist of wheat endogenous xylanases and kernel associated microbial xylanases, located on the surface of wheat kernels. The objective of this work was to gain insight in the variability of xylanase activity levels of both endogenous and microbial origin in wheat and in the factors affecting this variability. The effects of genotype, harvest year and their interaction on the levels of both wheat kernel associated microbial and endogenous xylanases were studied using 14 varieties grown in three successive growing periods with diverse climatologic conditions. Total xylanase activity levels varied more than a factor 20 between the different wheat samples. Endogenous xylanases typically accounted for only 10-15% of this activity, but when preharvest sprouting occurred, the contribution of endogenous xylanases can amount to over 40%. Endogenous xylanase activity levels were mainly determined by the genotype-by-harvest year interaction, while wheat associated microbial xylanase activity levels were predominantly determined by genotype alone. Endogenous and microbial xylanase activity levels were strongly correlated, suggesting that wheat varieties which are susceptible to preharvest sprouting are often also susceptible to microbial contamination. Agronomic factors, such as

fungicide treatment, N-fertilisation and harvest date, also had an impact on the wheat associated xylanase activity. These results clearly indicate that genetic, climatologic and agronomic circumstances significantly affect the levels of xylanases in wheat, and that these levels can be high enough to possibly affect wheat quality.

S.23

Response of zinc sulphate doses on the physical and biochemical parameters of hybrid rice varieties. J. PRASAD (1), J.P.Misra (1), A.B.Abidi (2), R.Yadav (2), S.K.Chauhan (2). (1) N.D.University of Agriculture & Technology, Dept. Biochemistry, Faizabad, (UP) India, (2) Division of Genetics, IARI, New Delhi, India.

Rice is a principal food and cereal crop of South-Eastern Asia. India earned the distinction of emerging as the country after China. Experiments were conducted during the kharif season 2001-02 and 2002-03. Five varieties of hybrid rice viz: Proagro-6111, Proagro-6201, Proagro-6207, Proagro-6444 and NDRH-2 were used as the experimental material in this trial. Zinc sulphate was applied according to the treatment levels 0, 10, 20, 30, and 40 kg/ha. Physical observations were recorded for plant height, number of tillers/plant, grain yield, test weight, rice recovery, polished rice recovery, broken rice recovery, seed size, length, breadth ratio, moisture in seed, water absorption capacity. The biochemical analysis of seeds were carried out periodically (1-12 months) during storage along with alkali spreading clearance test, starch iodine blue value, protein, amylase, methionine, lysine, tryptophan, total ash, reducing sugar, non-reducing sugar, total sugar content, cooking quality and enzymatic studies for nitrate reductase and peroxidase were carried out. Rice stored after dehulling showed changes in its biochemical parameters. The starch content reduced with storage time whereas amylase content increased during storage. The essential amino acids content also diminished substantially. However, the rice improved in fluffiness, which is a good index of rice quality. Variety Proagro-6444 was found superior among all the varieties of hybrid rice tested under this study. Application of zinc sulphate @ 30 kg/ha led to best performance of varieties both, in case of physical and biochemical characteristics.

S.24

Raman analysis of ferulate content in wheat arabinoxylans. M. MARTELLI (1), V. Micard (1), C. Barron (1). (1) UMR1208, INRA-UMII-Supagro-CIRAD, Montpellier, France.

Ferulic acids (FA) moieties are key molecules implied in cell wall (CW) architecture of cereals grain. Esterified to arabinoxylans (AX), the main cell wall polysaccharides observed in wheat grain, they are implied in polymer crosslinking. The extent of crosslinking (analysed through the amount of diferulic bridges) was correlated with mechanical properties of wheat grain tissue, and then the milling behaviour. If their relative amount has been biochemically determined in grain tissues, their exact localisation within the grain CW is still unknown. Coupling microscopy and spectroscopy seem powerful to obtain these data *in planta*. Raman microspectroscopy, which is sensitive to this type of molecules, could allow to detect such constituent at the micrometer scale. The objective of this work was to evaluate the potential of Raman spectroscopy to detect and quantify ferulic acid composition (monomeric vs dimeric forms) in pure AX systems. In a first step, the relative amount of monomeric form of FA was quantified by Raman spectroscopy. Water-extractable AX with various degree of FA esterification were analysed. The FA content was determined by HPLC method and Raman spectra were recorded with a dispersive Raman microspectrometer (Almega, ThermoElectron). A linear relationship was observed between the FA concentration (0.65 to 2.27 $\mu\text{g}\cdot\text{mg}^{-1}$ AX) and the ratio of the peak areas detected between 1652-1570 cm^{-1} and 1150-1046 cm^{-1} . In a second step, the phenolic acid composition was modified by sequential oxidative treatment with a laccase. AX gels with FA monomers/FA dimers ratio from 0.5 to 26 were obtained. Biochemical and Raman spectroscopic analyses were carried out on exactly the same samples in order to correlate biochemical and spectroscopic data. Statistical

modeling, implying multivariate models such as PLS, were carried out to achieve this quantification.

S.25

Importance of nutrition education of school-aged children and their attitude towards fortified cereal foods. E. BEIZADEA (1). (1) Faculty of Tourism and Commercial Management, "Dimitrie Cantemir" Christian University, Constantza, Romania.

General food and nutrition problems, caused by the inadequate quality and quantity of food, start early in life and continue into adulthood, and there is an urgent need to address the problems of diet-related chronic diseases through effective food and nutrition education. Research confirms that fortified foods make a substantial and beneficial contribution to the diets and nutritional status of consumers. This is particularly important for those susceptible to micronutrient deficiencies such as children, women of childbearing age and the elderly. Nutrition education of children can have an important role in ensuring appropriate dietary patterns and good health. A nutrition education study is currently conducted in three randomly selected schools in Constanta, Romania from November 2006 to February 2007. Children (girls and boys, aged 13 to 14 years) participate in four experimental lessons, using teaching materials prepared at the Faculty of Tourism and Commercial Management, "Dimitrie Cantemir" Christian University, Constanta, Romania. The experimental lessons discuss micronutrients and their main sources, nutritional requirements, the range of foods to which vitamins and minerals can be added, and the benefits of food fortification, especially fortified cereal products. Pupils are asked nine questions before, and after the lessons. Analyzing the initial answers, we observed that they showed a low level of knowledge about basic food and nutrition topics prior to the lessons. Students were aware of key topics such as micronutrients and energy values, but they were confused about nutritional values and foods to which vitamins and minerals can be added. The initial results showed that a significant number of students don't know whether or not they consume fortified foods; this could be explained by the importance of taste, as the deciding factor for children regarding food purchase, rather than the nutritional content. Parents' attitudes towards food fortification are generally positive, with recognition of the contribution that these products have to the diet. The initial results determined that the availability of fortified foods will be effective in helping to improve the diet, only if combined with appropriate nutritional information, made available to the students by education programs.

S.26

Investigation of barley protein concentrate, isolates and hydrolysate by gel filtration chromatography. S.CELIK (1), E.Yalçin (2), B.Bilgi (1). (1) Hacettepe University, Dept. Food Engineering, Ankara, Turkey, (2) Abant Izzet Baysal University, Dept. Food Engineering, Bolu, Turkey.

In recent years, there have been some technological applications of barley in human nutrition. Barley is available in both hulled and hull-less forms. However, hull-less barley, which does not require dehulling, offers some advantages for food uses. Although proteins are minor components (8-15%) compared to carbohydrates, their amount and composition affect industrial uses of barley grain. In this study, a hulled barley protein concentrate, hulled and hull-less barley protein isolates and their hydrolysates were investigated by gel filtration chromatography. Protein solutions of 0.3% concentration were prepared in 0.006N KOH and 1 ml was injected into the gel filtration column (75 cm x 1.5 cm) filled with Sepharose CL-6B matrix. 0.006N KOH was used as mobile phase with a flow rate of 0.5 ml/min. Marker proteins were used for determination of molecular weight distribution. Fractions were collected with the amount of 1.5 ml and relative protein amount was determined by UV-spectrophotometer at 280 nm. Gel filtration chromatograms of barley proteins were divided into high (3600-515 kDa), medium (515-1.5 kDa) and low (<1.5 kDa) molecular weight regions in order to compare their molecular weight distribution. Compared to the hulled barley protein isolate, hulled barley protein concentrate had a higher level of high molecular weight proteins. The amounts of medium

molecular weight proteins of the isolates were higher than that of the concentrate. High molecular weight fractions of barley protein isolate increased with an increase in degree of hydrolysis which led to a decrease in medium molecular weight fractions. Low molecular weight fractions reached to the highest level by 6% hydrolysis degree.

S.27

Reverse engineering approach on cereal food foams processing and behaviour: a knowledge management approach. C.Raboutet (2)(3)(4), H.CHIRON (1), G.Della Valle (1), C.Fernandez (2), B.LeBlanc (3), A.Ndiaye (2). (1) INRA, BIA, Nantes, France, (2) INRA, US2B, Bordeaux, France, (3) Institut du Cognitique, Université de Bordeaux, Bordeaux, France, (4) ADRIA Développement, Quimper, France.

Cereal foams involve a large number of foods: bread, biscuits, snacks. The practical control of their processing and texture design is still a matter of empiricism, mainly because of the slow transfer of scientific results in the manufacturing industry. Conversely, food science develops new approaches, based on material science, for instance, which increases the gap between the scientific knowledge and the know-how of human experts. In a recent project on the processing and behaviour of cereal food foams, namely Salve, three PhD studies and a postdoctoral work have been carried out. All of them focus on “cellular structure” as a common preoccupation but they also deal with the effects of product composition on expansion and its sensory properties, its creation and influence on mechanical properties, heat and mass transfers during baking and numerical modelling of these various steps. Beyond these scientific aspects, these works were also concerned with the technological know-how. The purpose of this work, performed in a fourth task, also a post-doc fellowship, was to develop a knowledge management approach in order (i) to collect the knowledge in this well defined domain (cereal food foams) (ii) to represent it using semantic graphs (concept maps) by locating the tasks and identifying the lack of knowledge and finally (iii) to verify experimentally the accuracy of the representation using an implementation through an electronic knowledge book or an expert-system. Data collecting was performed by adapting the models available from the MASK method, destined to the know how capitalisation, to scientific knowledge. A knowledge book was engineered for the Web based on the concepts of navigation, ontologies and keywords, using the MySQL data bases management system. It is the tool for checking the accuracy of the representation as well as the basis of knowledge transfer to the main people involved in manufacturing, towards the computer aided design of cereal food foams.

S.28

Comparison of the methods used for the estimation of damaged starch in wheat flour samples. S.YALCIN (1), H.Kökel (1), A.Basman (1), I.H.Boyaci (1). (1) Hacettepe University, Dept. Food Engineering, Ankara, Turkey.

Many methods have been used over the years for the determination of starch damage, but the majority seem to be time consuming. The most generally used AACC method (76-30A) has 1h analysis time and requires several chemicals. The aim of this study was to compare the AACC method with Rapid ViscoAnalyzer (RVA) (Newport Scientific, Australia) and SD Matic results for the estimation of the amount of damaged starch in wheat flours. Nineteen flour samples with a wide range of starch damage levels were used. The SD Matic is a laboratory instrument specifically designed to measure starch damage rapidly. This process is based on the measurement of iodine quantity which is absorbed by the starch particles at 35°C. The sample quantity used in this method is small (1 g) and the analysis time is 10 min. RVA was used for the estimation of the amount of damaged starch in a 10 min profile, without using any chemical reagents. The correlation coefficient (r) between the amount of damaged starch determined by AACC method and RVA results was calculated as 0.92. The correlation coefficient between the amount of damaged starch determined by AACC method and SD Matic method was found to be 0.90. A lower

correlation coefficient ($r=0.77$) was obtained between the amount of damaged starch determined by RVA method and SD Matic method. The results indicate that the amount of damaged starch in wheat flour samples could be estimated with a small amount of sample in 10 min by using SD Matic. RVA also gives an idea about the level of starch damage indirectly in 10 min by using 8 g sample.

S.29

Quality evaluations and high throughput analysis of aromatic Italian rice varieties. E. LUPOTTO(1), C.Lanzanova (1), S. Cavigiolo (1), D.Greppi (1), F.Catenacci (2), M. Mariotti (2), B. Cavagna (3), F. Corana (3), G. Mellerio (3). (1) C.R.A. - Istituto sperimentale per la Cerealicoltura - Sezione specializzata per la Risicoltura, Vercelli, Italy, (2) DISTAM, Facoltà di agraria, Università di Milano, Milano, Italy, (3) Centro Grandi Strumenti, Università di Pavia, Pavia, Italy.

Rapid, reproducible and reliable analytical methods focused on the detection of the main components of the aromatic rice quality are needed to develop new cultivars, in aid to breeding and selection procedures, as well as for the characterization and valorization of the European product. Besides this, methods for the detection of adulteration of aromatic rice by artificial flavours or mixing with other non-scented long-grain varieties are also desirable. High throughput analytical tools make a great contribution to the varietal characterization of fragrant rices, such as DNA-based methods and GC-MS, to protect brand names and the consumer choices. This study describes a qualitative analysis of five Italian rice aromatic varieties by means of the headspace solid phase microextraction (HS-SPME) coupled with gas chromatography/mass spectrometry (GC-MS) for the aroma characterization, the starch composition characterization by means of amylographic profiles and gel texture analysis, and the use of molecular markers to trace the *frag* gene. Results obtained describe in terms of quality components the aromatic Italian rice varieties currently cultivated. The aroma is characterized by a volatile fraction composed of aldehydes, alcohols, hydrocarbons, ketones, heterocycles, phenols, terpenes; all aromatic Italian varieties characteristically contain 2-AP. The amylographic profiles obtained by RVA processing of rice flours, were representative of the starch and protein content of the varieties, and gave indications of variability depending on the area of cultivation. All fragrant varieties are high amylose but one, and show a high content in proteins. The combined techniques represent important tools for quality evaluation and exploitation.

S.30

French bread as source of dietary fibres. F. SKIBA (1), S. Navéos (1), F. Souply (2), V. Mousques-Cami (3). (1) Arvalis-Institut du végétal, Montardon, France, (2) Association nationale de la meunerie française (ANMF), Paris, France, (3) Centre d'information sur la farine et le pain (Cifap), Paris, France.

In France, the daily consumption of dietary fibres is estimated between 15 and 22 grams. Dietary fibres, which are not digested by the organism, present some health benefits, and this has led to the current recommendations which are to consume 25-30 grams of fibres per day. In France, we often associate dietary fibres only with fruits and vegetables, but other foods are also good fibres sources. In order to evaluate the interest of French bread as a dietary fibre provider we conducted a bibliographical synthesis to improve the knowledge on dietary fibres, then to identify the dietary fibres from cereal products, particularly from bread, and finally to determine the contribution of those products to the daily recommended intake of dietary fibres. White French bread contains mainly fibres originating from the endosperm, and in addition resistant starch and Maillard products formed during bread-making process. Wholemeal breads or bran breads are richer in insoluble fibres from the pericarp. White French bread, with 3.5 g/100 g of fibre and a mean consumption of 150 grams per day in France, is a good contributor to the fibre intake (17% of the 30 grams recommended daily). Moreover, thanks to its content in complex carbohydrates, nutritionists

recommend to increase our consumption of bread until 300 grams per day, which would provide 35% of the recommended daily fibre intake. The increase of bread consumption in parallel with the increase of fruits and vegetables consumption would permit to achieve more rapidly the 30 grams of dietary fibres recommended daily, with a diversification of the fibre sources as it is advised.

S.31

Behaviour of carotenoids and tocopherols originating from corn in the process of production of corn oil and corn semolina. F. SKIBA (1), F. Leprince (1). (1) Arvalis-Institut du végétal, Montardon, France.

In France, the consumption of corn is not developed as its consumption is not anchored in the French culture. However some corn is consumed in its sweet canned form or as breakfast cereals. Corn, as other cereals, is mainly consumed in human nutrition as a starch provider however little concern has been placed in its micronutrients contents and their behaviour in end products. We speculated that promoting corn derived product not only as an energy source but also as a micronutrient provider could help the development of corn derived products and their promotion to consumers. Little is known about corn micronutrients and their behaviour in corn derived products. Consequently, we decided to produce corn germ and semolina from four corn varieties. Corn oil was cold-extracted from the germ (without solvent) in order to protect micronutrients. We analyzed, as micronutrients, carotenoids contents in corn grain, corn oil and semolina. Tocopherols were analyzed in corn grain and corn oil. All the carotenoids (xanthophylls including lutein and carotens) originating from the grain were found in semolina and only traces were analysed in corn oil. On the other hand all the tocopherols from the grain were found in corn oil. The next step will be to produce pastas and bread made with corn semolina or corn flour to study the behaviour of carotenoids in these end products.

S.32

The content of vitamin E in organic wheat- and spelt flour depending on the type of grinding. M.M. NIELSEN(1), A.Hansen (1). (1) Department of Food Science, Faculty of Life Science, University of Copenhagen, Copenhagen, Denmark.

The objective for this study was to determine the content of vitamin E in organic wheat- and spelt flour depending on the type of grinding. Vitamin E is an antioxidant, which protects the cellular membranes against oxidation. There are 8 isomere of vitamin E, four tocopherols (α , β , γ , δ) and four tocotrienols (α , β , γ , δ), where α -tocopherol is the best known and have the highest vitamin E activity. Vitamin E is a fat-soluble vitamin and it serves as an antioxidant for the unsaturated fatty acids and hence prevents rancidity. The Danish population mainly obtains vitamin E through vegetable oil and cereals. However, a majority of people have a lower intake than recommended. Therefore it is important to know the composition and content of vitamin E in flour and bread. Because of the low intake of vitamin E it is interesting and important to make flour and breads with the highest possible content of vitamin E and therefore will this study also illuminate what is happening during bread baking. Vitamin E is located in germ and bran and it is therefore expected that whole meal flour has the highest content of vitamin E. Commercial mills normally grind the grain at a stand of rolls where the germ is sorted. However, organic grown cereals are in some cases milled on stone mills where the entire grain is milled. In this study the content and composition of vitamin E is compared for organic flour milled with both methods.

S.33

Structural analysis of exopolysaccharides produced by sourdough related microbes. H. N. MAINA(1), L. Virkki (1), R. Juvonen (2), A. Laitila (2), K. Katina (2), M. Tenkanen (1). (1) Dept. of Applied Chemistry and Microbiology, University of Helsinki, Viikki, Finland, (2) VTT, Espoo, Finland.

With the current trends toward reduction in utilization of food additives, alternative methods for improving bread quality are being developed. Recent reports have indicated that in-situ production of exopolysaccharides (EPS) during sourdough production is a feasible method for replacing hydrocolloid additives in bread. In fact, EPS produced in situ have been found to be more effective hydrocolloids than those added externally. Current research is focusing on identification of potential EPS producers, characterization of EPS produced, optimization of EPS production and analysis of the rheological properties of sourdough and breads containing EPS. Additionally, the pre-biotic effect of EPS is being investigated. In order to determine the structural architecture of EPS produced by sourdough related microbes, EPS from potential strains were isolated and characterized. Results from evaluation of the isolated EPS by monosaccharide analysis, high performance size exclusion chromatography with a multiple detection system (HPSEC-MD), 1D and 2D nuclear magnetic resonance spectroscopy (NMR) will be shown.

S.34

MONIQA—A new EU-project towards the harmonization of analytical methods for monitoring food quality and safety in the food supply chain. R. E. POMS (1). (1) ICC—International Association for Cereal Science and Technology, Vienna, Austria.

A globalised economy has rapidly increased international trade of a large variety of foods and food products. Consumer satisfaction and health are of utmost importance. Ensuring high quality and safety of food requires powerful and reliable tools and methods for food analysis and control. The MONIQA Network of Excellence (NoE) integrates key organisations across the food supply chain around the world to find acceptable solutions for all stakeholders including the consumer, food manufacturers, food research institutes and regulatory bodies. The network members will investigate mechanisms to coordinate and merge research activities, personnel and infrastructure to achieve synergetic affects. The resulting harmonised analytical strategies and methods, databases and training modules will extend beyond the network to associated partners and involved stakeholders. Food production industries and SMEs will benefit through harmonised analytical methods and technologies, as will the end consumers. MoniQA will play an important role in European and worldwide food quality and safety research by creating a virtual laboratory for joint research, training, dissemination and mobility programmes. It will allow sharing of data and knowledge for harmonising the standards and performance quality of analytical methods for monitoring food quality and safety. Integrating activities will facilitate shared access to world's best research facilities, technological platforms, databases, analytical tools and knowledge. Joint research is directed towards the most pressing issues to fulfil food quality and safety policies, as well as citizens' concerns. The network will develop common strategies for harmonising and validating detection methods and technologies to set new standards in quality and safety— within food production and extending throughout the whole food supply chain. International food trade helps promote economic development, but likewise creates risks. Complex food supply chains now require harmonised standards in analytical methods and technologies to ensure quality and safety in the global food production and supply chain.

T.1

Optimization of a ripening chamber including energy recovery: innovative possibilities for the ripening control. K. LOESCHE (1). (1) European Institute of Baking Technology, ttz-Bremerhaven, Bremerhaven, Germany.

Retarding is one of the most important and complex stages of the ripening process. It is used in certain bread recipes in order to develop a characteristic quality profile (i.e. flavour, colour, freshness). During the ripening process the dough is placed into a cold environment in order to slow the activity of the yeast but allowing primarily enzymes to continue their activity. The longer the enzymes can be active (within a controlled period), the more intensive the flavour and the better the quality in the final product will be. During the retarded dough-ripening step, besides controlling the temperature, the humidity in the chamber plays an important role. In current retarding chambers, the humidity is generated through conventional electro-humidifiers (hot steam) and at low temperatures they can only assure a humidity level of approx. 80–90% in the chamber. In consequence, there is a transfer of humidity from the dough to the atmosphere (desorption) leading to irreversible drying-effects. The overall quality of the final products is negatively affected by this (i.e. volume, freshness). Within the frame of a collaborative project between the *ttz-EIBT* and the company *Ungermann* an innovative dough retarding-system “MICROTEC” has been developed. In this novel chamber the humidity is generated by the use of a specific ultrasonic-humidifier which produces a cold steam with water drops below 1 µm (drops in hot steams are between 50-150 µm). These small sized drops have a very low sedimentation rate in comparison to conventional hot steam drops, assuring a unique relative humidity in the chamber during the whole retarding process near to 100%. Additionally, the energy consumption of the ultrasonic-humidifier is much lower in comparison to the conventional electro-humidifiers and at the same time the waste heat of the cold cycle can be used completely to heat up the chamber (energy recovery). Under these conditions, the desorption (drying-effect) of the dough surface can be avoided. An extreme homogene distribution of temperature and humidity along the complete dough piece is achieved, so that the biochemical and physical reactions work optimally and the quality parameters of the final product (i.e. crust, shape, colour, volume) are positively affected. In addition, for the processing of frozen dough, while standard electro-humidifiers are only able to start producing humidity at around +8°C (during the thawing-phase), the use of the specific ultrasonic-humidifier enables the chamber to start producing humidity both during the critical cooling-phase (until +1°C) and during the thawing phase (beginning at +1°C). As an effect of the mentioned homogeneity distribution of temperature and humidity, the heat-transfer within the dough pieces is faster, so that the thawing process takes less than 45 Minutes (case study: rolls). As a result, the overall processing time and energy consumption can be reduced leading to the most economical and environmental advantages. The MICROTEC chamber allows an optimal control of temperature and humidity during the whole retarding-process, producing premium qualities baked goods and opening new possibilities to retard big bread loafs (>600 g), with excellent properties and in short production times.

T.2

Forecasting Karnal bunt of wheat and its management. S. K. S. MANN (1). (1) Department of Plant Pathology, Punjab Agricultural University, Ludhiana, Punjab, India.

Conditions during the wheat crop season are favouring different stages of the life cycle of *Tilletia indica*, so that the the infective stage is available during the heading of wheat. The occurrence of severe incidence of Karnal bunt on artificial boot inoculations were correlated with the disease incidence observed on the farmers field in Punjab. The coefficient of determinations were found to be significant only with the number of days which favoured

development of the infective stage of the pathogen to threshold levels during the heading of wheat crop. The expected and observed incidence of the disease in the field correlated significantly. Presence of teliospores, the primary inoculum, showed poor correlation with the disease as the expected values deviated significantly. The model was validated with significant accuracy when PBW 343 was the predominant spring variety in the fields in Punjab in 1996-2005, heading from mid February to mid March. Experimental validation of this epidemiological model was done by simulating conditions: no disease was observed when inoculations were done 24 hours before the recommended fungicide was sprayed. The incidence of infected kernels increased, as the gap of fungicide spray increased in both the treatments. This pre-harvest method of prediction can be used in a “decision support system” for the management of Karnal bunt in wheat, as it can be adopted by the extension advisory services. Fairly accurate weather predictions are being made for at least 48-72 hrs in the country by the National Centre for Medium Range Weather Forecasting.

T.3

Business informing science and science informing business for the benefit of improved customer health. G. S. FROST (3), D. G. Edwards (1), A. A. Marson (2), L. Rocha (2). (1) Gareth Edwards Consultancy, Reading, UK, (2) Holgran - RHM group Ltd, Lichfield, UK, (3) School of Biomedical and Molecular Sciences, University of Surrey, Guildford, UK.

RHM is one of the largest food companies in the UK and Ireland and the home of famous brands such as Hovis, Mr Kipling, Sharwood's and Bisto. Through its innovation business Holgran, RHM has maintained a long term research partnership with Surrey University aimed at improving the understanding of the health benefits of carbohydrate-rich foods. Two examples of projects arising from this beneficial two-way partnership are: Development of a low Glycaemic Index (GI) bread for Food Standard Agency and British Heart Foundation projects: using an *in vitro* method put in place at RHM Technology Ltd (the RHM R&D centre), ingredients and then a combination of ingredients have been screened before doing the GI testing. The *in vitro* method was based on Englyst et al. (1999) and involved the measurement of Rapidly Available Glucose (RAG) and Slowly Available Glucose (SAG) in bread samples. RAG and SAG Control and test bread samples were compared to determine the effect of various added ingredients on RAG and SAG as potential predictors of glycaemic index. Results for fibre rich ingredients showed a decrease in RAG as high as 15% for wheat fibre, though other samples gave reductions in the range of 6 to 8%. Ingredients containing organic acids, such as vinegar and sourdough, showed a decrease of about 3.5%. Recipes using combinations of the test ingredients were designed based on these results and were subjected to GI testing. When tested *in vivo*, GI values were lower for recipes containing more organic acids. It appeared that the *in vitro* analysis may be a good predictor of the influence on GI of ingredients like fibre that are likely to exert a physical effect on digestion, but not the effect of organic acids. Therefore, this *in vitro* method can be recommended for the purpose of pre-screening some categories of ingredients, but it cannot replace GI testing as such. Benefits to University: access to RHM knowledge on new product development, and bread supply for the research. Benefits to RHM: extensive knowledge gained about GI, ingredients and recipes for that application. Slow Carb Project: collaborative project involving 4 non competitive partners looking at slowly absorbed carbohydrates under Surrey University Trust. The four partners sponsor one PhD students each. Two students are looking at the medical implications of consuming slowly absorbed carbohydrates. The investigation covers the effect of different ingredients of interest to the partners on human metabolism. The two other students will evaluate consumer understanding of slowly absorbed carbohydrates and how they might be promoted. In addition to conducting research, the students will spend periods in the relevant departments of the partner companies to gain an understanding of the potential commercial

application of their research. The partners contribute to the development of the research programme and have direct access to the results as they emerge.

T.4

Can you mix hot dough? M. L. BASON (2), C. Charrié (1), J. Dang (2), R. I. Booth (2) (1) Newport Scientific Europe, Cheshire, England, (2) Newport Scientific, Warriewood, Australia.

Dough mixing characteristics, such as water absorption, development time, and stability, are important measurements in the food and baking industries. Several instruments have been used to study the mixing characteristics of doughs at low temperatures, including the Brabender Farinograph, Newport Scientific doughLAB, National Mixograph, and Chopin Mixolab. There is currently a push to design an instrument that can also measure the heating and gelling characteristics of the dough to mimic baking conditions. This paper investigates the feasibility of heating a dough up to 80 °C (past the gelatinisation temperature of its starch), and explores the usefulness of data obtained from such a test. Hard flours were tested on the doughLAB fitted with a 300-g bowl, using AACC Method 54-21 (63 rpm, 30 °C, 20 min.), then heating to 80 °C and cooling again to assess pasting properties of the dough. The high solids concentration of the dough resulted in a strong gel forming when the starch gelatinised at high temperature. The shearing action of the mixing blades caused the dough mass to tear, which was evident as a spike and subsequent unstable torque readings in the resulting curve. Tests on batter made from the same flour, with a lower solids concentration than the dough, showed smooth torque curves. The results indicate that accurate viscometric data cannot be obtained from hot dough due to its thick consistency. Newport Scientific is currently developing a Micro doughLAB, which can heat and cool a 4-g flour sample while measuring its consistency. The Micro doughLAB can subject the dough to small scale deformation during heating, allowing it to obtain true rheometric data without tearing the gelled mass, offering a superior test to current methodologies.

T.5

Bread dough modification related to exogenous phospholipase usage.

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From biochemical point of view, the structure formation of dough is depending on their main compounds: gluten proteins and starch, and interactions between them, as well as the presence of minor compounds which can affect the biochemical matrix of dough. Although the lipid content in flour is lower (ca. 1%), they influence dough and end-products properties depending on their ratio and nature. Therefore the fatty acids content and HLB of lipid compounds are important for interactions like lipids-gluten proteins and lipids-starch during flour processing in bread making. As it is known, phospholipids (PL), like phosphatidyl choline (PC), phosphatidyl ethanolamine (PE), phosphatidyl inositol (PI), and phosphatidic acid (PA), are minor compounds of wheat flour, which contain phosphoric acid, fatty acids, glycerol and nitrogenous bases. Phospholipids are amphiphilic molecules with unique physicochemical properties. It is considered that PL traces in wheat flours are insufficient to develop a significant technological effect by themselves in bread-making process, but effect becomes obviously by using exogenous phospholipids. Phospholipase A₂ (EC 3.1.1.4.) is an enzyme that converts phospholipids into enzyme-modified PL (PE, PC) and fatty acids. Phospholipase A₂ (PLA2) reacts with lecithin, and it can be used in emulsifier formulations. Previous studies showed that PLA2 is able to modify of dough behavior and improve the quality of baked end-products. Although their functionalities are different and the reaction mechanism is distinct, it seems that phospholipase could perform similar in baking as chemical emulsifiers (ex. DATEM) and could be replaced successfully by them. Previous researches proved that bacterial exogenous PLA2 in

certain added doses in dough formulation (recipes with soy lecithin and egg yolks) have a proximate effect on dough processing like DATEM. The aim of this work was to study the effect of different doses of exogenous PLA2 which act solely on endogenous PL. Lysomax and Belpan were used as exogenous phospholipases. Lysomax is an industrial enzyme, which contains phospholipase A₂ from bacterial source (*Streptomyces violaceoruber*), and Belpan is an enzymatic preparation of fungal lipase. The baking trials were performed with a weak wheat flour type 650 (ash content = 0.65%). For analyses two batches of samples were used, each of them composed of enzyme dosages plus blank samples. The samples of flours comprised in addition different doses of exogenous lipases, starting from 1x10⁻⁶% to 10x10⁻⁶% (flour basis). Relationships between exogenous phospholipases acting on endogenous phospholipid of dough were analyzed. Their influence was determined by rheological and technological methods, as well as chromatographical ones. The results were compared with samples without exogenous phospholipids. Rheological behavior was investigated by using a Chopin alveograph and standard method SR ISO 5530-4:1998 was applied. The alveograph parameters were registered. Baking tests were done and the loaf properties were analyzed according to STAS 91-83. The bread recipe comprised out of flour, water (accord. WA, %), 1.6% dry yeast (% flour basis), 2% salt (% flour basis), and enzymes – Lysomax or Belpan (variable doses, from 1x10⁻⁶% to 10x10⁻⁶% (flour basis). The biochemical compounds, non-polar (NL) and polar (PL) lipids from bread samples were extracted with solvents and analyzed by HPLC. Lipids extraction was carried on Soxhlet apparatus. Firstly non-polar lipids were extracted by using petroleum ether, after which polar lipids were extracted by methanol. Extracted lipids were analyzed through HPLC method. Qualitative and quantitative analysis were performed by chromatography. Chromatographic determinations were achieved with the following operating conditions: column - Superspher-100 RF 18 endc., 180 mm x 4.6 mm, 4 µm particle diameter; eluent – acetonitrile : methanol = 80 : 20 for PL and 40 : 60 for NL; flow rate 0.5 ml/min; temperature 25°C; injected volume 20 µl; recorder UV 205 nm, 225 nm, 250 nm. Although the samples were made from flours without exogenous lecithin, rheological modifications of dough by adding different phospholipases were registered. Even if results were not spectacular, it proves that PL traces in flours can develop a certain technological effect in bread-making process. Results indicated an improvement of rheological properties of dough for samples in the middle of rank. Also an increase in loaf volume, as well as crumb properties improved, when certain doses of phospholipases were used. On the basis of qualitative-quantitative analysis by liquid chromatography (HPLC), concentrations of separated lipids from bread are discussed in relationship with the rheological parameters of dough.

T.6

Extrusion cooking: a comparison of the effect of vegetable oils from different sources on wheat starch extrusion behaviour.

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Wheat starch has been extruded in the presence of three commercial vegetable oils, namely; palm oil, soybean oil and sunflower oil. The effect on extruded starch expansion and the degree of conversion were investigated, samples were collected in two sets where all extrusion parameters were fixed i.e., temperature, feed moisture content and screw speed and the only variable was the material feed rate which was doubled. The results suggested that at a low feed rate, neither the oil type nor the concentration significantly affected the specific mechanical energy (SME) and as a consequence there was no pronounced effect on starch conversion. When the feed rate was increased from 3.23 kg.hr⁻¹ to 6.5 kg.hr⁻¹ (db), the SME was decreased as the oil content increased up to 5%, further rise in oil concentration did not impart any changes the same effect was observed for the three oils used. Material expansion was increased as the oil concentration increased for the three vegetable oils used, and no major differences were observed for the samples extruded at a low feed rate, on the other hand, samples extruded at a high feed rate the expansion levelled at 5% oil concentration up to 7% before a sharp decrease took place at 8% oil concentration. The

x-ray crystallography indicated a v-type crystalline pattern that was related to the amylose lipid complex formation, the crystallinity indices did not show any evidence of a contribution from any of the three oils which have been added to the complex formed. Apparently the only source of oil that interacts with amylose was from the endogenous lipids naturally present in wheat starch.

T.7

Isolation of the mycoflora of the cereal grains and testing of the application of essential oil of *Thymus capitatus* in an enclosure as an antifungal agent. L. BELYAGOUBI (1), D.E. Abdelouhid (1), A. Moussaoui (1). (1) Laboratory of Natural products, Dept. of Biology, Faculty of Science, University Abou Bekr-Belkaïd, Tlemcen, Algeria.

Throughout history, storage of cereal grain has provided humans with a buffer against crop failure and starvation. These grains form an excellent substrate for the moulds where the fungal flora during storage forms a significant factor of deterioration and secretion of mycotoxins. According to mycological analysis of the cereal samples (common wheat, durum wheat, corn, rice and barley), corn suffers more severely, from a quantitative as well as from a qualitative point of view. In the 118 selected samples *Aspergillus* and *Penicillium* species are the most dominant, followed by *Fusarium* and *Trichoderma*. On the other hand, the mucorales are less abundant. Seven of the 118 samples were selected for the study of the antifungal effects. The essential oil yield of the local plant *Thymus capitatus* is about 2,30%. The antifungal effect of the essential oils of the *T. capitatus* at 5,2 or 7,8 µl/L on the spores and the mycelium started after five hours of treatment. After 24 hours closure of the reaction vessel and saturated vapour of essential oils, the microscopic observations show that the effects on the hyphae or the spores are almost identical for the various levels of the reactor (5cm, 15cm and 30cm). According to the modifications and the cellular disorganizations observed in an optical microscope, the moulds appear to be very sensitive to the vapour essential oil of *T. capitatus* especially when they are treated during the first period in August. This effect appeared to be less at the end of August and in September, probably because of the higher temperatures facilitating the evaporation of oil. The external fungal flora of common wheat (2kg), put in an artificial silo and treated with *T. capitatus* essential oils (approximately 52 µl/L), was reduced by 24% after a 30 day treatment. This method presents a weak effect compared to the two methods described previously. This can be attributed to some methodological problems (agitation, quantity, fumigation, intergranular space, temperature of treatment, etc...). In conclusion, the essential oils from *T. capitatus* have a very good antifungal activity. The yield of these essential oils is substantive. These oils could be used as alternative agents for the chemical antifungal products, used during the storage of cereals.

T.8

Fractionation and characterisation of protein hydrolysates produced by enzymic hydrolysis of brewers' spent grain. I. CELUS (1), J. M. Ceulemans (1), K. Brijs (1), J. A. Delcour (1). (1) Center of Food and Microbial Technology (M2S), K.U.Leuven, Leuven, Belgium.

Brewers' spent grain (BSG) is the extracted residue of barley malt resulting from the manufacture of wort. Although it is the main by-product of the brewing industry, it has received little attention as a marketable commodity and is mainly used as animal feed. Our work focuses on one of the main constituents of BSG, i.e. the protein constituents. The lack of solubility of BSG proteins is one of the limitations for its more extensive use in food processing. Proteolytic enzyme modification of proteins is an effective way to improve their solubility and functionality. The aim of this study is to generate BSG protein hydrolysates with improved techno-functional properties. Brewers' spent grain protein concentrate (BPC) was prepared by alkaline extraction of BSG followed by acid precipitation. BPC was hydrolysed in a pH-stat set-up at optimal protease conditions for different times in order to obtain hydrolysates with different degrees of hydrolysis

(DH). The DH was determined by the pH-stat procedure or by colorimetric reaction with o-phthalaldehyde. Physico-chemical properties, such as protein content, solubility as function of pH and molecular weight distribution, as well as techno-functional properties, such as emulsifying and foaming properties, were determined. Taste and colour of the resulting hydrolysates were also evaluated. Hydrolysates were fractionated by differences of their molecular weight or hydrophobicity. The resulting fractions were evaluated for their physico-chemical and techno-functional properties. These findings will lead to the valorisation of BSG and provide the basis for the production of peptides with improved emulsifying and foaming properties to be used as attractive adjuncts in the food and drinks industries.

T.9

Wheat Protein for lipid management. W. VERAVERBEKE (1), A. Redl (1), G. Maesmans (1). (1) Tate&Lyle Europe N.V, Aalst, Belgium.

Tate & Lyle has developed a novel process to create wheat proteins with remarkable oil binding and oil pasting properties. Not only do these proteins bind significant amounts of oil, they also have the unique property of producing a paste-like texture when mixed with oil. Proteins of this type are commercialised by Tate & Lyle under the name Meripro 430. Based on its properties, potential applications of Meripro 430 in "lipid management" (i.e. reductions of saturated and/or total fat levels) of fat-based food products can be envisaged. Objectives of this study were therefore (1) to investigate in more detail the rheological behaviour of Meripro 430 in fats and oils and (2) to evaluate the potential of Meripro 430 for "lipid management" in a model application. Cream fillings were chosen as model. Viscosity measurements during cooling of molten fats containing Meripro 430 showed that Meripro 430 not only significantly increased viscosity of the molten fat but also rheological analysis of the crystallised fat indicated that Meripro 430 gave additional "structure" to the fat system. These findings were used in model cream fillings where both improvement of the nutritional profile of fat used in cream fillings (towards more unsaturated) and a total reduction of the fat level were feasible without compromising on cream filling texture (cfr WO 2005/063049). This study demonstrates the potential of Meripro 430 in improving the nutritional profile of fat-based food products which is currently a major concern in the Western world.

T.10

Functional properties of resistant starch preparations formed by acid hydrolysis and heat treatment. H. KOKSEL (1), A. Basman (1), K. Kahraman (1), S. Ozturk (1). (1) Hacettepe University, Dept. Food Engineering, Ankara, Turkey.

In this study, effects of acid hydrolysis, autoclaving and storage on resistant starch (RS) formation in corn starch were investigated and functional properties of the RS preparations were determined. Corn starch was acid modified with HCl at 40°C for 1-4 hr. For RS formation, the starch samples were autoclaved at 121°C for 30 min and stored at 95°C for 0, 2, 3 and 4 days. These samples were dried at 50°C. RS content, solubility and water binding, emulsion capacity and stability values were determined. Pasting properties were tested using a Rapid ViscoAnalyzer (RVA). RVA viscosity values of the hydrolysates decreased significantly ($p < 0.05$) with increasing hydrolyzation level. Peak and final viscosity values of the RS preparations decreased gradually for each storage period with increasing hydrolysis time. RS contents increased to 13-17% as a result of storage after autoclaving. For each storage period, RS content increased as the hydrolysis time increased up to 3 hr. RS contents of the samples dried without storage increased to 14% with increasing hydrolysis time. Solubility values of RS preparations were higher than those of the native and hydrolysed samples. Water binding values of the native and hydrolysed samples were low. RS preparations had much higher water binding than the hydrolysates. The native and acid hydrolysed samples affected the emulsion properties of soy protein inversely in contrast to RS preparations. Emulsion stabilities

of soy protein solutions supplemented with RS preparations were within the range of 13-28%. An increase in emulsion stability value was observed for the samples with low hydrolyzation levels.

T.11

Machinability of dough: simulation of bread dough's performance during the baking process. A. M. FILLOUX (1), M. Vignolle (2). (1) ENILIA, Surgères, France, (2) ENILIA, Rungis, France.

As flour is the main ingredient for bread-making, it is important to be able to choose a flour that is most appropriate for the required use and which respects industrial constraints. This means the dough must be "machinable", i.e. non sticky yet possessing a certain adhesiveness in order to transfer easily to the conveyor belt; it must have limited elasticity so it does not shrink too much while at the same time retaining a certain extensibility so it can change shape without breaking up. MARIE SURGELES has set in motion a research project in order to establish a test procedure coherent with real industrial demands and which can be considered as a criterion for the flour quality necessary for a given usage. Using pilot equipment, we set up technological test procedures in the bread and biscuit making workshop. The pilot scale process together with the use of a texturometer (TAXT+ type) allows the determination of the influence of intrinsic parameters of the flour (percentages of water, protein and pentosans, etc.) on the rheological behaviour of the dough. This apparatus can be used to set up reliable routine tests, characterising the rheological reaction of the dough and the finished product. The values obtained (stickiness, consistency, plasticity...) can serve as references for specifications taking into account cereal products' formulations and industrial constraints.

T.12

Valorisation in bread of dietary fibres from by-products of the agro-industries. O. ROISEUX (3), M. Sindic (1), E. Vanderbeke (2), C. Blecker (1), C. Deroanne (1). (1) Dept. Food Technology, Gembloux Agricultural University, Gembloux, Belgium, (2) AVEVE Groep, R&D, Merksem, Belgium, (3) R&D, Wal. Agri SA, Sombreffe, Belgium.

For many years, the Department of Food Technology located at the Agricultural University of Gembloux has been interested in characterizing and valorising dietary fibres like cellulose, hemicelluloses, lignins, resistant starches, pectins, inulins, and many more. It is well known that the consumption of dietary fibres is recommended for preventing or treating Western diseases including colon cancer, gastrointestinal disorders, diabetes and coronary heart disease. However, current consumption of dietary fibres in Western countries is only about 20g/day/person, while the recommended intake is 30-45g/day/person. Moreover, dietary fibre intake must be balanced between soluble and insoluble fractions: most cereals are rich in the insoluble dietary fibres fraction, whereas fruits and greens contain more soluble dietary fibres. By-products from the transformation of agro-production are inexpensive, available in large quantities and they have a high dietary fibre content. They are commonly used in the feed or fertilizer industries. The consumers seek new pleasant tastes for the bread. Here, we present the case of bread enriched by insoluble dietary fibres from a local cereal by-product source and their effects on the final properties of such a product. A comparison is made with bread enriched by commercial soluble dietary fibres from lemon. Enzymatic/chemical – gravimetric methods have been employed to characterize the dietary fibres used in this study. In addition, techno-functional properties like water holding capacity (WHC) and nutritional properties of dietary fibres have been evaluated for determining future application in bakery. Finally, after an evaluation of the hydration of the dough by farinograph, bread-making tests have been realized to determine the evolution of the crumb firmness, dry matter or the density of breads in the course of time.

T.13

Nitrogen content of Durum wheat grown on bentonite amended sandy soil. R. Y. HOUCINE (1), B. Moulay (2). (1) University of Mostaganem, Mostaganem, Bulgaria, (2) Université de Oran, Oran, Algeria.

The sandy soils of the Mostaganem table land have a light texture, a very low clay content, inducing strong leakage of mineral salts and fertilizers. Their fertility is very low and their water retention capacity is very limited. The low fertility of these sandy soils is one of the constraints which are limiting the agricultural production in the area. The addition of 10% bentonite to these soils and the culture of durum wheat, Waha variety, in association with chickpea, Ain Temouchent variety, are the basis of the two eco physiological strategies to rehabilitate this agricultural region. Nitrogen content of the plants grown on the amended soil was compared with the plant nitrogen level in of the plants grown on an untreated soil, at all development stages of the two species. Nitrogen content in durum wheat in association with chickpea was high at all development stages when grown on soil treated with bentonite. However, the amount of the nitrogen in the plants is higher in 10% of bentonized substrates at tillering stage.

T.14

Mathematical description of wheat cultivar quality. I. Svec (1), O. Jirsa (1), M. HRUSKOVA (1). (1) Institute of Chemical Technology, Dept. Carbohydrate Chemistry and Technology, Prague, Czech Republik.

Mathematical description of wheat cultivar quality consists of assessment of the wheat cultivar and crop year effects at classification into quality classes. For statistical evaluation, basic data form eleven Czech wheat cultivar tested in the four crop years (2002 to 2005). Wheat samples included varieties of different technological quality, according to classification at four quality classes. Table 1 shows minimal values of the six basic characteristic for wheat cultivar classes (E, A and B) used for bakery production. The fourth wheat group (marked C) was designed for non-food usage. Together fourty parameters were measured for each sample, including grain properties, grain and flour analytics and flour visco-elastic attributes, characteristic of fermented dough and finally, bread and bread crumb traits. Mathematical apparatus was based on the variance, cluster and principal component analyses. Usual quality parameters as grain protein content, Zeleny sedimentation test or water absorption have indicated dominant quality of the highest class E varieties, closed quality of A and B class cultivars and unsatisfying one of C class wheat. Also specific bread volume as mean values of the four crops in order of quality classes E, A, B and C were 366, 320, 340 and 287 ml/100 g, respectively (Figure 1). Dependence of grain hardness, Zeleny test and alveograph energy on wheat genotype (quality class) was confirmed by analysis of variance. Clustering of all eleven varieties signify the affinity of E and A-classed varieties as well as B and C-classed ones (Figure 2). Principal component analysis confirmed that wheat technological quality depends mostly on the fermented dough characteristics, specific bread volume and bread crumb penetration.

T.15

Effects of dietary protein from Japanese and proso millets on plasma levels of lipids, glucose, insulin and adiponectin in type 2 diabetic mice. N. NISHIZAWA (1), T. Togawa (1), K. Park (4), Y. Miyakoshi (3), K. Inagaki (3), N. Omori (3), T. Nagasawa (1), Y. Ito (1), M. Choi (2). (1) Dept. of Agro-Biosci., Faculty of Agric., Iwate Univ., Morioka, Iwate, Japan, (2) Dept. of Biotechnology, Chonnam National University, Yeosu, South Korea, (3) Chiba Flour Milling Co. Ltd, R&D, Mihama-ku, Chiba, Japan, (4) United Graduate School. of Agric. Sciences, Iwate Univ., Morioka, Iwate, Japan.

Millet has been widely consumed as human food in Africa and Asia. In Japan, the consumption has recently increased because people think that these cereals may have a health benefit. We previously reported that the intake of a diet containing protein concentrate (PC) from proso millet

clearly raises plasma levels of HDL cholesterol without an increase in LDL cholesterol levels as compared with a casein diet in rats and mice. We also showed the protective effect of dietary proso millet PC against hepatic injury in rats. No study on effects of dietary proso and Japanese millets in type 2 diabetes has been reported. We therefore examined the effects of dietary PCs from Japanese and proso millets on blood levels of lipids, glucose, insulin and adiponectin in type 2 diabetic mice. When mice were fed a high-fat diet with Japanese millet PC for 21 days, plasma levels of glucose and triglyceride were significantly lowered, whereas HDL cholesterol and adiponectin levels increased significantly compared to control diet mice. When mice were fed a normal diet with proso millet PC for 21 days, plasma levels of glucose decreased significantly, HDL cholesterol and adiponectin levels increased significantly compared to control diet mice. In experiments with Korean proso millet, similar results were also obtained. Considering the roles of adiponectin and HDL-cholesterol in diabetes and atherosclerosis or obesity, it seems likely that these millet PCs may improve insulin sensitivity and cholesterol metabolism through an increase in adiponectin levels. Therefore, these millet PCs could serve as another beneficial food component in obesity-related diseases such as type 2 diabetes and cardiovascular diseases. This work was supported by a grant-in-aids for Dreamland Iwate Strategic Research Promotion Project (2004-2006) of Iwate Prefecture, Japan.

T.16

Effect of flour type on cake volume and cookie diameter evaluated dynamically during baking. M. H. NEZHAD (1), F. Butler (1). (1) Biosystems Engineering, University College Dublin, Dublin, Ireland.

Volume is an important characteristic in the evaluation of cakes and cake quality. Similarly cookie spread during baking is an important characteristic for cookies. The effects of ingredients on final cake volume and cookie diameter have been studied extensively, but there are few studies of what happens during the baking cycle. Digital imaging provides a convenient way to dynamically monitor changes in cake volume and cookie diameter during baking. Monitoring cake volume during baking can be used to study the effect of cake ingredients on cake batter expansion. During baking, cookie spread rate and set time, which are responsible for final cookie diameter, appear to be controlled by cookie ingredients and cookie dough properties. The objective of this study was to determine the effects of different flour types on changes occur in cake volume and cookie diameter during baking. For cake volume measurements, five pins were fixed through equidistant holes on a frame clipped to the sides of the cake pan. Height of the cake at the pin locations was calculated using digital images taken at 2 min intervals during baking. Cookie diameter during baking was calculated using digital images that were taken at 30 s intervals. The cakes made from three different flour types showed a similar trend, with no significant difference in the development of the top contour during baking. In the first 6 minutes of baking, there was little expansion of the batter, from 6-19 minutes, there was a period of rapid height expansion, followed by a period of slight shrinkage (19-23 min). Cake volume peaked at approximately 16 min and declined by approximately 8% by the end of baking. During baking, the diameter of cookie increased linearly then became static with little shrinkage at the end of baking. Flour type affected final cookies diameter ($P < 0.001$). The results showed that cookies made with flours that had higher set time and faster spread rate reached a bigger final diameter.

T.17

Fundamental studies on the reduction of salt in wheat bread. E. Lynch (1), M. M. MOORE (1), E. K. Arendt (1). (1) Department of Food and Nutritional Sciences, University College Cork, Cork, Ireland.

Cereal products are regarded as high salt foods with bread products contributing a quarter of the sodium intake in the Irish diet. Salt is added to bread to give flavour, act as a preservative (increasing microbial safety and shelf-life) and enhance strengthening of the gluten network. The

objective of this study was to investigate the impact of different salt levels on the rheological characteristics of wheat dough and overall bread quality. Sodium chloride was added to a standard wheat bread recipe at different levels (0.15%, 0.3%, 0.6% and 0.9%) and these breads were compared to a standard wheat bread (1.2%) and a bread made without salt. Standard baking tests were performed including specific volume, digital image analysis and texture profile analysis. Results showed differences in the baking characteristics for all the breads. Specific volumes for breads with different salt levels were found to decrease as salt concentration increased, salt free bread having the largest loaf volume. A significant decrease in the total cell and mean cell area were found in the breads made with salt, indicating a more compact structure. The 1.2% salt bread recorded the lowest crumb hardness followed by the 0.3 and 0.6% breads. Bread made without salt showed the highest crumb hardness and highest degree of staling. The ultrastructure of the breads and dough samples were obtained using confocal laser scanning microscopy and scanning electron microscopy. Differences in rheological behaviour were recorded between all bread and dough samples at the different levels of salt. It can be concluded that although the addition of salt is necessary for the production of high quality bread, it is possible that this level can be reduced without adverse effects on technological aspects of bread production.

T.18

Fundamental studies on the high pressure treatment of oat doughs. E. K. Hüttner (1), E. K. Arendt (2), M. M. MOORE (1). (1) Department of Food and Nutritional Sciences and Biotransfer Unit, University College Cork, Cork, Ireland, (2) Department of Food and Nutritional Sciences, University College Cork, Cork, Ireland.

Recent studies report that the majority of person's with Celiac disease can tolerate oats. Oats are high in nutritional value and are linked to health claims attributed to β -glucan. High hydrostatic pressure (HP) is a new technology in the food processing industry. HP can change structural and functional properties of proteins due to weakening of electrostatic and hydrophobic bonds leading to an improvement in the functional and nutritional properties of ingredients. The objective of this study was to investigate the impact of HP-treatment on the rheological and baking characteristics of oat based batters and breads. The oat batters were treated at different pressures (200, 300, 350, 400 and 500MPa) for 10 minutes and these were compared to a control where no pressure was applied. Rheological tests such as amplitude and frequency sweeps and creep and relaxation test were performed. After baking, standard parameters such as bake loss (%), specific volume (ml/g) and crumb moisture (%) were evaluated. Crumb hardness was determined using texture profile analysis over a storage period of 5-days. Confocal laser scanning microscopy (CLSM) and scanning electron microscopy were used to characterise the ultrastructural changes taking place during HP treatment of oat batters and breads. The rheological results revealed differences between the various oat batters. There was an increase in elasticity for all pressure treated batters with increased pressure as indicated by the frequency sweep and creep tests. Furthermore there was an improvement in the structure of the oat bread with increasing pressure. However, at 400 and 500MPa deterioration in the structure of the oat breads was observed which was indicated by the increase in crumb hardness, springiness and decrease in specific volume. Overall, it can be concluded that the application of HP to oat flour has a positive impact on the rheological properties as well as the final structure of oat based bread. Results are, however, dependent on the pressure applied.

T.19

Fundamental studies on the impact of emulsifiers and dough improvers on gluten-free bread quality. M. B. NUNES (1), M. M. Moore (1), E. K. Arendt (2). (1) Department of Food and Nutritional Sciences and Biotransfer Unit, University College Cork, Cork, Ireland (2) Department of Food and Nutritional Sciences, University College Cork, Cork, Ireland.

The development of well structured and good quality bread using gluten free (GF) cereals is a major challenge. Rice flour is one of the most suitable cereals used in gluten-free bread formulations, although its properties are considered poor. Emulsifiers are often used to improve bread quality as they increase dough strength and crumb softness. In this study four different emulsifiers: Lecithin (LC), Diacetyl Tartaric Acid of Mono-diglycerides (DATEM), Distilled Monoglyceride (DM) and Sodium Stearoyl Lactylate (SSL) were evaluated at three different levels [low (L), medium, (M) and high (H)] depending on each emulsifier and compared to a control (C) bread where no emulsifier was added. Standard baking tests such as bake loss (%), specific volume (ml/g), crust colour (L*), crumb moisture (%), cell size and distribution were measured. Crumb hardness was determined using texture profile analysis over a storage period of 5-days. Fundamental rheological tests were performed as well as Confocal Laser Scanning Microscopy (CLSM). Results revealed significant differences between the different levels of emulsifiers and the control. Higher specific volumes were found for L, M and H levels of DM ($p < 0.05$) whereas lower specific volumes were obtained for L, M and H levels of DATEM ($p < 0.05$) in comparison to their respective GF counterparts. Significant differences were found for the emulsifiers within the different levels for cell size and distribution ($p < 0.05$). Significantly higher bake loss values were found for M levels of LC. Furthermore crumb hardness revealed significant time effects as well as significant interactions for each emulsifier ($p < 0.05$). Lower crumb hardness values were found for DM and SSL for all days at H levels of addition. Rheological tests as well as CLSM showed significant differences between the different formulations. Overall it can be concluded that the addition of emulsifiers at their respective optimum levels enhance the quality of GF breads.

T.20

Study on the morphological, molecular weight distribution and crystalline properties of ultrafine rice starch. Z. ZHANG (1), J. Shi (1), S. Zhao (1), S. Xiong (1). (1) College of Food Science and Technology, Huazhong Agricultural University, Wuhan, China.

Ultrafine powder is the powder with average granule sizes in the range of 0.5-5 μ m and nanoparticles below 0.1 μ m. Ultrafine powder has some special properties because of its ultrafine sizes. Previous researches on the ultrafine powder focused on metal materials, and only a few looked at ultrafine starch. The study of ultrafine starch can contribute to applications in specific fields, for ultrafine starch has special properties such as a lower pasting temperature, lower paste viscosity and higher solubility. We have prepared ultrafine rice starch (URS) with average granule sizes of 0.05-5 μ m. This paper further explores properties of URS, isolated from Indica rice and prepared by ball milling. The morphological, molecular weight distribution and crystalline properties of URS were characterized using Scanning Electron Microscopy (SEM), Gel permeation chromatography (GPC) and X-ray diffractometry respectively. When rice starch was milled by increasing the milling time, its shape changed from native polyhedron to small anomalous granules and adhered together. When milled for 300h, the average granule sizes decreased to 0.102 μ m. By means of ball milling, the crystal structure was destroyed, and the starch molecular chain was decomposed. The crystal structures disappeared completely after being milled for 30h. The result is that the percentage of amylopectin fractions decreased; the percentage of smaller molecular fractions increased; and the intermediate fraction decreased slightly. Having been milled for 300h, the amylopectin content of the starch reduced to half of that of native rice starch. This study could be of assistance to the development of URS for specific applications as a new type of modified starch.

T.21

The effects of different mixing processes on dough rheology and baked attributes. A. K TENIOUDAKI (2), F. Butler (1), E. Gallagher (2). (1) College of Life Sciences, School of Agriculture, Food Science & Veterinary Medicine, University College Dublin, Ireland, (2) Prepared Foods Dept., Ashtown Food Dept., Ashtown, Dublin, Ireland.

Different mixing techniques alter the rheological properties of dough, which, in turn relate to the baking quality of the product. This study examined the effect of mixer type and energy input on the rheological and baking properties of wheat flour dough. A Farinograph (63 rpm) and a Stephan mixer (250, 500, and 750 rpm) were used and the energy inputs were 160 kJ/kg and 350 kJ/kg for each mixer. A biaxial extension test by compression measured dough extensional properties and a Chopin rheofermentometer monitored the dough fermentation process. Baked loaves were assessed for volume and texture. The biaxial extensional viscosity of the dough was affected by the mixer types. Dough mixed in the Farinograph showed a higher biaxial extensional viscosity ($P < 0.001$) than dough mixed in the Stephan mixer at all three speeds. When using the Stephan mixer, however, increasing the mixing speed increased the biaxial extensional viscosity, although only the result at the lower speed was significantly different ($P < 0.001$). With regard to the work input, it was found that increasing the energy input, for all mixer types decreased the biaxial extensional viscosity ($P < 0.001$), indicating a better developed dough. The final dough height during fermentation increased by increasing energy input for all mixer types ($P < 0.001$). This was also correlated with the biaxial extensional viscosity ($r = -0.7$), the slice area the slice height of the baked loaves ($r = 0.7$). The slice area and the slice height of the baked loaves from all mixer types were both increased following an increase in the energy input ($P < 0.001$).

T.22

Influence of nitrogen fertilizer treatments on soft wheat starch characteristics. C. MASSAUX (3), J. Lenartz (1), M. Sindic (3), B. Bodson (2), G. Sinnaeve (1), A. Falisse (2), P. Dardenne (1), C. Deroanne (3). (1) Département Qualité des Productions agricoles, Centre wallon de Recherches agronomiques, Gembloux, Belgium, (2) Unité de Phytotechnie des Régions tempérées, Faculté universitaire des Sciences agronomiques, Gembloux, Belgium, (3) Unité de Technologie des Industries agro-alimentaires, Faculté universitaire des Sciences agronomiques, Gembloux, Belgium.

The influence of nitrogen fertilizer treatments on the flour protein content, which correlates with the efficiency on the gluten-starch separation and the gluten yield is well known; but the literature on the effect of this agronomic factor on the starch properties is relatively scarce. Consequently, it is interesting to determine whether increasing nitrogen (N) fertilizer rates induce variations in starch characteristics. Generally, the N-fertilization is equally distributed over three applications: the first during tillering, the second at beginning of stem elongation and the third at flag leaf emergence to assure the survival of the photosynthetically-active flag leaf. In this study, soft wheat samples (*Triticum aestivum* L.) grown at the same experimental site were fertilized with different N rates and split applications: 50-60-0 kg N/ha, 50-60-75 kg N/ha and 0-60-155 kg N/ha. Native starches were isolated by the 'Batter' procedure from white flour extracted from soft wheat varieties. Several starch properties were evaluated: granule size distributions, amylose content, viscosity parameters with and without α -amylase inhibitor, and completed by some flour characteristics: water absorption, starch damage, flours starch content and starch yield. The results showed an influence of the N-fertilization rates on most of the flour and starch characteristics. These data suggested that an appropriate N-fertilization could lead to wheat samples with starch properties better adapted to required end uses.

T.23

Protein content: not an unambiguous concept for the effect on baking quality of wheat. A. MOLDESTAD (2), A. Uhlen (2), E. Magnus (1), E. Mosleth Færgestad (3). (1) Bioforsk - Norwegian Institute for Agricultural and Environmental Research, Aas, Norway, (2) Department of Plant and Environmental Sciences, Norwegian University of Life Sciences, Aas, Norway, (3) Matforsk - Norwegian Food Research Institute, Aas, Norway.

The behaviour of the dough during baking and the quality of the baked product depend mainly on the properties of the gluten proteins. The variability in gluten quality among wheat varieties is caused by genetic differences, but environment and fertilisation regimes will affect the building of macromolecules during grain filling. Size distribution of the proteins was analysed by two-step extraction method with sonication to solve the largest polymers followed by SE-FPLC. Hearth bread baking procedure was used; involving optimal mixing time, fixed proving time and baking without support of a tin. Protein quality, represented by high molecular weight glutenin subunits (HMW-GS) 5+10 vs. 2+12 and percentage of non-extractable polymeric proteins (%UPP), was the most important factor influencing the hearth bread characteristics. The effect of protein content, however, was not consistent. The hearth bread characteristic form ratio (height divided by width) has shown to be sensitive to variation in the size distribution of the proteins. The size distribution of the proteins changed with increased protein content, and it changed differently in the different materials studied. The study showed a clear relationship between the hearth bread characteristic form ratio and the size distribution of the proteins. The fact that the size distribution changed differently with increased protein content in different materials reveals that protein content is not an unambiguous concept.

T.24

Separation of viscous and elastic rheological behaviors of gluten: a step towards possible standard methods. H. Liang (3), D. Zhao (3), B. Allvin (1), R. Chinnaaswamy (4), P. Rayas-duarte (2), S. J. MULVANEY (3). (1) Applications, Perten Instruments AB, Huddinge, Sweden, (2) FAPC, Oklahoma State University, Stillwater, OK, USA, (3) Food Science, Cornell University, Ithaca, NY, USA, (4) GIPSA, USDA, Kansas City, KS, USA.

It is generally accepted that the long range reversible extensibility of dough is due to gluten (hydrated gluten proteins) in the dough. However, traditional instruments used to evaluate dough and/or gluten physical properties do not lend themselves to clear unambiguous separation of elastic and viscous behaviors. Thus, it has been difficult to investigate the elastic properties of gluten separate from viscous effects, and in turn to evaluate the effects of variations in HMW-GS composition on the elasticity of gluten. Recovery after preceding shear creep is one of the few ways to isolate delayed elasticity from viscous flow. The experimental conditions of a creep-recovery test were optimized in this work (100s of creep followed by 1,000 s of recovery at 40 Pa applied stress). Major findings of this work were that the delayed elasticity of gluteins varied substantially for a series of "5+10" gluteins with good HMW-GS quality scores and the recoverable extensibility of gluten was maintained up to temperatures of 60 °C. Comparison of the overall patterns of the creep-recovery results (compliance versus time) for gluten relative to several linear, amorphous synthetic polymers suggest that gluten lies in the rubbery flow region of viscoelasticity, which in turn represents a transition from the rubbery plateau (pure elastic behavior) to the terminal melt flow region (pure viscous flow). This could be useful in explaining differences in end-use quality of cultivars within wheat classes and/or between whole grain and refined gluten and is consistent with the appearance of simultaneous elastic and viscous behavior in gluten.

T.25

The present state of the art of processing machinery in Ukraine and the prospects for grain processing. Y. A. CHURSINOV (1), V. S. Koshulko (1). (1) Dnipropetrovsk State Agrarian University, Dnipropetrovsk, Ukraine.

In Ukraine, the main share of the total costs for grain and oil crops production is attributed to the post harvest processing of seeds. Cost reduction and minimization of losses in post harvest processing are feasible only if all-round mechanization of processing operations at all the stages can be provided. As it has been proved by performance evaluation of Ukrainian machinery, some of the equipment fails to take proper account of physical and mechanical properties of the grain. In order to ensure ES quality in processed grain, special attention is paid nowadays to the development of alternative machines such as gravity flow separators, reciprocating non-screen sieves and other equipment, which are capable of effective separation of a seed mixture by its flow elasticity, its density of the separated particles or its friction factors and angle of gliding. The utmost technological and technical challenge in oil crop processing is soybean cleaning from fungus-infected beans, which usually differ by their colour from high-quality seeds. The machines equipped with sensor devices and reciprocating sieving surfaces show considerable promise as the most effective means in this branch, however, their production in Ukraine is practically nil. Separation of fine seeds, like amaranth, mustard, etc., can be effectively performed in sieving machines as well as in units utilising an electromagnetic field. Our investigations into grain mixture processing techniques using vibrating fields are innovative and offer good promise, but this method requires careful selection of units for an integral technological procedure. A systematic approach of the main principles of grain mass processing and thorough analysis of optimal design and operation parameters in the working principles in similar machines of foreign manufacture, could help elaborate the strategy for development and production of high-tech equipment in Ukraine.

T.26

Study of the frozen part-baked bread odour. C. RANNOU (3), P. Courcoux (2), E. Vanzeveren (1), A. Le Bail (3), C. Prost (3). (1) Puratos, Groot-Bijgaarden, Belgium, (2) Sensometrics and Chemometrics, ENITIAA, Nantes, France, (3) UMR CNRS GEPEA (6144SPI), ENITIAA, Nantes, France.

The market share of the frozen part-baked bread technology is growing due to its convenience even though it has the reputation of being less aromatic than breads done with direct conventional process. To answer this question, tests have been done by comparing similar breads prepared by different bread making processes. Four types of bread making processes have been compared (part-baking, freezing, storage time). All analyses were performed on crushed bread 1 hour after final baking. A first comparison in between these 4 breads was done using a triangular test. A non trained panel of consumers has been used. This test shows that consumers can't distinguish the four breads by odour evaluation only. The second test consists in giving breads to trained judges in order to see if experts will distinguish them. The test used is Flash profile. No differences between breads were perceived. This result indicates that in our conditions, no significant difference in odour perception was observed in between the selected bread making processes considered. The third and final test was done using olfactometry coupled to GC/MS analysis to identify and quantify the compounds, odorous or not, constituting the odour of each bread. Some quantitative differences were noticed, but related to previous test, these have no influence on global bread odour. As a first conclusion, it appears that in our conditions partial baking freezing and storage time didn't impact significantly the odour of bread. Another important point lies in that there might be differences between the olfactometric perception and the organoleptic perception. Further work is planned to assess this aspect of the problem using a mastication simulator (artificial mouth) connected to GC/MS. Thanks to this system, it will be possible to study and compare flavour release only and to correlate this result with textural analysis and taste.

T.27

Oxidative enzymes: new tools for bread making. E. SELINHEIMO (1), J. Buchert (1). (1) VTT, Biotechnology, Espoo, Finland.

Cross-linking enzymes act on biopolymers such as proteins and carbohydrates by generating permanent covalent bonds in and between the biopolymers. These enzymes are interesting tools for tailoring dough and bread structures, as the strong covalent linkages significantly determine viscoelastic and fracture properties of dough and bread. In this study, the influence of two different oxidative cross-linking enzymes, *Trichoderma reesei* tyrosinase and *Trametes hirsuta* laccase, on wheat dough and bread were examined. Oxidation of phenolic compounds of flour, cross-linking of gluten proteins, dough rheology, and bread making were characterized during or after the enzymatic treatments. In dough and bread experiments, laccase and tyrosinase were studied also in combination with xylanase. Laccase and tyrosinase turned out to act in wheat dough and bread via different cross-linking mechanisms. However, on the whole their influence on the structural properties of wheat dough and bread seemed to be rather similar and mostly positive. In the presentation, the presumable phenomena behind the outcome of the oxidative enzymes in wheat bread making will be discussed.

T.28

Flour quality determination using a controlled benchtop performance method in a model pizza dough system. J. A. GRAY (1), M. L. Morrill (1), T. S. Hansen (1). (1) Kraft Foods, R&D, Glenview, IL, USA.

Flour quality can be assessed by a variety of methods, yet performance testing under simulated baking conditions remains one of the most reliable estimates. A well-used pup-loaf baking method (AACC International Method 10-10B) has been employed for years for this very purpose. However, the AACC method has limitations for some applications, including for frozen pizza dough evaluation, where accurate oven spring (% volume rise during baking) and effect of freeze/thaw abuse are imperative. Therefore, a new method was developed. This method employed a simple dough system (wheat flour, water, chemical leavening agents) and used controlled steps similar to commercial pizza dough processes. This method was used to evaluate and characterize the performance of diverse quality flours, and results were correlated with other commonly used flour functionality tests, such as alveograph, mixograph, and SRC values. The ability of the method to predict flour performance in full-formula, pilot scale pizza doughs was evaluated using commercial conditions. Results indicated the usefulness of simple, controlled methods to assess flour functionality for frozen dough applications.

T.29

Evaluation of hard red spring wheat quality with Mixolab. F. Manthey (2), M. Tulbek (3), A. DUBAT (1). (1) Chopin Technologies Paris, France, (2) NDSU Department of Plant Sciences Fargo, ND, USA, (3) Northern Crops Institute Fargo, ND, USA.

Mixolab is a quality control tool which may be used to determine the rheological and gelatinization properties of flour. The objective of this study was to evaluate the rheological and gelatinization properties of hard red spring wheat varieties with Mixolab. Banton, Choteau, Glenn, Knutson and Reeder cultivars were used. Bowl temperatures were applied at 30, 45 and 60°C and results showed significant differences ($P<0.05$) in terms of protein quality and starch pasting properties. Cultivars showed variability in terms of water absorption ($P<0.05$), with Glenn giving the highest and Choteau the lowest trait values. The latter cultivar was also characterized by the lowest protein. Starch gelatinization, cooking stability and starch gelling properties varied by cultivar; and altered by bowl temperatures. Glenn had the lowest cooking stability score in contrast Choteau gave the highest. In terms of gelling properties we observed significantly lower scores ($P<0.05$) for Glenn and Reeder cultivars. Cultivars had similar results at 30 and 45°C in terms of rheological and gelatinization properties,

whereas 60°C showed significant differences ($P<0.05$). Bowl temperature at 60°C indicated protein-starch interactions and accelerated gelatinization profile for all cultivars, which may be implemented in pasting profile characterization. Mixolab helped detect variability in terms of protein quality and starch pasting properties, which may be used to predict end use properties of hard red spring wheat quality.

T.30

Assessment of the robustness of the NIRS method for its application in wheat quality control. M. POJIC (1), Ž. Kevrešan (1), J. Mastilovi (1), M. Pestori (1). (1) Institute for Food Technology of Novi Sad, Novi Sad, Serbia.

Near infrared spectroscopy (NIRS) is widely used to assess the composition of whole grains in a rapid, simple and non-destructive way. NIRS is an indirect analytical method that heavily relies on the use of chemometric calibration and statistical analysis of data. In order to provide reliable control, the wide range of the characteristics of a NIRS method should be assessed where the robustness is one of them. The robustness of NIRS methods could be defined as the ability of the method to give good results when external factors such as variations in environmental, instrumental and sample conditions, are changing. The assessment and optimisation of the robustness should improve the reliability of the application of an analytical method. The objective of this study is to determine which variables (environmental and sample temperature, humidity, voltage and lamp deterioration) affect the analytical results in order to control them in the routine use of the NIRS method in wheat quality control, as well as to reduce the influence of uncontrolled variables. Three samples of commercial wheat with different moisture, protein, wet gluten content and sedimentation value were used. A scanning monochromator Infracore 1241 Grain Analyzer (Foss Analytical AB) with an application model for wheat, developed by Foss, was used for NIRS measuring performed in eight replicates. The statistical evaluation of data showed the NIRS method's capacity to remain unaffected by small deliberate variations in method parameters as indication of its reliability during routine usage in wheat quality control.

T.31

Automation of methods for cereal qualification: development and validation of macro- and micro-scale sedimentation-tests. S. TÖMÖSKÖZI (1), M. Nádosi (1), J. Nánási (2), J. Varga (1). (1) Dept. of Applied Biotechnology and Food Science, Budapest University of Technology and Economics, Budapest, Hungary, (2) LabIntern Ltd, Budapest, Hungary.

Today, standardized methods are available for the determination of swelling capacity of gluten (ICC Standard No. 116/1, AACC Methods 56-60 – 56-70). However, till today, the procedures are carried out manually. An automated apparatus is not yet available. On the other hand, there are some fields (breeding programs, basic research programs etc.), where the amount of sample available for testing is very limited, therefore the necessity of small-scale equipment and methods is unambiguous. Recently, an automated sedimentation tester was developed at our Department in collaboration with a Hungarian industrial partner, LabIntern Ltd. The results with the prototype of the apparatus were shown at ICC Conference in Vienna, 2005. In the second phase of this research, the final version of the measuring system was developed for commercialization. This instrument is applicable also for standard- and micro-scale measurements, where the sample requirements are 3.2g and 0.4g of flour, respectively. The reshaped architecture and the operation of the equipment are compliant to the requirements of standard procedures. The sedimentation process is followed by a computerized digital imaging system and is evaluated with software. The sensitivity of the imaging system was increased and the evaluation procedure was reformed in the software. Almost all types of sedimentation procedures will be applicable on this equipment. The validation procedures for standard- and micro-scale methods were carried out. Results show

that the sedimentation values measured with standard and new methods provided fairly good correlations. Generally, it can be stated, that the new modular apparatus makes for simpler and quicker measurement procedures, automates the evaluation and reduces the uncertainty of results.

T.32

Determination of shear rate and viscosity from planetary mixer data.

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Non-conventional mixers, such as planetary mixers, are commonly used in flour dough processing. In such mixers, dough development results from the nature and the efficiency of the mixing action. These parameters are respective to the design of the mixing device, resulting in high difficulties to compare the performances of planetary mixers with those of well-established conventional mixers. Classically, with a vertically and centrally mounted impeller, the dimensional analysis allowing to plot the power curve and to determine apparent shear rates and viscosities is well established. Unfortunately, this is not yet the case for planetary mixers. In this study, we proposed modified Reynolds and Power numbers for a planetary mixer: the P600 bowl (Brabender OHG, Germany). The mixer, equipped with a dough hook, presents two revolutionary motions around a vertical axis and is driven by a unique variable speed motor. The mixer is coupled to a lab-station which allows continuous recording of torque and mixing speed. The proposed modified Reynolds and Power numbers, which involve the maximum impeller tip speed as characteristic velocity and a dimension perpendicular to the vertical axis of revolution as characteristic length, allowed the obtention of a unique power characteristic of the mixing device. Apparent dough viscosities and shear rates can hence be calculated and directly compared with data obtained from other shear instruments.

T.33

Development of methods for real time PCR quantification of *Triticum durum* sourdoughs microflora.

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The bread making process is one of the most typical technological uses of cereals. Indeed flour chemical composition is essential in order to confer bread nutritional, structural and sensorial characteristics. Most typical Sardinian breads are produced from *Triticum durum* wheat flour instead of the more common *Triticum aestivum*. Once mixed with water, the flour is allowed to be spontaneously fermented by an autoctonous microflora, composed by yeast and bacteria. Before baking, a small quantity of this sourdough is preserved throughout frequent reactivations for subsequent bread preparations. In order to keep their technological properties, sourdoughs should have a stable and unchanging microflora. The aim of our work was to develop and test a molecular method to monitor the presence of inoculated yeast and bacterial strains in *Triticum durum* sourdoughs. During dough conservation (freezing) and reactivation, samples were collected at different time intervals. From these samples total DNA was extracted and analyzed by means of Real Time PCR with primers specific for yeast and bacterial species. Preliminary results showed the quickness and reliability of the method proposed.

T.34

Influence of wheat starch modification on bread staling.

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Starch, about 75% of wheat flour, fulfils different functions during bread making. In the dough stage, it dilutes the gluten to a suitable level. As temperature increases and starch gelatinizes during the first stage of the baking process, the starch absorbs water from the gluten and competes

with other components for the water available in the system. During the final stage of baking, the starch "establishes" the structure of baked-product system, preventing it to collapse upon cooling. After baking, the starch fraction influences the staling rate due to reassociation and recrystallisation of starch molecules. The main objective of this study was to gain insight in the functionality of starch in bread making and staling through the use of modified starches. Modifications consisted of cross-linking and hydroxypropylation, as cross-linking of starch minimizes starch granule rupture and loss of viscosity during heating and hydroxypropylation of starch increases the starch hydrophilic nature and weakens the internal bond structure holding the granule together. This reduction in bond strength is reflected in a decreased starch pasting temperature. Modified starches were characterized using RVA, DSC and swelling power characteristics. They were applied in bread making, using gluten/starch flour as a model system. Modified starches affected bread making characteristics, decreased bread quality to large extent, and influenced the staling properties differently. The applied modifications were able to increase our insight in functionality of starch during bread making and staling

T.35

Steam cooking effect on couscous cooking quality.

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Traditionally, home made couscous is prepared by an agglomeration process according to the following stages: mixing-agglomeration of commercially produced semolina, sifting, steam cooking and sun drying. In some Eastern regions of Algeria couscous is made without the steam cooking stage. If manufacturers would use this process they could reduce considerably the manufacturing cost of couscous. The aim of the present work is to produce couscous following these stages: mixing-agglomeration, sifting, steam cooking and sun drying. Next to this, we compare its cooking quality to couscous made without the steam cooking stage to determine whether the steam cooking stage has a positive effect on cooking quality of couscous. The cooking quality was evaluated by the determination of the cooking time, water absorption index, water solubility index and by sensory evaluation using a nine-point hedonic scale. Both couscous types have the same water absorption index and present a low water solubility index. Steam cooked couscous needs a longer time to be cooked than the non steam cooked. The non steamed couscous was rated significantly higher in the sensory evaluation than the steamed couscous by all the panel members.

T.36

Diagram of some traditional durum wheat products.

H.NAMOUNE (1), R.Kezih (1). (1) Institut de Nutrition d'Alimentation et des Technologies Agroalimentaires, Université Mentouri, Constantine, Algeria.

Durum wheat (*Triticum turgidum* L. Var *durum*) is the first important and strategic cereal crop for Algeria's population. It is the most important staple food of most Algerians. Because durum wheat is probably better adapted to the Algerian climate than other cereal crops, durum wheat is used to make semolina for industrial and traditional pasta products like couscous, spaghetti and other home made pasta products. It is also used to make different types of home made flat bread and pastries such as *zalabia*, *makroud*, *baklawa*, etc. Diagrams of some pasta and non pasta durum wheat products are presented in this paper and briefly discussed according to the results of surveys carried out in the eastern Algerian regions.

T.37

New rapid Glycemic TNO Index method (GTI) for prediction of Glycemic Index and measurement of carbohydrate digestibility. P.SANDERS (1), R.P.Happe (1), M.J.E.C. van der Maarel. (1) TNO Quality of Life, BU Food and Biotechnology Innovations, Groningen, The Netherlands.

Over the last years the Glycemic Index (GI) of food and the digestibility of carbohydrates has become an important issue for the food industry. Products with a low GI and slowly digestible carbohydrates can play a role in the prevention of obesity and diabetes. TNO has developed an *in-vitro* method that gives a good indication of the Glycemic Index and digestibility of a carbohydrate containing food products. This method is based on the well known and widely recognized method of Englyst et al. (1999). The Englyst method is an *in vitro* method for the determination of rapidly, slowly, and non-degradable starch. TNO has made two major improvements to the Englyst method. The first improvement is the use of a microbial mix of enzymes capable of converting all digestible carbohydrates present in foods. The second improvement is the analysis of released glucose at specific time points. From these data the rate of digestion and the Glycemic Index of a food product can be calculated. This novel method was tested for various pure carbohydrates and different kinds of carbohydrate containing food products demonstrating that Glycemic Index values obtained with the TNO method corresponded well (correlation $r^2 = 0.85$) with results obtained from human studies. The TNO method is therefore very suitable for the pre-screening of carbohydrate ingredients. The next development will be the improvement of this method to determine the total dietary fibre content of foods in a way better than the currently accepted methods, i.e. inclusive all types of resistant starch (RS1-4) and low-molecular weight fibres, like FOS, GOS and resistant maltodextrin.

T.38

Isolation and characterization of aleurone from wheat bran. W. VON REDING(1). (1) Buhler AG, Uzwil, Switzerland.

A new, patented industrial process has been developed to isolate aleurone in good yield and high purity from wheat bran. Most of the nutritionally important substances of whole grain, such as dietary fiber, vitamins, minerals, antioxidants and phytonutrients, are concentrated in the aleurone.

From a technological point of view a part of the endosperm, aleurone is removed along with the bran layer in the flour milling process and used predominately for animal feed. This process breakthrough enables recovery of the valuable aleurone from wheat bran to yield a light colored, free-flowing powder ingredient that can be used to enrich a host of food applications without sacrificing taste and texture. To characterize this new ingredient, chemical composition, *in vitro* digestibility and *in vitro* fermentability were investigated and microscopy was used to visualize morphological changes. Arabinoxylans with an A:X ratio of 0.43 constituted the main part of the dietary fiber fraction. Digestibility was 28%, and a 56% increase in protein digestibility versus wheat bran was measured. The rate of *in vitro* fermentability was 30% higher than wheat bran. Ratios short chain fatty acids were similar, with ratios of propionate and butyrate slightly above average compared to other dietary fiber sources. Arabinoxylans from aleurone were completely degraded within 8h, whereas with wheat bran, substantial amounts were still present after 24h. Microscopic investigations confirmed the better fermentability of aleurone compared to wheat bran. Determination of lignans and plant sterols revealed a significant enrichment of these important phytonutrients in aleurone. Free radical scavenging capacity of aleurone was 36% higher than wheat bran, and an impressive 60% higher than whole grain. The use of aleurone in food applications such as bread & bakery, RTE-cereals and pasta will be discussed, and the results of clinical studies in human volunteers to determine the Glycemic Index of aleurone-enriched bread will be disclosed.

T.39

Extruded cereals with added value by using pre-biotic inulin. R. THOMANN (1). (1) IGV, Bergholz-Rehbrücke, Germany.

Extruded cereals have got an increasing acceptance by consumers. They represent most of the healthy properties of grain products. The combination with ingredients like vitamins, minerals, dietary fibres (for example inulin) lead to additional benefit for consumers. Different types (long chain, short chain, mix products) of inulin are available. They have been added at increasing levels to extruded ready to eat cereals. Processing properties and sensory effects have been detected. This data show limiting parameters for recipe and technology and give an excellent base for product development. Inulin enrichment up to 15 % is possible. Inulin enrichment is possible up to 20 % after optimizing the parameters.

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