



VALUE ADDED WHEAT CRC PROJECT REPORT

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Proceedings of 2005 AACC International Annual Meeting
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INTRODUCTION

The 2005 AACC International meeting was held in September at the Gaylord Palms Resort and Convention Centre in Orlando, Florida, USA. The meeting theme was "Enhance Your Mind, Energize Your Business and Rejuvenate Your Connections". To this end this years meeting incorporated a number of new forums including Prime-Time Forums to highlight current industrial trends, Interactive Poster Sessions allowing authors to interact with interested delegates and Working Groups to facilitate the exchange of information between individuals with common interests.

Due to the large number of presentations to be given, a number of session structures were employed throughout the meeting program in order to highlight session themes and allow discussion of the themes. These included a more structured symposium format as well as themed technical sessions.

SYMPOSIA

How to Make Bread Healthy and Tasty

The focus of this symposium was to discuss current trends and technologies in development as related to bread with designed health profiles intended to meet industrial demand for both convenience and taste.

The first speaker was, Kaisa Poutanen from VTT Biotechnology, Finland whose talk considered the overall challenge of meeting the ever increasing taste, health and convenience challenges posed by the modern consumer and the need for ongoing development of bread products in local, national and international markets to achieve this.

K.Autio, also of VTT Biotechnology followed on with a presentation focussed particularly on the balance between health benefits and product palatability. In keeping with trends seen in the Australian industry, the Finnish market is seeing a growing interest in the health benefits of bread products in general and whole grains in particular. The interest in resistant starch and minimisation of processing is a driving force behind the production of many new products aimed at meeting Finnish taste requirements. As is often the case, problems have arisen with maintaining product characteristics while increasing the levels of whole grain ingredients leading to (re)formulation problems for many major producers.

Stefan Capelle of Puratos Group, Belgium went on to consider the importance of meeting consumer requirements with regard to encouraging consumers to continue purchasing products. The theme of this talk was "From consumer understanding to bread engineering" and presented the view that producers need to know what their consumers are looking for in terms of convenience, quality assurance and diversity and that it is critically important when formulating 'healthy breads' to stabilise flavours and optimise ferments to meet individual market requirements.

The importance of meeting the needs of those suffering from coeliac disease was then considered by E. Gallagher of the National Food Centre, Ireland. With one in 266 people worldwide displaying gluten intolerance, the importance of finding ways to mimic the gluten matrix in order to produce quality gluten-free products is increasingly important. The work presented here aimed to use traditional rheological methods to study ingredient effects on gluten free doughs and batters. This study indicates that sodium caseinate shows promise with regard to comparable rheological characteristics and acceptability of baked products. Further, the protein product fish surimi (odourless and flavourless itself), particularly surimi

from blue whiting resulted in high quality products though crust showed darkening and both crust and crumb were softer than for wheat dough.

Continuing on the theme of health versus palatability, Rob Hamer of the University of Wageningen, Netherlands spoke next delivering a presentation dealing with the increasingly popular addition of health promoting ingredients such as antioxidants to cereal products and the processing problems this presents. This talk centred on several major statements, firstly that "a food product not consumed has no health benefit". Rob suggested that health statements may sell products once but the taste of the product is the sole determinant of whether a consumer will continue to purchase the product and therefore "sensory performance is more important than health claims" and further that this indicates that "a healthy product can only be useful if it meets sensory requirements". To this end, it was suggested that when looking to reformulate around the potential created by a health claim it is critical to consider all likely processing problems that may be encountered and consider whether the health claim justifies the expected problems.

J. Abecassis of UMR Ingenierie des Agropolymers et Technologies Emergentes in France, was next to present. This talk looked at the potential for millers to isolate the nutrient rich mill fractions normally discarded during the production of white flours with a view to 're-fortifying' the white flour using these fractions. Aleurone cells, for example, are rich in antioxidants and arabinoxylans and therefore, provided processing conditions are optimised, may be capable of delivering significant health benefits. It was suggested that approaches on both local and global levels combined with appropriate data integration may allow exploitation of those bioactive compounds already present in grain without serious effects on consumer acceptability.

The next speaker T.Kujala of Vaasan and Vaasan, Finland, discussed the significant shift in taste and texture requirements experienced in the Finnish market in recent years. Previously Finnish consumers favoured large heavy loaves with a coarse particulate structure however over recent years the popularity of this type of bread has waned in favour of softer breads and single servings such as buns and rolls. There have also been small increases in the popularity of white breads as opposed to the traditional wholemeal sour dough. Recent studies showing the importance of high fibre diets however have shifted this trend back towards the wholegrain sour dough style of bread and Finnish advertising encourages people to eat 6-9 slices of this bread and 500g of vegetables a day to meet fibre needs.

The session was brought to a close by Noël Haegens of Vandermoortele, Belgium who highlighted differences in the dietary habits of northern Europeans (who eat more meat, eggs, milk, cheese, fat and alcohol) as opposed to the healthier diet of southern ('Mediterranean') Europeans (whose diets are higher in fruit, vegetables and wholegrains). It was suggested that certain areas of southern Europe actively oppose the use of non-natural and/or non-traditional ingredients in food products. Thus, it is not uncommon to find bread ingredient lists consisting only of flour, salt and yeast. This is in stark contrast to the ingredient list of many American breads which can contain as many as 33 ingredients per loaf. It was suggested that it is important for products to maintain their healthy profile and to remain authentic and recognisable to the consumer.

Sampling and the Nature of Variation

This symposium dealt with statistical analysis in cereal sciences with particular regard to sampling protocols and statistical reporting.

Terry Nelson of the USDA started proceedings with a presentation looking at the nature of randomness and the propensity for people, researchers in particular, to look for order rather than accept that results may be random. This leads to incorrect conclusions being drawn from statistically random results.

Continuing on the theme of randomness, Thomas Whittaker also of the USDA spoke next on the randomness of the occurrence of mycotoxins within grain shipments. He suggested that testing of a single sample of the grain is, when taken alone, insufficient as a means of assessing the mycotoxin load of the entire shipment. The suggestion here was that the three

major steps in the procedure, sampling, sample preparation and analysis, must all be considered with regard to the variability within each step in order to optimise use of resources and reduce uncertainty within procedures.

Debra Palmquist then discussed the occurrence of 'errors' in the statistical analysis of data and the negative connotations associated with the term. Debra suggests that mixed model analysis software packages can overcome some of these problems by selecting appropriate components for the testing of the significance of other components.

The next speaker of the morning was Phil Williams of PDK Grain, Canada and his talk looked at the 15 statistics used to describe NIR results. Phil suggests that in order to avoid drawing incorrect conclusions from NIR data it is important that these statistics be fully understood and correctly appraised by the operator.

To complete the symposium Paul Wehling of General Mills, USA gave a software demonstration illustrating a recent Microsoft Excel Add-in capable of simplifying stochastic simulation and therefore allowing simpler, less expensive modelling of systems variations.

Science Based Risk Assessment of Biotech Products

Due to the increasing interest in biotechnology, products relating to the field have flooded the market. It is therefore essential to both the benefits and the risks of these products. This symposium looks at some of the recently developed techniques used to accomplish this

The first speaker of the session was Jeff Wolt of Iowa State University, who discussed the need for consistent assessment and approval systems across the world market. Alan McHughern of the University of California then discussed the difference between genetically modified food products and non-genetically modified products with particular regard to some of the myths and misconceptions surrounding this controversial topic.

The symposium was then concluded by Wayne Parrott of the University of Georgia, USA who continued on the theme of genetic modification discussing the massive genetic changes in domestic plant crops caused by agronomic traits. This talk suggested that changes in DNA caused by genetic engineering are minimal compared to those caused by agronomic traits and that regulation relating to GMO should reflect this.

Looking Beyond Food: Generation of Novel Starch and Biopolymer Based Materials

This symposium looked at using biopolymers such as starch and polysaccharides, as opposed to petroleum based polymers, in novel applications such as thermoplastics. Biopolymers such as these have a number of advantages over petroleum based derivatives including both price and biodegradability. Yonas Gizaw of the Procter and Gamble company, Ohio, touched on these advantages as well as addressing some of the challenges involved in production of these biopolymers. These challenges stem from factors such as the high molecular weight of these molecules as well as structural configurations, eg helices, and high levels of hydrogen bonding. Problems with end-product mechanics and waterproofing also need to be overcome.

Ramani Narayan then continued the theme discussing the production of 'foams, films and molded articles' using starch based biopolymers. Again the hydrogen bonding causes thermo processing challenges as degradation occurs before thermal melting. This can be overcome with some success using plasticisers to break the bonds leading to a characteristic thermoplastic flow.

Victoria Finkenstadt from the National Centre for Agricultural Application Research then discussed the potential use of biopolymers as electroactive bioplastics (EAPs) such as biosensors, membranes and controlled release devices. Current research indicates that these biopolymers have mechanical advantages over synthetic EAPs.

Genomics: Concepts and Applications for Cereal Grain Quality Improvement

This symposium addressed some basic genomic concepts as well as updates on wheat genome mapping and recent method development for the study of gene structure and expression.

Firstly, B.Gill of the Genetics Resource Centre, KSU, provided an update on the wheat genome sequencing project including major reports from numerous international conferences and meetings. This talk was followed up by O. Anderson of the USDA-ARS Genomics and Gene Discovery Research Unit who discussed how genomics can be used to better understand grain quality as it relates to gene families. This type of work has been difficult due to a level of similarity between the relevant proteins however genomic resources such as expressed sequence tags allow these related groups to be studied.

Debbie Laudencia-Chingcuanco then presented a talk addressing the changes in genomic composition of grain over the first 35 days post anthesis. This resulted in 3178 of the 7835 genes represented (5818 of those mapped) being conserved at all time points.

Following on from this, Ann Slade from Anawah Inc. presented a novel, non-transgenic approach to improvement of wheat crops. The technique is known as Targeting Induced Local Lesions IN Genomes (TILLING) and is used to identify natural and induced genetic variation. Thus far the test has only been used to analyse diploid species such as *Arabidopsis* however this study indicates that it is just as viable for polyploid species such as wheat. In this study TILLING was used to identify alleles of the waxy genes in wheat. 246 waxy alleles were identified from 2000 plants representing a broad range of phenotypes.

Lastly, Pierre Hucl from the University of Saskatchewan, Canada presented on the current applications of genomics to crop improvement. These include protein quantity and quality, pre-harvest sprouting and Fusarium Head Blight among others.

Formulating for Health

This highly popular symposium focussed mainly upon whole grains and their associated health benefits. Whole grains were described as having gone through a 15 year cycle of being 'adored' to 'reviled' (Low Carb) to now being just tolerated.

Glen Weaver opened proceedings by looking specifically at the formulation of sweet products. Glen suggested that the critical requirement during formulation is to consider the system as a whole so as to achieve a balanced formulation. Included in this is the need to consider all ingredients eg enzymes, dough strengtheners as well as flavours and to consider how each ingredient particularly whole grains will affect processing, eg do they require soaking? A number of ingredients can be replaced eg processed flours with whole grains, fat with fruit, sugar with sweetener and some will need to be excluded altogether eg trans fats. Although these changes in formulation may present challenges, when proper consideration is given exceptional products can be produced.

Judi Adams of the Grain Foods Foundation continued with an update on the low carb situation and the 'hangover' effect still being experienced in certain markets as a result. This effect has led to a number of misconceptions being held by consumers and subsequently underconsumption of carbohydrates/whole grains (though at it's peak only 9% of Americans were committed to low carb diets, this figure is now 4.4%). Dietary guidelines suggest 3 servings of whole grains a day should be consumed and that carbohydrates should represent 45.7% of caloric intake. Only 1/10th of consumers meet these demands even though 75% think they do. Judi also discussed the decision by American authorities not to promote low GI diets as GI doesn't account for unhealthy macronutrients such as saturated fat which can appear to reduce GI giving a 'false negative' result. Further, the complex nature of the glycaemic index makes it hard to explain to the public at large. An example given here was the fact that a Snickers bar has a GI of 40 while many grain foods have a GI of 70. Alternatively, it was suggested that consumers make choices based on dietary fibre and whole grain content in order to slow digestion and lower caloric intake while increasing nutrient intake.

It was stressed that in order to keep grain foods increasing in popularity it is important to advertise and continue to undo the damage done to the reputation of grain foods by the low carb phenomenon. A number of posters currently displayed on American billboards were also shown. These promote bread products as important to brain and muscle development among others.

Continuing with a major theme of this meeting, Katherine Wiemer of General Mills then went on to discuss whole grains and the recent claim by the FDA that consumers should 'make half your grains whole'. This has led to a push for standards to be brought in to label food as an 'excellent' or 'good' source of or 'made with' whole grains. Current standards have set these limits at >16g required to be labelled an 'excellent source' of whole grains while >8g is required to be a 'good source'.

Maureen Storey of the Univ. of Maryland emphasised the recommendations of the Dietary Guidelines Advisory Committee and the need to increase intake of shortfall nutrients including folic acid. Currently recommendations are for a simultaneous increase in consumption of whole grain products that are not fortified with folic acid along with a decrease in consumption of refined grain products that are fortified. The conclusion of 3 large data studies were that few if any consumer groups would exceed the recommended daily dosage of folate if whole grain products became enriched.

Oats: Health and Technology

As health claims can now be made for oats and oat based products, research into the functionality and biochemistry involved in oats, oat starch and beta-glucan have increased recently. This symposium presents some of the recent work in this field.

S. Miller of Agriculture and Agri-Food Canada began proceedings with an overview of the microscopic organisation and biochemistry of the oat kernel and its specific tissues. Following from this overview Rebecca Mathews (R. Mathews & Associates) discussed the potential for further health claims for oat products. Currently oats, certain oat products and oat derived beta-glucans can make health claims pertaining to reduced risk of heart disease and certain cancers. Research is currently being carried out looking at the ability of these products to help with regulation of blood glucose, weight control and blood pressure. These may form the basis of further health claims, if approved.

K. Behall of the USDA then continued this theme, presenting data indicating that oats and barley (which are high in soluble fibre) can reduce blood cholesterol and blood lipids better than those grain with lower levels of insoluble fibre (eg. wheat).

The structure-function relationship of oat beta glucan was then detailed by Peter Wood of Agriculture and Agri-Food Canada. This talk emphasised the importance of the manner in which the beta-glucan is cleaved to the resulting behaviour of the fibre in solution. Further research also indicated that gelation of beta-glucan occurs only for the lower MW beta-glucans.

F. Collins (also of Agriculture and Agri-Food, Canada) then discussed the role of bioactive phenolic compounds found in oats. Though research in this area began relatively recently these compounds are already showing promise not only as antioxidants but may have potential in a number of other health applications.

George Inglett of the National Centre for Agricultural Utilisation Research discussed the development of the product Oatrim which was used as a fat-replacer in certain formulations and recently had a health claim for heart health approved. Following on this success a number of other fat replacers derived from oats have been produced including Nutrim and Z-Trim.

The symposium was then brought to a close by Kaisa Poutonen of VTT Biotechnology Finland, who discussed the most recent developments in oat functional products. These include oat milk, yoghurt and ice cream, oat replacement-meal drinks as well as the addition of oat products to breads, pasta and biscuits.

Rapid Detection Techniques in Food Safety

This symposium looked at recently developed and revised tests for detection of contaminants in food products and thus Roland Pomms of the ICC began with a discussion of the nature of rapid testing techniques and the need for these tests to be standardised across institutions. To this end the ICC are working with other organisations such as CEN and ISO in order to begin this process. Hendrik Emonds of IRMM-JRC-European Commission, Belgium went on to discuss the need for available reference systems for method control and validation and the requirements of such reference materials.

Kurt Johnson of Biopharm then continued with an in depth presentation looking at developments in the detection of mycotoxins in food. Specific examples of these developments were illustrated including an ELISA array capable of quantifying levels of five mycotoxins simultaneously, as well as a biosensor that is used, much like a pH meter, to give highly accurate quantitative results in minutes. The development of biosensors as well as the use of proteomics and transcriptomics, is also being employed by the European Union as explained by Hans van Egmond of the National Institute for Public Health in the Netherlands. 7 million Americans are believed to suffer food allergies and so the issue of allergens and their presence in processing plants and resulting food have become a major issue recently.

Tim Hendra (Neogen, USA) presented on this issue, in particular the tests currently used to detect the presence of allergens in the manufactured product. Currently the most common means of testing for these allergens is the use of rapid test kits. These are currently in use to test for the presence of peanuts, milk, egg, wheat, soy and almond. Rapid tests based on DNA and in particular the polymerase chain reaction are also used and Matthias Kuhn (Congen, Germany) detailed how these tests work and their applications in detection of pathogens and allergens.

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an Willem van der Kamp of TNO, Quality of Life, Netherlands, discussed the development and application of technologies which use the recently elucidated genomes of many of the microorganisms of concern. This provides information such as biomarkers, organism characteristics and identification as well as information on strain virulence and resistance.

Rapid Instrumentation for Grain Quality Assessment

This session aimed to look at new and developing techniques for grain quality analysis and R. Pierce of the USDA Grain Marketing and Production Research Centre started proceedings with a discussion of instrumentation used for analysis of end-use wheat quality. This research looked at the wheat functionality required by end-users, current quality tests and whether they may be applicable to field testing environments as well as correlations between quantitative and qualitative testing. Of those tests studied, both NIR spectroscopy and Fourier Transform NIR techniques showed the most promise though a number of challenges existed in creating calibrations capable of dealing with the diversity present in the US wheat market.

C. Culbertson of KSU then detailed the development and use of Lab-on-a-Chip technologies similar to those used currently in the VAWCRC. This type of testing is capable of assessing the quality variation not attributable to variety. This technology employs rapid protein extraction methods to reduce cost and time constraints followed by separation of proteins using small glass or plastic chips and hand-held devices.

Mike Sissons of the Department of Primary Industries Tamworth, Australia, then discussed the single kernel characterisation system (SKCS) using a Perten 4100 instrument. The technique is both accurate and reliable and is capable of replacing slower tests such as 1000 kernel weight and PSI hardness. This instrument has the potential to be used to gauge both semolina mill yield and vitreousness and could prove useful for durum breeding programs.

The next talk, by P. Armstrong of the USDA-ARS, also looked at single kernel analysis though using single kernel NIR instrumentation. This instrument which has an increased throughput of 10 kernels/s (up from 2-3 kernels/s) measures the spectra of the kernels while they are in a semi-free fall. This increases the rate of collection of the spectra and provides results

comparable with other single kernel analyses. Spectra collection needs to be altered however to overcome problems with kernel orientation due to the falling motion.

S. Symons of the Canadian Grain Commission, then discussed the development of kernel imaging over the last 25 years beginning with the earliest technologies capable of simple measurements of many grain kernels within a single sample. Previously measurements had been done by hand meaning that only a couple of grains were studied in detail. Over the next 20 years imaging technologies continued to develop allowing colour as well as densitometric analyses among others.

Analysis of insect damaged wheat was then discussed by R. Haff of the USDA-ARS. This talk focussed on two non-destructive methods of analysing insect damage including x-ray analysis. This analysis was done using both digital and film photography with detection errors occurring less frequently by subjects when photographs were taken on film. This technique employed a Bayesian algorithm for detection of small and large insect larvae with varying degrees of success (74-94% of infestation detected). The second technique involved impacting grain kernels on a steel plate resulting in damage to the weaker infested kernels while the uninfested kernels remained undamaged.

To complete the symposium B. Alvin of Perten Instruments, Sweden presented on the range of single kernel analysis techniques currently available and in development between Perten and the USDA.

Better Rice: From Seed to Table

This symposium looked at recent developments in the rice industry from the breeding stage through to processing and end-use quality.

Starting off on rice breeding technologies J. Stroike of Rice Tech. Texas, spoke on the development of hybrid rice strains in the USA. Hybrid varieties are commercially grown in Asia and provide significant yield advantage over comparable non-hybrid varieties. Delilah Wood of the USDA-ARS, Canada, then discussed the use of fluorescence microscopy as a means of detecting lipid distribution in rice grains. This talk described a new method capable of sectioning and mounting rice grains without solubilising lipids using a formalin-ethanol-acetic acid solution.

L. Gingras then discussed the potential to replace partially hydrogenated oils containing trans fatty acids with rice bran oil. Rice bran oil is rich in antioxidant compounds such as tocopherols and tocotrienols and may provide a healthy alternative to current ingredients.

J. Wang of the University of Arkansas then looked at the physical and chemical properties of long and medium grain rice as determined by both genetic and environmental factors and the relevance to end-users.

Rice drying was also looked at (J. Siebenmorgen, University of Arkansas) with regard to modelling of the process of drying within single rice kernels. This led to the development of the "glass transition hypothesis" which uses internal kernel temperature and kernel moisture gradients to predict the onset and cause of kernel fissure development.

Milling was discussed with regard to optimisation of the process for Buhler milling (D. Blass Buhler, Germany) as well as processing technologies, in particular polymer science (a. Perdon, Kellogg Co.).

The use of stabilised rice bran (SRB) as a nutraceutical was addressed by D. Hoffpauer. SRB has a number of health benefits including reduction of low-density lipoproteins in the blood. This has led to the development of a product called Heartbran™ which used SRB fortified with vitamin C and the B vitamins and has been shown to have positive effects on heart health in clinical studies.

Continuing on the health benefits of rice, A. Banville of the USA Rice Federation discussed a recent promotion of the nutritional benefits of rice called "Rice fits". This promotion points out that rice contributes to nutrition and public health and can help consumers implement many dietary and healthy eating plans.

The final talk of the session was given by Anna McClung and looked at current molecular marker technology in the rice industry with particular regard to cooking, processing and sensory quality of rice.

Proteomics Analysis of Grain and Food Proteins: Technical Obstacles, Best Practices and Future Potential

Proteomics has become increasingly popular recently as a means of studying structure-function relationships of grain and food proteins. This symposium looked at current technologies including associated problems and potential.

Firstly, K. Preston of the Canadian grain commission discussed how mass spectrometry (MS) can be used (in the form of MALDI-time of flight (TOF) MS) as a proteomic tool. This technique is capable of rapid identification of variety/class as well as protein characterisation and peptide sequencing in wheat and barley.

Barley proteomes can also be probed using 2D gel electrophoresis as compared with malting quality. This technique, as described by C. Finnie of the Technical University of Denmark, allows a large number of individual cereal proteins to be used in correlative studies with qualitative characteristics.

An overview of recent proteomic advances was given by D. Wilson of Thermo Electron dealing with development of sample preparation techniques, separations and detectors in the last five years.

E. Mills (Institute of Food Research, UK) then presented the results of a recent study looking at proteomic analysis of the aqueous phase of bread doughs. Results showed that β -amylase, tritin, serpins as well as a number of the α -amylase/trypsin inhibitor family were abundant. These components are believed to play a role in stabilising dough bubbles and thus contribute to the crumb structure of baked products.

The final presentation of the session was given by W. Vensel of the USDA Western Regional Research Centre. This talk looked at how current identification of LMW-GS by MS can be improved using tandem MS/MS and using enzymes other than trypsin as a means of cleaving the subunits. Cysteine residues can also be aminoethylated to create more trypsin cleavable sites to be exploited.

Frontiers of Rheology in Nutrition

As nutrition becomes increasingly important so to does analysis of both sensory and nutritional characteristics and both of these can be assessed using rheology. This symposium considered how rheological characteristics and mechanisms can be used for these applications.

Daniel Gallagher of the University of Minnesota began this symposium with a discussion of viscosity and the role it plays in nutrition. Dietary fibre is a major contributor to gastrointestinal viscosity and recent studies indicate that the viscosity is a more important factor in lowering cholesterol than is the structure of the dietary fibre. There is also some evidence that glucose tolerance can be improved by viscosity however the mechanism for this is not known.

K. Autio of VTT Biotechnology, Finland, then looked at the insulinaemic index (II) of a number of bread types on women of normal glucose tolerance. Results indicated that wholemeal and endosperm rye breads result in a lower II than softer wheat breads provided no gluten or wheat flour was added.

As discussed in previous symposia reformulation of products for health benefits, particularly addition of higher fibre ingredients, can lead to processing problems. Teri Paeschke of Cargill described the increased viscosity and decreased available water observed with addition of a number of fibres including inulin and beta glucan. Other fibre types can disrupt proteins

including the structural gluten complexes. These sorts of processing issues can often be overcome with rheological characterisation.

The symposium concluded with a talk by J. Tomlin of the Royal Hallamshire Hospital, UK, looking at the intestinal viscosity as well as the levels of glucose, insulin and gut hormones in the blood of ileostomates following bread consumption. Results indicated that the presence of guar gum in the bread consumed can decrease the insulin and glucose response observed though this also appears to cause fluid secretion into the gut.

Roles of Dietary Fats and Carbohydrates in Insulin Resistance

With rates of type II diabetes expected to reach epidemic proportions in the years to come, this symposium aimed to look at some of the metabolic changes that often precede the disease including insulin resistance.

The symposium began with an overview of the topic by Wallace Yokoyama (USDA). This talk discussed the perceived link between the high blood glucose associated with type II diabetes and the high glucose content of carbohydrate based foods. Though this has led recently to a negative view of carbohydrate foods, the studies here indicate that saturated fats pose a more significant threat. Further, carbohydrate based foods such as oats can actually help to minimise the negative effects of high fat diets. Later, the theme of dietary fat was continued with Rosemary Walzem of Texas A & M University discussing the role of dietary fat in lipotoxicity which can ultimately lead to hyperglycaemia and type II diabetes.

Paul Davis of the University of California then detailed the importance of antioxidant consumption in reduction of the rate of diabetes. This is seen in the ability of adipocytes to release free fatty acids (which negatively affects insulin signalling). This release results in increasing numbers of reactive oxygen species that adversely affect glucose transport and insulin sensitivity. Antioxidants neutralise these oxygen species reducing the risk of tissue damage.

The advantages of whole grains was discussed by Len Marquart of the University of Minnesota particularly with regard to the ability of whole grains to slow weight gain and promote weight loss while N. Nishizawa of the University of Morioka Japan, detailed these effects for millet particularly. Indications in animal studies are that millet grain may be capable of increasing levels of 'good' HDL cholesterol and decreasing blood insulin.

TECHNICAL SESSIONS

Enzymes

This session incorporated a detailed discussion of the range of ways in which enzymes can improve the product quality of grain-based foods. P. Leman of Katholieke Univ., Belgium began by reporting on the functionality of maltogenic exo alpha amylase for retarding bread staling. The study used starch slurries, starch/gluten breads and whole bread matrices in order to build up a functionality profile. Both high and low thermostable amylases were used with *Bacillus stearothermophilus* being the most effective in retarding bread staling through decreased bread firmness, lower starch PV and higher CPV. A correlation was found between the CPV of starch slurries supplemented with amylase and the chain length of amylose.

I. Povlsen of Danisco, Denmark discussed the functionality of lipase with galactolipase activity and the improvement conveyed to bread crumb structure and loaf volume due to the interaction between lipids (particularly polar) and gluten (lowering surface tension) resulting in a stronger, more elastic and ordered gluten network. The effect of air bubble expansion on gluten was studied in resting dough at 34°C using image analysis microscopy.

H. Lundkvist of Novozymes, Denmark used low field NMR to study changes of water with storage time in bread and the effect of various enzymes on this process. The enzymes studied included: fungal alpha amylase which has a low thermostability and affects mostly damaged starch, xylanase which affects arabinoxylans that bind water, glucose oxidase which strengthens gluten and has a dough drying effect and maltogenic alpha amylase which has anti-staling properties. With storage time, free water mobility and amount decreased while bound water mobility increased. Of all the enzymes studied, maltogenic alpha amylase

inhibited these water changes with time to the greatest extent. Xylanase and glucose oxidase affected only dough water properties and had minimal effect on staling.

C. Primo-Martin of the Wageningen Center for Food Sciences, Netherlands described enzymatic control of the surface properties of gas cells in dough which largely determines final bread crumb structure. It was shown using IR spectroscopy that a mixed interface of protein and lipid adsorb to air-water interfaces. Lipase increased surface tension most notably through increased lipid polarity and protein-lipid interactions however loaf volume increase was greatest with xylanase and DATEM addition.

Rheology and Texture

The first talk in this session was given by D. Vazquez of the INIA, Canada. The research presented here looked at the importance of dough extensional studies when gauging ingredient effects for hearth and pan breads. The results of the study indicated that extension characteristics correlated more strongly with baking quality than did mixing properties.

J. Visser of the Wageningen Centre for Food Sciences, Netherlands, then presented on recent work looking at crispness characteristics in terms of both mechanical fracture properties and the audible acoustic that accompanies this fracture. These results indicate that higher dissipation energy impairs optimum fracture of crispy products and that in order to quantify this characteristic, both mechanical and acoustic properties need to be considered. This theme was continued by E. Cheng of Kansas State University, who discussed the relationship between mechanical and acoustic properties of food foams. These results indicated that when acoustic properties were taken alone samples were correctly classified in 84% of cases while when both products were considered together accuracy rose to 95%.

Noodles were discussed next with M. Cash of Aqualon discussing the effects of CMC type (in terms of level of substitution and molecular weight) on noodle quality. Results indicate that increases in both level of substitution and molecular weight were accompanied by increased firmness and adhesiveness and decreased chewiness and resilience. Increased substitution, however, also resulted in an increase in fat absorption.

NIR Analysis

This session involved a technical discussion of the practical applications of NIR spectroscopy and calibration considerations. C. Don from TNO Quality of Life, Netherlands reported on grading on gluten macropolymer (GMP) quality basis with NIR. GMP correlation with loaf volume was $R^2=0.38$ however with NIR this correlation was improved. GMP quantity was also measured and shown to be related to dough mixing characteristics (GMP phase angle correlated with mixing energy $R^2=0.91$).

P. Williams of PDK Projects, Canada discussed spectral complexity in wheat analysis by NIR. He explored how similar spectra can be obtained from samples of differing composition. Detailed in the presentation were over 50 factors which can affect the spectral reading including kernel size, colour, density, texture, growth location, season, class etc. Examples included samples having similar protein content but different spectra caused by kernel texture. A high correlation is also often found between test weight and many quality parameters. The examples illustrated the importance of identifying variables that can influence spectra before choosing samples for NIR calibration.

An unknown presentation on deoxynivalenol (DON) affected grain and its detection by NIR in segregation was lastly delivered. Grain affected by DON was presented and showed a highly shrivelled and whitish appearance. A 7000kg/hr optical NIR sorter was used to detect affected grain in large quantities with affected grain having a lower absorbance and test weight than unaffected. 1152 and 1248nm wavelengths were selected that gave the highest number of positively classified samples which was better than 1 wavelength alone or visible spectra could achieve.

Specialty Grains

This short session commenced with a talk from R. Scheonlechner (University of Natural Resource and Applied Life Sciences (UNRALS), Austria) regarding the potential use of

pseudo-cereals such as amaranth, quinoa and buckwheat in the production of sweet biscuits. The crispiness of the buckwheat biscuits was preferred in sensory tests however the soft amaranth biscuits were preferred over quinoa due to a strong bitter flavour present when using quinoa. Both amaranth and buckwheat produced good quality biscuits.

S. Siebenhandl (also of UNRALS) then looked at the distribution of phytochemicals in a number of less popular grain varieties. This research found that spelt contained the highest levels of yellow pigments while anthocyanin content was highest in blue wheat and barley and purple wheat. Results also indicated that in the grains tested antioxidant levels were 3-5 times higher in the bran than in the endosperm.

This session concluded with discussion of the digestibility of starches from sorghum and maize flours by J. Taylor of the University of Pretoria, South Africa. This paper indicated that starch from vitreous sorghum endosperm is less digestible than floury sorghum or either floury or vitreous maize starches. This difference was less marked when flours underwent pressure cooking with all having increased digestibility. This was found to be due to an increase in the ratio of beta sheet to alpha helix protein structure in the endosperm proteins.

Proteins

This session commenced with a discussion of the characterisation of LMW-GS of common wheats coded for at the *Glu-B3* allele by Tetsuya Ikeda (of the National Agricultural Research Centre for the Western Region, Japan). Many Japanese soft wheats were shown to include the *Glu-B3i* allele while Japanese noodle wheats often exhibited the *Glu-B3g* allele. This *Glu-B3g* allele was shown to have the same amino acid sequence as the *Glu-B3b* allele often seen in Australian soft wheats.

Next, Francis Dupont of the USDA-ARS-WRRC detailed the results of a study looking at how protein content and composition change as a result of fertiliser and temperature. Results indicated that drip application of fertiliser at moderate temperature (24/17°C) increased protein accumulation rate and time and doubled protein percentage however this effect was not seen at higher temperature (37/28°C). Rather, at higher temperature grain filling time decreased along with single kernel weight and protein content was similar to that of the cooler regiment when fertiliser was not added at all.

Lukasz Pietrzak (ECORC, Ottawa) then discussed the changes in alpha helix to beta sheet ratio as determined by FTIR synchrotron microspectroscopy. Results indicated that this ratio increased rapidly during farinograph mixing until the arrival time at which point the increase slowed until breakdown where it remained static.

Rob Hamer of the University of Wageningen then delivered a presentation entitled Glutenin Particles: Facing the critics, reviewing the evidence. This paper hypothesised that contrary to consensus, the aggregated protein fraction, when isolated from flour, is actually particulate in nature and further that the mixing process actually served to break down structures as opposed to aiding in their formation.

Anneliese Rittau of the VAWCRC then discussed the effects on sedimentation testing of environmental conditions such as climate during growth, storage and grain sprouting. Results indicated quality changes observed with both growth climate and long term storage were detectable using sedimentation. On the other hand, results indicated that sedimentation testing might be an inappropriate means of testing sprouted grain.

Hamid Naeem (University of Manitoba, Canada) continued next with a discussion of the effects of the protein composition responses to protein content. The studied comprised of four protein isolates (HMW-GS, LMW-GS, omega gliadins, sulfur-rich gliadins), finding that the UV spectra of HMW-GS AND omega gliadins were highly distinctive while the S-rich and LMW-GS fractions were similar. Omega gliadins showed the highest response to flour protein content (FPC) while as FPC increased gliadins increased at three times the rate of HMW-GS. Ritu Saini of Michigan State University then discussed the changes observed in Chinese noodle texture with variations in protein composition. Results showed that both mono and

polymeric proteins contribute to Noodle springiness while hardness, gumminess and chewiness all correlated positively with the gliadin peak (as described by SE-HPLC).

The next presentation, by George Robertson (USDA-ARS), looked at the manner in which protein solubility in ethanol changes as the temperature of the solvent decreases results indicate that maximum solubility in ethanol occurs at 60% when temperatures exceed 0°C however at sub-zero temperatures this increases to 70%.

The final speaker of this session was Baninder Sroan of Kansas State University who described recent research looking at how rheological behaviour and surface activity (of both lipids and surface proteins) affect baking quality.

Health and Nutrition

T. Wolever of the University of Toronto, Canada began this session with a talk on the metabolism and absorption of an enzymatically modified carbohydrate (LGS or low glycaemic syrup). Tests against unmodified high fructose corn syrup and a sucrose/fructose/inulin mix designed to imitate malabsorption indicated that the LGS is actually absorbed slowly but completely as opposed to being malabsorbed.

R. Tahvonen of the University of Turku, Finland then discussed the formulation of a low GI, high fibre sweet bread with high omega 3 fatty acid content. This was achieved using fructose, oat bran and canola oil respectively. Though the fibre content was reduced due to processing the GI of the product was 44% of that of a comparable white flour product.

L. Tovar of CIEMAD-IPN, Mexico then presented on the nutrient and microorganism content of a native Mexican alcoholic drink known as *Pulque*. The drink is known to contain phytase producing micro-organisms. *E. coli* and total coliforms were also assayed to allay public health concerns. Studies showed phytase activity present in several stages of fermentation, activity studies are ongoing.

The production of gluten free beer was discussed next by G. Zweytick of UNRALS, Austria. This study aimed to find alternative grains or pseudo cereals capable of malting in a similar fashion to barley and thus producing viable beer products. Results indicate that corn, sorghum, quinoa, buckwheat and amaranth are all capable of producing brewed product though corn and buckwheat scored best in terms of sensory tests.

The session was complete with a talk from I. Gawrilow (Spectrum Organic Products) who looked at organic vegetable oils and fats and the growing, processing and approval challenges faced by the baking industry..

Whole Grains

This session followed on from a number of other sessions dealing with health issues with a particular emphasis on whole grains. D. Kappelman of Danisco USA, presented first on using whole grain products for healthy bakery goods. In particular, this talk looked to solve the problems faced by companies looking to reformulate with whole grain ingredients. Suggestions included addition of enzymes to increase softness and shelf life, flavours to overcome bitterness, xanthan fibre to slow staling and xylanase and DATEM to help with processing.

E. Arndt of ConAgra Foods Inc. Then discussed the difficulties of increasing whole grain consumption in children. With American children consuming less than one serving of whole grain foods per day (and only 9% consuming the recommended 3 serves), tests were carried out to assess the acceptance of whole grain foods when substituted into popular foods such as pizza and pasta. Both sensory testing and assessment of plate waste in a school canteen environment indicated that when substituted into these products, whole grains were readily accepted.

The session was concluded with a talk by M. Camire of the University of Maine, who discussed the tendency for consumer to judge the 'healthiness' of products based on their

colour. This study indicated that consumers associate 'healthy' products as those that are not made from white wheat, regardless of other attributes, suggesting that further education on selection criteria may be required.

Bread and Biscuits

Despite the promise of the title, this session focussed entirely on bread products and the current and emerging technology being employed to improve or measure product quality. G. Campbell of the Satake Centre for Grain Process Engineering, UK first reported on aeration of bread dough during mixing with and without the use of pressure-vacuum.

The use of pressure-vacuum mixing is increasing in the UK in which mixing under 2bar initially enhances air incorporation and entrainment before bubbles break into smaller ones and finally air is disentrained. Nearing end of mixing pressure is lowered to 0.5bar to facilitate the creation of a finer bubble structure. The air in dough is consequently measured by density. A mass balance model was used to describe aeration of dough such that the amount of air entrained in dough = amount of air disentrained from dough per unit time. Bigger bubbles were also shown to be more likely to be disentrained than smaller bubbles. When increasing pressure, the increase in density is much slower than lowering pressure and lowering density effects. Pressure mixing improved the uniformity of gas cell distribution as evidenced by C-cell imaging.

R. Dempster from the American Institute of Baking introduced the idea of ash not just being due to bran content alone but also from a fraction called high ash endosperm. It was found using the Branscan and Fluoroscan that adding aleurone back to flour (10 varieties studied) at increasing levels decreased loaf volume while bran content remained constant.

M. Tulbek of North Dakota State University has evaluated the use of fermented chickpeas as a leavening agent in straight sourdough bread, which is currently used in some Mediterranean countries as part of her PhD project. Fermented chickpea (5-10%) decreased Farinograph water absorption and loaf volume but increased Extensigraph dough strength. Incorporation of fermented chickpea and dry yeast increased loaf volume above dry yeast alone. Crumb firmness and moisture loss was lower over time than the grain bread control.

T. Maeda of Hyogo University, Japan spoke about the practical application of polished wheat flours to baking. It was noted that Sponge and Dough and Long Fermentation baking methods were required to improve poor dough and baking quality of polished flours.

P. Babin of GPM2, INPG, France used X-ray tomography to study the development and setting of bubble structures in bread dough. Three main stages were identified relating to internal gas pressure, dough viscosity, bubble coalescence and gas percolation. Up to 50°C there is no more gas cell expansion and at 75°C the cellular structure is completely set as starch granules have swelled and gluten crosslinked.

M. Whitworth from Campden & Chorleywood FRA discussed new applications of bread colour measurement and structure by C-cell image analysis. A DigiEye camera can measure colour and structure standard deviations (not just average) throughout the sample, peak regions of colour and product appearance in different illuminations. It also uses diffuse (daylight) illumination. The spatial distribution of cells relating to orientation provided information on processing conditions (i.e. moulding).

R. Keiffer from DFA Lebensmittelchemie discussed mechanisms of dough improvement using ionic and neutral emulsifiers including SSL, DATEM, CTAB, MG, Pglyc and SL. He described the unique functional properties of wheat dough being due to macro-structures built on by gluten, starch and water. He further explained that gas bubbles are surrounded by starch granules, not gluten. It was shown that high Rmax of fresh Glutomatic gluten correlates highly with loaf volume but this was not replicated with rehydrated commercial gluten. Glutenins were also shown to be lost more readily in gluten washing than gliadins. The study found that DATEM addition decreased water holding capacity of dough and weakened gluten structure. In conclusion, emulsifiers were found to affect gas bubbles as the maximum contribution of gluten to dough strength (as measured by Rmax) is limited in dough - starch is important too.

Starch

This session started with S. Peterson (USDA-ARS-NCAUR) discussing the effects of supercritical fluid extraction (SFE) of lipids on pasting properties of cornstarch. This study compared this SFE technique with the more traditional reflux extraction. Results indicated that peak viscosity quadrupled for the SFE method.

M. Seguchi of Kobe Women's University, Japan then discussed the structure and formation of ghost type B starch granules (following treatment with 25% KI/10% I₂). The appearance of the granules differed markedly from the double structure observed for ghost type A granules. As with the A-type granules occurrence of ghost granules was positively correlated with amylose content.

A. Regina of the CSIRO Plant Industry, Australia then looked at generation of high amylose wheat starch via suppression of RNAi genes. This research looked at suppression of the starch branching enzymes SBEIIa and SBEIIb. It was found that SBEIIb could be suppressed without suppression of SBEIIa and without any affect on amylose content. SBEIIa suppression however resulted in suppression of SBEIIb and this in turn produced wheat with amylose content >70%.

The changes in starch granules and polymerisation were described by W. Ratnayake of the University of Nebraska-Lincoln. The study looked at the behaviour of different potato and maize starches over a range of temperatures. Differential scanning calorimetry indicated that prior to starch gelatinisation energy is absorbed by granules facilitating the breakage and reforming of bonds within the structure.

A. Jurgens of TNO Quality of Life, Netherlands then looked at the link between starch functionality and laboratory approaches with particular regard to the difficulty of mimicking industrial conditions in a laboratory situation. This study presented a lab-scale model for noodle texture and snack expansion. This model is linked to a starch database describing industrial outcomes/problems with different starches.

This session conclude with a presentation from R.Gilbert of the University of Sydney, Australia. This research looked at how the molecular weight distribution (MWD), as determined by capillary electrophoresis or size exclusion-HPLC can be used to trace starch synthesis events in vivo.

Analytical

This session made consideration of changes occurring with constituents such as starch, protein and lipid at a molecular level. D. Himmelsbach of USDA discussed changes in protein and starch conformation during parboiling of rice using FT-Raman and ¹³C CP-MAS NMR spectroscopy. Raman spectroscopy was useful in determining protein conformations in parboiled rice. Solid-state NMR spectroscopy indicated that starch did not become completely gelatinised under standard parboiling practices although it did under commercial heat treatment. However treatments used in the study may be beneficial enough to prevent disintegration through denaturation of enzymes and annealing of rice.

S.Abraham of Northland Laboratories spoke on novel technology for rapid pathogen detection in cereals using IMS-PCR, an immunogenic separation and polymerase chain reaction system with specificity and sensitivity to 1 CFU/g. Conventional methods require time consuming techniques – up to 5-7 days for a result. This technology allows sampling of 25g of product or raw material for Salmonella spp, Listeria spp, E.coli 0157:H7. It may be applied in research or quality control settings and coupled with ease of use and high accuracy makes it an attractive technology for the cereal based food industry.

S.Hill from the Univ. of Nottingham discussed changes to lipid and starch when stored in the rubbery and glassy state. Previously, changes in the glassy state were not assumed to occur, but they do – at low moisture content lipid oxidation progresses rapidly. This was shown in a study involving oxidised and fresh lipid with free fatty acids. Lipid oxidation was measured by

hexanal concentration which indicated glassy state progression was more rapid than rubbery state.

P. Williams of PDK Projects, Canada discussed prediction of breadmaking quality of wheat using FT-NIR. He spoke on the necessity of mixed composition of wheat lines from various locations to remove variability and subsequent undesirability of some varieties when looking at genetic factors. Correlations were found between farinograph and amount of HMW glutenin as well as farinograph water absorption and pentosan content (not protein content or starch damage). Calibration models were developed which would be suitable in wheat breeding applications.

Wheat

This session revolved around a discussion of wheat flour genetic qualities and composition in relation to product quality and assessment. R. Jonnala from Kansas State Univ used 24 near-isogenic lines to characterise baking quality of the US variety Pegaso. The main quality factors were reported to be the number and type of HMW glutenins and Glu/Gli ratio. Highest quality was found with Gli-A1 (with B1 and D1 deletions) + Glu-D1 (5+10) and Glu-B1 (7+8) combinations.

S. Frazer from Horizon Milling, USA looked at developing new methods of evaluating whole wheat flours for breadmaking purposes since most methods to date are focussed on white flours. Correlations were found for wheat colour predicting bread colour but better using flour colour, day 1 bake softness with day 7 softness, hardness with loaf volume. Crust colour did not correlate with crumb colour. Hard white spring wheat was better than winter for whole wheat bread products in terms of colour, flavour, consistency, volume and texture.

T. Beta from the Univ. of Manitoba reported on environmental variation in wheat phenolic acid composition (which protects against oxidative damage diseases). 15% of variation was attributed to genotype and 18% to environment. Wheat grown in Winnipeg was found to have the highest concentration of ferulic acid in Canada.

W. Funatsuki from the National Agriculture Research Centre for Hokkaido Region, Japan reported on the current lack of strong flour produced in Japan (only 1%) but medium strong is produced. Therefore blending extra strong with medium strong could produce a desirable strong product for bread and noodle products. A winter wheat line with alleles HMW Glu D1 (5+10) and LMW Glu B3g combined had properties close to extra strong flour.

S. Peighambardoust from Wageningen Univ., Netherlands has studied the effects of mixing with z-blade and simple shear devices in terms of dough microstructure and rheology and the need to redesign mixing equipment that are optimised for the product structure intended. Simple shearing lacked elongational flow, which is reported to be responsible for break up of large protein aggregates. Prolonged mixing using both processing types caused dough weakening due to increasing dough homogeneity and breakdown of coarse protein aggregates.

Carbohydrates

C. Courtin from Katholieke Univ., Belgium reported on dough syringing in refrigerated dough systems which involves liquid separating from dough upon storage and is objectionable to consumers. Degredation of soluble and insoluble arabinoxylans by wheat endoxylanases was presented as the main cause. Degredation was shown to be related to the amount of xylanases present in particular wheat varieties as HMW arabinoxylans are reduced to LMW forms. Debranching of wheat prior to milling and endoxylanase inhibitors were presented as a means to reduce syringing.

B. McCleary of Megazyme International, Ireland reported on the improvement of methodology for the measurement of dietary fibre and glycemic carbohydrates. He described the current difficulty in accurately measuring total dietary fibre due to overestimation of resistant starch and fructo-oligosaccharides. An amended method for dietary fibre was submitted which measures HMW soluble and insoluble fibre plus resistant starch and for glycemic carbohydrates which includes non-resistant starch plus maltodextrins, sucrose, D-glucose, D-

fructose and D-glucose from lactose. Modifications to the AOAC/AACC dietary fibre method included simplified pH adjustment, sample handling and fructan removal.

S. Finnie from the Univ. of Idaho looked at the effect of wheat variety and growing location on pentosan content using soft winter and spring wheat. The study over 2 years used 10 locations. Of the winter wheats, location had greater influence on pentosan content than variety. There was only a small interaction between location and year, meaning that varieties ranked in the same order most of the time. For the spring wheats the opposite was observed indicating variety as being a greater influencing factor.

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