ABSTRACTS

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2012 Annual Meeting
Abstracts of Symposia or Science Café Presentations

Abstracts submitted for presentation at the 2012 annual meeting in Hollywood, Florida, September 30–October 3, 2012. The abstracts are listed in alphabetical order by title of symposium, special session, or science café. Abstracts are published as submitted. They were formatted but not edited at the AACC International headquarters office. Recommended format for citing annual meeting abstracts, using the first abstract below as an example, is as follows: Dar, Y. L. 2012. Introduction: Addressing texture challenges in baked products. (Abstr.) Cereal Foods World 57:A1. http://dx.doi.org/10.1094/CFW-57-4-A

Addressing Texture Challenges in Baked Products

Introduction: Addressing texture challenges in baked products
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Cereal Foods World 57:A1

A brief introduction to the current texture challenges in baked products.

Measuring and addressing texture challenges in healthy baked products
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Cereal Foods World 57:A1

Achieving or maintaining a desirable product texture is a key challenge for developers of healthy baked products. Sensory assessments provide a detailed characterisation of texture and consumer acceptability. Instrumental measurements of mechanical properties provide useful predictions of texture attributes, suitable as standard methods for product development and quality control. Instrumental tests typically involve measurement of force and, in some cases, acoustic emission as samples are compressed. Methods for different product structures will be reviewed. For bread and cake crumb, samples are typically compressed with a flat or ball probe. Initial loading provides information on firmness; subsequent unloading and recompression measure properties such as springiness. Products such as biscuits and crackers are typically tested using methods such as 3-point bending, rod or cone penetrometry to assess fracture and hardness properties related to sensory characteristics such as crispness. Applications of these methods are presented for studies of fibre addition, sodium reduction and gluten-free recipes for bread, biscuits and cakes. Fibre addition studies include a comparison of bran addition levels in a model bread product produced in four laboratories using common production and assessment protocols. For biscuits, effects of a wider range of bran or inulin fibre addition levels, bran particle size and dough water content on texture of digestive biscuits are presented, including a comparison of measurements using a single rod indenter and a multiple-indentation approach. Examples for sodium reduction include a study of salt addition effects in bread. Principal component analysis of texture measurements showed distinct effects of flour type and salt content on crumb texture, with a reduced effect of salt when yeast levels were adjusted.

Leveraging fiber's properties to manage and improve the texture of baked goods
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Cereal Foods World 57:A1

Fiber is one of the least studied food macro-molecules when it comes to its effect on taste. Consequently, the functionality of fibers is only partially understood and leveraged in food systems. The chemical and physical properties of different types of insoluble, soluble and other fibers need to be effectively utilized to control food characteristics in a manner similar to approaches used in selecting appropriate starches and hydrocolloids. Fiber types and their effective utilization for optimum effect on target product, process, and storage characteristics of foods will be reviewed. Additionally, the impact of fiber type on functionality in some representative foods will be presented. Key functionalities that will be discussed include texture control, maximizing fiber levels, and quality improvement. Improving the texture of foods such as gluten-free and whole grain baked goods with their unique challenges will also be reviewed.

Gluten-free food products with texture comparable to wheat flour-based products
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Cereal Foods World 57:A1

Formulating gluten-free brings some textural challenges to bakery manufacturers. Common issues in gluten-free bakery product development are reduced volume, lack of an even cell structure, and a dry, crumbly, grainy texture. Native flours/starches, modified cook-up and pre-gelatinized starches, and gums are some of the ingredients used in gluten-free bakery formulations. This presentation will focus on use of functional flours in gluten-free bakery formulation. Initially, the textural attributes of gluten-free and gluten-containing benchmark products were identified using descriptive sensory analysis. Then, possible solutions were evaluated and optimized using Design of Experiments to match the textural attributes of wheat-containing products. Moisture management, dough consistency, machinability, volume, cell structure and textural sensory attributes were evaluated as variables for optimization studies using cookies and muffins as model systems. Descriptive sensory analysis showed that the gluten-containing benchmark products displayed smooth, moist, chewy textures. In contrast, commercial gluten-free products had significantly drier, more crumbly, and less moist and smooth profiles. The optimized solution, on the other hand, ranked very close to the benchmark products in texture, mouth feel, and moistness. Optimized solutions also tested and confirmed in different applications including bread, pizza, cake, cookie, muffin, waffle and tortillas. The solutions optimized included clean label functional rice and tapioca flours created by proprietary technology. The studies also showed that these functional flours enhanced dough hydration by picking-up 10% more water and reduced baking losses by 2% while improving the shelf-life compared to native flours. Study showed that functional flours can provide a gluten-free product with a taste and texture that is similar to gluten containing products.

Overcoming the challenges in replacing sugar in bakery products while maintaining desired texture and taste
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Cereal Foods World 57:A2

Current health issues and consumer awareness require reformulation of many (bakery) products to contain, e.g., less sugar and fat. However, these ingredients are main contributors to the texture and sensory properties, which play an essential role in consumer liking and acceptance of products. In general, reduction of sugar leads to changes in structure, either on micro- or mesoscale of the product. Since sugars have multiple functionalities, e.g., bulking, sweetening, network formation and crystallization, the answer to replacement is usually found in a combination of ingredients that replace these aspects. Reformulation of food products and the study of effects on product quality, texture and sensory properties is one of the key activities in TNO's food research. In the case of sugar reduction, focus is on the replacement of bulking sugars (e.g., sucrose, glucose syrup) while maintaining the textural quality of the products. A reduction strategy to overcome negative sensory issues was established for confectionary products and baked goods, based on structural models, ingredient interactions and supported by physicochemical analyses. Examples will be given during the presentation on how sugar replacers can be used to mimic sugar functionality.

Best Student Research Paper Competition

Action pattern of amylases with bread crumb anti-firming properties
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Cereal Foods World 57:A2

The bread industry faces the challenge to provide products to its consumers that remain fresh and attractive for many days after production. During storage, bread loses its palatability. Rearrangements in the starch structure are associated with bread crumb firming. Prevention of starch crystallisation and, hence, lowering the rate of bread firming is of particular interest. A maltogenic α-amylase from *Bacillus stearothermophilus* (BStA) is much used to this purpose. By shortening amylopectin side chains and releasing maltose, it lowers the rate of amylopectin retrogradation. It also reduces firming without excessive weakening of the amylose network. A more recent anti-firming solution for bakery products is the use of a modified maltotetraose forming α-amylase from *Pseudomonas saccharophila* (PSA) with increased thermostability. However, the precise action pattern and/or specificities of these enzymes are not known. Indeed, the action pattern of PSA has, to the best of our knowledge, not been described. In this study, a thorough comparison was made between the action patterns of both BStA and PSA. Hereto, the action pattern was studied on amylose, amylopectin as well as on β-limit dextrins. It was found that the impacts of PSA on these polymers differ from those of BStA. We found that BStA has a higher ratio of exo- to endo-attack than PSA, thereby altering the starch polymer structure less than PSA does. Since these enzymes are used in breadmaking, where temperature is gradually increased, the effect of increased temperature on the action pattern was also studied. While both enzymes were optimally active at about 60 °C, BStA at higher temperatures displayed a relatively higher endo-activity than at lower temperature, while this was not observed in the case of PSA. This is of particular importance when considering the use of these enzymes in breadmaking.

Effect of sorghum polyphenols on in vitro starch digestibility
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Cereal Foods World 57:A2

Starch is the major component of cereals. Most of the calories in cereal foods come from starch. Decreasing starch digestibility is fundamental to prevent/control obesity. This study investigated the effects of sorghum polyphenols on in-vitro starch digestibility. Freeze-dried phenolic extracts obtained from white (low in polyphenols), black (high in monomeric polyphenols) and high-tannin (high in polymeric polyphenols-condensed tannins) sorghum brans were mixed with normal and high amylose starches and cooked in RVA (standard 2 profile) and autoclave (121°C/30 min). Total phenols before RVA cooking were higher for tannin phenolic extracts (43.8 mg GAE/g) than black (38.8 mg GAE/g) and white (4.81 mg GAE/g). However, after cooking, samples with black phenolic extract had significantly ($P < 0.05$) higher phenol content (5.8 mg GAE/g) than samples with tannins (4.6 mg GAE/g). Unlike other treatments, samples with tannins had significantly ($P < 0.05$) lower setback in the RVA test, suggesting a possible interaction of tannins and starch. Starch had significantly ($P < 0.05$) higher resistant starch (RS) content in the presence of tannin phenolic extracts after RVA cooking. White sorghum phenolic extracts did not affect starch digestibility. When high amylose starch was used in an autoclave cooking/cooling technique, the RS content of control (26.4%) was similar to samples with black phenolic extracts (27%); samples with tannin phenolic extracts increased RS to 37%. This suggests that the condensed tannins directly interacted with amylose, increasing RS content, whereas the monomeric polyphenols did not. This study opens potential opportunities to increase RS content of foods using condensed tannins, while providing additional antioxidant benefits, which is important to colon health. Ongoing studies aim to uncover precise mechanisms of the starch/tannin interactions.

Variability in arabinoxylan, xylanase activity, and xylanase inhibitor levels in hard spring wheat
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Cereal Foods World 57:A2

Arabinoxylans (AX), xylanase, and xylanase inhibitors have an important role in many cereal food processing applications. Xylanase occurs naturally in wheat, and microbial xylanases are routinely added in some food processes. Xylanases hydrolyze AX, altering their functional properties. The effect of genotype, growing location, and their interactions on apparent xylanase and apparent xylanase inhibition activities of TAXI (*Triticum aestivum* xylanase inhibitor) and XIP (xylanase inhibiting protein) of wheat was studied using six hard red spring wheat and six hard white spring wheat genotypes. To our knowledge, there has been no research done on xylanase inhibitor activates in U.S. grown hard spring wheat. Total AX, arabinose-to-xylose ratio and arabinose substitution pattern were also determined. The wheat was grown at three locations in 2008 using randomized complete block design with four replications. Apparent xylanase activity was largely dependent on growing location, although there was also some dependence on genotype. The variation of bran xylanase was about a factor of 50 among genotypes, while in flour the variation was a factor of 7. There was strong correlation between the xylanase levels in whole meal and flour. XIP showed a negative correlation with xylanase activity. TAXI and XIP were more highly concentrated in the bran than in flour. TAXI activity levels were mainly determined by genotype. The bran TAXI level and XIP level varied by a factor of about 700 and 3000, respectively, among genotypes. These results are helpful to wheat breeders for development of new varieties, by providing an insight into characteristics that are under genetic control. Also, the results enable the industry to choose between different wheat varieties with varying xylanase activities to complement its intended end-use.

Oxidative gelation of alkali-extractable arabinoxylans from corn bran
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Cereal Foods World 57:A2

Arabinoxylan (AX) gels are interesting materials for application as food gels as well as in colonic drug or bioactive molecule delivery. Studies so far have mainly focused on gels from wheat endosperm water-extractable AXs. Less attention has been given to AXs from corn bran, which has much higher AX content and ferulic acid content than wheat endosperm. The objective of this study was to determine the effect of alkali concentration and treatment time on the ferulic acid content, oxidative gelling capacity and gel properties of alkali extractable corn bran AXs. We show that AXs extracted through mild alkali treatment, when treated with laccase in presence of oxygen, form strong gels through ferulic acid crosslinking. Increasing alkali concentration and treatment time led to a decrease in average ferulic acid content of the AXs and in the G´ of AX gels. Average ferulic acid content is not a good indicator of gelling capacity. It is proposed that this is due to the presence of molecules with different FA contents within a sample. Molecules rich in FA can form crosslinks and participate in the gel network, while those with low FA content cannot. A gel is formed only if there is a sufficiently large proportion of participating molecules in the network. This concept of participating molecules was proven by establishing the presence of crosslinks in non-gelling samples through SEC and rheological measurements through the Cox-Merz rule. The study offers an insight into the mechanism of alkaline extraction of arabinoxylans. The concept of participating molecules may be useful in designing gels with different strengths, textures and colonic fermentation rates. Eventually, this possibility of controlling colonic fermentation by modifying alkali treatment conditions

can make it possible to design matrices for precisely targeted drug or bioactive molecule delivery in the colon.

Enhancing salt taste perception in wheat bread crumb through texture and inhomogeneous sodium distribution

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Cereal Foods World 57:A3

Excess intake of dietary sodium is seen as primary cause of hypertension. Reducing sodium in bread and cereal products will be crucial, since they contribute up to 20 % of daily sodium intake in the US. Due to its essential technological and sensory functions in bread, no strategy for salt reduction is entirely satisfactory. Therefore, the aim of this study was to investigate the parameters affecting salt taste perception in bread crumb as a basis for new salt reduction strategies. Sensory analyses revealed that a coarse-pored bread tasted saltier than a fine-pored bread at both constant weight and constant volume. Further, bread with an inhomogeneous salt distribution tasted saltier than the homogeneous reference, all at the same NaCl content of 1.5 %. Sodium extractability from bread crumb was measured after time-resolved mastication in the mouth and in a mastication simulator. At a constant sample weight, sodium was extracted more quickly from the coarse-pored than from the fine-pored bread, thus offering an explanation for the sensory difference. However, at a constant sample volume, the extracted amounts of sodium were similar at the beginning. Thus, the sensory difference had to be due to another parameter. Correlations of the pore size, texture and sodium extractability showed that the texture was the second parameter affecting salt taste perception. The third parameter that influenced salt taste was the distribution of sodium. An inhomogeneous salt distribution led to an increased velocity of sodium release and a more intense salt taste due to the principle of sensory contrast. All in all, an enhancement of salt taste perception in bread crumb may be achieved by increasing the release of sodium during the first ten seconds of mastication by generating a more coarse-pored crumb or addition of coarse-grained NaCl, thus enabling a salt reduction by up to 25 %.

Does particle size affect antioxidant activity and extractability of phenolic compounds in wheat bran?

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Cereal Foods World 57:A3

The production of whole wheat products provides increased nutritional benefit for the consumer and increased use of by-products for the industry. When particle size is reduced, there is an increase in surface area to mass. In many biological settings, an increase of surface area to mass provides increased susceptibility for degradation. Wheat bran contains many micronutrients that are not bioavailable, due to structure and transit time in the human gastrointestinal tract. A reduction in particle size may increase the proportion of available micronutrients in wheat bran. The distribution of phenolic compounds and antioxidants with particle size reduction has not been well documented. In this study, unmilled bran was compared to bran milled to 200 µm from the same kernels. The ability of whole bran fractions of differing particle size to scavenge free radicals was assessed using three in vitro models, namely, DPPH radical-scavenging activity, ferric reducing/ antioxidant power (FRAP) assay and total antioxidant capacity. In addition, phenolic compounds (total, flavonoids and anthocyanins) and phytochemical contributions in each fraction were compared to bran composition. Significant differences in phenolic and phytochemical concentrations were observed between whole bran fractions of reduced size. Whole bran was comparatively higher in phenolic acids (0.67 mg FAE/g), antioxidant capacity (0.79 mg/g), and antioxidant activities (55.29% DPPH inhibition and 165.32 µmol FeSO4/g), than bran milled to 200 µm. Bran milled to 200 µm was higher in flavonoid (206.74 µg of catechin/g), anthocyanin (0.074 mg/g), and carotenoid contents (beta carotene, 14.248 µg/100 g; zeaxanthin, 35.214 µg/100 g; lutein 174.589 µg/100 g). The investigation of particle size and nutritional composition provides critical information for formulation of functional foods using by-products from flour milling.

Chemistry and Nutrition of Pulses and Minor Cereals

Pargem, the technology for a new family of healthy, safe, and convenient food ingredients based on partial germination

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Cereal Foods World 57:A3

Pulses, also commonly referred to as “legumes”, are a nutrient powerhouse. Pulses are a rich source of vegetable protein, dietary fibre, vitamins and minerals, such as folate and iron. Despite their high nutritional value, pulses have not been widely developed as food ingredients, particularly for Western style products. In fact, their use as ingredient in these products is limited by the undesirable “beany taste” that they can confer to the food formulation even at small concentrations. Additionally, their nutritional value is hampered by the presence of antinutrients that reduce protein digestibility and micronutrient bioavailability, as well as by the presence of raffinose family oligosaccharides (ROF), which cause digestive discomfort. Germination is the natural and traditional way performed at household level in many countries to improve the nutritional value and taste of pulses. The industrial process pargem® has been now developed in order to apply the advantages of pulse germination at industrial level and under high food processing standards. In the pargem process, pulses are partially germinated under controlled conditions and stabilized through drying for convenient long shelf life. It has been verified scientifically on several types of pargem pulses that these novel ingredients are characterized by reduced antinutrient content and improved amount of micronutrients. ROF in fact decrease up to 70% and the antinutrients reduce up to -35%. This increases the mineral bioavailability, as indicated by an improvement of dialyzable iron by +150%. Also, the concentration of several vitamins increases remarkably, as shown for instance by a 500% higher thiamine (vitamin B1) content. Moreover, the content of fructose greatly increases, thus improving the ingredient taste with a desirable sweet note. These results show that pargem pulses have a great potential as valuable ingredients with high nutritional value and improved taste for novel food formulations.

Novel starches and proteins from *Amaranthus* and buckwheat

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Cereal Foods World 57:A3

90% + of world crop agriculture depends on fewer than 10 species. There is every reason to expect new major crops to arise over periods of several decades. The dramatic rise of soybean in the US is a prime example. In initial stages of development “new” and specialty crops such as *Amaranthus* and buckwheat must compete on niche uses and on value-added fractionation to create biomaterials with special properties. *Amaranthus*—a “pseudocereal” produced for grain and leaf, is a rapidly expanding crop in China. We have extensively studied its starch (for extraction/content, properties, modification, molecular genetics, structure, genetic variation, GxE, and agronomic practices effects). Similarly the protein of *Amaranthus* varies widely in properties and applications, depending on genotype and other factors. I will present some results on starch and proteins of *Amaranthus* and buckwheat, and comment also the development of other fractions such as oils and pigments which can add value to integrated development of the crop.

Current advances in human studies on the health benefits of cereals and pulses

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Cereal Foods World 57:A3

Epidemiological studies have identified strong associations between diets rich in plant-based foods and reductions in the risk of developing several types of non-communicable chronic diseases, such as coronary heart disease, cancer, and type 2 diabetes mellitus. Specifically, regular intake of certain cereals and pulse foods (particularly beans and lentils) is associated with improvement of blood glucose control and lowering of plasma LDL-cholesterol, which is a risk factor for cardiovascular disease (CVD). Many advances are being made in generating evidence on which to base submissions to regulatory agencies for approved health claims associated with these foods. However, major knowledge gaps exist in relating the health promoting effect of cereals and beans to their structural and chemical characteristics. In an attempt to fill this gap, preliminary studies with lentils have shown that the post prandial blood glucose response is influenced by processing. In particular, the glycemic index is increased when lentil is milled into flour and when stored at -20°C for 30 days. Others have shown

that pulse fibre and hull have potentially useful effects in promoting insulin sensitivity and weight loss in humans. Traditional cereals such as oats and barley are able to lower LDL-cholesterol and recent work has shown that this action is related to the content and molecular weight of β-glucan found in the food products. Studies are currently on-going to find the mechanism by which β-glucan lowers LDL-cholesterol. Emerging evidence suggest that millet and sorghum based foods lower blood glucose response in a dose dependent manner and appear to be effective in improving long term glycemic control in persons with type 2 diabetes mellitus. Finally, there is growing evidence that cereals and legumes make significant contributions to dietary phytochemical intakes, which may contribute to the health benefits of these foods.

Overview of nutritional aspects of millets and minor millets
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Cereal Foods World 57:A4

Millet has traditionally been grown in Africa and Asia. It is an important crop in these regions due to its short growing season, resistance to pest and diseases, and ability to tolerate drought conditions. Millets are rich in calcium and dietary fibre and in terms of energy density, its protein, fat and vitamin content are superior to wheat, maize and sorghum. Millets do not contain gluten, and they have also been shown to have a beneficial role on blood glucose and cholesterol regulation. Millets can therefore be used to produce functional foods that are gluten-free and may be helpful in the management of persons with type 2 diabetes or in the reduction of those at risk with cardiovascular disease. However, millets are difficult to process and have low extraction rates when milled. Furthermore, the products also have a bitter off taste and off colouring that are especially disliked by consumers in the Western society. Thus, new and innovative methods need to be investigated to produce products that are nutritionally beneficial and acceptable to consumers.

Cereal-legume synergy: Exploiting differences in polyphenolic composition of sorghum and cowpea to provide complementary health benefits
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Cereal Foods World 57:A4

Traditional consumption of cereals and legumes together has been promoted based on their complementary amino acid profiles. Recent evidence indicates that health benefits attributed to cereal and legume consumption are contributed by components not traditionally considered nutrients; the possibility that these components could also provide complementary benefits is strong. Among cereals and legumes, sorghum (*Sorghum bicolor*) and cowpea (*Vigna unguiculata*) present particularly interesting opportunities due to their drought tolerance and high levels of specific types of phenolic compounds. Sorghum is a rich source of uncommon 3-deoxyflavonoids that have been demonstrated to elicit positive response in various cell and animal models, often at lower concentrations than those of compounds derived from other grains or food sources. For example, *in vitro* and *in vivo* data suggest that relatively low levels of sorghum extracts can contribute to colon cancer prevention, and the mechanisms involved are specific to the type of 3-deoxy-flavonoids present in the sorghum. Cowpea accumulates high levels of flavonols, flavan-3-ols and anthocyanins that are not found in meaningful quantities in most cereal grains. Recent evidence indicates that cowpea varieties that accumulate a mixture of these flavonoid compounds are more effective at reversing endotoxin-induced inflammation in non-malignant cells than varieties that accumulate only a homogeneous type of flavonoids. This suggests that synergy can be derived from combining bioactive compounds with different chemistries and structural profiles. The latest evidence on the different chemical and biochemical attributes of sorghum and cowpea polyphenols, and how the differences can be optimized to design products that promote health, will be discussed.

Current Status and Development Trends of Asian Products

Current status and development trend of Asian products in China
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Cereal Foods World 57:A4

The main types of wheat flour-based food products in China are Asian noodles, mantou (steamed bun), dumpling, Chinese style pie, breads, biscuits and snacks. Currently, the scale of industrialization of various flour based products is getting larger, and more large corporations are taking part in the competition. Automation of food processing with large capacity is also increasing. Some international equipment manufacturers have started to set up factories in China catering to the local market. As consumers in China have become more concerned about food safety and nutritional issues, food companies are standardizing their manufacturing practices and have started developing some nutritious mixed grain and whole grain products. As the urbanization accelerates in China, young generations prefer convenient and fast foods. In addition to nutrition, health and food safety requirements, product mouth feel is also very important to Chinese consumers. Therefore, it is essential to use high quality ingredients in food processing, and the requirements of flour, grains and ingredients become much more important. Both traditional Chinese staple foods (such as noodles, dumplings and steamed buns) and western baked products are being developed towards a more industrialized, automated, large-scaled and branded direction.

Japanese perspectives on grain products: Viewpoints from the marketplace and from research and development
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Cereal Foods World 57:A4

Japan is one of the largest grain importers in the world, including maize, wheat, soybean, barley, and even small quantities of rice. In Japan one can find many fine products made from those grains. However, one is less likely to be aware of Japanese research and development of grain-based ingredients and foods. In this presentation I will review the markets for the grains with a special focus on bakery foods made from soft and hard wheat. In addition, I will outline research and development that is underway, and which is targeted to Japanese food markets.

Current status and development trend of Asian products in Brazil
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Cereal Foods World 57:A4

Brazil has a great number of Asian immigrants, especially Japanese descendants. Therefore, many Asian products, such as tofu, shoyu (soy sauce), rice noodles and instant noodles are available in the Brazilian market. Amongst these products, instant noodles have shown a high growth rate, since they are cheap and easy-to-prepare products. In 2011, the Brazilian pasta industry reached sales of around USD$ 3.3 billion. This revenue increased 3.5% when compared to 2010, greatly due to the evolution of the instant noodles sector (5.9%). Considering the last 5 years, the instant noodle market increased from USD$ 0.77 billion in 2007 to USD$ 1.02 billion in 2011, representing a growth of more than 32%. With regard to volume, instant noodles growth in the last year was 1.1% and 16.6% in the last 5 years. And consumption increased from 0.8 kg/inhabitant/year in 2007 to 1.0 kg/inhabitant/year in 2011. However, since they are fried products, instant noodles contain high residual oil contents, and there is currently considerable concern with respect to health and the consumption of high fat foods, and the low ingestion of fibers, vitamins and minerals. Various alternatives have been proposed in an attempt to increase the consumption of these nutrients, amongst which the development of new products with improved nutritional value as compared to the original food, but also highly acceptable and available for the consumers. We will present a study of the development of instant noodles with functional and nutritional properties aimed at a reduction in calories by reducing both oil absorption and the carbohydrate content by adding soy protein isolate (SPI) and resistant starch (RS3), using conventional and vacuum frying processes.

Use of ultrasonic measurements of Asian noodles at different frequencies to differentiate product texture: The influence of gluten strength
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Cereal Foods World 57:A4

Yellow alkaline noodles were prepared from 5 varieties of Canada Western Red Spring (CWRS) and 4 varieties of Canadian Prairie Red Spring (CPSR) wheat flours having significantly different protein contents and gluten

strengths as determined by Farinograph parameters. Using a customized assembly attached to a texture analyzer, longitudinal ultrasonic wave measurements at ~40 kHz were performed, enabling the noodles' biomechanical characteristics to be determined from the velocity and attenuation coefficient of the raw noodles. Cooked noodle texture, "bite" by the traditional maximum cutting stress (MCS) test, stress relaxation and Peleg's k_1 and k_2 parameters were also determined. Ultrasonic velocity was highest in the CWRS varieties, ranging from 492-508 m/s, while the velocity in the CPSR varieties was lower (449-487 m/s). CWRS varieties generally had the greatest attenuation, 520-587 m^{-1}, while the attenuation in CPSR doughs fell within the range 448-511 m^{-1}, highlighting the difference in the noodle dough matrix between these two classes. The generally lower attenuation in the CPSR varieties implies a more developed gluten dough matrix. The longitudinal storage modulus, longitudinal loss modulus, and tan delta measurements were determined from the ultrasonic parameters. No wheat class distinction was observed in the storage modulus, but all the CWRS varieties displayed a higher loss modulus than the CPSR varieties. The resulting tan delta measurements reflected this difference, as a clear distinction between all CWRS varieties and all but one CPSR variety was observed. Only the loss modulus of the raw noodle was found to significantly correlate (r=0.70, p=0.03) with the cooked noodle's MCS value. The benefits of performing these analyses at a much higher frequencies (1-12 MHz) will be presented relative to the 40 kHz study.

Enzymes in Cereal Science: From Improving Dough & Product Quality to Improving Bioavailability of Functional Compounds

Xylanases in cereal science: From dough syruping to producing prebiotic whole grain breads
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Cereal Foods World 57:A5

Since their introduction in cereal processing a couple of decades ago, the knowledge on xylanases and their functionality in cereal based processes has significantly improved. It has since then become convincingly clear that both limited as well as extensive modification of the fairly low levels of arabinoxylan in cereals by these enzymes can induce large changes in processing and final product quality. Of more recent date is the understanding that such modifications equally alter the nutritional properties of this dietary fibre fraction. After a short introduction on xylanases in cereal processing in general, this presentation will focus on two cases to demonstrate their possible technological as well as nutritional impact. While the first case deals with the problem of dough syruping in refrigerated dough caused by elevated levels of endogenous xylanases, the second case deals with the in situ production of prebiotic arabinoxylan oligosaccharides in whole wheat bread, from concept to clinical trial.

Enzymatic modification of wheat and rye brans—Effects on technological and physiological functionality
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Cereal Foods World 57:A5

Wheat and rye brans provide a good source of dietary fibre, but their applicability as such is limited. Enzymatic modifications both prior to food processing and as part of, e.g., baking are known to improve their functionality as ingredients. Wheat and rye brans not only contain close to half of their weight dietary fibre in the form of cell wall polymers and fructans, but also contain variable amounts of starch—rye bran typically clearly more than wheat bran—and up to 20% protein. All these components influence the way the bran particles will interfere with food structure formation. Thus particle properties, in addition to characteristics of the macromolecules, play a large role in evaluating the functionality of bran. The same properties will influence both the technological properties, such as sensory quality and stability of the product, and the physiological properties, i.e., reactions of the biopolymers in the gastrointestinal tract and the liberation and conversions of associated phytochemicals. Xylanolytic enzymes offer a good tool to modify the bran by partial solubilization and hydrolysis of arabinoxylan. Much of the experimental enzymatic work has been done at high water contents, but we have recently shown that xylanases modify bran properties at as low as 40% water content. Recent developments in milling technology offer an interesting possibility in the processing of bran, improving enzymatic accessibility, but also changing the water binding properties of the bran particles. Use of yeast and lactic acid starter cultures in combination with enzymatic treatments causes changes by lowering of the pH during fermentation, which changes the operational environment of the enzymes, and may also activate the endogenous enzyme system of the bran. Enzymatic processing has been shown to increase the bioaccessibility and bioavailability of phenolic acids of bran, resulting in changes in the phytochemical spectrum due to gut conversions.

Improving functionality and bioavailability of phenolics in wheat bran
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Cereal Foods World 57:A5

Innovative processes involving mild chemical pretreatment, mechanical processing, and enzymatic fermentation were developed to release phenolics locked in wheat bran matrix and improve functional properties. Liberation of phenolics and change in specific surface areas, water holding capacity, and viscosity were monitored in each step. Visual examination of processed bran shows disruption of bran surface by creation of holes and pores. These porous bran structures increase total surface area, binding sites, and trap moisture to increase viscosity and WHC. Optimizing process conditions created wheat bran with 500% increased viscosity, 400% increased WHC, a nearly 500% increase in soluble dietary fiber, and a three hundred fold increase in free phenolics. Combined processing and xylanase treatments achieved greater release of bound phenolics than chemical and physical processing alone. Viscosity was not significantly affected by targeted xylanase enzymatic treatments. Soluble dietary fiber dramatically increased nearly five-fold in bran with chemical and HPH processing while insoluble fiber decreased. The same treatment conditions for maximizing viscosity and water hydration capacity of the bran resulted in the best combination of increasing soluble fiber while preserving the maximum total dietary fiber content in the bran.

Xylanases for improved dough stability and bread quality
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Cereal Foods World 57:A5

Bread is a common food that is also associated with traditions in many different countries, and yet bread is closely related to biotechnology, which is synonymous with high technology—the word relating these two subjects to one another is *enzymes*. Enzymes have been used for decades in the bread industry, and the main enzyme classes used within baking are lipases for dough strengthening, hemicellulases (and especially xylanases) for dough conditioning, amylases for fresh keeping, oxidases for gluten strengthening and proteases for gluten weakening. But also "new" enzymes like asparaginase for removal of acrylamide in ex. biscuits and crackers have been developed and launched to the market. This presentation will mainly focus on use of xylanases for different applications. Xylanases are important enzymes in bread baking and are used to improve volume and give dough stability, to give finer crumb structure and to perform consistently in different wheat flours and applications. The true mechanism of xylanases in bread making has not yet been fully understood, but what is known is that xylanases degrade parts of the insoluble xylan to more soluble xylan, which improves the volume and crumb structure of wheat bread. However, too high levels of degradation can destroy the water-binding capacity of the wheat pentosans, which causes dough stickiness.

Novel carbohydrases (including ferulic acid esterase) for fiber extraction, modification, and solubilisation
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Cereal Foods World 57:A5

There has been extensive research in the past few years on enzymatic solubilisation of plant fiber (e.g., lignocellulose) for the production of a substrate for second generation bioethanol fermentation. For the food and cereal processing industries these enzymes have little value as they turn potentially valuable materials such as food fibre into sugars (monosaccharides). Whereas if the reaction is only partially carried out then you have the potential to turn insoluble fibre into soluble fibre and oligosaccharides some of which can perform as pre-biotics. This is an opportunity for the food industry to use enzymes to add extra value to by- and waste products (or products sold at low price to animal feed). The structure of plant cell walls and plant fibres is often very complex and quite difficult to even partially break down in a controlled way. Individually, many enzymes will have no impact as they need to work in synergy with a second or even third enzyme. For example, many xylans (hemicelluloses) are cross linked with phenolic (ferulic acid) dimers, and these can only be broken down by using a combination of ferulic acid esterase and xylanase, as individually neither enzyme will have much impact. The presentation will include a short review on different types of ferulic acid (feruloyl) esterases and their

synergistic action on plant hemicellulose with xylanases. There are many types of xylanases, and the presentation will cover a short review on the different types but also include information on a new xylosidase (xylanase) which is highly efficient in helping other carbohydases break down plant fibre (a booster enzyme). Finally there will be a third section on the enzymatic production of soluble fibre and oligosaccharides.

Exploring the Differences Between Conventional and Modern Biotechnology—A Focus on Grains

Mapping of quality traits in soft white wheat
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Cereal Foods World 57:A6

Mapping is a general strategy for tagging genetic variation, and is applicable to improving end-use quality in wheat. Mapping may be categorized as genetic mapping or physical mapping. The former involves linkage analysis and establishes "genetic distances", whereas physical mapping localizes genes to a specific segment or location on a chromosome. Usually quality traits are represented as Quantitative Trait Loci (QTL), wherein a QTL is the deduced genetic location of the "phenotype", a measured numerical value, as opposed to a known-function gene. The current study examined a set of 188 F5-derived F6 recombinant inbred lines derived from a soft white spring by soft white spring wheat (cvs. 'Louise' and 'Penawawa') mapping population. Lines were grown in two crop years at two locations in the Pacific Northwest region of the U.S., and data were collected on 17 end-use quality traits. Using an established genetic linkage map with 300 SSRs, composite interval mapping was used to identify QTL associated with 16 of the 17 quality traits. QTL were found on 13 of the 21 wheat chromosomes. A large number of QTL were located on chromosomes 3B and 4D and coincided with traits for milling quality and starch functionality. Chromosome 3B contained 10 QTL, which were localized to a 26.2 cM region. This interval mapped QTL for protein, break flour yield, flour yield; SRC water, carbonate, sucrose and lactic acid; and cookie diameter. Chromosome 4D contained 7 QTL, all of which were located on an 18.8 cM region, and included break flour yield, flour yield; SRC water, carbonate, and sucrose; and cookie diameter. The majority of the alleles for superior end-use quality were associated with the cultivar Louise. The identified QTL were highly significantly QTL included independent of grain yield and protein quantity. The identification of these QTL for end-use quality gives key insight into the relationship and complexity of end-use quality traits. It also improves our understanding of these relationships, thereby allowing plant breeders to make valuable gains from selection for these important traits.

Molecular and genetic characterization of polyphenol oxidase genes in wheat
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Cereal Foods World 57:A6

Modern geneticists employ a multitude of techniques to improve crop plants for end-use quality. To do so they must first understand the molecular genetic basis for the trait of interest. That includes determining the biochemical molecular players, identifying the genes encoding them, and determining the degree to which each gene contributes towards the expression of the trait. This information reveals what genetic changes need to be made and the degree of difficulty involved in combining the altered genes to make new varieties of superior end-use quality. This presentation will outline how research scientists are approaching the problem of time-dependent discoloration of wheat dough. Polyphenol oxidase (PPO) enzymatic activity is a major cause in time-dependent discoloration in wheat dough products. We found that wheat contains multiple PPO genes. Two of these have previously been shown to contribute to dough color instability. We recently identified an additional PPO gene family that consists of three genes. Members of this family were shown to be highly expressed in developing wheat grains. In this study, the Louise x Penawawa mapping population was used to genetically map all five of the PPO genes known to be expressed in wheat kernel. All map to the long arm of homeologous group 2 chromosomes. PPO-A2 was found to be located 8.9 cM proximal to PPO-A1 on the long arm of chromosome 2A. Similarly, PPO-D1 and PPO-D2 were separated by 10.7 cM on the long arm of chromosome 2D. PPO sequence variation was shown to correlate with PPO enzymatic activity. We have determined that at least five gene targets must be addressed to maximize wheat dough color stability. Our strategy for doing so will be discussed.

Mutagenic and transgenic approaches to improve wheat end-product quality
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Cereal Foods World 57:A6

Wheat end product quality is controlled to a large degree by variation in the type and amount of proteins produced in the endosperm. Two groups of proteins that impact wheat milling and baking properties are the puroindolines and the high molecular weight glutenins (HMW-GS). We have used both transgenic and non-transgenic approaches to dissect function of the puroindoline genes and mutagenesis to examine HMW-GS function. Transgenic experiments to overexpress one or both of the puroindolines have been illuminating in several ways. First, they have allowed us to demonstrate the degree to which each puroindoline controls grain hardness. Second, the ability to modify expression levels has allowed us to determine whether the puroindolines act individually or in tandem to bind polar lipids. Non-transgenic manipulation of gene function via EMS mutagenesis has the advantage that the novel alleles are free of regulation and readily useful as a source of new alleles for breeding programs. Further, the ability to identify and characterize a large number of allelic variants via mutagenesis would not be feasible transgenically. We have isolated and characterized many unique missense alleles of both the puroindolines and the HMW-GS. By measuring grain hardness for the 46 puroindoline missense alleles or dough strength for the 51 HMW-GS missense alleles we have been able to quantify the impact of each missense amino acid change upon protein function. For both the puroindolines and the HMW-GS the missense alleles encompass a range of function and point to specific protein regions as being most important. In addition, the newly created alleles may allow greater precision in selecting pre-defined levels of wheat grain hardness and mixing strength.

Improving nontransgenic crop varieties using plant transformation approaches
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Cereal Foods World 57:A6

Plant transformation approaches have been used directly to develop crops that are resistant to insect pests and herbicides. In addition, plant transformation has been used in basic studies of gene function that will ultimately have an impact on crop improvement. In our research, we have explored the use of plant transformation approaches that are indirect (i.e., the product is a nontransgenic crop) but applied in the sense that transgenic crops are used in the breeding process. We call one such approach proxy selection. In this method, a transgene encoding green fluorescent protein is used as an inexpensive quantitative reporter for the trait to be improved. The trait of interest in this study was the level of the 27 kDa gamma zein seed storage protein, and our reporter construct consisted of the green fluorescent protein coding sequence under the control of the 27 kDa gamma zein regulatory sequences. The transgene reporter was maintained in heterozygous state so it could be removed from the population in one generation by selection of non-transgenic individuals. We then used traditional breeding methods to increase expression of the reporter gene and show that the trait of interest is improved as well, even in individuals that do not carry the transgene. We hypothesize that the observed increase in reporter gene function was due to changes in cis regulatory elements interacting with regulatory sequences of the transgene. Since the transgene and the target gene have identical regulatory regions, these cis acting elements increase expression of the target gene as well as the transgene. This approach could potentially be applied to alter the expression any gene that is subject to cis regulatory control and for which genetic variation in this regulatory control exists.

Mining the wheat genome—Implications for grain quality research
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Cereal Foods World 57:A6

The wheat genome is remarkable for its size and complexity, being approximately 40 times the size of the rice genome and 5 times the size of the human genome. Aside from sheer size, three further factors complicate the analysis of the wheat genome: (1) the hexaploid nature of the genome, (2) the

presence of highly repetitive retrotransposon sequences and other repetitive genetic elements that make unambiguous alignment of sequences difficult, (3) the presence of a variety of translocations from related species in many cultivated wheats. These factors have conspired to slow down the progress towards a useful assembled representative sequence of the entire genome as is available for rice, maize, sorghum and other crops. In this paper, we describe progress towards developing improved genetic tools for the analysis of wheat traits, facilitated by the availability of transcriptome and DNA sequence data to identify SNPs, the use of recombinant and diverse MAGIC mapping populations to generate high density genetic maps, and the QTL mapping of traits in the MAGIC populations to identify key traits with high resolution and the ability to directly compare allelic effects from multiple founder lines at multiple loci.

Food Allergy Thresholds and Risk Assessment: Potential Stakeholder Benefits

The scientific, regulatory and clinical case for food allergen thresholds
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Cereal Foods World 57:A7

Allergists have known for many years that food-allergic individuals can and do react adversely to exposure to small quantities of the offending food. However, the concentration of allergenic food residues in the incriminated product and the quantity of product consumed is often unclear. Thus, the actual exposure dose is almost never available or even estimated. Furthermore, until very recently, there was no understanding of the percentage of food-allergic consumers who were potentially reactive to ingestion of very low doses of the offending food. As a consequence, clinicians have been conservative and advise food-allergic patients to completely exclude the allergenic food from their diets, a de facto zero threshold approach. The regulatory and legislative approach with respect of the labeling of allergenic foods has also been conservative. The Food Allergen Labeling & Consumer Protection Act requires that all direct ingredients derived from commonly allergenic foods be declared by source. In some cases, the amount of exposure to the allergenic food and its allergenic protein component would be extremely low. With all of these conservative decisions on the part of clinicians, the government and in effect the food industry, the food-allergic consumer is faced with a daunting task in implementing a specific avoidance diet. The establishment of regulatory thresholds would likely correct the existing situation. FDA has recognized the potential regulatory value of thresholds as documented in the 2006 report of the Threshold Working Group of FDA. This group concluded that thresholds would be useful, and that a statistical risk assessment approach would be the strongest and most transparent approach to the development of thresholds. This presentation will address the current science used to establish population threshold estimates for food allergens.

A food industry perspective on thresholds for allergen control and labeling
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Cereal Foods World 57:A7

The food industry is acutely aware of food allergens and the importance of proper control and label declaration. Food allergen management can be described as a linked chain. It is important that all of the links in the chain are intact. Every step of a food product's life cycle can present the risk of an undeclared allergen, and must be critically evaluated. Passage and implementation of FALCPA has led to a number of questions concerning cleaning, safety, and presence of food allergens driven by its de facto zero tolerance. In cooperation with the clinical community, the scientific understanding of a threshold for objective responses to an ingested food allergen has grown greatly in the last decade. With the knowledge gained in the scientific understanding of the amount of an allergen that must be ingested to elicit an objective biological response, all sides of the issue can benefit. The ability to address food allergens from a threshold perspective allows for many complex issues to be addressed that cannot be addressed where zero is a moving target and in situations where theoretical calculations can produce results that cannot be evaluated analytically.

The use of food allergen thresholds for quantitative risk assessment approaches
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Cereal Foods World 57:A7

Food allergy risks differ from chemical and microbial risks in that food allergies affect only a small portion of the overall population. Public health officials and food manufacturers must determine how to protect the allergic population without extensively limiting food choices and adversely affecting their quality of life. Quantitative risk assessment (QRA) utilizes the population threshold of an allergen and provides a transparent method to demonstrate the risk assessment process. The distribution of individual thresholds within the allergic population is a major factor in the results of the QRA. Population threshold distributions are modeled after screening clinical publications and unpublished clinical data for thresholds of allergic individuals who have participated in low dose food challenge studies. Other major inputs that are needed for a robust QRA include consumption patterns of a specific product and levels of allergen present. Consumption data for individual products of interest can be extracted from the U.S. NHANES dietary database or similar surveys. Allergen levels (ppm concentrations) are important for exposure assessment and can be either calculated through worst case formulations or obtained through lab analysis using specific commercial ELISA kits. Additional inputs can include acceptable risk, product serving size, consumption/market share, prevalence of allergy, and others. From the inputs above, QRA can calculate the probability of an allergic reaction on a population basis. Additionally, QRA can estimate the number of allergic reactions due to a specific product and provide valuable information when deciding if further action is necessary. This presentation will outline the current research we have conducted on QRA for food allergens and provide an example of how food industry can utilize QRA for risk management decisions.

Formulating Grain-Based Food for Glucose Control

Glycemic control—Definition and physiological effects
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Cereal Foods World 57:A7

Glycemic control consists of 2 components, the mean concentration of blood glucose throughout the day and the degree of fluctuation of blood glucose throughout the day. Mean blood glucose is most easily assessed by measuring the proportion of hemoglobin which is glycated (HbA1c). High levels of HbA1c, even within the non-diabetic range, are associated with increased risk for developing diabetes and cardiovascular disease (CVD). Recently it has been suggested that greater fluctuations of blood glucose throughout the day may also increase risk for diabetes and CVD by increasing oxidative stress and inflammation. In people with normal or near normal HbA1c, both mean glucose and the degree of glucose fluctuation are predominantly determined by postprandial glucose—i.e. the glucose response after eating. The factors in foods which determine glycemic responses include the amounts and types of carbohydrate, protein and fat consumed. Thus, there are numerous ways in which the composition of a food product could be altered to reduce its glycemic impact. However, not all ways of reducing glycemic impact are necessarily beneficial because different methods of reducing glycemic response have different short and long-term physiological effects. Thus, whether or not a food with a low glycemic impact is beneficial depends on the desired outcome and the mechanism by which the glycemic response is reduced. I will give evidence to support the position that to reduce risk for diabetes and CVD glycemic impact should be reduced without increasing energy intake and without reducing available carbohydrate intake.

Food processing effects on glycemic response
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Cereal Foods World 57:A7

As the incidence of type 2 diabetes increases around the world, there is an opportunity to produce foods for those who need to control their blood sugar. The glycemic impact of carbohydrate foods depends not only on the amount of sugar and starch they contain but also on the nutrient profile and microstructure. Formulating and processing carbohydrate foods to have low glycemic index (GI) can be optimized by understanding the factors that affect the absorption of glucose into the blood stream. Food ingredients high in soluble fibre can be used to modulate their GI. Soluble fibres like mixed linkage β-glucan in oats and barley and pectin in beans, peas, chickpeas and lentils, increase the viscosity of the gut contents after a meal. This slows the

mixing of the meal bolus with digestive enzymes and the absorption of glucose into the blood stream. However, different food processes such as milling, baking, extrusion and heating modify the effectiveness of soluble fibres. Milling and air classification can be used to increase the soluble fibre content of bran and fibre fractions. The proportion of soluble fibre in foods increases when they are heated in the presence of excess water. So boiling and baking increase efficacy by increasing fibre solubility. The high temperatures and pressures used in the extrusion of breakfast cereals increase fibre solubility while having minimal impact on molecular weight. Applications, including bread, pasta, breakfast cereal, muffins and snack foods will be discussed. There is an increasing need for foods which can prevent and manage type 2 diabetes. An understanding of the way in which soluble fibre in cereals and pulses affects blood glucose concentrations will help manufacturers to produce low GI foods to fill this expanding market.

Food formulation effects on glycemic response
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Cereal Foods World 57:A8

Efforts to formulate foods aimed at reducing blood glucose and insulin responses are not new. However, our understanding of how formulation affects glycemia, and ultimately body composition, has advanced. With new products, including resistant starches and higher protein flours, the opportunities to better control blood glucose while eating grain-derived foods are advancing quickly. This presentation will discuss how formulation affects glycemic index and provide insights into how those formulated ingredients and foods might impact metabolic health.

Issues and considerations with glycemic labeling and its regulation
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Cereal Foods World 57:A8

Understanding the glycemic response (GR) of foods is important, especially for those with impaired glucose tolerance. However, numbers reflecting the GR create measurement, interpretation and regulatory issues. This is partly due to difficulties in finding a value that characterizes the GR of a food as eaten. Variability in the measure even when conducted by experienced laboratories is problematic. Further, GR is affected not only by an individual's glucose tolerance, but also by qualities of food such as variety, ripeness, structure, and processing. Some argue that such variability is the same as that of other labeled components. While bioavailability and amount of vitamins and minerals are affected by food and other factors, a single, labeled quantity does not arbitrarily categorize a food as "low", "medium", or "high" and, as such, determine whether or not it can be selected. Consumer misunderstanding of the GR abounds. For example, a food might not be selected because it is categorized as having a high GR, but the amount eaten fails to raise blood sugar. Alternately, a food with a low GR may be over consumed and result in a large glycemic excursion. Consumers and health professionals are unaware that measures use 50 g of available carbohydrate in a food compared to 50 g of glucose, so the amount of food rated as having a high GR might be a portion much larger than 50 g. Further, consumers should know that the comparison of GR measures should be within food categories not across them. Regulators and the food industry responsible for verification of label accuracy must grapple with the measure's variability and work to identify other GR methods that reduce its variability. Educators must help consumers understand how to effectively use this measure to build diets that fit their needs.

Gluten Free: Opportunities and Challenges Across the Supply Chain

Implementation of gluten-free regulations in the food industry
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Cereal Foods World 57:A8

This presentation will include an overview of celiac disease and gluten intolerance, sources of gluten, consumer interest in this topic and the regulatory journey for General Mills in introducing gluten-free products into the market. It will also include a brief description of manufacturing challenges to assure that our products meet the FDA proposed definition of "gluten-free."

Gluten-free: Product development opportunities and challenges
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Cereal Foods World 57:A8

There is growing interest in gluten-free products amongst a wide cross-section of consumers. These consumers include those with celiac disease, non-celiac gluten sensitivity, and consumers who are addressing other health concerns or want gluten-free products for their perceived health benefits. This combined population is likely in excess of 21 million consumers in the US alone and as a result the gluten-free market is increasing by 30% a year. In a 2009 survey, 71% of consumers with celiac disease indicated that it is hard to find good tasting gluten-free foods. Consequently product developers and food companies are increasingly focused on meeting the needs of this growing consumer base. Our challenge as food product developers is to meet the taste expectations and other needs of these consumers. Traditionally gluten-free products and bakery goods have had significant textural, flavor, and nutritional shortcomings. This presentation will focus primarily on addressing textural challenges but will also briefly touch on approaches to address other deficiencies of this growing category. Gluten-free products inherently have defects because of the lack of structure traditionally provided by gluten. Other macro-molecules can allow food scientists to get close to that structure but cannot mimic it perfectly, especially without compromising on other traditionally desirable attributes of conventional products. The use of functional fibers, starches, hydrocolloids, enzymes, and alternate flours will be discussed to address these challenges.

Product development challenges and potential solutions for high quality gluten-free products
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Cereal Foods World 57:A8

Developing gluten free products with texture and flavor comparable to wheat flour based products has been a topic of growing interest over several years. Gluten is a protein which occurs naturally in wheat, barley and rye. Consumers who suffer from celiac disease, a severe intolerance to gluten or wheat allergy need to maintain a gluten free diet. Growing awareness and diagnosis of conditions related to gluten has led to a significant increase in the consumption of gluten free food products—especially baked goods. There are significant challenges associated with the manufacture of gluten free baked goods. Gluten is responsible for several critical properties for bread and bread-like products. It provides the properties needed to maintain dough elasticity before baking and texture after baking. Formulating baked goods without gluten commonly leads to significant texture challenges such as reduced volume, undesirable color, lack of an even cell structure, and a dry, crumbly, grainy texture that consumers find unattractive. In addition, maintaining a gluten free manufacturing environment and supply chain creates additional complexity and cost. Testing requirements for gluten free certification can introduce an additional, though necessary, layer of complexity for ingredient suppliers and food manufacturers. Highly functional wheat flour replacers based on rice and tapioca flour have been developed to provide the texture and processing properties of wheat flour without undesirable color or flavor. A systematic approach has been used to develop and optimize the texture and flavor of an entire line of baked goods. The texture and processing advantages of these functional flours over native flours and starches were demonstrated using moisture management, dough consistency, machinability, volume, cell structure and oral textural sensory attributes.

Detection methods for ensuring labeling compliance of gluten-free products
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Cereal Foods World 57:A8

Gluten-free foods continue to increase in the marketplace, making this category of food products appealing to many food industry companies. Currently, the United States does not have an official definition of gluten-free; however, many companies marketing gluten-free products in the U.S. adhere to the definition outlined by Codex Alimentarius and the European Union Commission, which indicate that foods containing < 20 ppm (mg/kg) gluten protein in the finished food product can be labeled as gluten-free. Food companies marketing gluten-free products often utilize analytical methods to analyze incoming ingredients and/or finished food products to ensure the products do not contain detectable gluten proteins. Regulatory agencies may also utilize analytical methods to test retail products to ensure label compliance. There are a number of analytical methods available for detection of the cereal grain proteins that cause adverse reactions in consumers who have celiac disease, namely gluten from wheat, secalin from rye, and hordein from barley. Enzyme-linked immunosorbent assays (ELISAs), which have become the standard of care in the industry, are commonly utilized by food industry for detection of gluten residues in raw ingredients, on equipment or

environmental surfaces, and in finished food products. In addition, PCR methods and more recently mass spectrometry methods have become available for analysis of gluten residues and label compliance. This presentation will examine the current detection methods available for analysis of gluten residues, provide an overview of the advantages of each method, and discuss limitations of each of these methods.

Developing effective gluten-free validation programs
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Cereal Foods World 57:A9

According to Packaged Facts, sales of gluten-free products have grown beyond $2.5 billion in the United States. Although consumer popularity is significantly driving this growth, it is vital these claims also protect those who must avoid gluten to maintain good health. Validating a gluten-free claim requires effort in three areas: ingredients, production facilities and finished products. In each area, ELISA testing may serve as the ultimate validation tool. Using this tool effectively, however, requires food manufacturers to apply such testing judiciously and thoughtfully as part of the larger validation effort.

Healthy Food Manufacturing: Process Challenges & Solutions for Salt Reduction, Fat Reduction, and Fiber Enhancement

Strategies for developing healthier bakery products
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Cereal Foods World 57:A9

Obesity, diabetes and cardiovascular disease are among the commonest causes of ill health in the developed world. In the UK, the food industry is co-operating with regulators to reduce sodium in the diet. With the equivalent of over 11 million loaves sold daily, white bread accounts for 71% of the £3.4 billion UK market. Its widespread consumption means that even small changes in white bread could significantly impact the health of the nation**.** However, reducing salt levels in bread without adversely affecting sales is challenging. Commercially, salt reductions in bread have resulted in processing issues including difficulties in dough handling and reduced volume. These are difficult to reproduce in the test bakery. Even dough without salt mixed in a small Tweedy mixer (up to 5 kg flour) can be moulded, whereas difficulties were encountered when larger batches (16 kg) were mixed in the same type of mixer. The underlying mechanism for this is being investigated. Another source of sodium in bakery products is from chemical leavening agents. Our strategy has been to look at ensuring that the raising agents are used effectively. If simple organic acids are used instead of the slow releasing acids SAPP or SALP, considerable sodium reductions could be made. Encapsulation of either the acid or the carbon dioxide carrier in fat slows the release of gas. However, its effectiveness as a raising agent depends on the timing of gas release to create the optimal structure. The addition of dietary fibre to improve the nutritional value of bread and biscuits is also being actively researched. Different fibre sources, techniques to determine the optimal hydration level and their effects on dough handling and product quality are currently under investigation.

Reducing oil uptake in extruded snacks—Mechanisms for fat absorption and distribution in a cellular matrix
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Cereal Foods World 57:A9

Fried extruded foods feature majorly in the modern diet. These products are typically high in fat (30-40% w/w), and contribute to increased prevalence of obesity and related chronic diseases such as diabetes and cardiovascular ailments. Research is increasingly focused on enhancing nutritive value of ready-to-eat food products, without compromising on sensory qualities. Fat reduction is one important aspect of this effort. In order to minimize the amount of oil absorbed during frying of extruded products such as expanded snacks, it is essential to understand the mechanism by which oil migrates within the structure. The objective of this work was to develop a fundamental understanding of the mechanisms of heat and mass transfer, and oil absorption into a starch-based cellular matrix. Non-invasive techniques such as X-ray Micro Tomography (XMT) were utilized for studying the distribution of lipid in the cellular walls and voids. Relationships between cellular architecture and oil absorption during frying were elucidated, thus allowing for control of the latter by engineering desired microstructures during processing by extrusion.

Strategies in reducing fat using starch
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Cereal Foods World 57:A9

Fat reduction is again on the top of the agendas of the food formulators. The driver is the ever-increasing obesity numbers. General fat replacement is virtually impossible. Therefore the starch industry had adopted the strategy in replacing fat or oil in given formulation starting from the specific function of fat in that product. In the early days of fat replacement, starch gels with particulate character were produced and proved to be quite successful. However, soon the barriers of this strategy were met and new approaches were developed. In oil in water emulsions, part of the function of oil is the thickening, which can be supplied by specialty starches. In water in oil emulsions, the water has to be trapped in the “stair way” structure using special gelling starches. A new generation of fat replacers has recently been introduced aiming not so much at the food formulation, but more at the sensory appreciation. In cake formulation fat imparts a certain moisturizing effect that novel specialty starch can mimic. In dairy formulations part of the creamy perception is imparted by the fat particles. In a recent development using a specialty enzyme, starch has been modified in such a way that the fat droplets are mimicked in the protein network. In general, fat droplets have a few important functions: in the mouth the droplet should yield between tongue and platelet, it should melt and lubricate. A model will be presented that shows that yielding and melting has been achieved. The challenge for the future is to find a starch that lubricates as well.

Impact of food ingredients and processing on salt flavor perception
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Cereal Foods World 57:A9

The sodium in foods may be there as a processing aid, but the other major reason is because we appreciate its taste. The value of salt as a flavour depends on the ability of the sodium ions to reach the receptors in the mouth. Hence, hydration of solid foods and the mixing of ingested material in the mouth with saliva are critical if the sodium ions are to reach the tastant receptors in the mouth. There are several challenges for the food manufacturer that they may need to undertake. Firstly, some understanding of how the food is eaten and the relationship between this and the perceived flavour. While there is some evidence that foods containing different levels of salt in different parts of the food are perceived as more salty than the average salt level, other studies have indicated that pulsed salt introduction does not give heightened perception of the sodium levels. Although ion levels in the mouth can be ascertained, via electrodes, and sensory panels may be asked to rank flavour, the interaction between sodium load and the brain’s response is very poorly understood. If the salt is added as a topical application, it is generally accepted that it needs to be in a form that can move rapidly to the taste buds and maximise the response. Hence, manipulation of particle sizes, creation of rapid hydrating mixes and altering the surface properties of flavorants containing sodium are all being created and marketed as ways to assist in the rapid dissolution and perception of the sodium. When salt is not added to the outer surface of the product or when on eating the salt is included in the bolus, the sodium may be entrapped in the bulk mass and cannot reach the taste buds. The question is then what formulations are optimal to maximise salt perception. It would appear that even changing the thickener in soups and sauces can make a major impact on salt perception levels.

The influence of healthy ingredients on food texture of snack products
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Cereal Foods World 57:A9

In the last years, there is a large tendency to develop food products with health promoting ingredients such as reducing cholesterol level or introducing satiety related feelings via fibres. Adding, replacing or diminishing components by healthy counterparts is not straightforward, because the consumer will ask for the same textural and sensorial

experience. The main question of our research is: what is the influence of the different components in indirect expanded snacks on their expansion, structure and texture? How could this knowledge be used to predict the effect on the snack characteristics by introducing healthy components, such as fibres, or diminishing or replacing salt? What is the relation between the glass transition temperature and snack expansion? How are these phenomena measurable on a quantitative and qualitative way? The latest results in this field will be discussed in this paper.

Is It Sweet Enough? A Dialogue on Sugar Reduction

Carbohydrates and energy metabolism
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Cereal Foods World 57:A10

The Dietary Guidelines for Americans, 2010, have stated that "calorie balance over time is the key to weight management." Overweight and obesity are the result of positive energy balance based on excess calorie intake and/or inadequate calorie expenditure through physical activity. Studies from the scientific literature would suggest a positive association between calorie intake and measures of adiposity, such as body mass index or body fat. Controlling caloric intake from foods and beverages can be done in a number of ways, including reduction in the energy density of foods and control of the portion size of the food being consumed. The purpose of this presentation is to discuss the current state of obesity and overweight and provide a discussion of proposed dietary solutions to reducing calorie intake.

Ingredient options for sugar reduction
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Cereal Foods World 57:A10

Of the many health issues today, sugar reduction is top of mind among consumers. Over consumption of sugar has been known to cause obesity, diabetes, cardiovascular concerns and has been linked to a host of other medical conditions. As awareness continues to grow in the general population, it is the educated consumer who is more apt to read labels and make decisions regarding their food choices based on sugar content. To complicate matters further, at least for the food manufacturer, the consumer is more critical of the ingredients used than ever before. Clean label as well as simpler, easy to understand ingredients weigh heavily in the purchasing process. Fortunately for the manufacturer, ingredient suppliers are able to provide a toolbox filled with products that enable product developers to mix and match components to meet their specific needs. The purpose of this presentation is to discuss various options available for sugar reduction, their benefits and primary applications.

Holistic approach for effective sugar reduction using high potency sweeteners and bulking agents
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Cereal Foods World 57:A10

There has been an increased emphasis on controlling calorie consumption with the increase in obesity. One strategy to reduce calorie consumption is to replace caloric sweeteners with non-caloric high potency sweeteners (HPS). However, this is not a straightforward process. Sucrose, high fructose corn syrup, and other caloric sweeteners have functional properties besides sweetness that have an important impact on the sensory attributes of foods. Texture, color, and flavor development can all be impacted when sugars are reduced. These attributes can be maintained by choosing the correct bulking agent. Replacing the sweetness lost due to the reduction of sugars with HPS is not as simple as it might first seem. Unlike caloric sweeteners, HPS sweetness does not increase linearly with concentration and have a maximum sweetness. Sweetness synergy can also play a role when considering substituting one sweetener for another. A holistic approach is required to successfully reduce the sugar content of food while minimally affecting the sensory attributes of the food.

Practical considerations in caloric sugar reduction
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Cereal Foods World 57:A10

Keeping in line with health and wellness initiatives and public health priorities related to the global rise in both obesity and type II diabetes, there is a need to reduce caloric density. The focus of this work is on the reduction of added sugars in cookies and cakes where lipids, sugars and flour are major contributors. Efforts to reduce significant amounts of added sugars in bakery applications present several challenges due to the multiple functional roles sugar plays. Adding to these challenges are requirements for "clean labeling", affordable cost, good digestive tolerance, and comparable taste to control or reference product. This work relates practical considerations when replacing the bulk and sweetness that sugar provides in baked goods. A number of the hurdles encountered in sugar reduction will be highlighted and commercially available ingredient options will be discussed.

Leveraging Innovation, Cost Management, and Sustainability for Profitability

Leveraging continuous improvement and other tools for profitability and cost reduction
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Cereal Foods World 57:A10

Organizations utilize multiple approaches to improve productivity, reduce costs, and improve profitability. It is widely recognized that technical innovation is a key component driving productivity. Research and development spending and per capita patents issued correlate to higher labor productivity and income. Adopting continuous improvement techniques further improves productivity. Continuous improvement processes have their roots in the pioneering work of Deming, which in turn was a direct result of America's efforts to help rebuild post World War II Japan. It started with statistical process control methods initially developed by Walter Shewhart of Bell Laboratories and taught by Deming in Japan, which resulted in dramatic improvements in quality and productivity. This presentation will focus on discussing how specific continuous improvement tools can be used to improve productivity. Examples of potential impact of these tools will be outlined. Finally, specific examples from SunOpta and other organizations of how these tools have been used in an innovative way to improve profitability will be reviewed.

Kaizen usage to drive continuous improvement
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Cereal Foods World 57:A10

As part of a panel discussion, this presentation will review the usage of kaizen events to drive continuous improvement and achieve productivity improvements at Bunge North America. Kaizen events are very effective and powerful because they are carefully selected, planned and completed by employees that are empowered to make change for the better. A kaizen is a systematic approach to rapid improvement in the areas of safety, quality, cost, delivery, and morale in all business functions. During the presentation the following topics will be explored: why use the kaizen methodology, what is a kaizen, kaizen breakthrough principles, kaizen elements and kaizen examples.

Science and technology insights to reduce costs and deliver sustainability
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Cereal Foods World 57:A10

Today, more than ever, food companies are challenged to deliver dependable cost savings while improving on sustainability metrics. Much of the low hanging fruit is gone, which places more emphasis on leveraging more sophisticated science and technology principles to achieve these goals while delivering food products that delight the consumer. This presentation will touch on different aspects where technology plays a role including: 1) Enhancing agronomics and value-added traits of grains, 2) Supplier-based techniques to reduce ingredient costs and 3) Process technologies to control variability that can result in waste and overage of high value ingredients.

Challenges and opportunities in improving profitability by managing costs
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Cereal Foods World 57:A10

To help consumers meet dietary recommendations for intake of grain foods, there is a need to increase the content and range of grain-based products made with whole grains. Whole grain ingredients and products are generally considered more expensive than their traditional counterparts, which can

reduce the likelihood of manufacturers and distributors to offer these products. Cost challenges include whole grain ingredient availability, manufacture rate, energy input, shelf life of ingredients and finished products, and production yield. The industry is not only challenged with increasing the whole grain content of grain foods and the range of offerings, but to also lower the content of sodium, added sugars and solid fats. Additional challenges facing the industry are food safety needs and the desire for cleaner labels. Partnerships between product developers and the miller can be used to help manage costs and maximize consumer liking of products made with whole grains. Examples that will be provided include the use of whole grain ingredients to improve end product shelf life and to reduce formula cost.

Case studies in value optimization without compromise using advanced texturizers
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Cereal Foods World 57:A11

Affordability is a key concern for food manufacturers and consumers due to global economic uncertainty and a significant increase in food prices in recent years. Three approaches are presented to develop affordable food products without compromising the texture and eating quality. 1. Optimizing the use level of expensive ingredients to minimize the impact of cost fluctuations. Supply/demand changes can lead to significant cost increases for several food ingredients. This impact can be minimized by reformulating with alternate ingredients using formulation science techniques to maintain texture, flavor, and nutritional characteristics. A case study is presented demonstrating the use of a carbohydrate based texturizer for use with unsaturated oils to provide the texture and processing properties of saturated fats while maintaining the overall fat content in baked goods such as pie and pizza crusts. 2. Avoiding capital investment by utilization of existing equipment for new products. New products frequently require new equipment or even new processing lines, e.g., the industrial manufacture of Greek style yogurt requires new equipment to concentrate the yogurt by filtering whey. A case study is presented to demonstrate the use of a carbohydrate based texturizer to enable the manufacture of Greek style yogurt using a traditional stirred yogurt manufacturing line while maintaining the texture, flavor, and nutritional characteristics, avoiding the need for additional capital. 3. Improving processing efficiency by lowering energy utilization. Soaring energy costs can contribute to significant escalation in cost for retorted products such as soups and sauces. A case study is presenting demonstrating the reduction of retort time by 20-30 %, lowering energy usage while maintaining desired food texture and food safety.

The use of statistical process control to improve manufacturing process performance and reduce cost
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Cereal Foods World 57:A11

Statistical process control (SPC) charts are one of the most underutilized tools in the effort reduce process variation and drive reductions in cost. Control charts allow process owners to gain an understanding of process behavior so that process improvements can be more efficiently and effectively implemented. This presentation will show how SPC was successfully used to drive improvement in several processes at a food ingredients manufacturing firm. Specific examples used to illustrate how SPC enabled reduced costs and improved quality include: an improvement in the control of product moisture content, a reduction of wastewater treatment costs and improved consistency and accuracy of package weights. Also covered will be an overview of the different kinds of control charts and which are most effective for different situations.

Lipids in Baking: Minor Components with Major Impact

Shortening and oil processing: Tools of the trade
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Cereal Foods World 57:A11

Before reaching the bakery, shortening and oils are refined, bleached, and deodorized to meet the critical functional and shelf-life requirements of the application. In addition to functionality and stability, products need to be cost competitive and adhere to strict environmental and processing requirements. The objective of this presentation is to provide an overview of the basic steps in the processing of shortening and oil, with specific attention to some of the more recent advancements in processes, including the use of enzymes in refining and interesterification. This presentation will complement the presentations that follow by providing background foundation in understanding the source of commonly used source oils, how the oils are expressed from their source and the processing steps required in optimizing and analysis for their end use.

Role of fat crystallization in bakery products
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Cereal Foods World 57:A11

Baked goods are popular in different countries and cultures. Although there are a great variety of different cakes, pies and pastries many similarities exist. Many of the products depend upon having a fat component which is solid. The crystallization and physical properties of this component are very important in delivering the final properties to a baked product. Of particular interest are layered products such as puff pastry, filo pastry or croissants. In these products the fat must form layers that can be folded and rolled as the dough is prepared. The structure of the fat is very important in giving these properties. Depending upon how the fat is crystallized the physical properties will be very different and so the quality will be much altered. As an example large crystals will mean low structuring and a system with less structure. The role and nature of the fat crystallization in such products is therefore of the utmost importance. In this presentation we will consider the structure of different bakery fat systems and consider the importance of the fat structure on the product properties. We will then look to see how by controlling this structure and ensuring that the crystals are more effective new products with lower amounts of total fat (lower calories) or solid fat (sats and trans) can be developed.

Functionality of oils and shortenings in baking
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Cereal Foods World 57:A11

Oil and shortening contribute a range of unique and diverse functional properties to baked products. The functionality properties imparted by oil and shortening in baked products include gas retention, volume, texture, dough handling, heat transfer (in frying), plasticizing, anti-firming and flavor. These properties are exhibited throughout processing, from mixing, sheeting, baking to storage of the finished product. The objective of this presentation is to provide an overview of the functional characteristics imparted by oil and shortening in various baked products, including cookies, doughnuts, laminated products, pie crust, cake and bread. A challenge facing the baking industry is the removal of trans and the reduction of saturated fatty acids. Bakery products such as cookies, doughnuts, laminated products and pie crust require shortenings with relatively high melt or sufficient solid content at processing temperatures to provide adequate functionality in the finished product. The higher solid contents at processing temperature provide structure allowing for discrete shortening particles or layers in the dough. Upon baking, the shortening melts, producing the flakey and layered characteristics desired in these types of baked products. In frying applications, the liquid shortening becomes absorbed into the doughnut, imparting a unique texture upon cooling. Shortening manufacturers are challenged with creating shortenings with adequate structure to provide the desired characteristics in the finished product, while removing trans and reducing saturated fatty acids. An overview of current and possible future solutions for the removal of trans and reduction in saturated fatty acids will be presented.

Functionality of emulsifiers in breadmaking
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Cereal Foods World 57:A11

Due to common structural elements polar lipids are surface-active and act as emulsifiers in breadmaking. To exploit the functionality of polar lipids, they can be isolated (e.g., lecithin from plant sources) or synthesized and used as improvers in breadmaking. A second approach is to enzymatically modify polar lipids endogenous to wheat flour into potentially more active compounds. However, only a few systematic studies on structure-function relationships of polar lipids in breadmaking based on molecular structures are available up to now. To get more insight into the techno-functionality of polar lipids, the synthetic emulsifier DATEM, lecithins from different plant sources as well as glycolipids from lecithins and cereals were studied. For polar lipids based on glycerol with only one fatty acid residue (DATEM, lysophospho-lipids, lysoglycolipids) the baking performance, crumb softness and retardation of bread staling were best when long-chain saturated fatty acid

residues were present. Polar lipids with two acyl residues (phospholipids, glycolipids) behaved differently. The effect on bread volume and crumb softness was stronger as compared to the lyso compounds, however, in particular for phospholipids medium-chain fatty acids were required to get an optimal effect. No effect on bread staling was observed with these compounds. Further functional groups within the molecules also affected emulsifier functionality. In phospholipids the phosphoric acid derivative had a strong impact on the bread volume. The galactosyl moiety of galactolipids also affected the functionality with digalactosyldiacylglycerols (DGDG) being more efficient than monogalactosyldiacylglycerols (MGDG). Removal of one fatty acid residue yielding the respective lyso compound (as, e.g., by recombinant lipases) showed that functionality was only improved in the case of MGDG, and not for DGDG.

Endogenous wheat flour lipids and their interactions during breadmaking

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Cereal Foods World 57:A12

Apart from the lipids added during mixing wheat flour and other ingredients into bread dough, wheat flour itself already contains *ca.* 1.5 to 2.5% lipids. The majority of these lipids originate from the wheat kernel starchy endosperm, but a part has also been transferred from germ and bran to flour during the milling process. Wheat flour lipids present a large structural diversity. This presentation starts by discussing wheat main lipid classes, their classification and analysis. In the context of bread making, it is more relevant to distinguish starch granule internal lipids and non-starch lipids than to classify the lipids as either polar or non-polar. The non-starch lipids have been divided into free and bound lipids, depending on whether they can be extracted with non-polar and more polar organic solvents, respectively. Despite their relatively low levels when compared to those of other wheat flour constituents, wheat flour endogenous lipids have a major role during bread making. We here discuss their role and interactions during the entire process of bread making, i.e., from dough mixing over fermentation to baking and, finally, storage. During mixing, a significant part of total wheat flour lipids becomes bound, i.e., they are no longer extractable in non-polar organic solvents. During fermentation and proofing, (mainly) polar lipids aid in gas cell stabilization, the effect of which merely depends on their levels and interactions with gluten proteins. The baking process transforms the dough liquid foam into a cellular sponge, the structure of which largely depends on the wheat lipids present as well as on their interactions (with, e.g., starch). Finally, wheat flour lipids, depending on their structure and properties, can affect both bread firmness and firming.

The New Generation of Professionals: Opportunities and Challenges in Transitioning from School to Work

The challenge of transitioning the net generation into the professional world

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Cereal Foods World 57:A12

Today's professional environment encompasses a widely diverse group and includes professionals ranging from seasoned professionals that grew up handwriting and mailing letters to young professionals that may never have heard of the slide rule! The challenge is to leverage the strengths of multiple generations working in concert to foster a rewarding and productive environment in today's workplace. This introductory presentation will discuss some key characteristics of the disparate generations and how they can effectively interact to address challenges and harness each other's strengths. The goal is to enable a smooth transition for young professionals to allow a rewarding experience for all involved, resulting in a win-win environment for the entire organization.

How KSU prepares undergraduate and graduate students to be productive professionals in the cereal food industry

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Cereal Foods World 57:A12

In KSU's Grain Science & Industry Department, we believe the keys to preparing undergraduate and graduate students to successfully transition from college to work and become productive professionals in the cereal food industry are: (1) outstanding faculty committed to student success and actively engaged with the cereal food industry, (2) relevant curricula and courses that challenge and inspire students to learn, (3) meaningful industry internship experiences for undergraduate and graduate students ideally at more than one company, (4) innovative and relevant research projects that engage and encourage undergraduate students, and that challenge and inspire graduate students to discover new knowledge, (5) active participation in student, professional and scientific organizations, (6) excellent facilities that provide the appropriate settings for learning, discovery and service, and (7) strategic partnering with the cereal food industry that cares about attracting and preparing its next generation of industry professionals! Two-thirds of our faculty have industry experience they bring into classrooms and labs. Our four unique B.S. and M.S./Ph.D. degree programs have seen substantial enrollment growth in the past 5 years with near 100% job placement. All undergraduates are encouraged to pursue industry internship opportunities, and more are involved in faculty-guided research projects. Most graduate students present their research at a scientific meeting before graduating. The prospect for completing our new Grain Science Innovation Campus in the near future is real. Cereal food company representatives (many of them alumni) are frequent guests interviewing students for internships and employment, giving lectures in classes and career advice at student club meetings, and presenting seminars on the latest research and product development efforts.

Opportunities for professionals in the cereal science and bakery industry

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Cereal Foods World 57:A12

One of the goals of the Research, Quality and Technology organization at the Kellogg Company is to provide an effective, efficient, and continuous pipeline of new and diverse technical talent at all levels in our organization. Active programs within our organization help us to achieve this goal through cultivating, developing, and nurturing the technical talent pool that is available to us. We use our programs to guide the next generation of employees and provide tools that allow a smooth and productive transition into the Kellogg Company. As early as high school, Kellogg Company targets technical talent through coaching and mentoring students in a school setting and on site at our global headquarters. These relationships can be continually built through the undergraduate and graduate years and ideally culminate in a successful placement with us. These programs provide insight to leverage the individual's technical and personal skills through applying past related experiences as well as performing in the role immediately. Key outcomes of the programs have been the ability to attract and retain a significant number of new hires with a broad diversity of ages, cultures and skill sets. At the Kellogg Company we strive to embrace the diversity of each employee and achieve an inclusive environment that allows each employee to contribute to their fullest potential. The challenging goal of innovation growth and launching new products requires us to constantly generate new and differentiated concepts and deliver those to the market place. This cannot be achieved without the collective power of a diverse and inclusive culture.

Opportunities for professionals in the food industry

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Cereal Foods World 57:A12

In our Research, Quality and Innovation department at ConAgra Foods, we follow eight technical competencies. Two of these are "Have Friends in Technical Places" and "Be Curious and Know Your Stuff". Building and leveraging internal and external relationships are important in helping "know your stuff" and in maximizing technical capabilities and results. There are several approaches that new professionals should use to make contacts, build relationships and add valuable information to their tool kit, which range from attending free webinars and meeting with suppliers to working on cross-functional team projects. To help ensure new employees get off to a productive start, ConAgra uses a program called 100% in 100 Days. New professionals can help maximize opportunities by becoming knowledgeable of their company's career path structure and by working with their manager, HR department and other team members to build an individual development plan for growth. To take advantage of growth opportunities in the food industry, it is important to be curious, take an active role and build relationships within and outside of your company.

A student's expectations in transitioning from school to work
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Cereal Foods World 57:A13

As a traditional student, I have completed my college education without leaving the university setting for an extended period of time. As of May 2012, I have had multiple internships, but never a permanent professional position. All professionals, whether working in academia or industry, have experienced the transition from school to work. My position on the panel of the New Generation of Professionals is to offer the perspective of a new graduate and, hopefully, that of a new hire. After completion of my bachelor's, master's, and Ph.D. degrees, in July 2012, I will be looking for a permanent position within the industry. Half of my presentation will be written prior to graduation, while the remaining slides will be drafted just prior to the October meeting in Hollywood, FL. This will allow for easy comparison of what was expected and what I discovered at the start of my career. All new graduates have expectations; I can only hope being a new Ph.D. in the industry will be as great as I have been imagining for the nine years I have attended a university, gaining knowledge in cereal science. Students, and professionals, attending this session can ask questions and obtain perspectives on the opportunities and challenges in transitioning from school to work.

An international perspective on entering the North American workplace
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Cereal Foods World 57:A13

While leaving school and entering the workplace can be challenging, there is an extra layer of complexity involved when attempting this transition from outside of North America. Knowing how to prepare when seeking employment in the US and Canada can alleviate some of the stresses involved. This symposium talk will highlight the issues facing international students attempting this transition. These can include: differing standards and non-recognition of qualifications and other credentials; requirements for minimum written and verbal language or communication skills; the frequent need for prior in-market work experience; cultural differences in the workplace. Strategies to address each of these issues will be provided and used as a starting point for the group discussion that is to follow the talk.

Peter Wood Memorial—Special Session

The life, times, and science of Peter Wood
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Cereal Foods World 57:A13

Peter Wood was a distinguished scientist, dedicated AACC International Fellow and Geddes Award recipient who brought new scientific perspectives to the membership in a distinctive and very endearing manner. All who knew Peter respected him, and those close to him valued his friendship very highly. Peter spent a career investigating the structure and function of cereals, most notably oats, and most specifically beta glucans. He published extensively on these subjects, and his publications are repeatedly referenced as irrefutable citations on numerous topics of importance to cereal chemists. His last publication was *Oat Chemistry and Technology,* a comprehensive treatise, which is part of his enduring legacy. This presentation will explore and celebrate the life of Peter Wood and his many contributions to the science of cereal chemistry.

An overview of beta glucans
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Cereal Foods World 57:A13

Peter Wood was involved in research on mixed linkage cereal β-glucans ((1→3)(1→4)-β-D-glucans) for over 35 years. During that time, he contributed an immense amount to our knowledge and understanding of the physicochemical properties of these cell wall polysaccharides and their influence on human health. Beginning in 1974, Peter conducted research on purification techniques and binding of dyes, like calcofluor and congo red to β-glucan. Later, he showed that the β-glucan in oat groats tended to be concentrated in the cell walls of subaleurone layer whereas the β-glucan in barley kernels was more evenly distributed through the endosperm. Peter explored the relationships between molecular structure and rheological properties of β-glucan, including applied solution and gel characteristics, theoretical polymer physics calculations and properties of simulated digestion extracts. A comparison of the molecular structure of β-glucan in different grains showed variation in the distribution of β-(1→3) and β-(1→4) linkages which influenced their gelling characteristics. He also studied the susceptibility of β-glucan to enzyme hydrolysis and fermentation in the colon. Peter collaborated with many nutrition experts to explore the relationship between the viscosity of oat β-glucan and the role of oat foods in reducing serum cholesterol and attenuating blood glucose concentrations in humans. He demonstrated that β-glucan was the bioactive component in oats. He showed that both blood glucose and serum cholesterol were dependent on the molecular weight and soluble dose of β-glucan. Peter Wood's dedication and enthusiasm for carbohydrate chemistry has left us with a better understanding of cereal β-glucan and its effects on human health.

Current research on arabinoxylans
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Cereal Foods World 57:A13

Since the work of Pence and coworkers and Perlin in the 1950s on cereal arabinoxylan (AX, formerly referred to as pentosans), significant research efforts have gone into isolation, characterization and structure determination of these AX and into understanding their functionality in cereal based processes. Research into AX got a new boost with the availability of xylanases, able to hydrolyse the AX backbone, and allowing to selectively modify AX for the benefit of industrial cereal based processes and final product quality. Of more recent date is an increasing interest in AX or degradation products thereof as major contributor to the dietary fibre fraction of a balanced diet. In this presentation, an overview is given of the current state of the art on AX and AX research in these different fields.

Cell wall polysaccharides
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Cereal Foods World 57:A13

Although our preoccupation with grain polymers has resulted in highly detailed and innovative approaches to analysis, extraction, concentration, manufacturing and nutritional quality of grains, we often overlook the fact that many carbohydrate polymers are synthesized and stored in discrete structures that reflect the genetic, environmental, and developmental history of the grain. They are highly variable in structure, concentration, and location, and this variation has tremendous influence on processing quality. With the exception of the massive carbohydrate reserves deposited as starch granules (and a few other, less pronounced polymers, such as fructans), the majority of the carbohydrate diversity in grains is a product of the process by which cell walls are synthesized during development. This certainly applies to pentosans and beta-glucans, both of which occur in cell walls that surround each cell in the grain, and each of which is deposited in distinctive locations and concentrations that reflect the temporal and spatial history of kernel development. They are, in fact, a highly diverse collection of polymers that also include an array of additional functional groups and adjuncts that provide a range of useful functions in the seed, both during development and during germination. Most phenolic acids, for example, are esterified to cell wall polymers, and the nutritional and processing traits of the cell walls (e.g., in dietary fiber) are a product of some of these unique combinations of high and low molecular weight compounds. The cell walls provide protection to the grain (from insects and fungi), they modify or control hydration rates, they influence processing traits and digestibility, and they always occur as complexes that include an array of different polymers. Understanding cell wall *structure* is as important as understanding its basic chemical composition if we are to fully comprehend, and exploit, their impact(s) on processing and nutritional quality of grain products.

Measurement of soluble dietary fibres
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Cereal Foods World 57:A13

Traditionally, the term "soluble dietary fibre" would have related simply to soluble polysaccharides other than starch, i.e., polysaccharides that are not digested and absorbed in the human small intestine. However, it has been known for some time that non-digestible oligosaccharides (NDO) also act physiologically as dietary fibre. So now, the soluble dietary fibre also includes these carbohydrates. The recognition of NDO as dietary fibre (DF) means that these also must be measured in determining total dietary fibre. Several methods have been developed for the measurement of specific dietary fibres such as beta-glucan, fructan, and resistant starch, and other less specific procedures for Polydextrose and Fibersol 2. However, for regulatory purposes, measurement of total dietary fibre (including insoluble dietary fibre, high molecular weight soluble dietary fibre and low molecular weight soluble

dietary fibre [i.e., NDO]), is generally all that is required. In this presentation, methods for the measurement of specific dietary fibres and of total dietary fibre will be described and discussed. Particular emphasis will be placed on problems in the measurement of NDO such as resistant maltodextrins and fructo-oligosaccharides.

Mechanisms of action of dietary fiber in the gastrointestinal tract: A physico-chemical perspective
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Cereal Foods World 57:A14

The effects of plant cell walls (PCW) or dietary fiber on the digestion of macronutrients such as starch have important implications for health and disease. For example, water-soluble cell wall polysaccharides reduce the rate of starch digestion, which in turn can attenuate the postprandial rise in blood glucose and insulin concentrations. These effects are of potential benefit in the prevention and management of disease, e.g., diabetes mellitus and cardiovascular disease. PCW are supramolecular assemblies of cellulose, hemicelluloses, pectic substances, non-carbohydrate components and water, the amounts and relative proportions of which vary depending on factors such as the type, function and maturity of the plant tissue. Some PCW are rich in water-soluble polysaccharides ("soluble fiber"), notably oats and legumes. The mechanisms of fiber in relation to the digestion are still not well understood. However, important mechanisms include viscosity enhancement, inhibition of enzymes (e.g., α-amylase) and cell wall encapsulation. The relationship between the rheological properties of soluble fiber (e.g., mixed linkage β-glucans, galactomannans) and events within the gastrointestinal tract will be reviewed. We have recently studied the role of PCW of almond seeds in regulating lipid release (i.e., bioaccessibility) in the gut and shown that cell walls play a primary role in influencing bioaccessibility. Initial results indicated that only lipid from fractured cells, created during mastication, is available for the early phase of digestion. In silico predictions of bioaccessibility appear to agree reasonably well with data obtained from digestibility studies in vitro and in vivo. Moreover, the in vivo data show that lipid is also released from intact cells, but at a much slower rate. Thus, cell wall encapsulation is a key mechanism in influencing the bioaccessibility and digestion of lipid in almond seeds.

Soluble fibers and health
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Cereal Foods World 57:A14

Soluble fibers come in many forms, and their associated health benefits relate to the structure, viscosity and molecular weight as well as the fiber matrix. Not all soluble fibers have the same health benefits, although all are fermentable and can alter gut microflora and function as prebiotics. The products of fermentation, short chain fatty acids (SCFA), can act locally to promote a healthy colonic environment or may be absorbed and act systemically to impact or regulate other physiological functions. Data exist that show soluble fibers attenuate blood cholesterol and glucose, affect intestinal transit and gut health, change certain hormones affecting satiety and weight control, improve bone mineral retention and even may alter cancer risk. Not all soluble fibers perform all the physiological functions or have the same impact, so it is important that consumers not only increase their total fiber intake to address the fiber gap, but they need to include a variety soluble and insoluble fibers in order to do the many functions that fiber performs.

Protein & Starch Changes Occurring During Various Cold-Forming and Dehydration Processing of Pasta, Noodle, & Pretzel Products

Process mapping: What we can learn from this approach
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Cereal Foods World 57:A14

When investigating the changes that occur in baked goods it is common practice to use model or simplified formulations and to produce samples using benchtop or small-scale equipment. This approach has been vital in establishing the fundamental principles of the transformations that occur throughout baking. However, prediction of the baking qualities of specific commercial products is complicated versus models due to formulation variations in the relative proportions of major ingredients (e.g., flour to sugar ratio), the contributions of quantitatively minor ingredients with potentially major effects (e.g., milk powder) and the inability of lab ovens to adequately replicate commercial oven conditions of, for example, humidity and heat flux. In investigating the behaviour of starch and proteins in a variety of product types (pasta, ramen, cookies, and crackers), we have adopted the approach of assessing real products from commercial facilities and relating the baking characteristics of these products back to actual oven conditions obtained from concurrent instrumental oven profiles. This approach, which we are calling "process mapping", allows placement of important baking developments into a timeline and thus represents an overview of a product and process conducive to the design of better benchtop experiments. Learnings from process mapping of pasta, ramen, cookies, and crackers will be presented.

Product model systems approach to study thermomechanical effects on wheat starch and protein
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Cereal Foods World 57:A14

A product model system can be a small scale "production" model of the actual final product, but also lab-scale mimics of thermal and mechanical processes which are the intermediate steps towards the final product belong to the product model systems tool-box. The combination of a relatively small scale of testing, thermal-mechanical information, analytical information (e.g., insoluble vs. soluble), and physical properties provides the industrial product developer with information that can be turned into a powerful predictive tool for physical product quality. In this study we used a variety of flours that are used for bread-making, biscuit, baked snacks (pretzel, cheese-flavoured "twists"), and pasta. Both starting materials and benchmark products have been tested in the so-called product model systems analytical toolbox. The lab-tests included Differential Scanning Calorimetry (DSC), Chopin Mixolab, Light Microscopy (LM), Viscometry, Glutenin-Macro-Polymer content, water swelling capacity, and starch damage. The Mixolab tests and DSC tests clearly demonstrated the effects of proteins, temperature, moisture addition, and moisture loss on rheological properties (dough viscosity), gelatinization, and glass-transition. The light microscopy survey revealed changes in the structure of the starch phase, disaggregated and aggregated protein structures. The level of observable retro-gradation can be related to processing conditions but also shows a link with texture of the benchmark products. Clearly, several physico-chemical transitions are key to the final physical properties of the product (e.g., texture). Furthermore, small scale tests are more easily repeated, conditions more easily altered, than pilot-tests performed on an industrial scale. Hence this reveals that a model systems approach is crucial to understand, better predict, and control physical product quality.

A molecular view of individual processing steps in pasta making
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Cereal Foods World 57:A14

The various molecular rearrangements induced on macromolecules during individual steps of pasta making were studied through a combination of methodologies. The main focus of this presentation will be on changes related to the use of various drying conditions, and on how they affect textural and sensory properties of the cooked product, and water distribution and mobility. Structural rearrangements in the protein components due to different drying conditions of pasta were addressed by solid-state spectroscopic approaches, by conditional solubility studies, by measuring thiol accessibility in the presence/absence of denaturants, and by using hydrophobic probes to assess rearrangements in non-covalent intra- and interprotein interactions. NMR imaging (MRI) was used to study water distribution and water mobility in differently dried pasta samples either before cooking or during cooking as a function of cooking time. Results from MRI studies pointed out the role of drying conditions for establishing appropriate gradients of water mobility in the cooked products, which were in turn related to the sensory properties. Information on changes in the organization of starch was derived from microviscoamylographic studies, providing indication that starch also plays a role in establishing the products' properties. For this reason, we are developing approaches based on the analysis of products generated by purified hydrolytic enzymes acting specifically on 1-4 and 1-6 glycosidic bonds. These approaches may represent a useful tool also for investigating the relationship between molecular and textural/sensory properties in pasta products where components other than gluten ensure the solidity of the macromolecular network.

Structuring of pasta components during processing: Impact on starch and protein digestibility and allergenicity
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Cereal Foods World 57:A15

Pasta is a staple food known to have a low glycaemic index. This interesting nutritional property can be attributed to its specific structure built by the concomitant and/or successive structural changes of its main components, starch and proteins, during pasta processing. We will describe how changes in pasta structure at different structural levels obtained by modification of its formulation (introduction of 35% legume) and/or its processing conditions can affect the *in vitro* digestibility of starch and proteins and their inherent allergenicity. This work highlights the need for a multidisciplinary approach for the rational design of pasta, in order to control digestion and nutrient absorption through the food structure.

Innovations in extrusion—Configuring a multioperation, low-shear, semi-cold process for novel and nutritious products
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Cereal Foods World 57:A15

Traditional pasta manufacturing is a cold-forming process involving little or no cooking (starch gelatinization and protein denaturation). The product matrix relies primarily on protein network formed during kneading for its resilience and strength after forming and drying. This presentation will describe a unique extrusion-based "semi-cold" multi-operational process involving kneading, cooking, cooling, forming and drying. All these operations (except drying) are carried out continuously yet sequentially in one equipment, typically a twin-screw co-rotating extruder. The product relies on cooking of starch, while maintaining granular integrity, for its binding, strength and cooking quality. The protein does not contribute to the product quality, as it is denatured during the cooking step and consequently exists in a dispersed fashion in the starch-based product matrix. Such a product can be termed as "pre-cooked" and requires very little time for preparation, as only thorough hydration is required, not further cooking. The same "semi-cold" processing technique has been used for a range of other novel products such as pre-cooked rice and rice analog, lentil analog, bean analog, etc. These analog products are dense in nature, and are designed to imitate regular rice, lentils or beans with the added benefits of reduced preparation time, micronutrient fortification as needed, and cost-effectiveness due to use of cheaper alternate ingredients such as corn, wheat, soybean, etc. Data will be presented related to degree of gelatinization, micronutrient retention, textural attributes, preparation techniques and sensory quality of "semi-cold" processed products. Fundamental interactions between starch, protein and other components will also be elucidated.

Protein Quality in Product Development: Regulatory Considerations

Protein quality: Methodology and benefits in grain-based foods
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Cereal Foods World 57:A15

Protein as a macronutrient can be provided from many dietary sources, including animal and vegetable. The need for dietary protein and for many of the specific amino acids that comprise protein has been clearly demonstrated. With the amino acid composition of the protein being quite variable among protein sources, protein quality is an essential element to meeting human needs. It is generally recognized that a majority of vegetable proteins do not contain an appropriate amount or ratio of amino acids to meet human requirements, while proteins from animal sources generally are sufficient to meet human protein requirements. Combining of complementary proteins or the addition of amino acid mixtures may improve the quality of these grain-based proteins. Protein quality is important for tissue growth and maintenance, with human requirements including both nitrogen and amino acid components. The amino acid requirements are dependent on content of essential amino acids, digestibility of the protein and metabolism of absorbed amino acids. Methods for evaluating protein quality have evolved over time although controversy still exists in selecting the appropriate method for use in protein evaluation for human needs. The purpose of this presentation is to give an introduction to the methodology used to evaluate protein quality and to briefly discuss the potential health benefits.

U.S. regulatory perspective—Claims regarding protein quality
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Cereal Foods World 57:A15

In the United States, the two primary agencies involved in regulating claims for foods are the Federal Trade Commission (FTC) and the Food and Drug Administration (FDA). The FTC has primary responsibility for regulating the advertising of food under the FTC Act, which prohibits false and misleading claims. FDA has primary responsibility for regulating label and labeling of food under the Federal Food, Drug, and Cosmetic Act (FDC Act), which also includes a prohibition against false and misleading claims. In addition, the FDC Act and FDA's implementing regulations include certain requirements for specific types of claims, namely, health claims, nutrient content claims, and structure/function claims. Health claims characterize the relationship of a nutrient to a disease or health-related condition, and must be approved by FDA. Nutrient content claims characterize the level of a nutrient in a food, and also must be approved by FDA. A structure/function claim is a statement that describes how a nutrient may affect any structure or function of the body, but the statement cannot mention any specific disease. Structure/function claims need not be approved by FDA. Specific claims concerning protein quality and the relevance of PDCAAS for these specific claims will be discussed.

Protein quality: A Canadian perspective—Is there movement toward the use of PDCAAS?
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Cereal Foods World 57:A15

Protein nutrient content claims on food products in Canada are based on both the quantity of protein in a food and the quality of the protein. The acceptable measure of protein quality is the protein efficiency ratio (PER), which is used to determine the protein rating of a food, and in turn, its qualification for a protein nutrient content claim. Canadian regulatory guidance provides a list of PER values for various foods and ingredients. Alternatively, a rat study to determine the PER must be conducted for foods and ingredients not on this list. The value of protein digestibility corrected amino acid score (PDCAAS) as a measure of protein quality is currently being recognized in Canada, and international developments on the use of PDCAAS are being monitored. This presentation will review the Canadian regulations on protein nutrient content claims and discuss the movement toward PDCAAS, including a review of some work that has been conducted in one food category to advance the use of PDCAAS.

FAO/WHO perspective—Upper limit of 1.0 for PDCAAS or unlimited
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Cereal Foods World 57:A15

PDCAAS, adopted in 1990 by the United States to assess protein quality for all foods except for infant formula, was accepted for protein evaluation in the 2002 WHO Technical Series Report Series 935 (Joint FAO/WHO/UNU Expert Consultation on Protein and Amino Acid Requirements in Human Nutrition). This approach depends on the amino acid profile of a protein source relative to the amino acid requirements of the intended population, as well as a digestibility factor. In addition to the PDCAAS limitations described in this report, the amino acid profile does not necessarily reflect the impact of chemical changes that occur following processing, including hydrolysis, or storage, or the dynamics of digestion that change throughout the lifespan. Current PDCAAS protocol, even based on the limiting amino acid(s), can produce values greater than 1.0. These values are possible for foods intended for infants, pre-school child as well as for adults. As novel proteins, such as those derived from plant sources, with appropriate amino acid profiles and excellent digestibility, PDCAAS values greater than 1.0 are common. The regulatory implications of these values, and their translation to protein quality communications intended to consumers and regulatory bodies require significant changes in the practical use of this protein evaluation tool for product labeling, and regulatory statutes.

Grain proteins—Combining incomplete proteins and amino acids for improved protein quality
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Cereal Foods World 57:A16

Grain proteins are incomplete with most having lysine as the limiting amino acid. They are also low in leucine and threonine with corn being particularly deficient in branched chain amino acids and tryptophan. However, they are high in methionine. Grains combined with legumes and nuts or small amounts of animal protein are staples and are found in many of the great ethnic dishes around the world. Food processors can create foods that deliver complete proteins by combining complementary proteins or they can specifically fortify with the needed amino acids. Either method can provide proteins for a variety of functions including: weight control, growth of muscle and body tissue from infancy through young adulthood and for sport and body building, especially critical for retention of bone and maintenance of lean body mass in the elderly and infirmed. Use of added specific amino acids such as branched chain ones or glutamine can target special needs or conditions and can be important for building tissues and strengthening the immune system. Product formulation requires care because the added proteins build food structure, which may or may not have positive sensory attributes. Off flavors imparted by proteins and isolated amino acids need to be addressed in the final product. Food processing procedures and storage conditions must be monitored to ensure protein quality and amino acid availability in the final products.

Starch Modification

Influence of granule hydration on starch chemical reactivity at the granular and molecular levels
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Cereal Foods World 57:A16

Some extent of granule hydration/swelling is necessary for any degree of starch derivatization to occur, with reaction efficiency reported to be proportional to the degree of granule hydration/swelling (without pasting granules). Nevertheless, the extent to which the degree of swelling impacts starch reaction patterns at the molecular level has not been established. A model reaction system utilizing a fluorescent probe, 5-(4,6-dichlorotriazinyl) aminofluorescein (DTAF), as a reagent was utilized to explore the impact of the degree of granule hydration/swelling on both granular and molecular reaction patterns within modified starch products. Reaction substrates included both normal and waxy starches of wheat and corn, which were hydrated to varied degrees under controlled relative humidity (RH) conditions (25, 55, 75, 86, or 100% RH), and then reacted within an organic solvent reaction system (to maintain pre-established starch moisture levels over the course of reaction). Confocal laser scanning microscopy was utilized to monitor granular reaction patterns of starch derivatives, while size-exclusion chromatography (equipped with refractive index and fluorescence detection) was used to track the extent of reaction on amylose (AM) and amylopectin (AP) branch chains. For starches equilibrated under conditions ≤ 86% RH, reaction was primarily limited to external granule surfaces (including those of channels and internal cavities). However, reaction within granule channels was enhanced with increasing levels of hydration, suggesting that channel structures likely swell open with appropriate granule hydration. At the molecular level, AP long chains were more densely reacted than AM (2-4.5 fold). However hydration of starch at 100% RH prior to reaction resulted in reaction throughout the granule matrix, with molecular reactivities approximately 40-fold higher than those observed for 86% RH equilibrated starches. Thus, extent of hydration greatly impacts both starch granular and molecular reactivities.

Amylose inclusion complexes produced by combining various ligands with jet-cooked amylose
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Cereal Foods World 57:A16

Our research on starch-lipid composites obtained by steam jet cooking showed the involvement of amylose/fatty acid complexes in both spherulite formation and the coatings that form on oil droplets, imparting composite stability. Native fatty acids present in cornstarch granules serve as ligands for the amylose complexes. By adding or substituting other ligands of interest for specific applications, the advantages of amylose complexes as environmentally favorable and simple bio-based materials could be exploited. A vast array of potential ligands is described in the literature, but they are usually prepared on a small laboratory scale. Therefore, our research project is aimed at large-scale production of amylose/ligand complexes using this scalable thermomechanical technique. The physical form of the complexes varies greatly depending on the nature of the ligands, cooking and cooling conditions, and the presence of other substances in the dispersions. Much of our initial research was done with complexes made with high amylose cornstarch and sodium palmitate. Dispersions of amylose/sodium palmitate complexes exhibit increased viscosity on acidification. By adjustment of pH, salt content, and complex concentrations, a wide range of liquid and gel properties can be obtained. Similarly, the formation of spherulites of different size and morphology can be affected by altering processing and cooling conditions of various combinations of high amylose starch and fatty acids. Potential uses for these complexes include alternatives for natural gums or covalently modified starches, biolubricants, carriers for functional food ingredients, substrates for microbial production or dispersal, and many others. We are investigating different amylose/ligand combinations and processing methods to develop new food and industrial applications in cooperation with industrial partners.

Exploring granular architecture of starches through physical modifications
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Cereal Foods World 57:A16

Physical modification techniques could be used as a probe to understand the inner structure of starch granules. Annealing (ANN) and heat-moisture treatment (HMT) are physical modification techniques that modify starch structure without destroying its granular structure. The term HMT is used when low moisture levels (<35% w/w) are applied, whereas ANN refers to treatment of starch in excess water (>65% w/w) or at intermediate water (40–55% w/w). Both HMT and ANN occur below the onset temperature of gelatinization and have been shown to modify the structural arrangement of starch chains to different degrees. Microscopic techniques (SEM, CLSM, BFM, PLM), 13C cross polarization magic angle spinning NMR, iodine binding (K/S spectra), XRD, DSC, granular swelling, amylose leaching and acid hydrolysis have been used frequently to examine the morphological (e.g., formation of fissures and cracks on the granule surface) and structural (e.g., the double helical content, crystallite reorganization and stability, amylose-lipid interaction, starch chain interactions) changes after the treatments of starches. However, structural changes within the amorphous and crystalline regions of starches (varying in amylose content) at different levels of HMT and ANN have not been thoroughly investigated. In this presentation, structural changes within amorphous and crystalline domains of normal, waxy and high amylose starches subjected to different level of HMT and ANN will be discussed with reference to differences in amylopectin unit chain profile (number of clusters, cluster size, interblock chain length), crystalline defects and crystalline pattern.

Preparation, structure, and properties of octenylsuccinic starch
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Cereal Foods World 57:A16

Native starch has limited applications and is often chemically modified to improve its functional properties. Octenylsuccinic anhydride (OSA) modified starch has the ability to stabilized oil-in-water emulsions and is widely used in beverage and encapsulation applications. The functional properties of octenylsuccinic (OS) starch depend on its degree of substitution (DS) and distribution of OS group as well as molecular structure of starch. The objectives of this study were to examine the reaction of OSA with different physical forms of starch, prepare OS starches with different substitution patterns, determine the structure of OS starches, and relate the structural information to the emulsion properties of OS starches. A systematic study was performed to investigate the reaction of OSA with granular waxy maize starch, microporous starch and soluble maltodextrin. FT-IR microspectroscopy was used to detect the heterogeneity of the OS starch products. Structure of the OSA and modified starches was studied by one-dimensional (1D) 1H and 13C and two-dimensional (2D) homonuclear correlation and heteronuclear correlation nuclear magnetic resonance (NMR) spectroscopy. In granular starch, most OS substitution occurred at the O-2 and O-3 positions, whereas in the maltodextrin, O-2, O-3, and O-6 positions were substituted, even at the reducing end. Alpha-amylase degraded OS starches with different OS distributions were prepared and characterized. The orange-oil-water emulsions prepared by the OSA modified maltodextrin had a smaller

emulsion particle size compared to a product produced by reacting OSA with granular waxy maize starch and then degraded by alpha-amylase.

Modification of starch in alcohol
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Cereal Foods World 57:A17

A variety of starch modifications, both physical and chemical, are known and used today to create starches with a wide range of functionalities. Modification of starch is usually performed in an aqueous media. The use of alcohol starch modification is less widely known and used. Both physical and chemical modifications of starch can be performed in alcohol. Granular cold water swelling starch can be made by controlled heating of starch in an aqueous alcohol system. Acid hydrolysis can yield unique products when done in alcohol, and high substitution levels can be achieved when starch ethers are made in alcohol systems. Alcohol extracts polar lipids and proteins from starch and alters the starch granule structure. When starches are heated in alcohol, the ordering of starch chains within the granule is altered, as evident by a change in birefringence. The crystalline structure of starch changes from a double helical structure (A- or B-type) to a single helical structure (V-type) when starch is heated in alcohol. The single helical starch is in a semi-stable state and changes rapidly when exposed to water. Due to the changes in granule structure, the starches resulting from physical and/or chemical modifications in alcohol have unique functionalities compared to starches modified in a traditional aqueous system. Depending on the modification applied, these starches may be cold water swelling, show rapid gel formation, form high gloss gels and/or exhibit very high water holding and freeze-thaw stability.

Statistical Tools Supporting Food Safety, Regulatory, and Processing

Using statistical models to understand food safety risk
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Cereal Foods World 57:A17

Mathematical models can be used to describe the relationship between measured outcomes and variables that are believed to influence those outcomes. Using sample data to choose the form of the model, and to estimate any unknown parameters, is referred to as *statistical modeling*. Once a model has been estimated, it can be used for a variety of purposes, including diagnostics, troubleshooting, planning, and prediction. For example, we might use a model to describe how microbial growth is impacted by environmental conditions and product formulation. We can fit that model using microbial counts taken over time for varied media that are stored under different environmental conditions. The estimated model could then be used to predict how a microorganism might respond in a certain formulation experiencing abusive storage conditions. In a food safety context we are primarily interested in using models to understand or predict the risk of occurrence of adverse events. A variety of statistical modeling techniques must be used for these scenarios, because the outcomes and influencing variables may be continuous measures or discrete events. In this talk we will describe a modeling framework for some food safety applications, and illustrate them with examples.

Labeling compliance: Overage and impact on cost of goods
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Cereal Foods World 57:A17

To meet labeling claims when nutrient delivery systems are subject to process variability the target values of the delivery systems must be set to deliver an average amount larger than the label claim. This required overage results in an increased cost of goods. In this paper we will demonstrate why these overages are necessary and how to use estimates of the delivery system standard deviation to set targets that will result in a low probability of failing regulatory inspection. A simple Microsoft Excel application will be used to set targets and conduct "what-if" analyses on the effects of reducing process variation on overage costs. Using the concept of tolerance limits we will show how the sample sizes used to estimate the standard deviations impact delivery system targets. We will also discuss the impact of measurement system error on target setting. A real-life example using fiber claims will demonstrate these concepts.

Ongoing process monitoring
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Cereal Foods World 57:A17

When multiple sites share a common daily process control sample for control charting purposes, the means, and control limits can be summarized to provide invaluable information about the network. Examples of such summaries will be presented to show how this information can be utilized to quantify multiple aspects of a Quality System such as: uncertainty of measurement, identification of individual site biases, quantification of method precision, identification of sites in need of improvement, measurements of competency and network performance, validation of new equipment or demonstration of method equivalency.

Measurement close to zero
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Cereal Foods World 57:A17

A common concern in the analytical method validation deals with evaluating a method's ability to detect an analyte at low concentrations. This is a critical method parameter that needs to be estimated and reported as a part of routine method development. Many techniques are available to estimate this important parameter. In this presentation, the statistical approach of estimating Limit of Detection (LOD) will be discussed. In addition, the concept of Limit of Quantitation (LOQ) will be introduced. Finally, as our ability to detect smaller and smaller concentrations improves, we paradoxically find it more difficult to reduce LOD, due to our inability to subsample large enough quantities of starting material. Eventually, the continuous improvement in detection ability may outstrip our ability to repeatably homogenize, subsample, and extract analytes from food matrices.

Sampling applications in research and quality
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Cereal Foods World 57:A17

We sample instead of measuring everything. We don't really need to measure every grain in a carload to estimate the protein and moisture levels of the grain in that car. Sampling is more efficient than measuring everything. If we want to evaluate and compare varieties of soft wheat, we can't measure all of the wheat in each variety, and next year's crop is not yet available. Researchers run experiments on samples of materials and then extrapolate their results to whole populations of similar materials. We use statistical sampling methods to ensure that the measurements of our samples can be applied to the material we want to describe. In this presentation we will discuss random versus representative sampling and the difference between replication and duplication. We will discuss sampling for general characteristics such as moisture, protein, ash, etc. versus sampling for rare events, such as insects, kernels infected with mycotoxins, bacteria counts, or product defects. We will look at probabilities associated with different sampling schemes. We will discuss advances in sampling for QA/QC.

Whole Grains: Where Are We and Where Are We Going?

Current state of global whole grain definition and the future of global whole grain foods definition
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Cereal Foods World 57:A17

Whole grains (WG) were defined by an AACCI expert committee over a decade ago. The definition states that WGs must have the "same relative proportions" of bran, germ and endosperm as the original grain. To further the definition, AACCI subcommittees are cataloging data on milling fractions and their variability within and among species for each grain type. While the WG definition is internationally agreed upon, an agreed upon definition of a WG food (WGF) is needed for nutrition research, education and labeling. Epidemiological studies that show health benefits of WG did not all use the same percentages or included items that may not be WG such as bran, "dark" bread, or barley and omitted some potentially WGFs, such as buckwheat pancakes. Neither is there a uniform definition of a WGF for use by regulatory bodies among countries or even within a country. Many issues exist in defining and labeling a WGF including: differences in daily

WG requirement; variations in the label basis (e.g., wet or dry weight) and amount of food nutritionally labeled (e.g., 100 g or serving); role of detractor (e.g., sugar) or enhancer (e.g., fiber) components in a WGF; and the lack of data for some WG and pseudocereals. Further, the following positions all need to be weighed: all WGs contribute to intake, the need for transition WGFs to re-train the palate, the need to increase the fiber intake, and the desire for labeled WGFs to be able to deliver the recommended amounts if dietary advice is followed. The definition of a WGF needs to be robust for researchers trying to prove the health benefits of WGs, to provide clarity to enable consumers to meet recommended WG intake while not confusing or creating a "halo" effect, and to be fair to industry trying to develop and label WGFs.

Whole grain health claims—Current state, what is needed for the future
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Cereal Foods World 57:A18

Whole Grain Health Claims were first established in1999 through the FDAMA process (1997 Food and Drug Modernization Act) by a petition submitted to the Food and Drug Administration (FDA) by General Mills. This health claim is based on an authoritative statement as required by FDAMA and is the only health claim that addresses two diseases in a single claim. This talk will discuss the development of the whole grain health claim and its evolution through additional amendments. A newly proposed qualified health claim linking whole grains to the reduced risk of Type 2 diabetes was published in March 2012 by FDA and is currently under review by the Agency. This presentation will explore the scientific basis for the proposed diabetes qualified health claim as submitted in a petition filed by ConAgra. Are additional health claims feasible based on current public health recommendations to consume more whole grains and as scientific evidence expands the link of whole grain to health benefits? We will explore areas that may hold future promise for whole grain health claims, including the Agency's scientific evidence guidelines and research needs for health claims.

Current gaps in whole grains health and nutrition research—What are the future needs?
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Cereal Foods World 57:A18

In spite of the extensive literature relating whole grains to health, there are still many questions surrounding the role of whole grains in health maintenance. Whole grain health research is hindered by lack of standards for whole grain foods and difficulties in assessing intakes of whole grains. For example, the 2010 US Dietary Guidelines recommendation that at least half of all grains consumed should be whole grains was largely based on evidence that whole grain intake protects against cardiovascular disease, but applying the FDA definition of whole grains greatly limits the scientific evidence to support the relation because few studies meet this definition. Measuring whole grain intake is also complicated by the ever growing number of whole grain-containing products and reformulations of these products. New biomarkers of whole grains, such as alkylresorcinols, are being examined for assessing intake, but these measures have their own limitations. Much of the focus on health benefits of whole grains has focused on fiber, but whole grains are also sources of many other nutrients and phytochemicals. The frequent failure of interventions studies to support the evidence derived from observational studies also calls into question the health benefits of whole grain consumption. These and other issues will be discussed for the purpose of clarifying future directions for whole grain research.

Meeting the whole grain dietary guidelines—Are they sustainable given the food supply and current consumer food environment?
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Cereal Foods World 57:A18

Over the past 30 years the Dietary Guidelines recommendations have not been effective in establishing dietary practices within the US population conducive to reducing risk for chronic disease. We have traditionally emphasized educational opportunities directed at consumers; however, effective education must coincide with a "healthful" food environment that allows consumers a fighting chance to select a "healthier" diet. The grains community must step-up to MyPlate—along with an equal and unified commitment to create a sustainable food environment emphasizing more healthful grain-based food options that meet cost, convenience and taste demands of consumers. Building multi-sector partnerships across the food system and embracing "shared value" is the most pressing and fundamental issue facing the development, delivery and enhanced consumption of better for you grain-based foods by consumers. Partnerships which focus on the practice of "shared value" will allow the grains community to contribute to the good of both business and for the well-being of society. Not only is there opportunity to include more whole grain and dietary fiber in already highly consumed grain-based foods, but we have the opportunity to address portion size and caloric density in augmenting grain based foods as a vehicle to a more healthful diet. Additionally this will allow us to rise to the challenge put forth by the 2010 Dietary Guidelines for Americans Advisory Committee—to make the healthy choice the easy choice.

Whole grain food technology—What are the current applications and future considerations?
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Cereal Foods World 57:A18

The types and consumption patterns of grain-based foods are changing. Wheat flour consumption is declining. We need to balance the intake of whole and refined grains. Other health needs and industry trends add complexity to increasing the availability and consumption of whole grain foods. Dietary Guidelines recommends lowering sodium, added sugars and solid fats in our diets. Food safety is a strong need, and consumers want products made with simpler ingredients. Hurdles to greater acceptance of whole grain foods are texture, color, and flavor. Texture can be improved by milling technology to minimize the impact of the bran on product mouthfeel. This is particularly important for certain foods like pasta. Color can be customized and controlled by considering seed coat color and other attributes in selecting grain ingredients. Along with skillful product development, supply chain management is important to eliminate development of off flavors and to maximize shelf life. Future considerations to increase availability and consumption of whole grain foods involve improvements in food manufacturing to gear processes to whole grain formulations. Another important consideration is to optimize and balance the formula to maximize consumer liking while minimizing added sugars, fats and sodium. Developments in grain genetics will also be important to make nutritional, flavor and functional improvements to grains for better end product quality and nutrition.

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2012 Annual Meeting
Abstracts of Oral Presentations

Abstracts submitted for oral presentations at the 2012 annual meeting in Hollywood, Florida, September 30–October 3, 2012. The abstracts are listed in alphabetical order by first author's last name. Abstracts are published as submitted. They were formatted but not edited at the AACC International headquarters office. Recommended format for citing annual meeting abstracts, using the first abstract below as an example, is as follows: Ahmadi-Abhari, S., Woortman, A., Hamer, R., and Loos, K. 2012. Kinetics of the formation of amylose-LPC inclusion complexes and their influence on enzymatic digestibility of wheat starch suspensions. (Abstr.) Cereal Foods World 57:A19. http://dx.doi.org/10.1094/CFW-57-4-A

Kinetics of the formation of amylose-LPC inclusion complexes and their influence on enzymatic digestibility of wheat starch suspensions

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Cereal Foods World 57:A19

Starch is the largest source of carbohydrate in human nutrition. Its enzymatic degradation results in glucose and the rate considerably implicates in the complications related to obesity, diabetes, etc. Because wheat starch is a basic ingredient of food, it formed the core of the present work. LPC (Lysophosphatidylcholine) is the most prominent phospholipid in wheat starch; hence we studied the starch-LPC interaction. LPC was employed in several concentrations in 9% w/w wheat starch suspensions. The effect on the thermal properties and the viscosity behavior of starch suspensions were studied using DSC (Dynamic Scanning Calorimetry) and RVA (Rapid-Visco Analyser), respectively. The influence on the morphology of starch granule was evaluated by light microscopy and CLSM (Confocal Laser Scanning Microscopy). DSC results proved amylose-LPC inclusion complexation. Depending on the LPC concentration and the employed time and temperatures, the characteristics of the starch granules differed. LPC at high concentrations blocked the functional properties of starch; however, at low concentrations the pasting time was postponed. The effect of temperature and time on the complexation was pronounced when the suspensions were heated at 50-60°C, shown by kinetic study. Time prolongation increased the amount of complexes. LPC hindered swelling and solubility, which suggest less starch accessibility to enzymes. Starch-LPC suspensions were incubated with α-amylase for several time intervals, and the reducing sugar was measured using DNSA reagent. The extent of hydrolysis strongly depended on the amount of LPC and subsequently the rate of complexation. Suspensions with greater complexes were more resistant to degradation, compared to the reference. We have shown that the amylose-LPC complexes are more resistant to digestion at body temperature even under prolonged degradation time.

B-crystalline starch granules with distinct architectures

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Cereal Foods World 57:A19

Probably the most extensively analysed starch of the B-crystalline type is that of potato starch granules, setting the dogma to explain a variety of B-type specific structural phenomena claimed to be typical generally for B-crystalline starch granules. This may not be true, and we critically analysed four different types of B-starches for granular properties and molecular structure, and found that potato (*Solanum tuberosum*) and canna (*Canna edulis*) starches are similar but clearly different from those of lesser yam (*Dioscorea esculenta*) and shotii (*Curcuma zeodaria*) starch. Thus, the growth ring pattern of canna starch granules resembles that of potato, whereas shotii granules possess "slices" rather than rings, and yam granules are very irregular with weak ring pattern. Potato and canna starch granules swell readily at 75 and 85°C, whereas yam and shotii swell less and at higher temperature. Moreover, potato and canna starches possess a lower gelatinization temperature (Tp ~65°C) than shotii and yam (~76°C). The temperature of lintnerization of potato starch granules affects the molecular composition of the remaining lintners, whereas it has no effect of the lintners of shotii starch. The amylose content is similar in all samples, but potato and canna have more long chain amylose. A distinct difference in the amylopectin structure is a higher content of the short Afp-chains (DP 6-8) in potato and canna compared to shotii and yam, possibly suggesting a larger degree of structural defects in the former types of starches. Unexpectedly, the phosphate content does not show any correlation with granular properties. We conclude that at least two groups of B-type starches exist based on distinct, but so far unidentified, differences, possibly resulting from minor differences in the molecular structure of the starch components.

Cereal bioengineering and the potential of new cereal models

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Cereal Foods World 57:A19

Cereals are by far the most important global crops, and they form the basis for the world's starch production. Temperate cereals like wheat and barley are tremendously important due to their adaption to a range of climates. Molecular breeding is, however, hampered by polyploidy and large genomes. New models may provide faster engineering and possibly disclose traits lost during pre-historic selection and domestication, such as alleles in starch biosynthesis that may be useful for modern cereal starch bioengineering. The genome of the grass *Brachypodium distachyon* is sequenced, and in order to explore pre-domesticated and novel features of cereal starch metabolism we carried out comparative analysis of its starch biosynthetic capacity. It is apparent that starch metabolism is conserved in *Brachypodium*, barley and wheat. Also starch structural features provided evidence for a close structural relationship to temperate cereals, even though kernel starch content and starch granule size were considerably lower. In contrast, kernel β-glucan content was much higher than in barley. X-ray scattering and differential scanning calorimetry (DSC) data showed low crystallinity of *Brachypodium* starch granules as compared to barley. Hence, *Brachypodium* can provide a valuable and efficient model for starch bioengineering in temperate cereals but does also provide interesting features for generating health promoting and functional cereals. Comparative starch bioengineering of barley and *Brachypodium* was carried out by genetic transformation to generate hyper-phosphorylated starch by overexpression of the potato glucan water dikinase

from potato (GWD). For barley, the hyper-phosphorylated starch granules had several pores providing support for the presence of a general mechanism in starch degradation in the plant kingdom. Preliminary data for GWD action in *Brachpodium* will be discussed.

Processing and properties of amaranth cake

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Cereal Foods World 57:A20

Because it is nutritious and gluten-free, amaranth is an alternative choice for celiac patients. The objective of this study was to investigate effect of processing conditions on the physical properties of puffed amaranth cakes. Amaranth grain was extruded and cut into 1-2 mm long pellets by an APV Baker twin-screw extruder with a 25:1 L/D. Pellets were dried in a hot-air oven at 65.5°C until 10% moisture (wb), cooled at room temperature and then stored at 5°C. Pellets were mixed with parboiled rice and water to desirable moisture and tumbled in a liquid-solid blender for 1 h. The mixture was tempered for 12 h before puffing. A 4×3×3×2 factorial experiment design with two replications was used, including amaranth pellets to parboiled rice ratio (100, 90, 80, and 70% amaranth), puffing temperature (215.6, 221.1, and 226.7°C), puffing time (4, 5, and 6 s), and moisture content (14 and 15.5%). The mixture was puffed using a Light Energy Rice Cake Machine. Physical properties of amaranth cakes including color, specific volume, hardness, and percent weight losses were determined by a colorimeter, rapeseed replacement, texture analyzer, and tumbling device, respectively. The results show that the color of amaranth cakes was more red and yellow when puffing temperature and/or puffing time was increased, but lightness was decreased. Specific volume of amaranth cake was raised when the puffing temperature and time were higher and the amaranth content was lower. The overall percent weight losses at 1, 3, and 5 min were higher when the amaranth content was increased but lower when puffing temperature and time were increased. Puffing moisture did not have significant effect on specific volume and percent weight loss, however. At 100% amaranth content, the hardness was decreased when the puffing temperature and time were higher. In contrast, when amaranth content and moisture content were lower, the hardness was increased.

Production of xylooligosaccharide (XOS) coproducts from *Miscanthus* x *giganteus*

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Cereal Foods World 57:A20

Miscanthus x giganteus (MG), a perennial grass, has potential as a new bioenergy crop due to its cellulose and hemicellulose content. Currently, MG has been tested in central Illinois and has been reported to attain an average yield of 36 MT/ha/year. The process for converting MG to ethanol only is not cost effective and not ready for commercialization. There is a need to make this process more economical by recovering high value coproducts in addition to ethanol. Xylooligosaccharides (XOS) are sugar oligomers made from xylose units and can be produced during the hydrolysis of xylan, one of the main hemicellulose components. The growing commercial importance of these nondigestive sugar oligomers is based on their prebiotic effect to human health. We recovered XOS through an autohydrolysis process using MG. Miscanthus from the University of Illinois research farm was oven dried overnight to 2.6% moisture and milled to pass through a 0.25 mm screen. Hot water pretreatment was performed in a 25 mL tubular reactor with solid:liquid ratio (1:9); temperatures varied from 140 to 200°C. XOS could be effectively produced at 160, 180 and 200°C at different reaction times. Depending upon reaction conditions, an XOS yield up to 13.9% (w/w) of initial dry biomass was observed. In gel permeation chromatography (GPC), molecular weight distribution migration at different reaction time and temperatures was observed. Further purification trials showed that using water/ethanol solution at the ratio of 50/50 and 30/70 could effectively recover XOS from carbon adsorption.

Modeling the effect of protein quantity and quality on rheological properties of gluten measured by creep-recovery and compression-recovery tests

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Cereal Foods World 57:A20

Among the challenges of studying wheat gluten proteins is the diversity of their composition and variation in their properties during processing. Variations of protein quantity and quality in baking processing continue to impact the wheat industry. The performance of discrete-element-modeling approaches to predict equilibrium rheological properties of gluten as affected by protein quantity and quality was examined. Protein content and quality were varied in increments of 1, 2, 4 and 8% by substitution using five gluten products. We compared elastic and viscous properties of gluten using: 1) creep-recovery test with stress of 100 Pa for 100 s and 2) compression test at 10 N. Experimental creep results were tested with a Burgers model consisting in a Kelvin and Maxwell model in series with one Kelvin element ($r^2 > 0.94$; $P < 0.0001$), to estimate and separate characteristics of pure elastic (spring), viscoelastic (spring-dashpots elements) and viscous flow (dashpot) retardation times and compliances. The model can predict the negative effects of low pH and small molecular weight properties of gluten on the elastic instantaneous response E_0 (49 and 64% decrease), viscoelastic response or retarded elastic behavior E_1 (52 and 76% decrease) and viscous flow (47 and 56% decrease). However, the compression-recovery test was more effective than creep-recovery in detecting differences of gluten recoverability. In the compression-recovery test, %recoverability of gluten significantly decreased at 8% substitution of low pH and small molecular weight properties of gluten, while the other three commercial gluten samples showed a significant increase in %recoverability. We proved that creep-recovery and compression-recovery parameters can predict gluten viscoelastic properties, while the compression-recovery test has more differentiation power for gluten recoverability.

Avenanthramides are bioavailable in healthy older adults when administered in a high avenanthramide oat bran muffin

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Cereal Foods World 57:A20

The major soluble phenolics present in the oat kernel consist of a series of hydroxycinnamoyl- and avenalumoyl-anthranilate alkaloids known as avenanthramides (AV). We have shown that both purified AV and concentrated AV mixtures have anti-atherogenic and anti-inflammatory activity in interleukin 1β-stimulated human aortic endothelial cell cultures, suggesting they may have similar effects in vivo if they are sufficiently bioavailable. To determine the bioavailability and pharmacokinetics of AV absorption, we have conducted an acute, placebo-controlled, crossover study in 12 healthy adults, age 50-70 years with Body Mass Index 18.5-29.9. We have developed a proprietary oat malting and abrasion milling process (US Patent Application 20120082740) producing an oat bran ingredient with 3,000 to 3,500 ppm total AV, about 25-30 times that of regular bran. This bran was incorporated (30% by weight) into a 60 g bran muffin which contained about 45 mg total AV after baking. After a 2 day run-in period following a diet free of oat products, subjects consumed either a muffin made with the enriched oat bran or a placebo muffin, with a 1 week washout period between each intervention. Plasma AV levels for the 6 major AV (A, B, C, O, P, and Q) were determined at specified time points before and up to 24 hours after muffin consumption. Maximal plasma concentration (Cmax) was highest for AV-O at 74.8 ± 41.3 ng/mL and lowest for AV-C at 2.9 ± 1.8 ng/mL. Time to reach Cmax (Tmax) for all 6 AV ranged from 1.4 ± 0.6 to 2.3 ± 0.8 hours. There was an apparent bimodal distribution for AV-O, P, and Q (which contain avenalumoyl functions) suggesting re-absorption of these AV analogues through enterohepatic circulation. This data indicates that AV in this new innovative food source (malted oat bran) are indeed bioavailable in healthy older adults.

Genetic markers in *HvCslF6* are major predictors of beta-glucan concentration in barley

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Cereal Foods World 57:A20

Beta-glucan accumulated in grain cell walls is an important factor determining end-use in barley (*Hordeum vulgare* L.). *HvCslF6* is one of the major genes responsible for beta-glucan biosynthesis. This gene was analyzed to determine the allelic variation between CDC Bold, a low beta-glucan (~3.3%) cultivar, and TR251, a high beta-glucan (~5.2%) line. Comparison of 6.4Kbp of *HvCslF6* showed 16 single nucleotide polymorphisms (SNPs) and two insertions/deletions (indels) downstream of the ATG start codon between TR251 and CDC Bold. Together the indels added 16 nucleotides to *HvCslF6* first intron in CDC Bold. In the third exon an SNP altered at 590 position a more commonly occurring alanine (A) in CDC Bold to a threonine (T) in TR251 allele. Genetic markers were developed for polymorphic sites surrounding the two indels and the A590T SNP. These markers were confirmed useful to select low and high beta-glucan lines in a previously characterized CDC Bold/TR251 genetic

mapping population and a novel recombinant inbred line (RIL) population derived from a Merit/H93174006 cross (4.8 and 5.3% beta-glucan, respectively). Analysis of parental lines of six other genetic mapping populations segregating for beta-glucan concentration validated association between the TR251 *HvCslF6* haplotype and high beta-glucan concentration in populations showing a beta-glucan quantitative trait locus (QTL) on chromosome 7H. The developed markers can be used in marker assisted selection to develop barley lines with desired grain beta-glucan concentration.

Molecular mechanism of bread dough stability improvement by pyranose and glucose oxidase

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Much as glucose oxidase (GO), pyranose oxidase (P_2O) can significantly improve dough stability and bread characteristics. We here studied whether their mode of action lies in crosslinking of gluten protein and/or of arabinoxylan (AX) molecules. Evidence of gluten crosslinking was obtained from changes in free thiol (SH) levels in model systems and in extractability of dough proteins in sodium dodecyl sulfate containing medium upon supplementation with P_2O or GO (0.03 or 0.51 U/g flour) or H_2O_2 (5 µmole/g flour). Analyses of ferulic acid levels in model and dough systems supplemented with P_2O or GO (0.03 or 0.51 U/g flour) or H_2O_2 (5 µmole/g flour) provided evidence for crosslinking of AX. Wheat flour gluten-starch separation experiments were used as a model system to study protein aggregation behavior. Upon addition of increasing levels of P_2O or GO (0.001 to 0.3 U/g flour) or H_2O_2 (5 or 50 µmole/g flour) before mixing, decreasing levels of gluten protein were recovered as large aggregates and, at the same time, a higher fraction of smaller aggregates was found. Simultaneously, an increased retention of AX in the largest protein aggregates was observed. In general, these results allow to hypothesize that in dough AX networks may be formed which sterically hinder excessive gluten crosslinking, hence, impeding the formation of large continuous gluten networks. In addition, high supplementation levels of P_2O, GO or H_2O_2 probably promote the creation of small gluten aggregates, through excessive disulfide (SS) bond formation. These aggregates hardly take part in SH-SS exchange reactions, and decrease the network forming potential of the proteins involved. Previous experiments indicated that supplementation with low levels of P_2O or GO (0.03 U/g flour) clearly improved dough stability in a stressed breadmaking procedure. The improved stability was reflected in a higher bread loaf volume. Low levels probably reinforce the gluten network by introducing a relatively low level of additional SS bonds, hence conferring extra stability to dough.

Quantitative imaging of the layered structure in croissant at different stages of processing

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Cereal Foods World 57:A21

Puff pastry is characterized by a light and flaky texture due to its unique combination of fat and dough in a layered structure. Lamination and sheeting are steps applied to create multiple layers and a fixed thickness. The layered structure has to be continuous to promote desirable texture after baking. The aim of the present study is to apply imaging techniques and imaging analysis used for other food systems, to better understand the croissant-making process, in particular the development of its structures (layers and bubbles). In this work, confocal laser scanning microscopy (pixel size = 0.6 micrometer × 0.6 micrometer) is used to study puff pastry after sheeting. Calculations applied on CLSM image after thresholding and labeling of fat layers provide information about the thickness along each layer (fat and dough), the number of fat layers compared to the expected number, and the number of ruptures in fat layers. The effect of the number of sheets, decreasing the thickness of fat layers, on these parameters was analyzed. If image processing and analyzing are available on CLSM image of croissant, so CLSM in combination with image analysis could be an applicable tool for analyzing effect of process in industry. Global and local expansion during proving was monitored with magnetic resonance imaging (0.5 mm × 0.5 mm) with lower spatial resolution than CLSM but compatible with a visualization of the whole product. Maps of gas, fat and dough proportions in each voxel were calculated from each image using a dedicate algorithm. This allowed to monitor the thickness of each dough layer as well as to evaluate their relative contribution to global expansion. The largest bubbles during proving were visualized, and ruptures in fat layers were also visualized and discussed relative to the sensitivity threshold of the measurement method.

High-speed imaging of wheat kernels for detection of defects

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The soundness of wheat kernels is a concern of domestic processing industries as well as overseas importers of U.S. grown grain. In large enough preponderance, kernels damaged either during plant development or later in storage may negatively affect the official grade of a consignment as well as affect the quality of the intended food product. Currently, official grain inspection for grade and class is performed by human visual analysis. This is a time consuming operation typically taking several minutes for each sample. Digital imaging research has addressed this issue over the past two decades, with success in recognition of differing wheat classes, and distinguishing wheat from non-wheat species. Detection of wheat kernel defects, either by damage or disease, has been a greater challenge. Beginning last year, a study has been undertaken that uses high-speed black and white imaging at 10-bit photometric resolution to detect kernel defects one kernel at a time. The system, composed of hardware (camera, lighting, power supplies, and data acquisition card), software (LabVIEW and MATLAB), and analytical (MATLAB and SAS) components, is designed to 1) capture images of free-falling kernels at opposing angles through the use of optical grade mirrors, 2) parameterize the images and, 3) perform classification. The system operates with a 1/30,000 second exposure time, though image processing has not yet been optimized to take advantage of such high collection rates. Since the first reporting of this system one year ago, a study was undertaken with 50 samples of hard red and hard white wheat subjected to weather related damage during plant development. Parametric (linear discriminant analysis) and non-parametric (k-nearest neighbor) classification models have been tested to determine the image features that best foster recognition of the damage conditions of mold, sprout, and black tip. The examined morphological features include projected volume, perimeter, elliptical eccentricity, and major and minor axis lengths. Likewise, the textural features, as determined from calculated gray level co-occurrence matrices, include contrast, correlation, energy, and homogeneity. The findings so far indicate that with as few as three image parameters, classification (damaged vs. sound) levels approach 85 to 90 percent accuracy. Information learned from this study is intended to lead to the streamlining of feature extraction in image-based high speed sorting.

Morphological and physico-chemical changes in superheated steam processed wheat bran

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Cereal Foods World 57:A21

Superheated steam (SHS) processing is an innovative and sustainable technology that allows for the physical modification of ingredient functionality without necessarily adding and/or producing chemical inputs or side streams. The physical modification of various ingredients to generate novel functionalities using SHS has been applied to food ingredients like starch (cross-linked, stabilized, etc.), among others. However, the effects of SHS processing on more complex ingredients such as the modification of wheat bran functional properties have not yet been elucidated. This study investigated the effects of SHS processing on the morphology and physico-chemical properties of wheat bran. Wheat bran was processed at various temperature (120, 140 and 160°C) and water activity (0.5 and 0.7) combinations using SHS technology. The changes in morphology of various wheat bran components were visualized using electron and fluorescence microscopy. Water-binding capacity via the centrifugation method and swelling capacity via differential volume protocol were measured. Briefly, the results indicate that controlling temperature and water activity during SHS processing leads to modification of physico-chemical properties such as increase in water binding (35%) and swelling capacity (20%). The amount of water-solubilized polysaccharides also increased twofold. Microscopy revealed changes in the ultrastructure of bran cell wall and specific bran tissue components. The implications of the observed morphological and physico-chemical changes are discussed with emphasis on the effect on technological function. This presentation is important for the development of sustainable technologies to enhance the functional properties of cereal and cereal by-products for application in a wider spectrum of food products. In addition, insight on structure (morphology) and function of wheat bran is discussed in light of the present results.

Inhibition of lipase for the stabilization of whole wheat flour during storage using salts commonly found in baking formulations

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Cereal Foods World 57:A22

Whole wheat flour production and demand has increased dramatically in the last decade. Unfortunately, whole wheat flour is highly susceptible to rancidity due to active lipase in dry flour. The addition of metal salts to seed lipases has been shown to reduce its activity. Therefore, the purpose of this research was to reduce lipolytic activity in whole wheat flour through the addition of salts commonly found in baking formulations. NaCl (0.25, 0.50, 0.75, and 1% flour weight basis, 14% moisture), 0.45% KCl, 0.19% Ca-propionate, and 0.03% ethylene diaminetetraacetic acid-ferric sodium salt (FeNa-EDTA) were incorporated into whole wheat flour. All salts except Ca-propionate were effective at inhibiting lipase; NaCl was the most effective inhibitor, reducing up to 76.7 ± 6.8% of lipase activity. The inhibition was greater in red wheat than white, probably because the lipase activity was higher in the red wheat. Samples were evaluated for non-esterified fatty acids (NEFA) and conjugated dienes (CD) as means of quantifying hydrolytic and oxidative rancidity during storage for 24 weeks at 40°C. All treatments significantly reduced the release of NEFA, except for FeNa-EDTA in white whole wheat flour. CD results showed that treatments in red wheat flour reduced auto-oxidation of flour, whereas no protection was observed in white flour. This strategy shows promise as a means of reducing lipolytic activity in whole wheat flour and ultimately increasing the shelf-life for manufacturers.

Manipulation of zein structure with co-protein addition for application in dough systems: A new approach to functionalize non-gluten cereal proteins

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Cereal Foods World 57:A22

Protein Division Walter Bushuk Graduate Research Award in Cereal Protein Chemistry

Wheat gluten exhibits a unique property to form viscoelastic dough upon hydration and mixing. The interactions between gluten proteins, gliadins and glutenins, are responsible for the formation of a three-dimensional viscoelastic protein network. High molecular weight subunits of glutenin (HMW-GS) have been recognized as the main determinant of gluten elasticity. The mechanism involves the structural transitions between beta-sheets and beta-turns and is related to the long repeat regions of HMW-GS and their interactions. On the other hand, maize zein is a relatively small protein and does not demonstrate viscoelastic properties at room temperature, but does above its glass transition temperature. It was hypothesized that addition of co-protein to a zein dough system similar to HMW-GS in wheat gluten might propagate secondary structural interactions and improve viscoelastic properties of zein. The objectives of this study were to develop a quantitative approach to study the secondary structure of proteins in the dough state and investigate and understand the structure-function relationship in structurally manipulated zein. Rheology and Fourier Transform Infrared (FTIR) spectroscopy were utilized to study the structural changes in a zein dough system in presence of a co-protein (i.e., glutenin and HMW-GS). Much improved elastic properties (decreased phase angle values) were observed with the incorporation of a small amount of HMW-GS. Measured phase angle values for zein with glutenin addition at room temperature were similar to those measured for zein mixed at 35°C. Promising results obtained from this study might enable cereal researchers to understand the structure-function relationship in other cereal proteins and to functionalize them in non-gluten dough systems.

A study of natural variation in raffinose family oligosaccharides (RFO) in chickpea

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Cereal Foods World 57:A22

Chickpea (*Cicer arietinum* L.) is the third most important pulse crop used as a source of protein and dietary fiber mainly in developing countries. RFO are nonstructural oligosaccharides characterized by the presence of alpha (1→6) linkage. RFO accumulate during seed maturation and act as a carbon source during seed germination. Humans and monogastric animals lack enzymes responsible for breakdown of RFO, thus causing stomach discomfort and flatulence. This restricts the acceptability of chickpea as food and feed in the western countries. To increase acceptability of chickpea in human diet, RFO concentration needs to be reduced without affecting seed germination. As a first step to develop chickpea seeds with reduced RFO concentration, we analyzed its natural variation in an ICRISAT (India) assembled germplasm collection (150 genotypes) from chickpea's center of origin, center of diversity and selected advanced breeding lines. These genotypes were grown in field (2009 and 2010, ICRISAT) and greenhouse (2010, U of S, Canada) conditions. A modified HPAEC-PAD (High Performance Anion Exchange Chromatography with Pulsed Amperometric Detector) based gradient method was developed to generate RFO profile. This method can separate individual RFO within 20 min of run time with the lowest concentration of detection reported till date. Genotypes grown in greenhouse showed significantly lower (1.58–4.67 mmoles/100 g) level of total RFO compared to field grown (2.08–5.83 mmoles/100g) genotypes indicating the role of RFO in stress tolerance. Stachyose was the major RFO in chickpea seeds followed by raffinose and verbascose. ANOVA revealed a significant effect ($P < 0.001$) of genotype (G), environment (E) and G x E on several chickpea seed constituents. The whole study will be useful in selecting genetic material to develop chickpea lines with reduced RFO concentration and understanding RFO biosynthesis in chickpea seeds.

Hybrid proteins with enhanced functional properties

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Cereal Foods World 57:A22

Young Scientist Research Award

Proteins play a major role in many food systems. Proteins are used in food systems for nutritional as well as functional properties. Some of the functional properties that proteins provide are emulsification, visco-elasticity, foaming, and solubility among others. Every source of protein has some unique functional properties. For example, caseinate proteins have excellent emulsification properties. Product developers are always on the lookout for alternative protein sources that can provide specific enhanced functional properties. A new process is discussed here for preparing hybrid proteins containing altered molecular weight distributions, thereby yielding proteins having enhanced functional and/or nutritional properties. The process can be used to hybridize two or more proteins from different sources. The paper provides a brief overview of the process with specific examples.

Structure of waxy maize starch hydrolyzed by maltogenic amylase in relation to its retrogradation

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Cereal Foods World 57:A22

Maltogenic amylase is used in bakery foods to improve their shelf life. The objective of this study was to determine the degree of hydrolysis and structure of starch in relation to its retrogradation. Waxy maize starch was cooked and hydrolyzed to different degrees using a maltogenic amylase. High performance anion exchange chromatography and gel permeation chromatography were used to monitor progress of hydrolysis and to determine oligosaccharides formed and molecular size (MS) distributions of residual starch structure, respectively. Hydrolyzed starch samples were debranched to study the chain length (CL) distributions which were further related to amylopectin (AP) retrogradation. Differential scanning calorimetry results showed a complete inhibition of retrogradation when starches were hydrolyzed to ≥20 percent degree of hydrolysis (DH). MS and CL distributions of residual AP structure indicated that with increase in percent DH, a higher proportion of unit chains with degree of polymerization (DP) ≤ 9 and a lower proportion of unit chains with DP ≥ 17 were formed. Higher proportion of short outer AP chains which cannot participate in double helices formation supports the decrease and eventually complete inhibition of retrogradation observed with increase in percent DH. The results indicate that the maltogenic amylase plays a very powerful role in inhibiting the staling of baked products even at limited hydrolysis of starch.

***In vivo* chemopreventive effects of yeast-leavened breads enriched with seleniomethionine**

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Cereal Foods World 57:A22

Selenium is an essential trace mineral in human nutrition; this element is found as mineral or associated to proteins named selenized or organic. There are several investigations that have researched the chemopreventive effects of organic selenium components such as selenomethionine (SeMet). This amino acid enhances the production of glutathione peroxidase, which protects mammalian systems against oxidative stress and cancer. We investigated the

chemopreventive effects of yeast-leavened breads enriched with selenized proteins using immune-suppressed mice (SCID CB.1) bearing human colorectal adenocarcinoma HT-29 cell line xenografts. Breads produced using sponge doughs fermented for 16 h with supplemented sodium selenite contained 4.16 µg of SeMet. Three groups of mice were fed with different diets elaborated according to the American Institute of Nutrition (AIN): a basal control, a SeMet standard and the one containing selenized bread. The SeMet dosage evaluated was 2.2 µg/kg/day as quantified by HPLC-Fluorescence detector. Hepatic glutatione peroxidase activity and tumor development was determined after 28 days. A direct relationship between SeMet and reduction of colon cancer was observed. Results suggested that the SeMet enriched diet significantly reduced tumor growth *in vivo*, whereas hepatic glutatione peroxidase activity increased significantly ($p < 0.05$). This study shows that it was feasible to produce yeast-leavened breads enriched with SeMet that protected a mammalian system against oxidative stress and colon cancer.

WITHDRAWN

Effect of gliadin-glutenin ratio on gluten network formation during thermomolding

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Cereal Foods World 57:A23

Gluten proteins can be applied for producing rigid biobased materials. We studied the effect of the gliadin-glutenin ratio on network formation and on the mechanical properties of the glassy end product after thermomolding. Hereto, the gluten proteins were fractionated into a gliadin and a glutenin fraction based on the extractability of the former in 60% ethanol. Both fractions were then combined in different ratios to obtain samples with different gliadin-glutenin ratios. Samples with 7.0% moisture content and without additional plasticizer were processed at 130 and 150 °C for 5 and 25 min. Gluten proteins polymerized during thermomolding and polymerization was faster for glutenin than for gliadin. Gluten polymerization at 130 °C decreases the water absorption of thermomolded gluten. Gliadin-rich samples molded under the same experimental conditions as glutenin-rich samples absorb more water than the latter. The relative contribution of non-disulfide bonds to the gluten network increased with the molding temperature and was higher for glutenin-rich than for gliadin-rich samples. During thermomolding, β-elimination of cystine occurred. Dehydroalanine derived lanthionine cross-links were detected in molded samples in higher levels in glutenin-rich samples than in gliadin-rich samples. The elastic modulus of bioplastic materials, as determined with a 3-point bending test, did not depend on the molding temperature and time at any gliadin-glutenin ratio. However, the modulus increased with increasing gliadin-glutenin ratio. The latter could be related to the higher relaxation enthalpies for the gliadin-rich samples. For glutenin-rich samples the stress at break increased with increasing molding temperature and was correlated with the degree of cross-linking. For gliadin-rich samples the stress at break was independent of the molding conditions.

Mapping of yeast metabolites in straight-dough bread making and assessment of their impact on dough properties

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Cereal Foods World 57:A23

Yeast's role in bread making is primarily the production of carbon dioxide to leaven the dough, and to a lesser extent, to contribute to bread aroma. However, yeast also impacts dough rheology, thereby affecting the quality of the end-product. This study aims to assess the impact of yeast and yeast metabolites produced during dough fermentation on the rheology of dough. Kieffer rig tests showed that extensibility of yeasted dough was reduced but a stronger dough was formed as a function of dough fermentation time. To underpin the mechanism behind this, yeast metabolism was monitored upon dough leavening in a straight-dough bread making process hereby focusing both on sugar utilization as well as the production of primary and pH defining metabolites. Different yeast levels and fermentation times were used. Up to 60 and 1.6 mmol/100 g flour of ethanol and succinic acid were produced in fermenting dough, respectively. Succinic acid was the main organic acid produced in our experiments and was shown to be the main contributor to the dough pH drop observed upon fermentation. Subsequently, the effect of such levels of ethanol and succinic acid on properties of (unyeasted) dough with regard to mixing, water absorption, dough extensibility and gluten agglomeration were studied. Dough mixing tolerance and water absorption were greatly reduced by succinic acid. Reduced dough extensibilities were observed upon incorporation of ethanol and succinic acid in the dough recipe: for 60 mmol ethanol/100 g flour, extensibility decreased up to 35%, depending on the flour tested, whereas for 1.6 mmol succinic acid/100 g flour, a decrease of about 25% was observed. Succinic acid significantly decreased gluten agglomeration. Overall, the impact of both ethanol and succinic acid can to a large extent explain the rheological changes observed upon dough fermentation.

Secondary structural changes in hard and soft wheat flours doughs during mixing

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There is evidence suggesting that dough and gluten network development are influenced by secondary structure changes in gluten proteins during mixing. The question remains, however, whether soft and hard wheat flours undergo the same structural changes during mixing. The aim of this study was to compare secondary structure of proteins in hard and soft wheat flours at various time points during mixing to determine if soft wheat flour dough development follows the same protein structural pattern as hard wheat flour. Optimal water absorption for hard red spring and soft red winter wheat flours was determined using a farinograph, and all doughs were formulated to 500 BU. Dough samples were collected at 30 sec, 1, 2, 3, 6 and 9 min of mixing for ATR-FTIR spectroscopy. A series of H_2O–D_2O blanks were created at various ratios to more accurately correct for the original water contribution in the FTIR spectra without affecting protein structural signals. Proteins in both hard and soft wheat doughs had a large fraction of pseudo-β-sheet structures (>70% of total) and lower content in aperiodic (~20% total) and β-turn structures (~10% of total). Hard wheat flours demonstrated an increase in pseudo-β-sheet structures up to peak mixing torque with a concurrent decrease in β-turn structures. Pseudo-β-sheet structures declined back to original levels for the rest of the mixing period, while β-turn structures increased. Aperiodic structures remained relatively constant in hard wheat dough for the entire duration of mixing. Soft wheat doughs exhibited little change in secondary structure over the entire course of mixing. These results indicate that current theories of dough development fail to adequately describe the physical mechanism(s) driving gluten network development in soft flour doughs and further study is warranted.

Impact of different sodium replacers on structure kinetics and sensory profile of wheat bread

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Cereal Foods World 57:A23

Dietary sodium reduction is an important factor in the prevention of cardiovascular diseases. Most of all, cereal products are particularly affected by regulations, since approximately 25% of the required sodium intake per day and person is taken up by cereal products. However, the traditional use of NaCl fulfills various important rheological, technological and sensory properties while manufacturing baked goods. With respect to this, different

sodium replacers (LiCl, NaCl, KCl, $MgCl_2$, $CaCl_2$, NH_4Cl) were tested in this study regarding their dough and wheat bread alteration. Microscopic structural changes of wheat protein were analyzed and quantified via confocal laser scanning microscopy (CLSM), correlated with Farinograph and Rheofermentometer data. Wheat bread qualities (volume, sensory attributes) were analyzed. Gluten network formation due to cross-linking followed the Hofmeister series which could be indicated by all dough analysis. Dough development time was 7% higher and water absorption 8% lower with NH_4Cl compared to NaCl. $CaCl_2$ illustrated contrary results than NH_4Cl and therefore lower dough development time (-5%) and higher water absorption (+7%) compared to NaCl. Accordingly gas retention capacity of wheat dough with $CaCl_2$ was significantly ($p < 0.05$) lower (-9%) than with NaCl. This effect is based on 7% less protein cross-linking, which could be quantified by image analysis of the micrographs. $MgCl_2$ significantly reduced loaf volume and decreased consumer sensory acceptance, when having added more than 30%. Replacing more than 25% of NaCl with $CaCl_2$ results also in off flavours. In terms of rheological, technological and also sensory aspects, KCl shows the highest similarity to NaCl. The results achieved by this study provide a valuable basis for designing functionally effective sodium replacers.

Establishment of a quantitative structure-function relationship of starch-gluten mixtures and wheat dough during the heating process using DoMiQ

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Cereal Foods World 57:A24

A detailed knowledge about the structure-function relationship (SFR) of biopolymers is essential to control the design of wheat based cereal products. During the formation and processing of wheat dough a large number of chemical and physical changes on the microstructural level of starch and protein take place, especially during the final heating process. The overlapping of the effect of these changes on the macrostructural behavior of wheat dough complicates the development of SFRs. Therefore, the behavior of a) wheat starch, b) gluten, c) model dough (consisting of starch, gluten, pentosan), in comparison to d) real wheat dough was examined at ambient temperatures and during a simulated baking process (4.25 °C min^{-1}). To establish a quantitative SFR, a methodology for dough microstructure quantification (DoMiQ) was used for the extraction of numerical structural features of micrographs providing the basis for a correlation analysis of the structure and functionality of biopolymers. The components were each prepared with up to 9 water levels, based on the solvent water retention capacity of all components and mixtures. The samples were continuously evaluated by fundamental oscillatory rheometry, additionally detached in 13 steps between 30 and 98 °C, and analyzed by a confocal laser scanning microscope in combination with image processing (DoMiQ). The complex shear modulus of the model dough correlated well with the real dough during heating ($r = 0.96$). The starch granule average size linearly increased by 117% as a function of temperature (55-98 °C) with $r = 0.97$ ($p < 0.01$), whereas the gluten denaturation as a function of the area fraction could not be significantly detected by DoMiQ. Based on the results, using the DoMiQ methodology it was possible to establish a quantitative SFR of dough structure on a micro- and macrostructural scale during the heating process.

Stabilization of starch granules using branching enzyme

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Cereal Foods World 57:A24

Branching Enzyme (BE, α-1,4 → α-1,6 glycosyltransferase, E.C. 2.4.1.18) from Novozymes A/S, produced by pure culture manufacture in *B. subtilis* containing a synthetic gene coding for glycogen BE from *R. obamensis,* was used to modify starches of various botanical origins. Industrial production was simulated by modification at extreme starch dry matter content (30-40%) at 0, 750, and 2250 BE Units/g) for 1 hour at 70°C. These conditions led to stabilization of the granular structure for low-phosphate starch types (<1 nmol/mg starch) and only when the highest concentration of BE was used. The effect was studied by differential scanning calorimetry showing that the melting enthalpy of high concentration BE treated sample was 40% higher than the heat treated control. Bright field/polarized light and scanning electron microscopy confirmed retaining of granular structure. The stabilizing effect was not due to decreased BE activity since the product had significantly increased branching as identified by shorter branch-length of the α-1,4 chains assessed by high-performance anion exchange chromatography. Size exclusion chromatography demonstrated the presence of smaller and more uniform molecules, and the product was 40% more soluble in water at 25°C than the heat treated control. Hence, the granules were molecularly modified despite the retained granular organization. The iodine-complex formed with the product absorbed almost similarly to the heat treated control at 620 nm indicating protection of amylose in granule or that high affinity iodine complexing branched glucan products were formed during catalysis. Both iodine binding and granule stabilizing phenomena were seen only for modification at high starch dry matter contents and high BE activity indicating the formation of cross-bound amylose segment in the starch granule product protected from BE action.

Frozen bread dough properties modified by thermostable ice structuring proteins extract from Chinese privet (*Ligustrum vulgare*) leaves

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Frozen dough baking industry has been growing very rapidly in the booming China market. The use of ice structuring proteins (ISPs) in frozen dough has attracted increasing attention in the last few years. Most of ISPs appeared to have low thermal stability, thus, novel ISPs with thermal stability would have definitive advantages for some industrial and biomedical purposes involving thermal processing. Chinese privet (*Ligustrum vulgare*) was an evergreen plant grown widely in China and could survive at low temperature. However, thermostable ice structuring proteins (TSISPs) from Chinese privet leaves and their use in frozen dough have not been reported. The objectives of this study were to improve frozen dough and its bread-making properties using TSISPs extracted from Chinese privet leaves. TSISPs extract thermal hysteresis activity (THA) ranged from 0 to 0.27 °C based on different ice fractions in solution. The effects of the TSISPs extract on melting enthalpy of ice (ΔH), water molecular state, microstructure, rheofermentation capacity and baking properties of doughs during frozen storage were investigated by differential scanning calorimetry (DSC), thermal gravimetric analysis (TGA), scanning electron microscopy (SEM), rheofermentometer and texture analyzer. The addition of TSISPs in frozen dough caused a decrease in freedom of water molecules and ΔH, which resulted in improved microstructure of frozen doughs, fermentation capacity and baking properties. Residual gluten fibril increased and exposed starch granules decreased while gas production and retention of frozen doughs was enhanced. These effects resulted in an increase in specific volume and a decrease in crumb hardness of baked frozen dough. The positive roles of TSISPs in a frozen dough system will make great technical contributions to the frozen dough baking industry.

Extrusion of wheat flour fractions to improve functionality and add value

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Milling of wheat generates different flour fractions which differ in composition and functionality. Based on ash content these fractions are graded, which also determines their economical value. Low grade fractions are high in ash and generally not used in baking applications due to their inferior breadmaking performance. Thermal treatment of wheat flour by extrusion process is a potential alternative to batch processes. Hydrothermal treatment of low grade flour fractions could improve their functionality such as gelling and pasting characteristics, and freeze-thaw stability. In this study 15 flour fractions of hard red winter wheat milled in Hal Ross Mill were grouped into low, medium and high ash fractions and extruded using TX 52 pilot scale twin screw extruder. The objective was to improve functionality of low grade wheat flour fractions and add value. Factors studied were 3 in-barrel moisture (18, 21 and 24% wb), 3 extrusion temperature (70, 90 and 110°C) and 3 flour fraction groups (0.47, 0.64 and 1.34% ash content). Extrudates were dried and ground to reduce the particle size below 240 µm. Resulting samples were subject to particle size analysis by laser diffraction, proximate analysis and water holding capacity tests. Rapid Visco-Analyzer was used to study pasting characteristics of extruded samples. Differential scanning calorimeter was used to determine the degree of starch gelatinization. The effect of extrusion treatment on the protein was studied using Size Exclusion-High Performance Liquid Chromatography. Fiber and protein decreased from high to low ash flour (0.57-0.03 and 19.8-13.8%, respectively). Extrudate flours had at least 4 folds (~90 to 450%) water holding capacity than control, and it generally decreased with increase in extrusion moisture and temperature. Moisture, temperature and ash content influenced peak viscosity, setback and final viscosities of extruded flours.

Influence of process parameters on end-product characteristics of extruded starch-based "half products" during microwave induced expansion

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High nutritional quality and low fat content are issues of great importance for today's consumers. Microwave expanded products provide a low fat

alternative to deep fat fried snack products. In this work, microwave induced expansion of non-expanded extruded "half products" containing wheat flour, 11.6 % sugar and about 41.56 % water was conducted in a drying processor. A bulk of 200 g of the pellets was expanded at different specific microwave power levels and at four different pressures between 20 and 190 mbar in a rotating drum. The bulk volume expansion index (Ex) was defined as the ratio of the initial and final bulk volume. In literature Ex-values up to 11 are reported. But a desirable product quality depends also on other quality attributes like homogeneous pore structure and acceptable hardness. As these factors depend very much on material composition and sensory necessities optimum parameters cannot be defined in general. Uniaxial compression tests for single expanded pellets were performed with a texture analyzer. The maximum penetration force was used to express the hardness of the samples and the coefficient of variance to express the homogeneity of the expansion. The maximum wall thickness was measured from digital pictures of expanded, halved pellets by image processing. A linear correlation between the specific microwave power and the Ex was found at a pressure of 50 mbar in the cavity. With increased microwave power the wall thickness and the hardness of the pellets decreased whereas the homogeneity of the air cell formation was increased. Different pressure levels of 20, 50 and 100 mbar had no significant influence on Ex and pore structure. Optimum process conditions of 50 mbar pressure at 16 W/g energy density led to the highest Ex of 2.2, to a homogeneous pore structure and a hardness comparable to commercial available products.

Effect of pre-germination process on the qualities of rice bread

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This research aimed to investigate effects of pre-germination process on the properties of pre-germinated brown rice flour (PGBRF), and the qualities of rice bread were studied to compare with polished rice flour (PRF), brown rice flour (BRF), and wheat flour (WHF). Paddy (*Oryza sativa* L. cv. KDML 105; 15% amylose contents) was soaked in 30°C water for 12 h and incubated at 30°C for 24 h until it germinated at the optimum stage, which had embryonic growth length between 1-2 mm and germination rate between 70-80%. The three rice flours exhibited significantly higher swelling power at 55°C (3.64-4.38 g/g), 75°C (7.54-8.50 g/g), and 95°C (17.02-19.14 g/g) compared to wheat flour at 55°C (3.66 g/g), 75°C (6.88 g/g), and 95°C (14.45 g/g). The solubility of PGBRF (10.71-27.82%) was higher than BRF (6.61-24.02%) while the PRF showed the lowest solubility (3.04-21.28%). Moreover, the solubility at 95°C of PGBRF and WHF were not significantly different ($p \geq 0.05$). The PGBRF was significantly ($p < 0.05$) reduced the pasting profile of BRF. The pasting profile of WHF was presented between the pasting profiles of BRF and PGBRF. We compared the qualities of rice bread from PRG (PRB), rice bread from BRF (BRB), and rice bread from PGBRF (PGB) on the batter process to the wheat bread on batter process (WHB) and wheat bread on dough process (WHD). The rice breads and WHB were lower specific volume (2.41-3.78 cm^3/g) than WHD (4.70 cm^3/g). The hardness of WHD showed the lowest value (118.20 g). The hardness of BRB (321.29 g) was significantly higher than that of PRB (173.53 g), PGB (190.44 g), and WHB (203.83 g) ($p < 0.05$). The pre-germination process caused reduction in the final viscosity of BRF (2,402.33 to 1,376.33 cP), which related to reduction in the hardness of BRB. The porous structures of all breads on batter process were not significantly different ($p \geq 0.05$). As a result, the rice breads could be produced by totally rice flour, although the rice breads presented lower qualities than WHD but similar to WHB.

Zein based nano-functionalized films: Characterization for mechanical and antimicrobial properties

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Nanoparticles (NP, core/shell TiO_2@@SiO_2) were incorporated in corn zein protein (CZP) films and characterized. CZP at 13.5% was mixed with 79.5% ethanol (19:1 ethanol:water) and plasticizers glycerin, 3.7%, and polyethelyne glycol 3.3% w/w. NP at 1.5% w/w was added to zein solutions and treated with high-power sonication at 0, 10, 50 and 100% amplitudes, along with no NP control. Ten, 15, and 20 g of the protein mix were cast on 100-mm dia petri dishes for 3 film thicknesses and dried at 25 ± 2°C. Films were then conditioned at 50 ± 2% relative humidity. Film properties, tensile strength, contact angle, thermogravimetric analysis (TGA), differential scanning calorimetry, rheology and water vapor transmission (WVTR), were measured. Sonication, presence of NP, and film thickness all affected mechanical properties of CZP films. NP in sonicated CZP films increased contact angle to 71° compared to 14° for no sonication. Droplet absorption time onto film increased from 120 to 360 s due to higher sonication. Films showed thermal degradation peaks between 260 and 320°C irrespective of thickness. Film glass transition temperature was between 105 and 120°C. Young's Modulus varied with thickness, degree of sonication and presence of NP. No significant difference in WVTR due to NP presence (10^{-11} g m/m^2 s Pa) in CZP films was observed. NP resulted in white/light yellow colored CZP film compared to dark yellow without it. The NP showed antibacterial effect in delaying the growth of bacteria *S. epidermidis*: a 2-log reduction in concentration after treatment with UV light for 1 h. The bacterial peak growth was delayed by 6 h. Microbial testing of cast CZP film with NP is being carried presently. The zein films were comparable to whey protein films in strength. Antimicrobial zein films/coatings will have functional applications in food processing/packaging/surface sterilization.

Effects of salt reduction on gluten hydration, microstructure, and dough rheology in a relation to bread-making

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With an increasing demand from consumers for healthier food, reduced levels of salt in manufactured foods has become a high priority for the industry. Salt (NaCl) is added to cereal based foods to provide taste, but also to promote the physical properties of the starch-gluten composite that are required for processing and creating the desired textural attributes of the end-product. In this paper, the effects of three levels of salt (0, 1 and 2%, w/w, fb) on (a) the hydration and network formation of gluten and (b) the rheological properties of the dough in a relation to bread quality was studied using Australian commercial high protein (HP, 13.5%) and low protein (LP, 9.0%) wheat flours. These two flours also have different ratios of polymeric to monomeric protein. Analysis by confocal microscopy showed that the presence of salt delayed the formation of the gluten network during dough mixing. This was attributed to a reduction in the rate of gluten hydration. When salt was added, an orderly fibrillar gluten structure was developed, but in the absence of salt the gluten formed a "honeycomb-like" structure with thinner protein strands. Changes in the gluten network were further characterised by determining the dough strength using the hardening coefficient and index, which were calculated from stress-strain curves obtained in large deformation extension measurements. It was found that lowering the level of salt had a greater effect on reducing the strength of doughs made from LP flour compared to those from HP flour. Lowering the salt level also caused a greater reduction in loaf volume and number of air cells in bread made from LP flour compared to those made from HP flour. This study suggests that both protein content and the ratio of polymeric to monomeric protein should be considered in the formulation of low salt cereal foods.

Production and characterisation of arabinoxylo- and xylo-oligosaccharides from xylanase and acid hydrolysis of wheat arabinoxylan

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The aim of this research was to develop an efficient procedure for the production of 1,4-β-D-xylo-oligosaccharides (XOS) from wheat flour arabinoxylan (AX). The plan is to use these oligosaccharides as starting materials in the preparation of *p*-nitrophenyl-XOS for use as substrates for measurement of *endo*-1,4-β-xylanase (*endo*-xylanase). Wheat arabinoxylan is depolymerised to oligosaccharide fragments by the action of *endo*-xylanase, but the degree of hydrolysis is limited and mainly arabino-xylo-oligosaccharides (AXOS) are produced. We have investigated the production of AXOS and XOS by *endo*-xylanase hydrolysis of arabinose depleted AX using a range of *endo*-xylanases and acid-debranched WAX with varying levels of substitution with <Infinity>-L-arabinofuranose. *endo*-Xylanases give quite different patterns of XOS and AXOS on hydrolysis of a particular debranched arabinoxylan. The structures of the AXOS have been studied using NMR, GC-MS and enzymic procedures. A broader range of AXOS structures are produced by *Cellvibrio japonicus endo*-xylanase than that from *Aspergillus niger endo*-xylanase. The patterns of XOS produced on extended, controlled acid hydrolysis of WAX and of oligosaccharides from β-xylanase hydrolysis of acid-debranched WAX have been compared with the aim of developing a format yielding maximum quantities of xylotriose, xylotetraose and xylopentaose. Attempts at producing bio-reactor columns based on <Infinity>-L arabinofuranosidase immobilised on Sepharose 6B will be described.

Practical implications of salt reduction for baked products
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Cereal Foods World 57:A26

The drive to reduce salt content in bread poses two questions: are current dough rheology test methods (using 2% or 2.5% salt) still relevant, and what is the effect of reduced salt on product structure and texture? We have addressed these questions using flours from several UK bread making wheat varieties representing the range of quality types encountered by UK bakers. In answer to the first question, the relationship between loaf volume and key rheological properties is independent of salt concentration used in the test method, although the relation between Extensograph parameters and loaf volume is strongest at 2% salt. There was no significant interaction between salt concentration and test parameters in the Alveograph test. Together, these findings show there is no reason to change the current industry standard methods. Furthermore, considering the salting in and salting out effects on adjusting the salt concentrations, the balance of solubility and protein interactions may optimise the predictability of quality parameters for the extensograph test at 2.0%. In answer to the second question, loaf volume, crumb structure characteristics and crumb texture were significantly affected by changes in salt concentration. Adjusting yeast levels in bakes compensated for some of these changes and enhanced others. These findings will be discussed in relation to development of salt-reduced baked products.

Oligofructose lowers energy intake in healthy humans
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Cereal Foods World 57:A26

Consumption of food components that lower food and energy intake could be an attractive approach to control the balance between energy intake and energy expenditure. Dietary fibres offer possibilities in this respect and current recommendations for weight management include an increase in dietary fibre intake. In the present study, the effect of two levels of oligofructose on the modulation of food intake, on appetite profiles and on blood levels of satiety hormones was determined in healthy human volunteers. Thirty-one healthy subjects (10 men, 21 women) aged 20-60 y with a Body Mass Index of 23-28 kg/m^2 were included in a double blind, crossover study. Subjects received an orange juice drink with 2*5 g oligofructose, 2*8 g oligofructose or 2*8 g placebo (maltodextrin) daily for 13 days in randomized order, with a 2-week washout period between the treatments. Appetite profile, glucagon-like peptide 1 (GLP-1) and peptide YY (PYY) concentrations and energy intake were assessed at day 0 and 13 of each treatment period. Energy intake was significantly reduced (11 %) over time on day 13 compared with day 0 with 16 g/d oligofructose. Moreover, energy intake was significantly lower with 16 g/d oligofructose compared with 10 g/d oligofructose on day 13. Area under the curve (AUC) for GLP-1 on day 13 was significantly higher with 16 g/d oligofructose compared with 10 g/d oligofructose . In the morning until lunch, AUC 0–230 min for PYY on day 13 was significantly higher with 16 g/d oligofructose compared with 10 g/d oligofructose and placebo. In conclusion, 16 g/d and not 10 g/d oligofructose may be an effective dose to reduce energy intake. Combined with the low caloric value and its use as a sugar replacer (especially when combined with high intensity sweeteners) these data further highlight the attractiveness of oligofructose in the development of products aimed at weight management.

Iron and protein in experimental wheat lines carrying the *Gpc-B1* gene from wild emmer wheat
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Cereal Foods World 57:A26

In a typical western diet, about 50% of iron (Fe) is derived from cereals and cereal products. This proportion will only increase as more people embrace vegetarian or low-meat lifestyles for health purposes. In less developed countries, where up to 60% of the calories consumed come from wheat, micronutrients derived from cereals assume even greater importance. At the same time, research in Europe suggests a decrease in micronutrient content in modern wheats. Primitive and wild wheats generally have higher amounts, which is not simply attributable to a smaller-seed-concentration effect. Thus, there is potential for micronutrient enrichment through plant breeding. A gene from wild emmer wheat, *Gpc-B1*, which can increase protein content without an accompanying yield penalty, produces lines which are reported to be higher in Fe as well. Several lines carrying *Gpc-B1* have been grown at ECORC, with higher protein (1-2%) and equal or greater yield than the parent Hoffman. Histochemistry has been used to map the distribution of protein and Fe in the experimental varieties, as well as in commercial checks. In addition to the aleurone layer, which is well known as the repository of most of the mineral content in wheat, significant Fe deposits were also observed in the scutellum. The distribution of micronutrients in the kernel is valuable information for millers and bakers, as by adjusting milling processes they can increase nutritional value of their end product.

Fine mapping the control of starch structural and functional properties in wheat
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Cereal Foods World 57:A26

In previous studies, we have isolated the key genes involved in starch synthesis and utilised techniques such as combining null mutations (e.g., in *ssIIa*) and RNAi (*BEIIa/BEIIb*) to define the roles of individual genes. In this study, we have utilised the diverse and highly recombinant MAGIC (Multi-Parent Advanced Generation Intercross) mapping populations developed at CSIRO to examine the genetic control of a range of starch structural and functional traits. QTL data will be presented, along with an assessment of whether known genes are likely to underpin the QTL. The implications of the analysis for the development of wheat cultivars with specific alterations in starch structure and function by traditional breeding techniques will be discussed.

The utilisation of wheat, oat, and rice brans into extruded ready-to-eat snacks acceptable for children's diet
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Cereal Foods World 57:A26

One of the main problems linked with the children's snacks is contain of high level of fat, sugar and salt and insufficient level of dietary fibre. The incorporation of different brans from wheat, oat and rice into ready-to-eat expanded snacks and their effects on the textural and functional properties of the extrudates have been studied. The brans at the level of 10%, respectively were incorporated in control sample developed with 80% maize starch and 20% milk powder. APV Baker MPF 19:35 twin-screw extruder (APV Baker, Peterborough, UK) with constant process conditions at feed rate of 3.8 kg/h, water rate of 12%, screw speed of 250 rpm and six barrel temperatures of 120, 110, 100, 80, 60 and 40C was used. Pressure, torque and material temperature were recorded during the extrusion runs and consequently Specific Mechanical Energy (SME) was calculated. Samples were palletised to form puffed cylindrical snacks then coated with cheese flavour. A number of nutritional (soluble, insoluble and total dietary fibre and phenolic compounds) and textural (hardness, bulk density, colour and structure) characteristics of the extruded samples were observed. SME during extrusion runs varied between 0.15 and 0.18 kW H/kg. The results revealed that the addition of brans significantly ($P < 0.05$) improved the nutritional quality of the extruded snacks: insoluble fibre and phenolics compounds increased in all the samples, while soluble fibre increased only in oat bran sample. Texture was significantly ($P < 0.05$) affected resulting with the increased firmness and bulk density and decreased lateral expansion. C-Cell analyses revealed significant ($P < 0.05$) difference in brightness, number and area of the cells and wall thickness. The products were highly accepted by the target audience.

Structure of starch salivary amylase hydrolysates after cooking at different water concentrations
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Cereal Foods World 57:A26

Food processing and molecular structures of starch polymers can impact the rate and extent of starch digestion. Digestion of starch in humans starts in the mouth and progresses to the small intestine. A thorough understanding of the progression of digestion, as regarding glycemic and possibly insulinemic responses, requires a better characterisation of the digestion products along the gut, as these represent the substrate in the subsequent hydrolysis by sucrase-isomaltase and maltase-glucoamylase. This submission focuses on the impact of water content during processing on the hydrolysis products obtained from cooked starch by human salivary amylase. Normal corn starch (NCS) was cooked at two moisture contents, 40% wb (NCS40) and 60% wb (NCS60). To remove the effect of granular structure, NCS was also dispersed using DMSO, and served as the reference sample. Cooked and dispersed NCS were subjected to human salivary amylase at conditions mimicking eating. All samples gave rise to different and complex mixtures of maltodextrins as measured by size exclusion chromatography. The smallest dextrins (DP < 15) constituted 35% in dispersed NCS and only ~20% in both NCS40 and NCS60. The hydrolysed samples were also debranched. This revealed that long linear chains were significantly reduced and the amounts of smallest chains (DP < 15) present in dispersed NCS, NCS60 and NCS40 were 54%, 39% and 26%,

respectively. Beta-amylolysis of salivary hydrolysed samples showed that the amount of largest dextrins (DP > 3000) was lowest in NCS60 and highest in NCS40. This indicates that more internal chains were hydrolysed in NCS60 than in the other samples. Thus, the results show that the amount of water during processing of starch affects the fine structure of salivary amylase hydrolysis products, which may impact on subsequent steps of starch digestion and/or in glucose homeostasis.

Statistics and the cereal chemist
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Cereal Foods World 57:A27

Edith Christensen Award for Outstanding Contributions in Analytical Methods

We use statistics to see some order in an imperfect world. Cereal based foods start with different varieties of crops grown in varying environments, the grains are subjected to different treatments and processes, the flours are mixed and blended with different ingredients and additives, and finally a uniform product is produced. We measure and evaluate grains, flours, mixes and finished products. We determine physical and chemical constituents along with contaminants such as mycotoxins and bacteria. We use statistics to describe our data in simple terms—mean, variance, correlations, etc. We use statistics to describe relationships among measurements and see how different treatments may or may not affect materials. We derive equations from our data and then use those equations to predict the influence of different treatments on our materials. We assign confidence values to our equations. We calculate the probabilities when predicted results are not certain. The QA/QC world in general has been transformed by the prudent use of statistics. Statistics is not a static science but is changing and improving constantly. The current revolution in instrumentation is driving a need for better statistical and graphical techniques and software. These needs are being met by instrument and software developers who are making many very good statistical and graphical products available.

Novel sorghum-based fortified blended food for infants, young children, and adults
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Cereal Foods World 57:A27

Micronutrient fortification in weaning foods is essential for undernourished and at-risk infants. A vitamin and mineral fortified blend of corn and soy known as Corn soy blend (CSB), that is currently in use, is being constantly optimized for product uniformity, micronutrient content and cost of production. The objective of this study was to develop a novel fortified blended food with sorghum as an alternate grain to corn and evaluate the effects of extrusion processing on various quality properties. Sorghum soy blend (SSB) was produced using high (450 rpm at 22% moisture) and low (350 rpm at 30% moisture) shear in a single screw extruder at a feed rate of 150 kg/hr. Prior to fortification, dried and milled samples were analyzed for particle size, starch pasting behavior and flow rates of cooked slurries at 11.75% solids using laser diffraction, Rapid Visco-Analyzer (RVA) and Bostwick Consistometer, respectively. SSB products showed lower end moisture (4-6% wb) when compared to 9% of CSB with favorable shelf-life stability. Particle size was uniform for all milled blends with passage of 85% and 100% particles through a 600 µm and 1000 µm sieve respectively. SSB had lower final viscosity (229 cP) than traditional CSB (579 cP) indicating thinner gruel consistency suitable for infant consumption between 40-45°C. Bostwick flow rates of blends were linearly correlated to final viscosity values (r = -0.826). SSB had higher flow rates (19.5-20.5 cm/min) than CSB (12.0 cm/min). The newly developed fortified SSB is less viscous and free flowing compared to traditional CSB and adheres to new recommendations by Tuft's report to United States Agency for International Development (USAID).

Brown rice can be a "good source" of dietary fiber
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Cereal Foods World 57:A27

According to the USDA National Nutrient Database for Standard Reference, traditional uncooked long grain brown rice has 3.5 grams/100 grams of total dietary fiber. We have found that parboiling and/or traditional cooking can substantially increase the levels of resistant starch in rice, but the amount of dietary fiber remains below the 2.5 grams per 45 grams of dry rice that is required for a "good source of dietary fiber" claim in the US. In contrast, pre-hydrated cooked rice products often have very high levels of resistant starch and thus increased levels of total dietary fiber. The resistant starch created is RS3, and it survives the microwave heating typically used to prepare these products for consumption. The amount of resistant starch is strongly correlated with amylose content, but many pre-hydrated cooked whole grain rice products have enough total dietary fiber as assayed by AOAC 991.43 to make a "good source of dietary fiber" claim based on >2.5 grams per 45 gram serving.

Effect and functionality of thermostable amylases in cakes and high sugar recipes including the impact of sucrose and fat on enzyme functionality
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Cereal Foods World 57:A27

Cakes undergo a staling process after baking where physico-chemical changes affect the appearance, flavor and texture. The staling characteristics observed by the consumer are related to parameters like firmness, dryness and crumbliness. However, the staling and starch retrogradation process of cakes is less well studied. Moreover, the use of enzymes affecting starch retrogradation in cakes is relatively new and not fully investigated. This presentation focuses on the functionality of thermostable amylases such as maltogenic α-amylase (MAA), maltotetraohydrolase (G4-amylase) and bacterial α-amylase in different cake systems. Baking trials and analytical data show the impact of the amylases on staling parameters like firmness and moistness as well as starch retrogradation. TPA data show an improved resilience and softness when adding amylases. Studies made by use of NMR reveal an increase in SFC during storage, whereas DSC measurements do not provide useful results with regards to amylopectin retrogradation. Consumer study and sensory profiling using an expert panel reveals how amylases impact the sensory properties of cakes. The cakes were evaluated up to 2 months of storage. G4-amylases changed the sensory profiles of all the cakes, adding more moistness and elasticity to the cakes along with a reduced crumbliness compared to the other amylases. The study explores the impact of sugar and fat on starch properties and the functionality of amylases by use of Chopin Mixolab and enzyme analysis. Increasing fat levels do not influence starch gelatinization temperature; however, the overall pasting viscosity is reduced. On the contrary, high sucrose levels delay starch gelatinization, but do not affect the total degree of starch gelatinization. Studies show that sucrose has an inhibiting effect on MAA. At 5% sucrose content, MAA loses 80% of its activity. In comparison, G4-amylases lose 10% of their activity.

Response of wheat plants to stress as expressed by antioxidant levels in the grain
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Cereal Foods World 57:A27

Producers of whole wheat products are interested in marketing nutritional benefits in their products. Wheat containing high antioxidant levels could help them achieve this goal. Since wheat antioxidant levels are variable, they need assurance that they can access wheat with consistent, significant antioxidant levels. In order to produce wheat with consistent levels of antioxidants, the factors and mechanisms involved for their expression by plants must be understood. Research has shown that grains from plants infested with insects had 24% higher antioxidant content and 80% higher free radical scavenging capacity than grains from control plants. The objective of this study was to optimize the expression level by determining the physiological stage where maximum expression is achieved. Sets of wheat plants (var. Karl 92) were exposed to damage by insect feeding in the following growth stages: tillering, heading, early and late kernel filling. Antioxidants were extracted from the bran fraction of grains from these plants by acidified extraction, alkali hydrolysis, and liquid-liquid separations. The acid and base extracts were analyzed for total phenolics content (TPC) and antioxidant capacity (AC) by the Folin Ciocalteau and DPPH method, respectively. Extract from grains of plants stressed with insects at the tillering stage had 420 µg FAE/g bran; this was 30% higher than the control. The effect of insect-damage on production of TPC and on AC at other physiological stages is being evaluated.

Adaptation of the Bostwick-based oxidative gelation method to the Rapid Visco Analyzer
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Cereal Foods World 57:A27

The Bostwick Consistometer method for measuring oxidative gelation of flour is time consuming resulting from the need for separate runs for controls, and for samples with reactants. The Bostwick also gives little

differentiation of samples with high viscosity. As the importance of oxidative gelation becomes apparent in soft-wheat products a method with better throughput and sensitivity, suitable to breeding programs, is required. We investigated the Rapid Visco Analyzer's (RVA) potential to test for oxidative gelation. Flour samples were obtained from the USDA Western Wheat Quality Laboratory and from the Pacific Northwest Wheat Quality Council. Preliminary results showed that 20 minute pre-mixing was needed to achieve complete hydration and reactivity as adjudicated by maximum viscosity in 75 ppm hydrogen peroxide in the RVA. Suspensions (50% w/w/ flour:water) were hydrated for 20 min. 30.0 g of the suspension was transferred to an RVA can. The can, with paddle, was placed in the RVA. Settings were: temperature 30°C; speed 960 rpm for 10 s, 160 rpm for 60s. Viscosity at 60 s was recorded for the water-only baseline. The RVA was stopped for 20 s to allow the addition of 65 µL of 3% hydrogen peroxide. The RVA restarted at 960 rpm for 5 s and 160 s for a further 300 s for measurement. Maximum viscosity was recorded. Water-only viscosity was correlated with water-only Bostwick flow ($r = -0.93$, $p \leq 0.01$) although there was little differentiation among the soft wheat set. Peak viscosity in hydrogen peroxide was also highly correlated with Bostwick flow in hydrogen peroxide ($r = -0.81$, $p \leq 0.01$). Increased RVA maximum viscosity was able to differentiate samples that were reactive to hydrogen peroxide compared to those that were not. Increased viscosity in the putatively reactive set ranged from 90 to 462 cP, and in the non-reactive group ranged from 14 to 54 cP.

WITHDRAWN

What has low intensity ultrasound informed us about wheat flour dough rheology?

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Cereal Foods World 57:A28

Rheology Division George Scott Blair Award for Outstanding Research in Rheology and Texture

The role of rheology in the processing behavior of dough, and its predictive capacity with respect to breadmaking quality, is of long-standing interest to cereal scientists. Over the last twelve years, we have undertaken a comprehensive examination of the rheology of wheat flour doughs using low intensity ultrasound. Although it is a low strain rheological technique, ultrasonic measurements of doughs made from flours with a range of breadmaking quality correlate well with parameters acquired from conventional large strain techniques, e.g., alveograph and farinograph. We have also used ultrasound to investigate how dough rheology is affected by bakery ingredients. Propagating shear waves at ultrasonic frequencies in conjunction with small strain shear rheometry allowed us to show how a very broad distribution of relaxation times is necessary to define the complex shear modulus of wheat flour dough. By subjecting samples of dough to uniaxial compression and monitoring relaxation behavior with ultrasound, contrasting results were observed for air-mixed doughs compared to those mixed under vacuum. Therefore, bubbles appear to substantially affect the short-time relaxation behaviour of dough. In conclusion, ultrasound is an emergent technique that has provided us with novel insights into the rheology of dough.

Physicochemical and morphological characterization of different starches with variable amylose/amylopectin content

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Cereal Foods World 57:A28

Starch-rich raw materials are widely used in the food industry. Their functionality and end-use applications are, however, markedly influenced by starch characteristics as well as starch chemical composition. Starches with varying amylose (AM) and amylopectin (AP) content are of particular interest because of their ability to modify and control the texture, quality and stability of starch-based food products. The present study shows the influence of the AM/AP content on physicochemical and morphological properties of a range of starches (Maize = 3%, 23%, 71%; Potato = 2%, 21%; Barley = 3%, 25% AM content w/w of starch). Starches have been analyzed in terms of their chemical composition, water retention capacity, morphological characteristics, and pasting/thermal properties. The changes in starch granule morphology during gelatinization were monitored by Confocal-Laser-Scanning-Microscope (CLSM). The different analyses have revealed that waxy starches (AM < 5%) had a high water retention capacity (1.2-1.5 times higher) and developed higher paste viscosities (up to 40% for maize; 43% for barley) compared to their regular counterparts. The swollen granules were highly susceptible to mechanical breakdown and solubilized faster. Higher AM contents showed inhibition of an extensive granule swelling and lowered the paste viscosity. The exceptional integrity of the high-AM starch even prevented its gelatinization at atmospheric pressure. Significant differences in physicochemical and morphological properties between the starches from regular, high-AM and waxy strains have become evident; no direct relationship between the AM/AP contents and the internal growth ring structures of the starch granules could be identified by CLSM. The waxy starches had a higher gelatinization temperature (up to 2°C) and enthalpy (up to 20%), which indicates a higher crystalline and molecular order.

Composition and properties of pinto bean flour subjected to air classification and extrusion

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Cereal Foods World 57:A28

Fractionation and extrusion can alter properties of bean flour. Pinto beans were milled and air classified in a commercial mill to obtain high starch flour (HSF), followed by extrusion of the HSF. Properties of HSF and its extrudate were compared to whole pinto flour (WPF). Expansion index and hardness of extrudates was 3.3 and 1949 g, respectively. Composition (d.b.) of WPF included 10% moisture, 4% ash, 1.64% extractable lipid (EL), 22% protein, 48.1% resistant starch (RS), 6.5% soluble starch (SS), and 46.4% total starch (TS). Significant differences in composition of HSF were observed in moisture (9.5%), ash (2.75%), EL (1.14%), protein (13.3%), RS (39.9%), SS (7.9%) and TS (56%). Extrudate composition was significantly different from WPF and HSF in moisture (7.4%), RS (0.0%), SS (55.7%) and EL (0.14%). Color of WPF, HSF and extrudates were significantly different. HSF was the lightest ($l = 87.5$) compared to WPF ($l = 81.5$) and extrudates ($l = 77$). Water solubility index of HSF was 14.1% compared to 24.7% in WPF and 32.7% in extrudates, and were significantly different. Water absorption index of HSF and extrudates was significantly lower than WPF by over 30%. Pasting and gelatinization evaluation by rapid visco analyser and differential scanning calorimetry did not produce peaks for extrudates but showed significant differences between WPF and HSF. Peak, breakdown, trough, setback and final viscosities of HSF were higher by over 34%, while pasting temperature and peak time were less by 1.9% and 23.5%, respectively. HSF had significantly lower onset (T_o), peak (T_p), and end temperature (T_c) while gelatinization enthalpy (ΔH) was not significantly different. Gelatinization and retrogradation temperature range ($T_c - T_o$) was 14.7°C (WPF) and 13.3°C (HSF), and were not significantly different. Differences in flours evaluated indicate potential for different food applications.

Effect of the introduction of D-genome related wheat proteins and elevation of starch amylose content in durum wheat on pasta and bread making quality

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Cereal Foods World 57:A29

Durum wheat is typically used to produce pasta, but in some parts of the world, durum is used to make bread but with inferior loaf volume and texture compared to common wheat bread. In addition, studies have shown that elevated amylose content in the starch can increase the resistant starch in food products and reducing the GI. This study describes the effect on technological properties of pasta and bread made from durum wheat cultivar Svevo (S) (recurrent parent, HMW-GS: null, 7+8) and four isogenic lines carrying pairs of subunits with 7+8/5+10 (S5+10), 7+8/2+12 (S2+12), and two lines in which the *Gli-A1/Glu-A3* loci of Svevo have been replaced by the *Gli-D1/Glu-D3* loci from bread wheat, designated CNN and CS. Using two different approaches (RNA interference and natural mutants), lines with higher amylose content (~70% and ~40%, respectively) were obtained by targeting SbeIIa and SSIIa genes in the durum wheat cultivar Svevo. Pasta and bread were made on a small scale and assessed for quality. The semolina was re-ground to flour and used to prepare loaves and mixed in various proportions with a baker's flour. The S5+10 line dough properties were markedly different to Svevo having over-strong, stable dough, low wet gluten and elasticity whereas S2+12 also displayed stronger dough while SCNN and SCS showed more desirable mixograms with a higher gluten index than Svevo. Pasta prepared from these lines showed lower cooked firmness (adjusted for protein differences) ranked S > SCNN > SCS > S5+10 = S2+12. There were no other differences in pasta cooking quality. Bread, loaf volume and loaf score was decreased as more baker's flour was replaced by durum flour, but the decline varied with the genetic material and dosage. The greatest reduction in loaf volume occurred using SCS and SCNN then S5+10 and the least with S2+12 which was similar to S. Bake score was reduced with S5+10, SCS and SCNN only. The best loaf was made using Svevo. The elevated amylose lines had superior firmness, lower stickiness and in vitro starch digestion than Svevo. This work shows that it is possible to manipulate the processing properties of pasta and durum-bread wheat blends by altering the glutenin subunit composition and amylose content, and represents an efficient tool to finely manipulate gluten quality in durum wheat.

Alveolar structure of bread dough and rheological properties of its constitutive phases

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Bread doughs of various compositions were prepared and the evolution of their cellular structure during proofing was studied by computed X-ray microtomography (XRT) with high resolution (5 µm). The cellular structure was followed during the last stage of proofing, from 40 min to 180 min, in order to focus on the connection of bubbles and their possible coalescence. Images analysis allowed to determine porosity, connectivity and the size distribution of the bubbles and cell; these variables were fitted by usual mathematical functions. They showed that different compositions led to different cellular structures, even for same porosity. The kinetics of porosity and connectivity had sigmoid shapes with 0.7 and 1 as asymptotic value, respectively. These results were discussed regarding the influence of the liquid fraction and the sugar content. The volume fraction of liquid increased the heterogeneity of the cellular structure. These results suggested that at the end of proofing, the dough could be considered as a three-phases co-continuous medium: gas/liquid phase/viscoelastic matrix. To elucidate the role of the matrix properties on the evolution of the cellular structure, the elongational behavior of dough was characterized by lubricated squeezing flow. It was found that these properties, alone, did not explain the influence of formulation on the cellular structure. So, the liquid phase of dough seemed to have an important role too, which underlined the relevance of the study of the dough liquor.

Effect of alkaline treatment on functionality of pea starch granules

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Alkaline treatment of starch is often used to enhance colour, flavour and texture of various food products, and also in the isolation of highly pure starch granules. However, the effects of alkali on starch structure and properties are not well characterised compared to other methods of starch modification. This report shows that treatment of native pea starch granules under conditions commonly described in the literature (0.1 M NaOH for15 days at 35°C) results in relatively minor structural changes, which bring about large consequential changes in functional properties. Alkaline treatment caused a loss of about 10% of total starch and decreased amylose content from 35% to 28%. These changes were accompanied by only small decreases in relative crystallinity and double helix content, indicating that most of the molecular and crystalline structures are retained after alkaline treatment. Swelling power was also largely unaffected, but the endothermic transitions, pasting and *in vitro* digestion of pea starch were altered significantly. Alkaline treatment resulted in the broadening of the endothermic transition, and decreased pasting viscosities (peak and final) and set back by about 25% and 40%, respectively. *In vitro* digestibility of the granules by alpha-amylase was greatly increased, with rapidly digested starch increasing from 4 to 16% and resistant starch decreasing from 66 to 50%. Based on the results, we propose that amylose molecules contribute in different ways to the internal organisation of pea starch granules. While most amylose molecules are in a state of low organisation in the granule core and in amorphous regions, there are likely to be some amylose molecules that are interspersed in the amylopectin clusters and provide long-range structural reinforcement to the granules.

Phase transitions of pea starch over a wide range of water content

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Starch gelatinization is defined as the "collapse of molecular orders within the starch granule with the solubilisation of starch polymer molecules". The changes that starch undergoes during gelatinization are major determinants of its functional properties for food processing and digestion. Although the phase transition of starch has been studied extensively by differential scanning calorimetry (DSC), the exact nature of multiple DSC endothermic transitions of starch-water systems is still not well understood. In this study, the phase transitions of pea starch over a wide range of water content (from 34.0 to 97.2 wt %) were investigated by DSC. To the best of our knowledge, this is the first study to address the mechanism of thermal transitions of starch granules over such a wide range of water content. Swelling of starch granules increased progressively with increasing water:starch ratio up to 20:1. The main endotherm G broadened progressively with increasing water content up to 94.5 wt % (water:starch ratio 15:1), above which it became too broad to define. The corresponding peak and conclusion temperatures and enthalpy change increased with increasing water content. Scanning electron microscopy (SEM) imaging of dried starch samples after DSC heating showed that at a water:starch ratio of 2:1, starch granules only swelled partially with discernible granular contours. The above results answer the question why at water:starch ratios of 2:1, there are still considerable residual crystallinity and lamellar structure at the end of the so-called complete gelatinization transition. The gradual transition from a sharply defined to broad endotherm G reflects the changes from very limited swelling to maximum swelling of starch granules (mainly amylopectin molecules) and partial dissolution of starch polymers (mainly amylose molecules).

Effect of drying temperature on the pasting, physicochemical, and qualitative properties of starch in whole wheat pasta

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Drying is considered to be the most important stage during pasta production because of its influence on texture and color in addition to reducing the moisture content. Whole wheat pasta has been linked to having greater cooking loss and being less firm, and it is postulated that drying may be a significant factor affecting these qualities. The objective of this research was to examine the impact of drying on the pasting and physicochemical properties of starch in pasta made using refined or whole wheat flour and to make connections to some key qualitative properties. Macaroni was dried under standard low temperature-long time (LT-LT) or high temperature-short time (HT-ST) oven conditions. Pasting properties using the rapid visco-analyzer showed that drying had a significant effect ($p < 0.05$) on starch in the pasta compared to their respective untreated flours, decreasing its peak, trough, and final viscosities. However, there was no significant difference between starch exposed to LT-LT or HT-ST conditions. Thermal processing has previously been shown to reduce granular swelling and lower amylose leaching, thus decreasing viscosity. Differential scanning calorimetry showed a significant increase in V_H-amylose formation in dried macaroni ($\Delta H = 2.492$ J/g) compared to flour ($\Delta H = 1.644$ J/g), suggesting that lipid complexation further reduces gelatinization by preventing water-starch interactions, a prerequisite for molecular disorder. In addition to firmness that was measured instrumentally, cooking loss also appeared to be significantly affected by LT-LT or HT-ST conditions in both refined (3.5% and 4.2%, respectively) and

whole wheat (4.0% and 7.1%, respectively) macaroni. This data correlates oven conditions to key qualitative properties of pasta, such as firmness and cooking loss, and may be helpful to processors, especially those of whole wheat pasta.

Quantified baking: Methods and bread improving ingredients

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Cereal Foods World 57:A30

The objective of the study is to model and quantify the latent structuralism for methodologies throughout the bread making process for yeast-raised toast bread. The a priori characteristics of baking are embedded in the 3 general information types (dough, baking simulation and final bread) from a stratified multivariate multi methodology study with unprecedented completeness, evaluating a representative ingredient population with well-known bread improving effects (e.g., a negative control, additional water, ascorbic acid and different types of emulsifiers, enzymes and hydrocolloids). The stratification is a complete classification of general methodology specifics naturally implied by proper information splitting from basic methodologies given by: (1) Dough is manifested by farinograph, penetration, kieffer and dough inflation system. (2) Baking simulation (e.g., heating-cooling rheology) is manifested by rapid visco analyser, mixolab and rheometer oscillation. (3) Final bread is manifested by basic descriptive measures of shape/size/appearance, texture profile analysis, c-cell, sensory analysis, nuclear magnetic resonance, surface laser scan, surfscan and videometer. A new statistical modelling frame, derived from a generalisation of existing methods, is argued and applied to model a hierarchical outer-inner structure of quantifiable latencies for stratified methodologies. The outer structure characterises observable latencies from manifestations, whereas the inner structure characterises unobservable factors from similarities. The causal baking process is modelled by an 8-dimensional inner structure, with 2 factors controlling dough, a single factor controlling baking simulation and 5 factors controlling final bread. The conclusion is that baking simulation methods have high coverage of latencies for final bread methods and are the primary baking efficiency discriminator.

Effect of endoxylanase addition on whole wheat flour breadmaking properties

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Cereal Foods World 57:A30

Endoxylanase has been widely reported to improve dough handling properties and bread quality in white flour breadmaking; few reports exist on the effects of endoxylanase addition on whole wheat flour breadmaking. Therefore, we investigated the effects of endoxylanase on dough rheological and breadmaking properties of whole wheat flour from five cultivars: Antelope, Darrell, Hatcher, Nuplains, and Orgallala, and compared them to the corresponding white flour. At 100 ppm endoxylanase in wheat flour, the rheological dough strength and crumb hardness were significantly decreased for both white and whole wheat flour as compared without adding endoxylanase in wheat flour. Dough resistance to extension decreased from 17 to 37% TQ.min in white flour, and 6 to 26% TQ.min in whole wheat flour. The crumb texture hardness was decreased from 444 to 719 N/m^2 in white flour, and 998 to 3554 N/m^2 in whole wheat flour. The crumb cells were more open in white flour and the cell number increased in whole wheat flour. Endoxylanase significantly and differently affected rheological and breadmaking properties of whole wheat flour as compared with white flour within cultivars. The differences in dough rheological and breadmaking properties of whole wheat flour before and after added endoxylanase were partially due to differences in arabinoxylan contents, arabinose to xylose ratio, and endoxylanase activities in the flour. They varied from 3.86 to 4.68 % d.w., 0.548 to 0.885, and 0.148 to 0.262 µmol/min.mg, respectively.

Starch structural effects on digestibility of cooked rice

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Cereal Foods World 57:A30

Starch-based foods which are slowly digested have nutritional advantages, especially with regard to prevention and management of diabetes and obesity. To extend current understanding of how various structural features of starch affect digestibility, 14 commonly consumed rice varieties from Cambodia and Malaysia were characterized using a battery of techniques based on size-exclusion chromatography, static light scattering and NMR. These gave the chain-length distribution of both the amylose and amylopectin components of the samples after debranching, and, for the whole (undebranched) molecules, the amylose size distribution, and the total weight-average molecular weight and radius of gyration. The latter two have not been hitherto characterized to any great extent; such characterization is especially interesting because studies on the growth-temperature of sorghum show that total size and molecular weight of a starch molecule are controlled by gross molecular geometry rather than biosynthetic processes. The same 14 rice samples, after cooking, were subjected to *in vitro* digestion, and the data reduced to a first-order rate coefficient fully expressing the time evolution of enzymatic breakdown to glucose. It was found that the structural parameters which had a statistically significant correlation with digestion support the known result that digestion rate depends on amylose content and degree of branching. In addition, it was found for the first time that there is a correlation with amylose structural details, specifically the average branch length and total size of the shorter of several components of amylose in the rice. This may prove useful in selecting rice grain varieties with improved nutritional values to prevent health complications associated with high carbohydrate diets.

Association mapping of starch quality with starch biosynthesizing genes in waxy rice (*Oryza sativa* L.)

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Though glutinous rice (or *waxy* rice) is not suitable for staple food, it is popularly used for traditional food processing, such as brewing, pastry, and other foodstuffs. Therefore, improvement of the quality of glutinous rice becomes more valuable than to increase its yield as compared to non-glutinous rice. In this study, association analysis was carried out between the starch gene markers and starch quality traits to explore the formation mechanism influencing starch quality of glutinous rice. With all 36 gene-specific markers, each produced polymorphic alleles with the polymorphic information content ranging from 0.0348 to 0.5409. Cluster analysis revealed two groups representing *indica* and *japonica* rice, indicating that the starch genes in *waxy* rice genome have already diverged into *indica* and *japonica* subspecies. The association analysis showed that eight genes, i.e., *AGPsma*, *GBSSII*, *SSI*, *SSII-1*, *SSII-3* (*SSIIa*), *SBE1*, *SBE3* and *ISA*, were significantly associated ($P < 0.05$) with starch quality traits. Among them, *SSII-3* and *SSI* have a greater impact on starch quality than the others. Gelatinization temperature and retrogradation were mainly controlled by *SSII-3* and *SSI*. Many genes were associated with rapid visco analyzer viscosities, indicating that the genetic mechanism of viscosity parameters were quite complex. Some starch property parameters were also controlled by a wide range of genetic interactions.

Creep test on wheat kernels: Influence of glutenins and their relationship to sedimentation volume and rheological properties

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Influence of high and low molecular weight glutenin subunits (HMW- and LMW-GS) on creep test was evaluated for the first time directly from intact wheat kernels of 34 bread wheat lines. Viscoelastic properties of wheat grains, glutenin subunits composition and dough rheology were studied. SDS-PAGE was used to determine glutenin composition. Creep test of wheat kernels was conducted using a texture analyzer TA-XT2 with stainless steel probe TA-510 (10 mm dia.) at 70 N of force compression, loading rate of 0.1 mm/s and 1200 sec of retardation time; data were analyzed by means of the generalized Kelvin-Voigt model with six terms ($r^2 \approx 0.94$; $P < 0.0001$). *Glu-A1*, *Glu-B1* and *Glu-D1* affected the creep coefficients in *Glu-1* loci. Regarding LMW-GS, the locus *Glu-A3* had highest influence on creep followed by *Glu-B3*; *Glu-D3* did not show differences. In general, the modulus of elasticity $E_0 \approx$ 242 MPa and viscosity was $\mu_0 \approx 1.6 \times 10^7$ MPa.s. Higher elastic moduli and viscosity were found in HMW-GS and LMW-GS of good quality compared to the poor quality performance genotypic groups. Samples with subunit *Glu-A1* null presented lower elastic modulus and viscosity compared to *Glu-A1* 1 and 2*. *Glu-B1* 13+16, which is associated with good quality performance, presented higher elastic modulus and viscosity. The elastic moduli, especially E_0 were positively correlated with SDS-volume and rheological properties. There was a highly significant negative relationship ($r = -0.88$; $P < 0.0001$) between retarded compliances D_2 and viscosity μ_2.

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2012 Annual Meeting
Abstracts of Poster Presentations

Abstracts submitted for poster presentations at the 2012 annual meeting in Hollywood, Florida, September 30–October 3, 2012. The abstracts are listed in alphabetical order by first author's last name. Abstracts are published as submitted. They were formatted but not edited at the AACC International headquarters office. Recommended format for citing annual meeting abstracts, using the first abstract below as an example, is as follows: Abdelaal, E. M., Hucl, P., Shipp, J., and Rabalski, I. 2012. Differences in anthocyanin composition of blue and purple wheat lines grown at three sites in Saskatchewan. (Abstr.) Cereal Foods World 57:A31. http://dx.doi.org/10.1094/CFW-57-4-A

Differences in anthocyanin composition of blue and purple wheat lines grown at three sites in Saskatchewan

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Anthocyanins are natural pigments found in fruits, vegetables and grains which play significant roles in human health due to their antioxidant, anti-diabetic, anti-inflammatory, anti-cancer and beneficial ocular effects. In the present study 19 anthocyanin-pigmented spring wheat lines grown at three sites in Saskatchewan, Canada, were evaluated in terms of their anthocyanin composition and antioxidant properties in comparison with purple (Laval 19), blue (Purendo 38) and red (AC Barrie & AC Crystal) wheat and amber durum (Avonlea & Strongfield) cultivars as controls over a 3 year period with a total of 9 field trials. The wheat crosses include hexaploid and tetraploid blue-aleurone or purple-pericarp wheat breeding lines. Anthocyanins in the grain were analyzed using spectrophotometric and liquid chromatographic (HPLC) methods, and antioxidant was based on oxygen radical absorbance capacity (ORAC). Two anthocyanin profiles were identified in the breeding lines, a blue profile and a purple profile. Experimental wheat lines with a purple anthocyanin profile had an overall higher anthocyanin concentration and antioxidant capacity than the blue aleurone lines. The study also identified two purple pericarp spring wheat lines (PIG03025 & PIG98027) as potential candidates for registration. These lines contained significantly higher anthocyanin levels than Laval 19, the only currently registered cultivar in Canada, and their agronomic performance was similar to that of AC Crystal. The milling fractions of these promising purple wheat lines were further characterized for their composition of anthocyanin and antioxidant potential.

Phytochemical analysis and hydrophilic antioxidant capacity of nejayote-fractions obtained after lime-cooking of white maize

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Wastewater (nejayote) of alkaline-cooking of maize is highly polluting due to its high pH (>10), soluble (NSO) and insoluble or suspended (NSU) solids. However, the nejayote is rich in phytochemicals (phenolic compounds). Total phenolics, hydrophilic antioxidant capacity (AOC) and total ferulic acid (FA) content were studied in NSO and NSU fractions of nejayote (NET). White corn kernels were lime-cooked and the nejayote collected and filtered through a 280 μm filter in order to recover three fractions: NSU, NSO and unfiltered NET. These fractions were lyophilized and subsequently weighed and the amount of solids in NET determined. Extractions of free, bound, and soluble conjugated phenolic compounds from samples were conducted. Determination of FA in each extract was performed with HPLC-DAD. Total phenolics of extracts were quantified using the Folin-Ciocalteu colorimetric method, whereas the hydrophilic AOC was determined using the oxygen radical absorbance capacity test (ORAC). The amount of total solids in nejayote was 17.8 ± 1.29 g/L nejayote. Of these 61.83% and 38.12% were of NSO and NSU, respectively. Free NET FA content was 26.62 ± 3.81 mg/L NET. The NSO contributed 85.53% of free FA (17.61 ± 0.06 mg/L NET), whereas NSU contributed 14.57% (2.98 ± 0.89 mg/L NET). Bound total phenolic content of NET was 18.79 ± 0.31 mg of gallic acid equivalents (GAE)/L NET, in which NSO contributed 26.66% (5.01 ± 1.04 mg/L NET) and NSU 68.01% (12.78 ± 0.83 mg/L NET). Most of the free and bound phenolic acids were associated to the NSO and NSU fraction, respectively. The understanding of the composition of NET fractions is needed in order to design processes for the recovery of these important phytochemicals. These compounds can yield value-added products with potential to treat and prevent oxidative stress, cancer and cardiovascular diseases and diminish the pollution of this wastewater.

Utilization of sorghum co-product (DDGS) in aquatic feed production

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Increasing cost of fish meal and declining price of shrimp has necessitated search for alternative source for protein, which is the most expensive aquatic feed ingredient. Plant sources of protein have shown great potential as indicated in recent research publications. This study examined the use of sorghum co-product–distillers dried grain with solubles (DDGS), in shrimp feed production using extrusion and pelleting methods. Five shrimp feeds were formulated with various levels of DDGS ranging from 0 to 40% and were produced using the aforementioned methods. Various physical properties of feeds were significantly influenced by DDGS inclusion. Specific mechanical energy (SME) showed some increase with more DDGS in the formulation, while expansion ratio was slightly above 1 for all diets, indicating the products were very dense. Practically all the feeds showed 100 percent sinking characteristics except for extruded feed with the most DDGS inclusion that had 88% sinking feed. The proximate content significantly ($P < 0.05$) changed at different levels of DDGS inclusion—as more DDGS was added, increased level of crude fiber and less starch were seen. Degree of gelatinization generally increased with more DDGS, and extrusion showed more gelatinized starch than pelleted feeds.

Novel sorghum based bean like product—bean analog
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Cereal Foods World 57:A32

The main objective of this study was to develop a beanlike product primarily from an underutilized grain—sorghum—and evaluate the effect of extrusion processing and ingredients on its physicochemical properties. This would allow improvement to the nutritional deficiency in beans/peas. Treatments were formulated using sorghum (25–70%), wheat (0–35%) and soy (30–50%) flours, and monoglycerides. In-barrel moisture was found to be slightly higher than the actual moisture of the extrudates. Specific mechanical energy (SME) input varied from 27.41–36.54 kJ/kg, leading to dense and minimally expanded products. The degree of gelatinization ranged from 54.1–93.6%, showing variation based on ingredients. Pasting curves showed minimal starch damage during extrusion with a peak viscosity and final viscosity in the range of 456.0–1138.5 cP and 297–584 cP, respectively. The effect of ingredients such as starch and cooking time significantly ($P < 0.05$) influenced the variation seen in the textural properties of bean analog. Hardness varied from 2200–3357 g force for natural navy bean (nnb) and bean analog, with nnb showing the least force. Starch based ingredients contributed to hardness (soy level increase led to increase in hardness from 2451–2515 g force to 2649–3357 g force) and cohesiveness, while fiber based formulations showed increased adhesiveness and gumminess. Bean analog is primarily targeted toward being used as food aid commodity where its nutritional composition can be engineered to meet human health need and improve the overall nutritional quality it supplies especially with possibility of inclusion of micronutrients.

Thermal properties of maize starch: Structure and biosynthesis of its amylopectin
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Cereal Foods World 57:A32

Thermal properties of starches are associated with the chain length of amylopectin. Biosynthesis of amylopectin chains involves the participation of several enzymes: starch synthase, branching and debranching enzymes. There are reports of maize starches with similar structural features but different thermal properties and vice versa. The aim of this work was analyze white and blue maize starch, and associate the thermal properties with its structure, and this with the enzymes that participate in the amylopectin biosynthesis. The maize was collected 20 days after pollination (DAP) to carry out enzymatic analysis, and in the physiological state (50 DAP) starch was quantified (total starch Megazyme kit) and isolated to determine thermal properties using differential scanning calorimeter and structural characteristics (by high-performance anion exchange chromatography using a pulsed amperometric detector). Blue maize had higher starch content (81 g/100 g) and lower amylose content (27 g amylase/100 g starch) than white maize (76 g/100 g; 32 g amylase/100 g starch, respectively). Both samples showed electrophoretic bands with molecular weight reported for three isoforms of soluble starch synthase, reflecting on the similarities of the analysis of length distribution of amylopectin chains of starches. Two isoforms of starch branching enzyme were found in blue maize, which could alter the branching pattern of amylopectin, producing highly branched structure with short chains, and less available space for amylose biosynthesis, as well as small and less perfect crystals that were disrupted at lower temperature with minor enthalpy than the white maize starch. This suggests that not only the chain length distribution of amylopectin is responsible for these properties, but also the organization and distribution during the biosynthesis of these chains within the concentric rings comprising the granular structure.

Phenolic and anthocyanin content of tortillas produced from Mexican blue maize by conventional nixtamalization and extrusion cooking
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The effect of traditional nixtamalization and extrusion cooking on the phytochemical profiles (total phenolics [TP] and anthocyanins) on Mexican blue native (criollos) maize genotypes processed into tortillas were investigated. Tortillas prepared from extruded blue maize increased 3.27–21.39% of total phenolics in comparison with raw kernels; just two types of blue maize retained 97.9 and 99.67%, and there was no increase; the retention in traditional nixtamalized tortillas was significantly lower compared to tortillas from extruded flours 49.57-80.33 of TP. Approximately 87-93% in raw kernels and 93-97% in their tortillas of TP were in their bound form. The retention of TP in extruded flours was higher compared to tortillas from nixtamalized flours. Blue maize lost 53-89 and 67-88% of the anthocyanin content when it was processed into nixtamalized and extruded tortillas, respectively. Results clearly indicate that the proposed lime-cooking extrusion strategy was instrumental in retaining higher levels of phytochemicals, particularly TP and anthocyanin in all tortillas.

Digestion and potential colon health benefits of octenyl succinic starch
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Objectives of this study were to compare in vitro and in vivo digestibility of normal cornstarch (NCS), high-amylose cornstarch (HA7) and octenyl succinic HA7 (OS-HA7), and to examine their effects on the development of mucin-depleted foci (MDF) (precursor of cancer) in rat colon induced by azoxymethane (AOM). The HA7 was modified with 10% (w/w, dsb) octenyl succinic anhydride at pH 8.0 and 35°C to obtain the OS-HA7 with a degree of substitution 0.058. Each of the starches was cooked and mixed (at 55%, w/w, db) with other ingredients to prepare the NC, HA7, and OS-HA7 diets. Resistant starch contents of the diets, analyzed using the Englyst Method, were 2.2, 11.8, and 13.3%, respectively. Three groups of male rats (Fisher-344, 10 per group) with control were fed with the respective diets for 8 weeks after the AOM injection. During the feeding period, there were no significant differences in the rat body weight and the weight of daily food-disappearance between different groups. Daily dry-weights of the feces obtained in Week 1, 3, 5, 7 and 8, from the rats fed with the OS-HA7 were 1.7, 2.0, 2.3, 2.4, and 2.1 g per rat, respectively, greater than that fed with the NCS (0.4, 0.5, 0.7, 0.6, and 0.5 g per rat, respectively) and HA7 (1.0, 0.7, 0.7, 1.1, and 1.0 g per rat, respectively). The starch contents of the feces from the rats fed with the OS-HA7 were 43.5, 55.5, 55.8, 55.9, and 51.1%, respectively, also greater than that fed with the NCS (11.9, 0.6, 0.5, 0.7, and 0.5%, respectively) and HA7 (44.7, 42.8, 31.2, 29.8, and 23.9%, respectively). The results suggested that the OS-HA7 was more resistant to in vivo digestion. The average number of MDF observed in the distal colon of the rats fed with the OS-HA7 (0.2 per rat) was smaller than that of the rats fed with the NCS (0.4) and HA7 (0.5).

Properties of starch from soft waxy wheat varieties
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Waxy starches are used in many food applications, including as a thickener and to improve the stability of frozen foods. The aim of our research is to characterize the physico-chemical and functional properties of starch isolated from grain of seven different waxy wheat varieties produced by mutagenesis of the Australian commercial soft wheat variety QAL2000. The amylose content of the waxy varieties was 1-2%, compared to 27% for QAL2000. The crystallinity of the waxy starch granules was increased to between 28 and 31%, compared to approximately 26% for QAL2000, and there were significant differences in granule size distributions between the mutant and parent varieties. Native waxy starch granules displayed morphological features that were clearly different from those of QAL2000, as examined by light and scanning electron microscopy. Swelling power (g/g water H_2O absorption) increased from 15 for QAL2000 to between 20 and 23 for the waxy varieties. The waxy starches had higher gelatinization temperatures (64-66°C) than QAL2000 (63°C), and very different RVA pasting viscosity profiles. *In vitro* conversion of native granules to glucose by alpha-amylase and amyloglucosidase was about twice as fast for the waxy starches compared to QAL2000. Our results have identified functionally useful properties in a series of waxy starches derived from a commercial soft wheat variety. Differences between the waxy starches are the subject of further studies.

Optimization of the roasting process for preparing instant amaranth (*Amaranthus hypochondriacus* L.) flours with high antioxidant activity
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Amaranth grains have an excellent nutritional quality; they contain approximately 15% protein with an adequate balance of amino acids, high lysine content, 60% starch and 8% fat, besides minerals and dietary fiber. Polyphenolic compounds, such as phenolic acids and flavonoids, have been characterized in amaranth grains and related to antioxidant capacity and nutraceutical properties. In addition to its promising nutritional qualities,

amaranth grains are considered to be an important source of food for celiac patients, since they are gluten-free, diabetic, hypercholesterolemic subjects and coronary heart disease and hypertension patients. However, no detailed data have been published about the optimization of processes (pomped, roasted, moist heating, extrusion) for producing maximum high antioxidant capacity amaranth foods. The objective of this research was to determine the best combination of roasting process variables for producing high antioxidant capacity roasted amaranth flours (RAF). Two amaranth (*Amaranthus hypochondriacus* L.) grain varieties sown and harvested in Morelos, Mexico, were studied. Roaster operation conditions were obtained from a factorial combination of roasting temperature (RT, 110-160°C) and roasting time (Rt, 1-10 min). Response surface methodology was employed as optimization technique; the numeric method was applied to obtain maximum values for antioxidant capacity (AoxC) and water solubility index (WSI). The best combination of roasting process was: RT=127°C / Rt=5.5 min. The AoxC of raw and optimized RAF were 4,425–4,663 and 6,828–7,053 μmol TE/100 g sample (dw), respectively. The increase in AoxC (51-54%) after roasting process is associated to the formation of melanoidins of low molecular weight. The optimized RAF with high AoxC might be used to prepare functional foods and nutraceutical beverages for human consumption.

WITHDRAWN

Effects of water addition, vacuum mixing, and wheat classes on the translucency and color of Chinese dumpling wraps

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Translucency of boiled Chinese dumpling wraps (CDW) is most important characteristic of dumpling appearance. Panelists can detect small differences in translucency of boiled CDW during sensory evaluation; sensory evaluation requires significant amount of resources. An instrumental method was developed for determination of translucency in boiled CDW. The effects of thickness of raw CDW, water addition, vacuum mixing on the translucency and color (as measured by CIE *L, a*, and *b*) of boiled CDW were investigated. Wheat classes of Canadian Western Hard White Spring (CWHWS), Canadian Western Red Spring (CWRS), and Canadian Prairie Spring Red (CPSR) were compared for the translucency and color of their CDW. Boiled CDW with a lower thickness were more translucent than those with a higher thickness. When the thickness is fixed at 1 mm, translucency of boiled CDW significantly increased from 55% to 68% when water addition to dough increased from 40% to 50%. The CIE *L* value of raw CDW also increased as the water addition to dough increased. Water addition increased by 10% when dumpling dough was mixed in vacuum. Translucency of boiled CDW was also increased significantly using vacuum mixing. The same trends were observed on all three Canadian wheat varieties in this study. However, CWHWS showed the highest translucency among the three wheat classes under both normal mixing and vacuum mixing conditions.

Exploiting iodine vapor as a tool to characterize the structure of millets starches

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The complexation of iodine with linear glucan polymers has been used to characterize and identify starch and amylose from different botanical sources. However, very little iodine-starch binding research has focused on millet starches. This study investigated the effects of iodine vapor exposure on the structural and architectural differences among different millet (Pearl, Foxtail, Finger, Kodo and Proso millets) starches. Millet starches exposed to iodine vapor after equilibration above potassium sulphate were evaluated for their absorption/scattering coefficient (K/S) spectra, Wide Angle X-ray Diffraction patterns and the degree of crystallinity. The highest K/S absorption values were observed for Kodo millet, meaning its glucan polymer bound more iodine, suggesting the presence of more mobile polymers. Finger millet starch, however, had the least K/S absorption values. The degree of crystallinity of the native millet ranged from 27.2 to 29.6%, and that of the iodine exposed samples ranged from 35.5% (Pearl millet) to 44.2% (Kodo Millet). Iodine exposure resulted in significant differences in the degree of crystallinity of the millet starches. Exposing the millet starches to iodine vapor showed different organization of starch polymers in the samples.

Effect of hermetic storage of maize grains on the characteristics of nixtamalized corn flour

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The quality of nixtamalized corn flour is influenced by storage conditions of the maize grain from which they are made. Maize can be stored in two forms: opened and closed storage or hermetic. The latter prevents gas exchange, and the atmosphere of storage is modified. In hermetic storage, the absence of oxygen inhibits the growth of fungus and insects, but also affects the quality of products made with these grains. In this work, the grain of corn was stored in 5 kg containers, hermetically sealed, at room temperature for 90 days. Every 15 days a container was opened and the maize was nixtamalized by the traditional way, and became dehydrated masa flour. Before opening each container was measured the concentration of CO_2 and O_2. The properties identified in the flour were: moisture content (MC), pH, water activity (Aw), water absorption index (WAI) and solubility (ISA), color (C), maximum viscosity (MV) and retrogradation (VR), enthalpy (ΔHgel) and gelatinization temperature (Tgel). The CO_2 and O_2 concentrations changed from 0.2 to 1.9% and from 19.6 to 15.4% by the respiration of the grain during the hermetic storage. The MC of flour declined from the grain storage time and showed values significantly different from day 0 (12.8%) until day 90 (5.4%). The C, for treatment with 90 days (L = 78.4), was darker, probably due to oxidation reactions of the lipid present. The pH, the WAC, WAI, and Aw of the flours showed significant differences between treatments. Their values increased due to partial gelatinization process of starch granule produced during its processing and transformation to nixtamalized flour. 0 days treatment showed the greater Tgel (67.93°C) than treatment of 90 days (65.27°C), caused by changes in the structure of the starch granule mainly, and induced by the losing of crystallinity during its cooking and milling. The dehydrated masa flour with better characteristics were obtained with maize with less storage time, although the flour obtained with 90 days also produced flours with good quality. We conclude that this type of storage is recommended for maize grain which will be used to produce nixtamalized flours, because it showed little negative effects on the quality characteristics of the final product.

Effect of soy flour addition on rheological properties of weak, medium, and strong wheat flour

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Soy flour is an important raw material for food applications within the emerging concept of functional foods. It reduces the risk of cancers, cardiovascular diseases and diabetes. Knowledge about the rheological properties of soy-wheat flour mixture could lead to effective use of flour to make high quality products. Mixolab (Chopin Technologies, France) is a

relatively new instrument, and the information related to its utilization on different aspects of soy-wheat flour mixture quality is limited. The aim of this study was to determine mixing and pasting characteristics of defatted soy flour (0, 10, 20%)–wheat flour (weak, medium and strong) mixture. Tests were carried out at the constant water absorption (80% dry basis) and mixing speed (80 rpm). For the analysis of mixing and pasting behavior this protocol was followed: initial equilibrium at 30°C for 8 min, heating to 90°C over 15 min (4°C/min), holding at 90°C for 7 min, cooling to 50°C over 10 min and holding at 50°C for 5 min. Water absorption (C1), mixing stability, protein weakening (C2), starch gelatinization (C3), amylasic activity (C4) and starch gelling (C5) were determined. The data of soy flour (0, 10, 20%)–weak wheat flour mixture were found to be in the range of 0.76-1.41 Nm for C1, 0.25-0.50 Nm for C2, 2.19-2.34 Nm for C3, 1.76-2.14 Nm for C4, 3.20-3.27 Nm for C5. The values of soy flour (0, 10, 20%)–medium wheat flour mixture were in the range of 1.14-1.74 Nm for C1, 0.42-0.68 Nm for C2, 2.20-2.36 Nm for C3, 1.74-2.22 Nm for C4, 3.23-3.35 Nm for C5. Whereas, the data of soy flour (0, 10, 20%)–strong wheat flour mixture changed between 1.63-2.16 Nm for C1, 0.67-0.83 Nm for C2, 2.12-2.20 Nm for C3, 2.18-2.30 Nm for C4, 3.24-3.51 Nm for C5, respectively. According to the profiles, defatted soy flour addition had greater impact on mixing and pasting properties in weak and medium wheat flours than in strong ones.

Effects of chemical and enzymatic modifications on the formation of amylose-stearic acid complex

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Cereal Foods World 57:A34

Amylose-inclusion complexes have been proposed to function as carriers for delivering and protecting bioactive compounds. The objective of this study was to determine the effect of chemical (acetylation) and enzymatic (beta-amylolysis) modifications of potato starch on the complexation between amylose and stearic acid. Potato starch was first acetylated (degree of substitution [DS] 0.039 or 0.072) and then debranched with isoamylase followed by a beta-amylase treatment. The treated starches were evaluated for molecular size distribution by size exclusion chromatography; the complexes were evaluated for apparent amylose content by iodine affinity, thermal transition by differential scanning calorimetry, and crystalline structure by X-ray powder diffractometry. The radius of gyration of acetylated starches was greater than the native starch. The iodine affinity of all starches increased after the isoamylase treatment and further increased with the beta-amylase treatment. The peak melting temperatures of acetylated amylose-stearic acid (~95°C) was lower than that of beta-amylase treated acetylated amylose-stearic acid complex (~100°C). The native amylose displayed both the B- and V- structures when complexed with stearic acid. The V-type structure became dominant while the B-type structure disappeared when acetylated amylose was used. Nevertheless, a high level of acetylation decreased the V-type structure intensity when combined with beta-amylolysis. The results demonstrate that acetylation inhibited amylose retrogradation and at the same time improved the complexation. The reduced amylose degree of polymerization improved amylose-stearic acid complexation, but there is an optimum acetylation and degree of polymerization for amylose to promote its complexation with stearic acid.

Effects of brans from specialty sorghum varieties on in vitro starch digestibility of soft and hard sorghum endosperm porridges

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There has been a popular desire to reduce calories, increase fiber, and provide energy over extended periods by lower-slower starch digestibility. Starch digestibility can be affected by grain hardness and inhibitors such as tannins. Brans of phenolic rich specialty sorghum varieties (high tannin, black, and black with tannin) were used to investigate the effects of sorghum phenolic compounds on starch digestibility of soft and hard sorghum endosperm porridges. White sorghum bran containing small amounts of phenolic compounds was used as control. Endosperms of varieties with the highest (white sorghum) and lowest (sumac sorghum) grain hardness index were mixed with brans of specialty sorghum varieties (85:15), and cooked into porridges with distilled water using a Rapid Visco-analyzer. *In vitro* starch digestibility and Estimated Glycemic Index (EGI) of the porridges were measured according to Goñi et al (1997). Resistant Starch (RS) content was measured according to Goñi et al (1996). Brans of condensed tannin-containing sorghum varieties significantly ($p < 0.05$) decreased starch digestibility and EGI, and increased RS content of endosperm porridges. However, the addition of phenolic-rich tannin free (mostly anthocyanins) black sorghum bran significantly ($p < 0.05$) increased starch digestibility and EGI, but did not affect RS content of endosperm porridges. SEM revealed that the larger and sharper particles of black sorghum bran may have physically disrupted the continuous gelatinous matrix by interfering with re-association of starch chains, causing weaker gels. This probably increased diffusion of the enzymes into porridges, resulting in higher starch digestibility. Our study showed regardless of endosperm type, phenolic-rich sorghum brans could be functional ingredients to make products with low-slow starch digestibility, taking into consideration bran structure.

A model system to understand phenolic compounds effect on in vitro starch digestibility in the presence of zein protein

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Whole grain cereals are considered health foods with a low Estimated Glycemic Index (36-71) and a high Resistant Starch (RS) content (2.9-6.8). Low protein digestibility of tannin sorghum has been attributed to the presence of tannins that bind protein and reduce protein digestibility. Studies conducted in our laboratory also showed that phenolic rich specialty sorghum bran extracts (containing tannins and anthocyanins) significantly ($p < 0.05$) decreased starch digestibility and EGI (49-65), while they significantly ($p < 0.05$) increased RS content (9.1-14.9%) of corn starch porridges. Thus corn starch, zein protein, and specialty sorghum bran extracts of tannin, black, and black with tannin sorghum brans (extracted with 70% aqueous acetone) were used to make porridges to investigate the effects of phenolic compounds in the presence of zein protein. White sorghum bran extracts containing small amounts of phenolics were used as controls. Porridges were cooked in a Rapid Visco-Analyzer with and without zein protein. *In vitro* starch digestibility and EGI of the porridges were measured according to Goñi et al (1997). RS content was measured according to Goñi et al (1996). Porridges cooked with phenolic-rich bran extracts and zein protein had significantly ($p < 0.05$) higher starch digestibility and EGI (89-93), while their RS contents (0.3-2.2%) significantly ($p < 0.05$) decreased compare to those cooked without zein protein; 49-65, 2.4-6.8%, respectively. High temperature and shear, generated during cooking, denatured zein protein, and likely reduced protein-protein and starch-protein associations, thus facilitating zein interactions with phenolic polymers, which increased accessibility of gelatinized starch by enzymes. However, porridges cooked with zein protein and white bran extracts had significantly ($p < 0.05$) lower starch digestibility and EGI than porridges made with zein and specialty sorghum bran extracts. This study showed that the effect of sorghum phenolic compounds on starch digestibility is dependent upon the presence of proteins.

Effects of salt stress and Ca^{2+} treatments on γ-aminobutyric acid accumulation in germinated foxtail millet (*Setaria italica* L.)

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The effects of NaCl stress on sprout length, soluble protein, free amino acid, GAD activity, and GABA content in germinated foxtail millet were investigated, and the regulating effects of exogenous Ca^{2+}, along with $LaCl_3$ (a specific inhibitor of the Ca^{2+} pathway) and EGTA (a chelator of Ca^{2+}) under salt stress, on GABA accumulation in germinated millet were explored in this paper. The results showed that salinity stress caused a decrease in sprout length of millet. Low concentration of the NaCl treatment promoted increase of soluble protein content, but higher concentration of NaCl inhibited soluble protein content, and the levels of free amino acid, GAD activity, and GABA accumulation significantly increased under salt stress. Exogenous Ca^{2+} application further increased GAD activity and GABA content; the optimal concentrations of Ca^{2+} for GAD activity and GABA accumulation were 2.5 and 5.0m*M*, respectively. GABA content reached the maximum under 100m*M* NaCl stress associated with 5m*M* Ca^{2+} for 48 hr, at which point GABA content was 31.71 mg/100 g, a 2.57-fold increase as compared with pretreatment. GAD activity and GABA accumulation in germinated millet decreased when treated with $LaCl_3$ or EGTA under salt stress, which indicated that GABA accumulation in foxtail millet was regulated by Ca^{2+}.

Influences of mill type on baking properties and lipid oxidation of whole grain wheat flour during storage

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Various milling processes used for preparation of whole grain wheat flour (WWF) impart uniquely different physical stresses to wheat grain and flour

particles, thus resulting in variations in physical characteristics, lipid oxidation and baking quality. WWFs of hard red and soft white wheat varieties were prepared using a stone mill, a Unifine (impact) mill, or a roller mill, and characterized for particle size, starch damage, lipid oxidation, and bread baking quality during storage. Roller-milled WWF was produced by blending white wheat flour with bran re-ground using a pin mill. Moisture content was highest in roller-milled WWF due to tempering prior to milling. Stone-milled WWF had much coarser particle size distribution, whereas particle size distribution was similar for Unifine- and roller-milled WWF. Stone-milled WWF also exhibited greater starch damage than Unifine- and roller-milled WWFs in both hard and soft wheat. Unifine-milled WWF exhibited intermediate starch damage content in hard red wheat and lowest starch damage in soft white wheat. Lower fat acidity and hexanal content, as measures of lipid oxidation, were observed in stone-milled WWF compared to Unifine and roller-milled WWFs during storage up to 24 months. Unifine-milled WWF exhibited lower hexanal content than roller-milled flour in both hard and soft wheat, despite similar particle size distribution. No apparent differences in mixograph water absorption and mixing time of WWFs were observed among mill types and storage durations. Unifine-milled WWF produced consistently greater bread loaf volume than stone- or roller-milled WWFs after storage for 0 to 18 months. Unifine-milled WWF also produced greater bread loaf volume when baked with addition of gluten to attain 18% protein content, after storage for 6 and 18 months.

Milling and functional properties of co-mingled rice cultivars

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Hybrid rice acreage has increased in large part because of the high crop yields of hybrid cultivars as compared to pureline cultivars. However, differences have been observed in the milling characteristics of hybrid relative to the pureline cultivars. Comingling of rice cultivars commonly occurs during harvest, drying and storage operations. Thus, there is a need to study the effect of comingling rice cultivars, particularly hybrid and pureline, on milling and functional properties. A long-grain, hybrid cultivar CL XL745 and a long-grain, pureline cultivar CL 151 were comingled in ratios of 10:90, 25:75, 50:50, 75:25 and 90:10. Milled rice yield (MRY), head rice yield (HRY), surface lipid content (SLC), color, chalk percentage and pasting properties were measured for individual CL XL745 and CL 151 lot samples, as well as the above mentioned comingled lot samples. To analyze the effect of comingling, samples with SLCs closest to 0.4% were analyzed using ANOVA. The MRYs, HRYs, SLCs, chalk and peak viscosities trended proportionately with the comingling ratios of the two cultivars. Color did not show a distinct trend as with the aforementioned properties. The same procedures will be repeated for pureline-pureline and hybrid-hybrid comingles, along with detailed investigation of cooking properties using a differential scanning calorimeter. Evaluation of bran-streaking will be done to look at kernel-to-kernel degree of milling variation.

The effect of speed differential on the particle size distribution from first break roller milling of wheat

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Roll differential is an important factor affecting wheat breakage during roller milling. A hard and a soft wheat were milled under Sharp-to-Sharp (S-S) and Dull-to-Dull (D-D) dispositions, at three roll gaps and under 12 differentials, and the output particle size distributions were measured by sieve analysis over the range 0–4000 μm. The data was fitted using the Double Normalised Kumaraswamy Breakage Function (DNKBF), which distinguishes two types of breakage: Type 1, which refers to the production of mid-range particles comprising both bran and endosperm, and Type 2, which refers to the production of predominantly small endosperm particles, with a tail of larger bran particles. Differential speed affected the parameters of the DNKBF and the nature of the breakage. At faster differentials Type 1 breakage was more prevalent under S-S milling and for hard wheat, whilst Type 2 breakage dominated for soft wheat under D-D. For both wheat types, larger particles were produced as roll gap size increased. Increasing differential caused more Type 1 particles to be produced due to the increased shear and scraping action created by the milling parameters, which acted to slice the bran and endosperm together into more uniform sized particles. At low differentials, Type 2 breakage predominated; the slower differential speeds subjected the kernels to more of a crushing action with less shear, encouraging the brittle endosperm to shatter whilst leaving the bran layers relatively intact. This resulted in the production of many small and large particles with fewer mid-size range.

Innovative healthy ingredients from controlled partial germination of cereals and pulses for food applications

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Germination is the natural and traditional way performed at household level in many countries to improve the nutritional value, technical and sensory properties of grains such as pulses and cereals. Pulses are a rich source of vegetable proteins, dietary fibres, vitamins and minerals. Unfortunately this high nutritional value is limited by the presence of antinutrients that reduce digestibility and micronutrients bioavailability. It has been scientifically proven that germinated pulses have higher vitamins and mineral bioavailability as well as less antinutrients like phytic acid and the raffinose family oligosaccharides (ROF) which cause digestive discomfort. It has also been proven that germination can improve the nutritional, technical and sensory properties of other grains such as cereals. The addition of germinated wheat flour to bakery products improves their nutritional, sensory and technical properties. The industrial process pargem® has been now developed in order to apply the advantages of germination at industrial level and under high food processing standards. In the pargem process, grains are partially germinated under controlled conditions and stabilized through drying for convenient long shelf life. It has been verified scientifically on several types of grains that these novel ingredients are characterized by reduced antinutrients content and improved amount of micronutrients. Moreover, the content of fructose greatly increases, thus improving the ingredient taste with a desirable sweet note. Baking trials have also highlighted that the addition of pargem wheat flour to bread remarkably improves its technical properties like loaf volume and shelf life. These results show that pargem grains and flours have a great potential as valuable ingredients with high nutritional value and improved taste for novel food formulations.

Innovative technology with high food safety standard to produce a new family of healthy and convenient food products based on partial germination of pulses and grains

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Pulses are a rich source of vegetable proteins, dietary fibres, vitamins and minerals. Unfortunately this high nutritional value is limited by the presence of antinutrients that reduce micronutrient bioavailability and by the presence of raffinose family oligosaccharides (ROF) which cause digestive discomfort. Also their industrial processing is complicated by hard husk removal, which causes quality and yield losses. A new industrial process and technology for controlled partial germination has been recently developed, and its effect on the improvement of the nutritive value, the sensory properties and the husk dehulling performance of pulses such as chickpeas, mung beans and pigeon peas has been scientifically verified. This innovative process consists of a partial germination under controlled conditions and a stabilization step through gentle drying; the resulting final products are whole dried partially germinated grains that can also be further processed into food ingredients, i.e., flours. The industrial solution to perform this innovative process is a unit that has a capacity up to 1100 t/a, and all the processing steps needed for pulse germination and stabilization—soaking, germination and drying—are successively performed batch wise. In each batch, 10 t of pulses are processed for a duration of 3-4 days, depending on the degree of partial germination to be reached. High food safety standards and homogeneous germination are guaranteed through the state-of-the-art technological solutions. This compact industrial plant, which is integrated in a standard container, is easily transportable, and is designed as a plug-and-play solution for rapid integration and commissioning. The plant does not require any additional building, and operates using only conventional utilities, such as water, power, and air. The technology has reached the mature prototype stage and is ready for industrial application.

Glycemic response of healthy rats fed with cereals bars

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Three cereal bars containing white maize, blue maize or unripe banana flours were prepared. The glycemic response in rats fed with different dose, between meals and glucose tolerance was evaluated. The dose of 0.85 g/kg was used in the experiments with the three bars. The experiment with a glucose load showed that rats fed with blue maize and unripe banana bars can trap glucose within the food matrix and produce a slow release being more pronounced in

unripe banana bar. The groups fed with amount equal amount of available carbohydrates from bars had lower and slower glycemic responses than control group that was administered with a glucose load. The white maize bar presented a maxim glucose level at 30 min, blue maize at 45 min and unripe banana bar at 60 min. Bars with variable glycemic response may be prepared following the proper choice of functional ingredients.

Novel anthograin instant noodles from purple wheat

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Cereal Foods World 57:A36

Pigmented grains containing anthocyanins are advantageous in food production due to the potential health-promoting effects of anthocyanins. Anthograin (fried) instant noodles, produced from purple wheat grain, were investigated to evaluate their antioxidant properties. The Folin-Ciocalteau method was used for determining total phenolic content (TPC), oxygen radical absorbance capacity (ORAC) method for assaying antioxidant activity, and pH-differential method for determining total anthocyanin content (TAC). Phenolic acid composition was determined using HPLC analysis. Total phenolic content (TPC) and oxygen radical absorbance capacity (ORAC) values of anthograin instant noodles ranged from 1393 to 1410 mg/kg and 9750 to 10775 mg/kg, respectively. Both were significantly higher than the TPC (290.3–602.3 mg/kg) and ORAC values (3604–4714 mg/kg) of three (fried) instant noodle controls, which were produced from common wheat. Due to the presence of anthocyanins in purple wheat grain, total anthocyanin content (TAC) of anthograin instant noodles was found to range from 130.7 to 148.8 mg/kg. Phenolic acid composition indicated that ferulic and *p*-coumaric acids in anthograin instant noodles ranged from 438.1 to 515.3 mg/kg and from 15.5 to 18.3 mg/kg, respectively. The high levels of phenolic acids were still maintained even after the frying process when compared with the low levels of ferulic (38.7–58.3 mg/kg) and *p*-coumaric (0.6–1.2 mg/kg) acids in the three instant noodle controls. Anthograin instant noodles containing high antioxidant capacity are a useful model to showcase the potential of purple wheat and other anthocyanin-rich cereals as novel ingredients in whole grain-based functional foods.

Distribution of total carotenoids and its composition among diverse cereal grain varieties and their fractions determined by spectrophotometry and HPLC

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To compare the distribution of total carotenoid content (TCC) and composition within the grain, a variety of cereal grains were hand dissected into endosperm, germ and aleurone layer fractions. TCC and carotenoid composition of these fractions and whole grains were analysed using spectrophotometry and high performance liquid chromatography (HPLC) coupled with photodiode array detection (PAD). Results showed that carotenoid content and composition varied significantly ($p < 0.05$) among the cereal types and in the different grain fractions. In the whole grain and endosperm, average TCC was higher in yellow corn (18.19 mg/kg) compared to wheat and barley varieties. TCC was lowest in oats (1.8 mg/kg). However, the germ fractions showed highest TCC in barley (13.73 mg/kg) and lowest TCC in yellow corn (3.78 mg/kg). Lutein and zeaxanthin were the main compounds identified. The latter was not identified in the endosperm of wheat, barley and oats. Whole grain and endosperm fractions of yellow corn exhibited the highest levels of lutein and zeaxanthin averaging 3689 and 9879 µg/kg and 3639 and 9404 µg/kg, respectively. Wheat and barley had intermediate levels (819 and 438; 497 and 637 µg/kg) while oats had the lowest content of lutein and zeaxanthin. A trend similar to TCC was observed in lutein and zeaxanthin content of the germ fractions. The ratio of zeaxanthin to lutein in the aleurone layer was 2-fold in wheat, 5.2-fold in oats and similar in yellow corn except in dasca corn where it was 4.3-fold. These study results suggest that the aleurone layer of all grains studied except barley, the germ of barley, wheat and oat, and corn endosperm have significantly enhanced carotenoid levels.

Impact of wheat bran on regularity: 80 years of research

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Wheat bran has a long history of use in foods. It has previously been described by others as the most widely studied fiber for providing bulking effects, and is reported to provide the greatest fecal bulking effect of all studied fibers. This systematic literature review was conducted to: (1) assess the full extent of clinical evidence on wheat bran for fecal bulking; and (2) to identify the full extent of clinical evidence on wheat bran for additional parameters of regularity, such as fecal frequency and transit time. The relevant literature was identified via PubMed and bibliographic reviews. A total of 75 papers using adult subjects and reporting endpoints in English relevant to regularity were published between the years 1932 and 2011. All papers that utilized statistical control/baseline vs. treatment comparisons were included in the analysis (a total of 42 papers). 72% of papers utilized healthy subjects; 9% of studies included constipated and 9% included Irritable Bowel Syndrome (IBS) patients. As expected the majority of the papers (39 of 42) reported fecal bulking/weight outcomes, and of those 92% reported an increase in fecal weight following consumption of wheat bran. Some studies also found the fecal bulking effect to occur in a linear dose-response fashion. Transit time and fecal frequency were also frequently reported endpoints. 28 papers reported on transit time, with a significant decrease in 68% of papers. 17 papers reported on fecal frequency, with a significant increase in 65% of papers. Overall, this systematic analysis of the nutrition science literature confirmed that across 8 decades of research, the benefits of wheat bran on regularity have been consistently demonstrated. These benefits include not only increased fecal bulking/weight, but also positive changes in transit time and fecal frequency.

Comparative fermentation of insoluble carbohydrates in an in vitro human faeces model spiked with *L. acidophilus* NCFM

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Dietary fibre and slow carbohydrates can have differential beneficial effects on gut microbial composition and metabolism. We have investigated insoluble carbohydrates including highly crystalline waxy maize starch granules, pectin-rich potato fibre and highly stable lintner starch and characterised and tested for possible prebiotic effects in an *in vitro* batch fermentation system with human fresh faecal microbiota spiked with the probiotic *Lactobacillus acidophilus* NCFM. Following batch fermentation, microbial quantification by real-time polymerase chain-reaction (qRT-PCR) revealed that the genus *Bacteroides* was specifically suppressed by each insoluble carbohydrate resulting in a clear decrease in the ratio of *Bacteroidetes* and *Firmicutes*. Notably, all carbohydrates tested completely blocked formation of the potentially harmful branched chain fatty acids (BCFA) fermentation products, but supported lactobacilli growth. Lactic acid accumulated in the fermentations, possibly due to the batch fermentation set-up (vs. continuous fermentation), which may have affected the results. Potato lintner starch had the greatest effect. Insoluble carbohydrates also suppressed production of short chain fatty acids (SCFA) as compared to the control medium. Importantly, potato lintner starch most efficiently suppressed the ratio between the *Bacteroidetes* and *Firmicutes* and suppressed growth of bifidobacteria, *Enterobactericeae* and *Faecalibacterium prausnizii*. The highly thermostable crystallites and degradative resistance of the lintner starch were linked to these effects.

Sulphur application alters gluten functional characteristics and protein structure in Ontario soft wheats

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The effort to reduce the release of airborne pollutants has led to a significant decrease in sulphur dioxide emissions. This has reduced atmospheric sulphur deposition in agricultural land used for food production resulting in the need for sulphur application in many areas, but the timing and amount of sulphur application may have a major impact on final grain quality parameters. The aim of this preliminary study was to assess the impact of sulphur management strategies on gluten functionality and protein folding in Ontario soft wheats. Five paired wheat samples were obtained from owner/operators in different growing locations. Nitrogen was held constant while sulphur was applied at 20 lb/acre as SO_4 to the sulphur treated (ST) samples. Control and ST samples were assessed for kernel hardness, milling extraction, protein and ash contents, lactic acid solvent retention capacity (LA-SRC), gluten peak tester (GPT) time and torque, and Fourier transform infrared (FTIR) spectroscopy protein structure. A trend was observed for greater kernel hardness values and milling extraction for control samples compared to ST samples. Sulphur application also resulted in a decrease (~1.5%) in LA-SRC values with a concurrent decrease in GPT torque (~3 BU). FTIR spectroscopy revealed differences in sheet and aperiodic structures (+1.6% and -2%, respectively) in control compared to ST samples. Protein and ash content remained relatively constant between paired samples. These results indicate that Ontario wheat growing regions

may already have some degree of sulphur deficiency and that sulphur application may result in a need to alter current processing strategies for major Ontario soft wheat users due to changes in gluten functionality. A larger study is underway to further clarify the impact of sulphur application level and timing on gluten functionality and protein folding.

A simple rheometer to measure firmness of cooked pasta
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Glutograph was designed to determine the stretch and relaxation values of wet gluten. Usage of this piece of equipment to evaluate cooked pasta firmness has not been reported, and thus is the aim of this research. Method development involved the evaluation of the number of impulses (1,000 to 10,000), relaxation time (10 to 120 s), and number of strands of spaghetti (1 to 6) and the number of tests per individual sample to give reliable treatment mean. Experimental design used was a randomized complete block with factorial arrangement of variables with three replicates. Data collected were subjected to Analysis of Variance (ANOVA). Results indicated no advantage in going above 5,000 impulses; three strands of spaghetti resulted in largest differences in stretch time among treatments; and four strands of spaghetti resulted in largest differences in relaxation among treatments. Glutograph has potential for use in accessing cooked pasta texture. Further work will be done to compare firmness results from glutograph with those obtained using a texture analyzer with a pasta blade (more commonly used to determine firmness of cooked pasta) as described by AACC International Approved Method 66-50.

Development of gluten-free brown bread utilizing brown hybrid sorghum
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Brown hybrid sorghum could be used to add dietary fiber, natural colorant, and antioxidants to develop formulations for gluten free brown bread. The objective of this study was to optimize gluten free brown bread formulations using brown hybrid sorghum. Brown hybrid sorghum bran was substituted at levels of 5, 10, and 15% and whole grain brown hybrid sorghum flour was substituted at levels of 20, 30, and 40% into the flour blend of a control bread formulation, adding between 0.4 and 4 g of dietary fiber per slice. Volume, texture profile analysis, crumb color, and total antioxidant activity levels were measured. Increasing levels of whole grain flour did not significantly decrease specific volume (avg 2.02 g/cm^3, $p < 0.05$). Treatments using brown hybrid sorghum bran had a darker crumb color, higher specific volume, and had the highest antioxidant capacity. Specific volume was not significantly reduced with bran addition (avg 2.04 g/cm^3, $p < 0.05$). Hardness and cohesiveness were significantly affected by the increase of flour or bran. Brown hybrid sorghum can be used for developing artisan gluten free breads similar to European brown breads that are high in dietary fiber and antioxidants. Brown hybrid sorghum bran is ideal for use in brown bread production due to maintaining crumb quality and specific volume while retaining antioxidant capacity.

Influence of milling method on the physical and functional properties of yellow pea flour used in cookies
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The addition of whole pea flour to wheat flour can greatly enhance the nutritional profile of the flour by increasing fibre, protein and mineral content of the blended flour. However, the presence of pea flours can also significantly affect the functional properties of the blended flour which in turn can affect end-product quality. Physical and functional properties of the pea flour will be significantly affected by the method used to mill the pea seeds into flour. The objective of this study was to determine the effect of pea milling method (hammer, stone, pin, roller) on the functional properties of a 30% whole yellow pea flour/70% soft wheat flour blend and how this affected cookie quality. Each flour blend was used to produce wire cut cookies following the AACC standard method (10-23) with modifications. Significant differences ($p < 0.05$) in cookie thickness, width and spread were observed among the cookies made with the yellow pea flours and the cookies made with 100% wheat flour. There were also differences among the cookies made with the various pea flours, indicating that milling method significantly affected end product quality. This can be attributed to differences observed among the pea flours in terms of particle size, water absorption capacity, starch damage and RVA pasting properties. Colour differences were also observed among the cookies, with the cookies made with the pea flour being darker than the control cookie made from 100% wheat flour. Overall, this study has shown that both physical and functional properties of flours are important factors to consider when selecting a pea flour for incorporation into food formulations. Pea flour properties are significantly influenced by the milling method used to produce the flour, suggesting that examination of flour specifications is critical when selecting a pea flour for use in product applications.

Use of pulse ingredients to develop healthier baked products
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With growing interest in formulating more nutritious ready-to-eat foods, the food industry is looking for alternative ingredients which deliver enhanced nutrition and functionality. Pulses are high in protein, minerals and dietary fibre and low in fat, making them ideal ingredients to use in cereal based products such as baked goods. Research undertaken at Cigi has shown that the substitution of pulse flours for wheat flour in baked goods is possible although modification to the formulations is necessary to achieve desired end-product quality. For products such as tortillas, pita bread and crackers it was possible to incorporate pulse flours at levels between 20 and 30%. Depending on the level of substitution, the total dietary fibre content could be significantly increased allowing for a high fibre claim. Studies which examined the addition of various types of pea hull fractions showed it was possible to enhance the nutritional profile of bagels without significantly affecting end-product quality. Pulse flours could also be used to produce gluten-free baked goods such as pizza crust and cookies, but blending of the pulse flour with other gluten-free flours was necessary to optimize quality. With growing interest in developing healthier baked products, pulse ingredients offer unique nutritional and functional properties and should be considered when formulating nutritiously enhanced foods.

Roles of alpha-amylase and amyloglucosidase in in vitro resistant starch test
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In vitro resistant starch (RS) tests often employ both alpha-amylase and amyloglucosidase. However, the roles of each enzyme and how they affect the test results are not well documented. The objectives of this study were to investigate the exact role of alpha-amylase and amyloglucosidase in determining the digestibility of starch and to understand the mechanism of enzymatic actions on starch granules. Four maize starches differing in amylose content were examined: waxy maize (0.5% amylose), normal maize (≈27% amylose), and two high-amylose starches (≈57% and ≈71% amylose). Without amyloglucosidase addition, RS content increased from 4.3 to 74.3% for waxy maize starch, 29.7 to 76.5% for normal maize starch, 65.8 to 88.0% for starch with 57% amylose, and 68.2 to 90.4% for the starch with 71% amylose. In the method without alpha-amylase addition, less RS was produced than without added amyloglucosidase, except in maize at 71% amylose content. During digestion, the physical nature of the digested material was compared with respect to the enzyme addition within the digestive media. Scanning electron microscopy (SEM) revealed the digestive patterns of pinholes with alpha-amylase and burrowing with amyloglucosidase throughout the residual material, as well as the degree of digestion between samples. To understand the roles of amyloglucosidase and alpha-amylase in the in vitro test, multiple analytical techniques including gel permeation chromatography, SEM, synchrotron wide-angle X-ray diffraction, and small-angle X-ray scattering were used to determine the molecular and crystalline structure before and after digestion. Amyloglucosidase has a significant impact on RS content of granular maize starches.

Impact of soaking and steaming conditions on breakage susceptibility of parboiled brown rice
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Rice parboiling is a three-step hydrothermal treatment, consisting of soaking, heating and drying of the grain. One of the quality parameters of the resulting rice is the reduced percentage of broken kernels during milling. It is, however, not clear how structural changes in the major rice components during parboiling impact the breakage susceptibility. The objective of our work was to study the impact of different soaking and steaming conditions during parboiling on the breakage susceptibility of parboiled brown rice and to relate it to changes in rice physicochemical properties. Two brown rice cultivars with low and high breakage susceptibility (*ca.* 2% and 10% for Puntal and Bowman, respectively) were parboiled using mild (40 °C - 60 min), standard (55 °C - 30 min) and severe

(60 °C - 60 min) soaking conditions and mild (106 °C - 30 min), standard (106 °C - 15 min and 120 °C - 15 min) and severe (106 °C - 15 min and 130 °C - 20 min) steaming conditions, after which they were dried. It was clear that parboiling intensity has a pronounced effect on the breakage susceptibility. Under optimal conditions, we were able to reduce breakage susceptibility to values lower than 1% for both Puntal and Bowman. The breakage susceptibility of parboiled brown rice depended on parboiling intensity, which itself is related to the degree of starch gelatinization and protein polymerization. By doing so, we gained more insight into the impact of structural changes in the major rice components on the breakage susceptibility of parboiled brown rice.

Significance of bran particle size on bread-baking quality of whole grain wheat flour

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Whole grain wheat flour (WWF) of diverse bran particle size obtained from different milling processes is commonly used for baking bread, though the influence of bran particle size on bread baking quality, especially crumb texture and starch retrogradation of bread, as well as appropriate bran particle size are not clearly understood. We studied the influence of bran particle size on dough mixing property, loaf volume of bread, bread crumb texture and starch retrogradation using WWFs of varying bran particle size prepared from a hard white and a hard red wheat. Bran was ground to fine, intermediate and coarse particles, and blended with white wheat flour to prepare WWFs. WWF of fine bran with the addition of gluten to attain 18% protein showed higher mixograph water absorption and similar mixing time as compared to WWFs of intermediate and coarse bran. Hard white WWF of coarse bran produced larger loaf volume of bread (827 mL) than those of intermediate and fine bran (780 and 765 mL, respectively), while no differences in loaf volume of bread were observed among hard red WWFs of varying bran particle size. Bread baked from WWF of varying bran particle size exhibited similar crumb moisture after storage for 7 days at 4°C. Crumb firmness of bread stored for 7 days at 4°C was 6.3, 5.3 and 5.0 N for hard white WWFs of fine, intermediate and coarse bran, respectively. No evident differences in crumb firmness of bread were observed in hard red WWFs of varying bran particle size. Greater starch retrogradation determined by using differential scanning calorimetry was detected in whole grain wheat breads with fine bran than in those with intermediate and coarse bran after storage for 7 days at 4°C in both hard white and red wheat.

Enzymatically modified gluten by amino acid binding on whole wheat flour for preparation of gluten-reduced breads for celiac disease treatment

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Celiac disease (CD) is an intolerance to gluten proteins, with a prevalence of 1-2% worldwide and health consequences if not treated. The treatment is the dietary gluten withdrawal, but gluten modification to avoid recognition by the immune system is desirable. Gluten proteins have been enzymatically modified at the laboratory scale by binding free lysine or methionine to $–NH_2$ groups from glutamine residues, using microbial transglutaminase (mTG) or chymotrypsin. The objective of the study was to enzymatically modify proteins in the whole wheat flour during dough formation and fermentation, by binding free amino acids and preparing safe and acceptable breads for CD patients. Firstly, lysine and valine were independently bound to the isolated gluten proteins (30% p/v) using microbial transglutaminase and chymotrypsin, respectively. The binding was monitored by HPLC and residual immunogenic gluten was quantified by R5-ELISA for optimization of pHs, reaction times, enzyme:substrate and free amino acid concentrations. For scaling to whole wheat flours for bread-making, conventional procedures were done just adding to the mix each enzyme and free amino acid as for gluten. The best conditions for isolated gluten reaction were 0.8 U/mL of mTG, 1M L-Lys, pH 8, 50°C and 45 min reaction, for lysine binding. For valine, conditions were 1:100 chymotrypsin:gluten, 3M glycerol, 5%Val, pH 10, 37°C and 60 min reaction. The breads prepared with modified gluten had lower specific volume (<3.2 cm^3/g) than the control wheat bread (4.6 cm^3/g) and did not develop cracks on the crust. Finally, the gluten in breads prepared with modified wheat flour proteins was at least 30% less immunogenic than the control bread from unmodified wheat flour. The incorporation of steric bulk into gluten proteins to avoid immune recognition is a promising way to obtain wheat-based breads for CD patients.

Physicochemical properties and proteomic analysis of starch granules in maize landraces from Sinaloa, Mexico

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The variability in starch physicochemical properties and the accumulation of granule-associated proteins of six maize landraces from Sinaloa (Chapalote, Dulce, Reventador, Elotero de Sinaloa, Blando and Tabloncillo) were studied. Significant differences were found for grain physical properties; the lowest kernel hardness value was for the Blando race, while the higher values were observed for Chapalote, Reventador and Tabloncillo, which have highly vitreous endosperms. The amylose content ranged from 8.38 mg/100 mg starch (Dulce) to 35.08 mg/100 mg starch (Tabloncillo), while the accumulation of granule-associated proteins varied from 0.04 to 0.29 mg/100 mg starch for the races Blando and Reventador, respectively. The amylose content showed a significant positive correlation ($r = 0.74$) with kernel hardness. Starch gelatinization enthalpy varied from 6.6 J/g (Reventador) to 15.9 J/g (Dulce), suggesting structural differences in the starch granules of the maize landraces studied. This parameter showed a significant correlation ($r = 0.64$) with the amylopectin content. Mass spectrometric analysis of starch granule-associated proteins identified Branching enzyme II (BEII), Debranching enzyme (DBE), Starch synthase I (SSI) and Granule bound starch synthase I (GBSSI); GBSSI had the highest and lowest accumulation in the races Chapalote and Blando, respectively, showing a positive correlation ($r = 0.54$) with kernel hardness. The results of this study show a great variability in the grain physical properties, with kernel hardness showing a significant correlation with starch composition and thermal properties, as well as with the expression of granule-associated proteins, suggesting the potential use of this variation for the genetic breeding of grain quality traits in the maize landraces of Sinaloa.

Effect of different amounts of fibres and water on gluten-free doughs and bread properties

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In gluten-free (GF) bread production, the absence of the viscoelastic gluten network and the presence of a high amount of starch make the whole process problematic and penalize the sensorial quality of the final product. GF dough, lacking in gluten, shows limited abilities of expansion and gas retention during leavening, that inevitably lead to bread with a reduced volume and a low crumb softness. In order to improve the sensorial and nutritional quality of these products, this study investigated the possibility to enrich GF bread with two fibres, Psyllium (P) and sugar beet (SB). Doughs having 200BU or 500BU consistencies were considered. Four different doughs, and the corresponding breads, were tested: A200 (2.5%P, 0.5%SB), A500 (2.5%P, 0.5%SB), B200 (1.5%P, 1.5%SB), B500 (1.5%P, 1.5%SB). The properties of the doughs during mixing (Farinograph) and leavening (Rheofermentometer) were investigated. Bread crumb softness was tested trough compression tests performed both on fresh and stored (20°C, 60%RU, 72h; paper bags) bread. Crumb holes distribution was investigated by means of Image Analysis. The presence of 2.5%P determined an increase of dough height and CO_2 production during leavening, for the 200BU samples; on the contrary, doughs having a 500BU consistency were characterized by reduced height developments and CO_2 retentions. Breads obtained from 200BU doughs showed a higher specific volume and height, and a good crumb softness. Significant differences ($p < 0.05$) in crumb softness were found between the 200BU breads (7.43 ± 0.82N, A200; 10.63 ± 0.59N, B200), that were even more evident after 3 days of storage (21.71 ± 1.34N vs. 37.56 ± 2.57N, respectively). P generally played a central role on GF bread development, while the water content of the dough was crucial for bread crumb softness. A higher anti-staling effect was evidenced for P in comparison to SB.

Optimization of structure, quality, and sensory acceptance of gluten-free bread enriched with inulin-type fructans using response surface methodology

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There has been an increasing need for research and development in gluten-free bread making, in order to make gluten-free bread (GFB) with good technological and nutritional properties, more available to celiac disease sufferers, contributing to a better compliance to a strict gluten-free diet and

improving the quality of life of these patients. Inulin-type fructans (ITFs) are soluble dietary fiber, and the most studied prebiotic food ingredients. Therefore, the objective of the present study was to use response surface methodology to identify the ITFs and water levels that would maximize the structure, quality and sensory acceptance of GFB formulation. A central composite design was used to assess the interaction between the ITFs and the water levels (independent variables) on the physical properties and acceptability of the GFB (dependent variables). The ITFs ranging from 0 to 30% and water from 69.8 to 110% (flour basis). Optimal ingredient levels were determined from the regression models fitted to the physical properties data [$R^2 > 98\%$, $p = 0.00$] and texture acceptability data [$R^2 = 76\%$, $p = 0.00$]. The optimized formulation contained 30% ITFs and 110% water (flour base) and presented specific volume of 1.2 cm^3/g, moisture of 50%, crumb firmness of 1.8 N and texture acceptability of 8 in a 9-point hedonic scale. Thus, data suggest that ITFs interact with water and produce a gel network structure that serves to increase batter viscosity and to strengthen the boundaries of the expanding cells, increasing gas retention through baking, enhancing the volume and the structural characteristics and texture of GFB. Results also show that ITFs are feasible ingredients in the manufacture of high-quality health GFBs, improving bread quality while providing nutritional and functional benefits to patients with celiac disease.

Effects of inulin-type fructans addition before and after extrusion cooking process on sensory acceptance and glycemic response of corn snacks

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The effects of adding prebiotic inulin-type fructans (ITFs), before and after the extrusion process, on the sensory and nutritional quality of corn-based snacks were assessed. Snack enrichment before extrusion was done by ITFs addition at 13.3% w/w corn grits replacement level. Snack enrichment after extrusion was done using a previously developed flavoring solution enriched with 13.3% ITFs applied on the surface of the product. The use of ITFs caused no damage to radial or volumetric expansion and reduced the shear strength of the corn-based extruded product when compared with the control sample. In experimental conditions, there was 100% ITFs retention during extrusion cooking. The addition of 13.3% ITFs, before or after extrusion, is required in order to obtain a snack enriched with 4 g of ITFs/portion (30 g), a proportion that can provide health benefits. The 13.3% ITFs-enriched snack showed an overall acceptability score (7.1 ± 0.9 for before and 6.6 ± 1.7 for after extrusion), similar to traditional snacks flavored with fatty fixing agent (7.4 ± 1.4). Both 13.3% ITFs- enriched snacks promoted an equal decrease in the snack glycemic index (GI from 81 to 71) and glycemic load (GL from 19 to 15), maintained the characteristics of high GI and moderate GL food. This study demonstrated that it is feasible to add 13.3 % ITFs, before or after the extrusion process, in snack production, yielding a product that combines a physiologically significant supply of prebiotic soluble dietary fiber, high-quality and acceptability. ITFs present low viscosity, which probably did not impair the rheology of the dough within the extruder, making it possible for the expansion ratio to be similar to that of the control snack. However, in order to obtain a snack with a low glycemic impact, another high viscosity soluble dietary fiber should be tested.

Improvement of bread-making properties of waxy wheat

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The low amylose content of waxy wheat flour may be exploited to retard starch retrogradation and therefore to delay bread staling kinetic. However, dough from waxy flours exhibits higher stickiness (that makes it difficult to handle) with respect to non-waxy flour dough. The present work aims at investigating the possibility of improving the workability of dough from two waxy wheat flours of different origin by using them in combination with different percentages (20% and 40%) of commercial flour from non-waxy wheat. Empiric and fundamental rheology of dough was investigated, and the texture of corresponding bread was evaluated. With respect to 100 % waxy flour, the use of blends, with 20% and 40% of commercial flour, allowed a decrease in dough adhesiveness, evaluated as detachment time of the dough from the plate during the test (44% and 55% lower for samples with 20% and 40% of non-waxy flour, respectively). The addition of commercial flour also promoted an increase in farinographic stability (from 3.0 min for 100% waxy flour to 4.5 min and 5.6 min for blends with 20% and 40% of commercial flour, respectively), without affecting starch retrogradation kinetic, as assessed by measuring the consistency of gels stored at 4°C ($F_{max} < 2.8*10^{-2}$ N after 14 days). The G′ and G″ modulus values of dough prepared from flour blends confirmed the elastic-like behavior. The specific volume of bread prepared from blends of either waxy flours resulted significantly higher (5.9–6.9 mL/g) than those of samples from non-waxy flour (5.4 mL/g). Bread made from flour blends containing 20% of non-waxy flour also maintained low firmness values (7.5 N vs. 9 N of 100% waxy flour and 15 N of 100% commercial flour) up to 7 days of storage.

Effect of micronized sugar cane bagasse and water content on the extrusion of rice flour

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The use of byproducts from food industry has been lately considered a new trend, following sustainable practices. Broken rice and sugar cane bagasse, both abundant and from rice millers and sugar-alcohol Brazilian agro industries, were blended with varied sugar cane micronized bagasse content (5-25%). The mixtures were processed in a single screw extruder running at constant screw speed (130 rpm) and two water contents (15 and 30%) producing cylindrical extrudates. The sectional expansion index (SEI) and crunchiness was measured. The extrudates were dried, milled and sieved into flours that were analyzed concerning paste viscosity and x-ray diffraction. SEI values varied from 0.7 to 6.9. A linear reduction of SEI values was found with the addition of sugar cane bagasse ($P < 0.05$) and water content ($P < 0.05$). The textural parameters showed that addition of sugar cane bagasse increased hardness hence reducing crispness. The interaction of water and cane bagasse substantially reduced the cold peak viscosity and the flour from high water and sugar cane bagasse presented the lowest values of viscosity along the paste curve. The original A-type crystals of rice flour changed to either amorphous or E and V type crystals structure showing complete rupture of the rice starch granules and formation of amylose-lipid complexes. The rice/sugar cane extrudates were not suitable as a snack, due to the negative effect on expansion and texture. On the other hand, they would suit as flours for formulating rich fiber products with functional properties.

Bread crumb quality: Correlation between bread crumb structure, texture, and bread volume

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Baking quality is determined through measurement of loaf volume, crumb colour, crumb texture and structure. Bread crumb structures such as cell size, shape, direction of formation and cell wall thickness are typically evaluated by the means of Sensory Evaluation. Calibre Control International Ltd. (Campden & Chorleywood Food Research Association and Calibre Control International, UK) have recently commercialised bread image analyser equipment (C-Cell) to objectively evaluate internal properties of a slice of bread. C-Cell uses high definition imaging and controlled illumination. The whole sample is analysed in fast and simple operation. Data can be used to relate to existing sensory techniques and develop more objective analysis systems. The objective of this study was to investigate the use of C-Cell (bread image analyser) to objectively measure internal quality attributes of pan breads and to investigate the use of C-Cell as a tool for breeding programs to select/discriminate between wheat varieties. In this preliminary study good correlation was observed between the following C-Cell outputs: slice area and number of cells and bread specific volume (calculated using volume measure by seed replacement measure and loaf weight) and crumb firmness (measured using a texture analyser—TA-XT2i Plus) and slice height. In addition the concavity outputs from the C-Cell will be discussed in relation to gluten quality.

Accelerated fouling rates of synthetic thin stillage

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Proteins, carbohydrates, fats and fiber in corn thin stillage are involved in evaporator fouling. Costs associated with fouling include labor and equipment needed to clean fouled heat transfer surfaces, increased capital, antifoulant chemicals and loss of production. Effects of starch (STA) and glucose (GLU) composition in a synthetic thin stillage (STS) fluid on fouling resistance (Rf) were studied. Effects of total solids (TS) content (1 to 10% db) on Rf (m^2K/kW) were investigated at a flow rate of 16 L per minute. Average

fouling resistance growth rate ($\Delta R/\Delta t$) was defined as the ratio of the difference of initial and final fouling resistance (ΔR) to the total time (Δt). An annular probe was used to measure fouling tendencies of STS having various starch:glucose (STA:GLU) ratios. STS viscosity was determined using a Rapid Visco Analyzer. Treatments with 1% TS and 3:7 or 4:6 STA:GLU composition had Rf =1.0 x 10^{-4} m^2K/kW. For STS with higher STA:GLU ratios (5:5 to 10:0), Rf = 2.0 x 10^4 m^2K/kW. Therefore, for 1% TS, Rf increased mainly because of the starch present in STS and glucose had little or no effect. For STS treatments with 1% TS and as increased STA:GLU increased from 3:7 to 10:0, ($\Delta R/\Delta t$) increased from 4.0 to 5.0 x 10^{-4} $m^2K/kW/min$. STS with 3% TS and with starch alone had the same ($\Delta R/\Delta t$) as that of STS with 10% TS and STA:GLU of 3:7, indicating starch had a larger effect, while glucose had a smaller effect, on Rf.

WITHDRAWN

Current status and development trend of Asian products in Brazil
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Brazil has a great number of Asian immigrants, especially Japanese descendants. Therefore, many Asian products, such as tofu, shoyu (soy sauce), rice noodles and instant noodles are available in the Brazilian market. Amongst these products, instant noodles have shown a high growth rate, since they are cheap and easy-to-prepare products. In 2011, the Brazilian pasta industry reached sales of around USD$ 3.3 billion. This revenue increased 3.5% when compared to 2010, greatly due to the evolution of the instant noodles sector (5.9%). Considering the last 5 years, the instant noodle market increased from USD$ 0.77 billion in 2007 to USD$ 1.02 billion in 2011, representing a growth of more than 32%. With regard to volume, instant noodles growth in the last year was 1.1% and 16.6% in the last 5 years. And consumption increased from 0.8 kg/inhabitant/year in 2007 to 1.0 kg/inhabitant/year in 2011. However, since they are fried products, instant noodles contain high residual oil contents, and there is currently considerable concern with respect to health and the consumption of high fat foods, and the low ingestion of fibers, vitamins and minerals. Various alternatives have been proposed in an attempt to increase the consumption of these nutrients, amongst which the development of new products with improved nutritional value as compared to the original food, but also highly acceptable and available for the consumers. We will present a study of the development of instant noodles with functional and nutritional properties aimed at a reduction in calories by reducing both oil absorption and the carbohydrate content by adding soy protein isolate (SPI) and resistant starch (RS3), using conventional and vacuum frying processes.

Optimization of flavonoids and saponins extraction from black bean (*Phaseolus vulgaris* L.) seed coat
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The optimal conditions for the extraction of total flavonoids and saponins from seed coat of black bean (*Phaseolus vulgaris* L.) were determined by maximizing a polynomial equation obtained adjusting the data from a Box-Behnken model. Temperature (°C), time of extraction (hr), and solvent composition (%) were varied. The contents of three main flavonoids were quantified by HPLC with a UV-Vis detector. The content of main saponins was quantified by HPLC with an ELSD detector and confirmed through mass spectrums previously reported. There was a significant increase in the amount of flavonoids and saponins extracted from black bean seed coat compared to the conditions previously reported. It was possible to recover 24% more flavonoids and more than 76% saponins from black bean seed coat. This research provide useful information to choose suitable conditions for extracting flavonoids and saponins from legumes seed coats, especially from black bean.

The relationship between sorghum and maize bran ferulic acid and diferulic acids with grain hardness
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The high concentration and cross linking of ferulic acid and its diferulates to cell walls of the pericarp and aleurone layers is thought to affect grain structural properties that influence hardness. A study was conducted among eight sorghum and maize cultivars of hard and soft classes to determine the role of these phenolic acids on grain hardness. Bran fractions were evaluated for ferulic acid and diferulic acids using high performance liquid chromatographic and mass spectrometric (LC–MS/MS) techniques. Bran samples of harder grains had more ferulic acid than those of soft types. Intra-class testing showed slight differences in cultivars within the hard and soft classes. Correlation coefficient between ferulic acid content of maize bran and grain hardness was higher than that of sorghum. Maize bran ferulic acid content was strongly negatively correlated with Tangential Abrasive Dehulling Device (TADD) hardness (percentage kernel removed) ($r = -0.776$, $p < 0.001$). However, diferulic acids were not correlated with grain hardness. This study indicates that ferulic acid content could be useful as an indicator of hardness to distinguish between hard and soft classes of these two types of cereals and that maize bran ferulic acid has a greater influence on grain hardness than that of sorghum.

Identification of botanical origin of starches using mass finger printing of starch granule-associated proteins
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Starches were commercially extracted from various plant sources including seed, tubers and roots. Some of the starches of high value are often adulterated with other cheap starches, degrading overall quality of the products. Thus the identification of botanical origin is very important for quality control of starches and starch-based products. The analyses used to identify botanical origin include indirect techniques, such as microscopy, rheology, NMR, XRD. However, it is almost impossible to identify the botanical origin using the indirect techniques when mixed with other ingredients or thermally processed. In the present study, innate starch proteins, mostly associated with starch granule, were used as a determining factor of the starch origins. Starch granule-associated proteins were extracted from various starches at 90°C in an extraction buffer of 10% SDS and 2% mercaptoethanol, and separated sodium dodecyl sulfate-polyacrylamide gel electrophoresis (SDS-PAGE) with Coomassie Brilliant Blue. And separated proteins were identified by peptide mass finger printing (PMF) with MALDI-TOF. The mass finger printing results showed granule-bound starch synthase (GBSS) were major proteins for most refined starches, and MALDI-TOF results exhibited the presence of unique peaks different based on the botanical source, including those of 1634.9 *m/z* for sweet potato, 1085.6 *m/z* for tapioca, and 1697.8 *m/z* for corn. The method in the present study can provide a powerful tool for identification of botanical origins of various starches and starch-based products.

Influence of allelic variations of glutenin and puroindloine on flour composition, dough rheology and quality of white salted noodles from Korean wheat cultivars

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Cereal Foods World 57:A41

Allelic variations in glutenin and puroindolines of 26 Korean wheat cultivars were evaluated to determine their effects on the physicochemical properties of flour and quality of white salted noodles. Cultivars carrying *Pina-D1b* and *Pinb-D1b* exhibited coarser particle size of wheat flour, and higher ash and damaged starch content than those with *Pina-D1a* and *Pinb-D1a. Glu-B1b, Glu-D1f, Glu-B3d* and *Pina-D1a* alleles exhibited lower protein content than other alleles. *Glu-A1c*, *Glu-B1b*, *Glu-D1f Glu-B3d*, *Glu-B3i* and *Pinb-D1b* alleles appeared to be related to lower SDS-sedimentation volume than other alleles. In dough rheological properties, *Glu-A1a* and *Glu-D1d* alleles showed longer mixing time on the mixograph and maximum dough height, but *Glu-A3e* and *Glu-B3i* alleles had lower mixing time on the mixograph and lower maximum dough height than other alleles at *Glu-1* and *Glu-3* loci. Regarding the quality of white salt noodles, about 10% of the variations in the hardness of cooked noodles were explained by *Glu-A1* and *Glu-B3* loci. Hardness rankings of cooked noodles were *Glu-A1a* > *Glu-A1c* > *Glu-A1c* at the *Glu-A1* locus. *Glu-B3h* showed higher cooked noodle hardness (5.10 N) than other alleles at the *Glu-B3* locus (<4.66 N).

Significance of starch property and quantity on sponge cake baking quality of soft white wheat

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Starch constitutes over 80% of soft white wheat flour, while its role in sponge cake (SC) baking is not well understood. We evaluated the qualitative and quantitative effects of wheat starch on SC baking quality. Twenty wheat flours, including SC standard, soft white and club wheat of normal, partial waxy and waxy endosperm, and hard wheat, were tested for amylose content, pasting properties, and sponge cake baking quality. Starches were fractionated from wheat flours of normal, single-null partial waxy, double-null partial waxy and waxy starch endosperm, determined for pasting properties and baked to SC. Double-null partial waxy and waxy wheat flours produced SC of 828 to 895 mL in volume, while the volume of SC baked from flours of normal and single-null partial waxy flours ranged from 1093 to 1335 mL. The amylose content of soft white and club wheat flour was positively related to the volume of sponge cake ($r = 0.790$, $P < 0.001$). Pasting temperature, peak viscosity, final viscosity, breakdown and setback also showed significant relationship with SC volume. Normal and waxy starch blends having amylose content of 25, 20, 15 and 10% produced SCs of 1570, 1435, 1385 and 1185 mL in volume, respectively. More than 80 g starch and more than 75% starch in 100 g starch-gluten blends in replacement of 100 g wheat flour in the SC baking formula were needed to produce SC having the maximum volume potential. Starch properties including amylose content and pasting properties, as well as proportion of starch evidently play significant roles in SC baking quality of wheat flour.

Use of dried egg powder in sponge cake baking test and flour-water batter viscosity as an estimate of sponge cake baking quality

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Use of fresh eggs in the sponge cake (SC) baking test poses an inevitable challenge in obtaining reproducible results, due to variations in fresh egg composition and quality. The SC baking test is also a low throughput test and thus not appropriate for testing a large number of wheat flours. We tested the possibility of replacing the fresh eggs with dried or frozen eggs in the SC baking test and developed a non-baking prediction test of SC baking potential. Dried egg powders of 20-25 g with addition of 3 g emulsifier and 8 min whipping produced egg foams of 25.9 to 26.2 g/100 mL density, which was comparable to the target foam density of fresh egg. Compared to SC baked with fresh eggs, SC baked with dried egg powders were smaller in volume, but still differentiated soft wheat flours of various SC baking potential. Frozen eggs produced a similar density of egg foam and comparable volume of SC to fresh eggs, indicating that frozen eggs can be an appropriate replacement of fresh eggs in SC baking test. Considering the potential relationship between physical batter properties and SC volume, SC batter, flour-sugar-water (FSW) batter and flour-water (FW) batter were prepared, determined for density, Bostwick flow distance and Brookfield viscosity, and then related to SC volume in 13 soft white wheat flours. FSW and FW batters exhibited larger variations in flow distance and viscosity than in density. Flow distance and viscosity of all three types of batters correlated positively and negatively with sponge cake volume, respectively, showing a maximum correlation coefficient of 0.778 ($P < 0.01$) between the flow distance of FW batter and SC volume. Bostwick flow distance of flour-water batter appears to be the most appropriate estimate of sponge cake baking potential of soft white wheat flour.

Effects of substituting oat flour on sugar-snap cookie quality

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Cereal Foods World 57:A41

Oats (*Avena sativa* L.) are rich in β-glucan and a number of bioactive compounds which include sterols, antioxidants, and minerals. The health-benefit properties of oat have led to an increase in using oat flour as a functional ingredient in food industries. This study was conducted to observe the effects of oat flour substitution to wheat flour on sugar-snap cookie quality. Oat cv. Joyang developed in the Department of Rice and Winter Cereal Crop, RDA, were ground using a roller mill followed by sieving through 120 mesh. Oat flour was substituted at 10, 20, and 30% levels, and micro-sugar snap cookie was prepared by the AACC method 10-52. Proximate analysis of oat flour showed a composition of 1.65% ash, 12.17% crude protein, and 10.01% lipid. Physical properties of cookies were evaluated by the measurement of diameter and thickness of cookies, and the spread factor (SF) was calculated (AACC method 10-50D). Three-point bending test was conducted as textural analysis, as force required for breaking individual cookies, to obtain the hardness and fracturability. With increasing oat flour, the diameter (mm) of cookies increased from 80.1 to 80.6, but the thickness (mm) decreased from 9.21 to 8.28. The SF increased from 0.87 to 1.04 with higher oat flour. Comparing to the 0.85 SF of control cookies (100% wheat), substituting oat flour resulted in increasing spreadable property. The texture analysis exhibited a decrease in hardness and an increase in fracturability of cookies. Though the control cookies had the highest fracturability value, incorporation oat flour in cookies up to 30% had no significant negative effects on sugar-snap properties, and could improve nutritional and functional properties.

Effect of hydroxypropylmethylcellulose (HPMC) on mechanical properties of corn starch gel

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Cereal Foods World 57:A41

The aim of this study was to investigate the possible interaction between corn starch and hydroxypropylmethylcellulose (HPMC). HPMC was prepared to two phases (powder and solution). Various degree of substitution (DS) of HPMC, containing 19~30% methyl group and 4-12% hydroxypropyl group, was added into 7% of starch gels. The sample was measured the gel formation ability and starch swelling power. To measure freeze thaw stabilization of starch gel, the gels were centrifuged and then subjected to syneresis test. Each of the HPMC which have the different DS were added in starch gel at 0.5% (w/w, based on total gel weight), and total solid content in the gel was adjusted to 7% (w/w) with starch. The gels containing starch and HPMC were repeatedly freeze-thawed three times. One cycle defined at -18°C for 20 hour and room temperature for 4 hour. To measure the freeze-thaw stabilization of gels and water release (syneresis), a centrifugation was used. The effect of HPMC addition on swelling power also evaluated. The microstructure of the gel matrix was observed by a scanning electron microscopy. The control gel showed the lowest syneresis (water release) among gels. As the degree of substitution (DS) of HPMC increased, syneresis of the gel was elevated. Also higher syneresis was observed at HPMC solution gels. Microstructure studies of gels mixed with HPMC showed that the starch granules appeared wrapped by HPMC especially when solution adding cases.

Comparisons of relationship and variance of rheological properties of gluten, dough and batter systems with baking properties

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Polymeric proteins in wheat flour affect functionality and quality parameters of wheat products such as processing and final product characteristics. It is assumed that different balances of gluten components determine the structures and properties resulting in a wide range of product properties. The objective of this study was to analyze the relationship of rheological properties of gluten and dough with baking properties, and their variance. Five commercial wheat flours which varied in protein content and quality were studied at different concentrations. Rheological properties included gluten (creep-recovery, tensile test, wet gluten and gluten index), dough (farinograph, micro-extensibility, and fermentation) and batter (aggregation) variables. Baking properties were analyzed using a pup loaf method. We applied principal

component analysis (PCA) to reveal the relationships. The total explained variance of the two principal components was 75.3% with 54.4 and 19.9% contributions of PCA axis 1 and 2, respectively. Viscosity of gluten and strength of dough had the highest variance contribution (PCA axis 1) followed by fermentation properties (PCA axis 2). Loaf volume of these samples was positively related to viscosity of gluten measured by creep-recovery test using a stress of 40 Pa (Pearson's r = 0.964, P < 0.01). Elastic properties of gluten were equally related to volume of CO_2 lost during fermentation and baking properties. The aggregation properties of these samples have the lowest explained variance suggesting a diluted protein aggregation test has less power to distinguish quality attributes easily detected with more concentrated systems.

Improving the nitrogen response of UK wheat varieties

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There are increasing concerns over the decline in the availability of UK-grown wheat which meets the 13% protein content (dry matter basis) specification for breadmaking. Substantial nitrogen fertiliser inputs are required to achieve this target, which are costly both in financial and environmental terms. Several studies have identified differences in the nitrogen use efficiency of modern and older varieties, where some varieties deviate from the typical negative relationship between grain protein and yield. There is a need to develop new varieties that are efficient and adaptable in nitrogen utilisation and stable to seasonal variation. Six varieties of UK wheat, including those known to exhibit so-called 'grain protein deviation', were grown with different levels of nitrogen fertilisation in multisite trials over three years. Grain was sampled during filling and at harvest, and the accumulation of glutenin and gliadin subunits determined. In addition, transcriptome analysis was also carried out at 21 days after flowering. These data will be related to studies of dough properties and baking performance using innovative statistical methods. Identified genes may facilitate the breeding of new breadmaking wheat varieties with reduced nitrogen requirements and greater stability of processing properties. Here, results concerning protein composition (determined using SE-HPLC Profilblé® method), processing properties (measured by reomixer, farinograph and extensograph) and baking performance at different levels of nitrogen input will be discussed. Varieties showed clear differences in their ability to partition nitrogen into the grain, and in grain protein composition. There was also a differential impact of nitrogen fertilisation rate on dough properties and baking performance of different varieties.

The role of barley starch structure in the production of sugars in wort

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Cereal Foods World 57:A42

Barley grains are the main starch source in beer brewing. During the mashing process, barley grains are milled and incubated with hot water to produce wort where the starch molecules are hydrolysed into smaller sugars and dextrins by degrading enzymes. The sugar profile of wort greatly affects the subsequent fermentation process. The production of fermentable sugar is controlled by several factors, one of which may be starch structure as different starch-structural features can lead to different rates of enzymatic degradation. The objective of this study is to understand the impacts of starch structure on the production of fermentable sugars and dextrins during mashing and subsequently on the quality of beer. Twenty different varieties of barley grains and the malts of ten varieties were used for mashing process. A number of commercial exogenous enzymes were added for the un-malted grain samples. An aliquot of each wort was collected for sugar profile analysis using HPLC and for enzyme susceptibility by reducing-sugar test. The starch, protein, lipid, and total dietary fibre contents were determined for the composition of the barley grain and malt samples. The whole (fully branched) molecular structure and branch-chain length distribution of starch in the grain and malt samples were obtained using size-exclusion chromatography. The solubility and water absorption were determined from the milled grain and malt samples. The results from the correlation and multiple-regression analyses indicate that there are significant relationships between structural characteristics of barley grain/starch and the sugar profile of wort ($p < 0.05$). With a better understanding of the role of starch structure in beer brewing, an improved method to select barley grains and malt for beer brewing was proposed for brewers.

Modification of starch using cold plasma technology

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New methods of modification of starch using physical methods, may be promising if they allow for a decrease in production costs and energy expenditure. The cold plasma method has been used in the chemical industry, in the area of polymers, in order to obtain physical and chemical modifications. This study aimed to modify corn starch using plasma and analyze the technological and chemical properties. At room temperature and cold plasma of H_2, four processes were run: A (5 min, 30 watts), B (15 min, 30 watts), C (15 min, 70 watts), and D (30 min, 30 watts). The analyses carried out were the following: moisture, color, pH, water absorption index (WAI), water solubility index (WSI), viscosity of paste, gel firmness and infrared spectrum. The results were evaluated by the Tukey's test ($p > 0.05$) in comparison with control starch (natural). The results showed that the plasma, at room temperature, was able to remove the free and strongly bound water from starch, the color was darker than that of the control (browning reactions are not visible). Treatments C and D were more affected by pH (A, B, C, control = 7; C and D = 5 to 6). WAI and WSI showed no difference (2% and 1%, respectively). All four processed samples increased the viscosity paste (3636-2189 cps), but only C and D had lower retrogradation (365-342 cps) in comparison with control (1878 and 762 cps, respectively). All samples treated had stronger gels (27mN to 19mN) compared to the raw starch (13mN), which may indicate the formation of starches modified by crosslinking. The infrared spectra analysis showed the presence of large changes in the bands related to the hydroxyls, evidencing the formation of intermolecular complexes in starches samples treated with plasma method. The results are promising for the starch industry, as no chemical reagents, water and heat were used, in addition to the modifications being obtained in a very short reaction time.
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Evaluation of solvent retention capacity and damaged starch as predictive tools in measuring US HWW flour quality

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Solvent retention capacity evaluates the ability of flour to retain a set of four solvents; 5% lactic acid (LA-SRC), 5% sodium carbonate (SC-SRC), 50% sucrose (S-SRC) and distilled water (W-SRC), to produce a flour quality profile. Each solvent quantifies the contribution of a flour constituent to the overall flour quality (glutenins, pentosans and starch damage). The SDmatic uses an amperometric method to measure the level of damaged starch encountered in a flour sample. The evaluation of breeding lines for noodle quality is labor intensive. It is important to identify rapid quality tests to enhance the screening process for the early generation lines. The relationships between white salted noodles (WSN) texture attributes, WSN cooking quality, SRC values, and SDmatic values were investigated. A total of 86 hard white wheat lines grown over 5 years (2006 to 2010) in Selby, South Dakota were evaluated (N=258). Some noodle quality parameters were correlated to SRC values (p value < 0.05). W-SRC was correlated to hardness (r = 0.263), LA-SRC to cooking yield (r = -0.404), S-SCR to springiness (r = -0.228) and cooking yield (r =-0.395). Starch damage levels were correlated with noodle cohesiveness (r = -0.263), adhesiveness (r = 0.245), cooking yield (r = -0.320), and cooking losses (r = -0.257). The strength of the correlations within years varied depending on the growing year, suggesting that environment plays an important role in noodle quality. The relationships between SRC, SDmatic, gluten quality and dough rheology (Mixolab, Kieffer rig) will also be investigated. Multiple regression, principal component analysis and partial least square regression will be used to further assess the relationships between the different parameters and to investigate the possibility of predicting noodle quality using these tests.

Adapting to the new Brazilian wheat quality resolutions

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Before 2010 Brazilian wheat was divided into five classes based on alveograph strength (W) and falling number (FN). Under that previous resolution, some wheat cultivars were classified in classes which did not correspond to their functionality, resulting in wheat commercialization and product manufacture difficulties. Therefore, since 2010 Brazil has a new

wheat quality resolution, which is based on W, farinograph stability (STA) and FN. The new wheat quality resolution is divided into six quality classes, with different end-use functionality. The first objective of this study was to verify how most planted cultivars are classified using the new and previous resolutions (both classifications established by the breeders using their samples). The second objective was to determine whether the wheat classification established by the breeders, based on the new wheat resolution, is suitable for a particular growing region. A database was compiled with 552 entries with milling quality lab parameters from the year 2000 to 2010 crop seasons for a particular growing region. When the previous wheat resolution was compared to the new one only one of 15 cultivars were downgraded to a lower classification and 12 of 15 were in an equivalent class. However, when the wheat classification established by the breeders (based on the new wheat resolution), was compared to the classification established by this study, six of 16 cultivars were downgraded to a lower classification. The wheat classification determined by this study downgraded the quality rating of 38% of the cultivars, indicating that some cultivars tend to drop to a lower classification in the region where the experiments were conducted. Therefore these results show that the classification of a given wheat cultivar should be performed in the region where the crop is grown, where it is segregated and subsequently commercialized for a specific end-use.

Flow properties of semolina and whole wheat flour fortified with flaxseed flour during pasta processing

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Cereal Foods World 57:A43

Semolina and whole wheat flour are the major ingredients used to make traditional and whole wheat pasta, respectively. Flaxseed, rich in omega-3 fatty acids and soluble dietary fiber, is a non-traditional ingredient incorporated into pasta products to increase their nutritional value. Experiments were conducted to determine the effect of flaxseed flour and hydration level on the flow properties of semolina and whole wheat flour during pasta processing. Semolina, whole wheat, semolina-whole wheat 49:51, semolina-flaxseed 90:10, whole wheat-flaxseed 90:10 and semolina-whole wheat-flaxseed 39:51:10 were evaluated. Flow properties were measured by determining the angle of flow and angle of repose of mixtures of ingredients hydrated to 10, 15, 20, 25, 30 and 32% moisture content. Flow properties within the extrusion barrel were determined by measuring extrusion rate of ingredients hydrated at 30, 31, 32, 33 and 34% moisture. Stickiness of the each dough was determined by running the texture profile analysis using the stickiness rig attached to a texture analyzer. Results showed that samples with whole wheat flour as the major ingredient had increased angle of flow and angle of repose than samples where semolina was the most predominant ingredient. Inclusion of flaxseed also increased the angle of both flow properties. Presence of whole wheat flour and flaxseed flour in the formulation reduced extrusion rate which is attributed to dough slippage inside the extrusion barrel. Optimum hydration of semolina before extrusion for traditional pasta making was observed at 32% moisture content. At that percentage, samples with flaxseed flour became over-hydrated forming large aggregates that could result in bridging and subsequently disrupt dough flow during pasta extrusion. Results indicated that blends containing flaxseed flour required less water in order to have similar flow properties as properly hydrated semolina.

Analysis of dough and bread crumb structure of pyranose and glucose oxidase supplemented breads

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Pyranose oxidase (P_2O), much as glucose oxidase (GO), can improve dough stability and bread characteristics, when used in the appropriate levels. Both enzymes oxidize glucose in the presence of molecular oxygen thereby producing H_2O_2. We here investigated the effect of both enzymes and H_2O_2 on dough and bread structure characteristics. Macroscale structural features of bread slices were studied by two-dimensional (2D) analysis using a flatbed scanner. Three-dimensional (3D) studies using computed tomography were executed to resolve micro- and nanoscale structural characteristics of bread and dough samples. 2D bread crumb analysis indicated no significant differences between breads made with H_2O_2 or with an optimal level of P_2O or GO and control breads, although bread loaf volumes of supplemented breads tended to be lower. Furthermore, the 3D porosity of breads, supplemented with an optimal level of P_2O or GO, was not significantly different from that of control breads. However, breads made with H_2O_2 clearly showed a lower micro- and nanoscale 3D porosity, a smaller average cell area and a lower degree of cell wall anisotropy compared to control breads. Similarly, overoxidation of dough with a high level of P_2O resulted in a significant increase in average cell wall thickness. Furthermore, enzyme supplemented bread crumb tended to be more structured compared to control bread crumb. Optimal enzyme supplementation levels probably impart few, but functionally important, changes on molecular level which are relevant for dough strength and stability, and final bread loaf volume and quality. The induced changes, however, are hardly perceptible in the nano-, micro- and macroscale structural features of the enzyme supplemented bread as tested here.

Transition to a one world definition of and analytical method for dietary fiber

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Scientific research, debate and collaboration in the decades since 1953 resulted in a single world definition for dietary fiber in 2009. That year, after 16 plus years of debate, the CODEX Alimentarius Commission adopted (and in 2010 slightly modified) an international standard definition. To most effectively apply this definition to improve human nutrition, appropriate analytical methodology was obviously necessary. An ideal future state is a single definition enforceable for food labeling utilizing a single method. Toward that goal, between 2007 and 2011, the AACC analytical community validated methodology commensurate with the CODEX definition. Achieving a single comprehensive method to fulfill the requirements of the definition has not been without hurdles, the majority of which have been cleared. Future opportunities remain: Improving method efficiency and precision; Fine tuning the method to even better match human physiology (if necessary); Assuring the methodology continues to perform accurately with widespread use; and Adapting if necessary for food fiber sources that may become part of the food supply in the future.

Comparison of phenolics in refined and whole-grain flours of white, light, medium, and dark red soft wheat varieties

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Wheat varieties can be classified into white and different shades of red based on the intensity of grain coloration. The bran of red wheat has been speculated to contain higher content of phenolic compounds as compared to bran of white wheat, but some contradictory studies have been reported in literature. The objective of this study, therefore, was to assess levels of phenolic compounds in whole-grain and refined flours from white and red (light, medium and dark) wheat varieties. Whole-grain flours and refined flour samples from representative white and different classes of red wheat were selected and analysed for their phenolic content. Various classes of phenolic compounds such as phenolic acids, flavonoids and alkylresorcinols were extracted and analysed using RP-HPLC. Ferulic acid is the major phenolic acid and its content in white, and light, medium and dark red whole-grain wheat flours was found to be 431, 447, 436, and 348 µg/g, respectively. In comparison to whole-grain flours, the refined flours contained higher amounts of ferulic acid which ranged between 525 and 667 µg/g for these samples. The total flavonoid content ranged from 99-470 µg/g in whole-grain flours to 57-118 µg/g in refined grain flours. In the next phase of this research, these results will be used to explain any flavor differences between baked products made using these wheat varieties.

Super-heated steam processing as a pre-treatment for the isolation of functional arabinoxylans from corn bran

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Industrial processes currently used for the isolation of arabinoxylan from lignocellulosic biomass employ either enzymatic and/or chemical routes. These processes are either expensive or entail production of chemical effluents. In order to develop a sustainable and environmental process, the extraction of arabinoxylan from cereal by-products was investigated by using superheated steam (SHS) processing as an alternative clean process route. SHS technology is able to control temperature and water activity independently. The added water activity dimension may allow for the introduction of milder conditions for the modification of physico-chemical properties of corn bran for extraction of arabinoxylan. In this study, corn bran was used as a model lignocellulosic biomass. Various SHS time (30 to 60 mins), temperature (120 to 180°C) and water activity (0.5 and 0.7) combinations were evaluated. Current results point out that under SHS pretreatment conditions, high molecular weight arabinoxylan with a high degree of arabinosylation may be obtained. The yield from SHS pre-processed corn bran was compared using traditional enzymatic (ferulic acid esterase) and chemical (NaOH) processes. In addition, characterization of

hydrodynamic and physico-chemical properties of the arabinoxylan were also conducted. The current results suggest that SHS processing may be used as a pre-treatment for extraction of arabinoxylan comparable or better than using existing industrial processes alone. This presentation will detail the technological function of the isolated arabinoxylans, their industrial importance and the advantages of SHS processing. This presentation is important for the development of sustainable technologies and novel utilization strategies for cereal and cereal by-products.

Distribution and composition of fractions of commercial whole wheat flours separated by sieving

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Cereal Foods World 57:A44

Conditioning and milling techniques for the production of commercial whole wheat flour differ. This may affect particle size distribution, which can influence functionality. Therefore, the purpose of this research was to survey the differences among commercially available whole wheat flours at time of purchase with respect to particle size distribution and composition of fractions that had been separated by sieving. Three lots from four different national brands of whole wheat flour were used. Weight fraction, color, protein, and ash content in seven different particle size fractions (i.e., >0.841 mm, 0.718-0.841 mm, 0.507-0.718 mm, 0.358-0.507 mm, 0.273-0.358 mm, 0.230-0.273 mm, <0.230 mm) were determined. Interestingly, not only were significant differences discovered among the four brands for particle size distribution, but lots within two of the brands were significantly different ($p < 0.05$), suggesting that flour particle size produced by the same company is not always consistent. As expected, darker colors were associated with the larger particle size fractions, and the colors lightened as particle size decreased. This suggested that the differences in particle size were due to differences in the degree to which the bran fraction of the kernel was milled, an observation substantiated by the distribution of ash in each particle size fraction, which ranged from 0.37-31.56%. Distribution of protein ranged from 0.191-61.8%, whereas no differences were found in the moisture content of each particle size fraction. Because particle size of the bran fraction in whole wheat flour plays an important role in functionality, sensory acceptability, and shelf-life, standardized methods for milling whole wheat flour and more research on the optimum particle size distribution for whole wheat flour functionality in different food products are needed.

Production of whole wheat flour on a laboratory scale

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Cereal Foods World 57:A44

Studies on whole wheat flour have used a wide variety of milling techniques for production. The objective of this study was to establish a method for the production of whole wheat flour that resulted in a flour that mimicked commercial whole wheat flour with respect to particle size distribution and starch damage. Whole wheat flour mean particle size and starch damage in three lots of from four national brands ranged from 137-458 µm and 4.67-7.69%, respectively. Four cultivars (i.e., three hard red wheat varieties: Overland, McGill, and Wesley; one hard white wheat: Anton) and a composite (i.e., combination of the red cultivars) were adjusted to 6.89-7.98%, 9.01-10.6%, and15.6% moisture and then milled on either a Buhler or a Quadramat Jr mill. All milling fractions were collected and recombined after milling to obtain 100% extraction. As moisture content decreased, mean particle size of the flour decreased ($r^2 = 0.76$ Buhler mill, and 0.77 Quadramat Jr mill, $p < 0.05$). For the samples milled with a Buhler mill, mean particle size ranged from 135.3 µm to 170.5 µm; however, when wheat was tempered to 15.6% moisture, 14.9-17.0% of flour particles were >841 µm, which was not consistent with commercially milled whole wheat flour. At 6.89-7.98% moisture, mean particle size was 135-149 µm, and particle size distribution was more consistent with the commercial brands analyzed above. Results using the Quadramat Jr mill were similar. Milling at these moisture contents did not result in an appreciable starch damage, which ranged from 3.04-7.96% on both mills. These results suggest that milling wheat with low moisture on a Buhler or Quadramat Jr mill, collecting and recombining all fractions, produces a whole wheat flour that is similar to commercially milled whole wheat flour with respect to particle size distribution and starch damage.

Change in carotenoid content and oxidative stress during grain development of durum wheat

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Cereal Foods World 57:A44

A primarily role of carotenoid pigments in plants is to protect the integrity of cellular membranes from lipid peroxidation. Limited research has been conducted on deposition of carotenoid pigments and the effect of oxidative stress on carotenoid pigment content during kernel development. The primary objective of this research was to measure change in carotenoid pigment with occurrence of oxidative stress during grain filling. A field experiment was conducted in 2009, 2010 and 2011 near Prosper, ND. Spikes (50) were collected every 3 to 4 days from each plot beginning 7 days after anthesis. Carotenoid pigment content was determined using AACCI Approved Method 14-50. Lipoxygenase (LOX) activity and malondialdehyde (MDA) content were measured as determinants of oxidative stress. Environmental stress (manifested by high air temperature) was high in 2011, which was reflected in low kernel weights. Carotenoid pigment content per kernel was greatest at the beginning of grain filling and declined as grain filling progressed. MDA content per kernel and LOX activity increased with grain filling. MDA content per kernel peaked at physiological maturity then slowly declined. LOX activity peaked just before physiological maturity then declined. Thus as LOX activity increased, there was a decrease in carotenoid pigment content and an increase in MDA content. Carotenoid pigment content per kernel and MDA content per kernel were greater in 2009 than in 2010 and 2011. LOX activity was highest in 2010, followed by 2011 and 2009 respectively. Data indicate that environment can affect carotenoid pigment content per kernel, MDA content per kernel, and LOX activity in durum wheat.

Development of an innovative way to assess durum wheat sample using 6 quality indexes

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Cereal Foods World 57:A44

The Profiler tool gives a comprehensive interpretation (in hexagon graph) of the raw curves from the Mixolab using the device standard protocol. The obtained Profile corresponds to the conversion of the raw curve measured by the machine into 6 indexes (water absorption, mixing properties, gluten strength, maximum viscosity, amylase activity and retrogradation) ranked from 0 to 9. The common wheat flour (*Triticum aestivum*), is the most cultivated variety the in the world and many profiles are available. However, there is much less information on durum wheat flour (*Triticum durum)*. The aim of this study is to study if the tool is applicable to durum wheat and, if possible, to create a specific Profiler tool adapted for testing durum wheat flour. 477 samples of durum flour samples were analyzed by the Agricultural Research Council using the standard protocol (AACC 54-60.01) for a complete flour characterization (protein, starch and enzyme activity). Results have been statistically analyzed by CHOPIN Technologies. To create a Durum Profiler, the samples were selected in order to express a wide variation in quality. For example, water absorption ranged from 51.5 to 61.4%. Concerning protein weakening, the observed range was 0.32-0.62Nm. The parameter characteristic of starch gelatinization varied between 1.37Nm and 2.29Nm. The 477 standard curves obtained were then exported to a spreadsheet and divided in 5 parts to individually quantify every steps of the test (Mixing, first part of eating, end of heating, heat stability and cooling). For each part we determined characteristic parameters (up to 4) best describing the dough behavior. Every parameter distributions was then statistically studied using Minitab15 software. For every parameter, the sample set was divided into 11 classes with upper and lower limits allowing to have the same number of samples in each class and give them a ranking from 0 to 9. This research allowed us to develop a specific Profiler tool adapted for durum wheat testing.

Changes in lipids and selected B vitamins in whole wheat flour during 1 y of storage

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Whole wheat flour storage is a problem in the food industry due to the instability of the lipids. Other nutritional components of whole wheat flour may also decline with storage. In this report, whole hard red winter and hard white spring wheat flours were stored at 25°C and 60% rh in paper bags for 1 y and changes in conjugated dienes and free fatty acids were monitored in three month intervals to assess lipid degradation. Thiamin, riboflavin, and folate were also assayed over the storage period. In flour from red wheat, conjugated dienes increased significantly during storage from 0.526 to 0.812 (p for trend 0.05), except for a slight decrease in riboflavin in the red wheat sample (p for trend = 0.02). Despite the instability of the lipids in whole wheat flour, the B vitamins appear to be remarkably stable over 1 y of storage under non-abusive conditions.

Production of gluten-free beers with sorghum malt and adjuncts mashed with different amylolytic enzymes
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Cereal Foods World 57:A45

Celiac disease is one of the most prevalent food intolerances worldwide. The most effective treatment for celiac disease is a lifelong strict gluten-free diet which highlights the importance of the availability of a wide variety of gluten-free products to satisfy this market. This work researched the development of gluten-free beers with sorghum malt (red or white sorghum malt) and adjuncts (regular or waxy sorghum) mashed in the presence of B-amylase or amyloglucosidase. The fermentable carbohydrates generated after mashing and ethanol produced after a typical lager fermentation was assessed to determine which was the best treatment to produce gluten free beer. The results were compared with worts and beers produced with barley malt under the same enzymatic and process conditions. Results indicated that it was feasible to produce gluten free beers from sorghum malt and adjuncts especially when amyloglucosidase was supplemented during mashing. The best gluten free beers, in terms of fermentable carbohydrates In wort and ethanol, were produced from red sorghum malt and either brewing adjunct. The addition of amyloglucosidase increased 20% the fermentable sugars content in wort and 1.5% v/v the ethanol concentration in beer. Therefore, it is highly recommended to supplement this enzyme to counteract the low B-amylase activity generally observed in sorghum malts. The sorghum beers supplemented with amyloglucosidase had similar alcohol content compared to conventional barley beers.

Protein quality of commercial high fiber breakfast cereals consumed in northwestern Mexico
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Cereal Foods World 57:A45

The importance of dietary fiber and the contribution of fiber-rich commercial breakfast cereals to the Mexican diet have long been recognized. The objective of this study was to biologically evaluate commonly consumed “high fiber” commercial breakfast cereals selected from the local market using Sprague Dawley rats. Three cereals were chosen, two are whole wheat and wheat bran based, that differ in terms of size and quantity of bran, and the third is based on oats. Biological indices determined were food efficiency ratio (FER), net protein ratio (NPR) and *in vivo* digestibility (dry matter, and apparent and true nitrogen). Results were analyzed by JMP (statistical software) with 95% significance. *In vivo* digestibility of diet based on oat cereal was 83.5% to 85.1%, superior to diets containing wheat bran, presenting values from 62.2% to 64.3% of apparent nitrogen digestibility, and 66.3% to 66.8% of true nitrogen digestibility, which corresponds to up to71% of casein digestibility. NPR of diet based on oat cereal was 3.20 also superior to diets containing wheat bran, presenting values from 1.82 to 2.0, which corresponds to up to 46% of casein. Results from eight independent experiments showed that commercial breakfast cereals with different type and level of dietary fiber showed significant differences in protein quality. This study indicates that fiber in wheat bran products reduces nitrogen utilization in growing rats by causing increases in excretion of endogenous and dietary fecal nitrogen. It also shows that some fibers alter the biological value of the nitrogen that is absorbed.

Genistein detoxifies acetaminophen-induced hepatic toxicity via the potential impact on activation of UDP-glucuronosyltransferase pathway
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Cereal Foods World 57:A45

Soy food has been associated with a contribution of detoxification and hepatic protection, which are related to metabolism activation of soybean isoflavones. The purpose of this study is to investigate genistein’s influence on the association between activities of uridine diphosphate glucuronosyltransferase (UGT) and protection against acetaminophen-induced (APAP-induced) liver toxicity. Animal experimentation revealed that the activities of alanine aminotransferase and aspartate aminotransferase were altered in different doses of genistein, and the contents of glutathione were regenerated both in serum and in liver. The histological observation was significantly different from doses of genistein. The results showed every single difference of UGT1a1, 1a6, 1a10, and UGT2b1 mRNA expression level during toxication and detoxification in the liver. This discovery may explain the mechanism of genistein as a chemoprevention for disease or cancer prevention.

Quantitative approach to study secondary structural changes in protein in the dough state leads to understand the structure-function relationship
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Cereal Foods World 57:A45

Wheat gluten is recognized as the only cereal protein to have the unique ability to form a viscoelastic dough upon hydration and mixing. Gluten proteins are composed of two fractions: gliadins and glutenins. The elasticity of gluten has been associated with high beta-sheet structure of the high molecular weight subunits of glutenin (HMW-GS). Structural transitions during dough development have been found to be particularly important. Zein is the major protein fraction of maize and unlike gluten does not form a cohesive mass at room temperature. Zein is an alcohol soluble protein analogous in a number of respects to gliadin and lacks HMW-GS which are assumed to be responsible for the elasticity of dough. It is hypothesized that addition of co-protein similar to HMW-GS might improve the elasticity of zein dough. The objectives of this study are to: 1) functionalize zein in dough state and improve the elasticity of the system by manipulating the secondary structure of protein, 2) develop a quantitative method to study the secondary structural changes. Fourier Transform InfraRed (FTIR) spectroscopy is widely used for secondary structure estimation of proteins and is based on molecular vibrations. Prediction of secondary structures of proteins was conducted using the Amide I (1700-1600 cm^{-1}) region. Water and starch spectra were subtracted to eliminate their effect. Peak assignment was achieved using Fourier-self deconvolution and second derivative techniques. Quantitation of structures was based on calculation of areas under the peaks. Changes in secondary structure of zein were observed with co-protein addition and temperature change. Quantification of secondary structure of protein in dough state might lead to new strategies to understand the effect of secondary structural motifs on dough elasticity.

Effect of fiber enrichment level and fiber particle size on the extrusion properties of split yellow pea flour
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Cereal Foods World 57:A45

Pulse ingredients are increasingly being used in formulating healthier food products. Split yellow pea flour, due to its high starch content and good nutritional quality can be used as an ingredient in extruded snack formulations. The nutritional benefit of split yellow pea flour can be further improved by re-incorporating the fiber rich hull fraction, although the effect of fiber on end-product quality is not known. This study examined the effect of fiber enrichment and fiber particle size on the extrusion properties of split yellow pea flour. Yellow pea hulls were pin milled at 10, 15, 18 and 22K rpm to produce fiber fractions of different particle size distributions. Fiber fractions were added to commercial split yellow pea flour at 5, 10, 15 and 20% and extruded into a puffed snack using a pilot scale twin screw extruder. Extruder feed rate, screw speed and barrel temperature were kept constant. As the fiber levels increased the expansion ratio decreased on average from 4.16 to 2.93 and the bulk density increased from 0.03 to 0 .04 g/cm^3. Increased fiber levels also resulted in a decrease in *b** (yellowness) on average from 29.64 to 27.79. Fiber particle size did not affect bulk density, color or texture of the snacks. However, the addition of finely milled fiber (milled at 22K rpm) resulted in a decrease in the expansion ratio at the 20% inclusion level compared to the other levels of inclusion (2.67 versus 3.02). Overall, the addition of pea hull fiber to split yellow pea flour had an effect on the quality of the extruded product which was more pronounced for the finer milled fiber added at the higher inclusion level.

WITHDRAWN

Developing the compositional breakage equation using FTIR spectroscopy to characterise wheat components and milled fractions
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Cereal Foods World 57:A46

The initial breakage of wheat during First Break roller milling is a key process that affects the quality of the final flour. The breakage of wheat kernels during First Break roller milling has been modelled previously, to predict the outlet particle size distribution from the physical properties of the inlet wheat kernels and the operation of the mill. However, the broken particles vary in composition as well as size; a full model of First Break roller milling would predict particle composition as well as size. The composition of broken particles can be characterised in terms of the four major wheat components, pericarp, aleurone, endosperm and germ. Kernels of Consort and Mallacca wheat were soaked (to about 44% moisture content, wet basis) and manually dissected into these components, which were then dried back to around 13% moisture (wet basis). The botanical tissues and different milled fractions were ground to a homogeneous size (<50 μm). The distributions of pericarp, aleurone, endosperm and germ in the size fractions were quantified using Fourier-transform mid-infrared (FTIR) spectrometry equipped with attenuated total reflectance (ATR). FTIR was able to distinguish the different components in milled fractions. Extending the breakage equation to include composition would make it more powerful and suitable to understand the fate of the major constituents of the wheat kernel through the milling process.

Impact of digestive enzymes on the optimization of in vitro digestion and beta glucan viscosity measurement using Rapid Visco Analyzer
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Cereal Foods World 57:A46

The solubility of beta glucan (BG) in conjunction with its chemical structure helps to increase the viscosity of foods during digestion. The luminal viscosity is important in lowering serum cholesterol and postprandial blood glucose levels. Recently, a simple in vitro digestion method using rapid visco analyzer (RVA) was established where the digestion process takes place in the RVA canister. The digestion was conducted at 37°C for 2 h with thorough mixing by the rotated paddle. Enzyme types and concentration significantly affected the viscosity developed by this method. The impact of different combinations of alpha amylases and proteolytic enzymes on the RVA digestion method was evaluated. The salivary, bacterial and pancreatic amylases possessed the same effect on the BG viscosity and solubility obtained after digestion. Bacterial amylase was selected mainly for practical reasons. For protein hydrolysis, the effect of pancreatin, pepsin, bacterial and porcine proteases, trypsin and chymotrypsin differed between various samples. Pancreatin was the most effective one, especially for extruded cereals, while other enzymes were not significantly different. Bacterial protease was superior in digestion of bread samples. Increasing the activity of all the enzymes from 6 to 30 units/ml had no significant effect on the BG viscosity or solubility. Generally, the effect of enzyme type was more pronounced than the amount used in the digestion. Thus, a simplified RVA digestion method using a combination of microbial alpha amylase, and pancreatin and/or bacterial protease at pH 6.9 can be used to measure BG viscosity in food products which correlates with physiological response.

WITHDRAWN

Effects of wheat bran color and particle size on whole wheat bread baking quality
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Cereal Foods World 57:A46

Whole wheat bread is a standardized bread product in the U.S. Popularity of whole wheat breads may be due to their appeal as sources of good nutritional value or their perception by the consumer as healthful products. Incorporation of wheat bran into food matrices poses technical challenges for food manufactures. This study investigated the effects of wheat bran source and particle size on whole wheat bread quality. Three types of wheat with different bran color (white, red and partially red—not having all color genes) were milled. The bran and shorts were combined and ground into coarse and fine particle sizes. White flour from hard red spring wheat was used as the base flour and was blended with each type of bran, producing course and fine whole wheat flours from the respective three wheat types. The same base flour was used for all samples to keep the gluten content the same so that the quality could be evaluated solely on the effect of the bran type. Flour quality was determined using Minolta colorimeter (L*, a*, b*) and Brabender Farinograph. Two types of dough formulations (with and without vital gluten) and bread making procedures were followed to evaluate baking quality of the samples. Bread quality was determined by C-Cell analysis, loaf weight, and loaf volume. The coarse bran from all wheat types had a high proportion of large particles remaining on the 425 micron screen (65.5-70.4%). Finely ground bran from all wheat types had bimodal distributions in particle size. Red whole wheat had the highest Farinograph stability (20 minutes). Fine whole wheat flours had higher L* values, Farinograph water absorption and loaf volumes in comparison to course whole wheat flours. Loaf volume was most significantly affected by bran particle size. Wheat bran color had a noticeable effect on L* and b*. Addition of vital wheat gluten increased loaf volumes in all samples.

Process mapping and quality characteristics of baked instant noodles
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Cereal Foods World 57:A46

Baked instant noodles were formulated to reduce trans-fat and its associated health risks to consumers. These noodles were bake-dried after steaming, instead of the deep fat frying process used in making conventional instant noodles. However, consumer acceptance of baked noodles is quite low due to unacceptable textural properties. The objective of this study was to map the changes in product characteristics of baked noodles at different stages of processing. Thermal and pasting properties, light microscopy, noodle surface features, X-ray diffraction, textural characteristics and percent rehydration analyses were carried out on noodle dough, steamed and baked noodle samples received from a processing plant. The enthalpy of gelatinization value for the baked noodles (0.57 J/g) was found to be lower than that of steamed noodles (2.11 J/g) and noodle dough (5.67 J/g). In addition, baked noodles exhibited decreased peak viscosity and no viscosity breakdown was observed. Polarized light microscopy also indicated a loss of molecular order in the starch granules of baked noodles. These results

coupled with X-ray diffraction pattern, suggested that starch granules in the baked noodles were fully cooked. Differences in the drying method, i.e., baking vs. frying, were found to impact the noodle quality. When compared to fried noodles, baked noodles had smooth transverse surfaces, which were less easily rehydrated and significantly less springy, chewy, and resilient. These results indicated that processing variables and formulations impacted the quality of the baked noodles and when effectively optimized can help improve the cooking quality of these noodles. This information can be of use to manufacturers currently developing formulations and processing conditions.

Technological and nutraceutical properties of Mexican blue maize

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The technological properties of Mexican blue native (criollos) maize were evaluated. The technological characteristics are indicators of the commercial quality, handling and grain storage; besides, they are important factors which impact the process of nixtamalization and quality of end products. The test weight, flotation index and remnant pericarp of the Mexican blue maize varied from 76.41 to 79.97 kg/hL, 34.67 to 88% and 5, respectively. These values corresponded to a grain hardness of very soft to hard. These properties are closely related to endosperm texture. Grains with hard endosperm are more compact and heavier than grains with a floury endosperm; generally the former present higher test weight and lower flotation index values than the last. Most blue genotypes possess a floury endosperm that requires less extensive lime cooking compared to other types of hybrid maize. Other researchers have reported that soft kernels tend to overcook and consequently yield sticky doughs which are more difficult to handle and produce tortillas that lose flexibility and develop a more rigid texture upon staling. This last phenomenon is mainly attributed to their higher susceptibility to starch retrogradation. The antioxidant capacity and anthocyanin content of the Mexican blue maize studied varied from 22,722-31,921 ORAC value and 17.18-31.00 mg cyanidin-3-glucoside equiv/100 g (dw), respectively. Differences in technological properties among blue maize genotypes were observed in the present study. However, all Mexican blue maize used in this research could be appropriate for producing tortillas.

Physical differences between baked and extruded pet foods

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In 2010, the pet food industry sold $18.76 billion worth of pet food. There is a predicted growth of the pet food market, where 60% of all pet foods are extruded. Pet food is typically extruded or baked; however, the effect of baking versus extrusion has been researched very little. This study focuses on the physical differences of a pet food after extrusion and baking. Three iso-nutritional diets were formulated for 0%, 10%, and 20% fresh meat inclusion. Major variations between diets were inclusion rates of mechanically deboned chicken, cereal grains, and chicken fat. Each diet was extruded using a single screw extruder at two screw RPMs (353 and 453) and baked using a 30 foot experimental oven at 425°F. Samples were sent to an analytical lab for proximate analysis to ensure the products were nutritionally equal. Each product was measured and weighed for bulk density, piece density, and expansion ratio. As fresh meat inclusion increased (0–20%), expansion ratio decreased (4.1–3.5) for each extrusion treatment. Expansion was not evident in the baked kibbles. Each formula had similar bulk densities for both extruded and baked kibble. However there was a 56% increase in bulk and piece densities between extruded and baked kibble. During texture analysis, each formula of baked kibble displayed identical texture curve and peak hardness (3 kg). With increasing meat inclusion, extruded kibbles decreased in peak hardness (2.9–1.5 kg) and displayed a serrated curve compared to the baked products. This serration supports the presence of cell structure in the extruded products. Extrusion processing showed expansion and promoted cell structures due to a high pressure and shear in the extrusion system. Baking lacks mechanical energy input compared to the extrusion process. As a consequence baked pet foods yield products with little expansion and cell structure formation.

Nutraceutical beverage from germinated amaranth (*Amaranthus hypochondriacus* L.) flour with high antioxidant activity and protein content

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Amaranth grain is a good source of proteins (12.5-22.5%, dw), carbohydrates (60-65%, dw), unsaturated fatty acids (linoleic); furthermore, it has a good content of pytochemicals, which has been associated with healthy benefits. Commonly, amaranth grain is consumed popped. However, there are many alternative technologies to process this grain; one of them is germination. The objective of this research was to optimize the germination bioprocess for the production of germinated amaranth flour (GAF), with high antioxidant activity (AoxA) and protein content (PC), suitable to prepare a nutraceutical beverage with good acceptability. The germination temperature (GT, 25-35°C) and germination time (Gt, 14-82 h) were chosen as process variables. A central composite experimental design with five levels of variation was applied. The desirability method (Response surface methodology) was applied to obtain maximum values for the response variables (AoxA and PC). The best combination of the germination process variables was GT = 35°C / Gt = 82 h. The germinated amaranth flour prepared applying this combination had a global desirability of 0.9; it contained 20% (dw) proteins and AoxA = 19,756 µmol TE/100g of sample (dw). 200 mL portion of the nutraceutical beverage prepared from the optimized germinated amaranth flour had 1.82 g proteins and AoxA of 1,936 µmol TE. The beverage was sensory evaluated with an acceptability of 85 (between “I like it” and “I like it very much”). This nutraceutical beverage might be used for health promotion and disease prevention as an alternative to beverages with low nutritional and nutraceutical values.

Mechanical properties of guava seed (*Psidium guajava*) proteins isolate in wheat dough and loaf bread

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Cereal Foods World 57:A47

Guava seed proteins have been reported to be a suitable ingredient in food for human and animal consumption. Some functional properties of the guava seed protein isolate have also been reported, suggesting its possible application in food formulations and for food processing. In the present work, guava seed proteins have been isolate, extracts were obtained with different buffer solutions at pH 11.5 and 40°C, followed by its precipitation at pH 5. A study was done of the effect of nine guava seed proteins isolate (sour/guava seed proteins mixture) inclusion concentrations (0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8 and 0.9%) on the mechanical properties of white wheat bread dough using a texture analyzer; these concentrations were for tryptophan content in the guava seed. Guava seed protein isolate content was 82.0%. Loaf bread made using the 0.1, 0.2, 0.3 and 0.4% concentrations showed crumb quality to be similar to the control in the 0.6 and 0.7% treatments, but more open and less homogeneous in 0.9 % treatment. Guava seed protein isolate concentration affected bread volume, with the higher concentrations lowering volume by up to 50%, in response to increased water retention. Sensory analysis showed bread containing 0.1, 0.2 and 0.3 % Guava seed protein isolate was not different from the control, with an 83.33% acceptance rate. The 0.1 and 0.2% concentration was optimum for white wheat loaf bread production since its mechanical and sensory properties were most similar to the control. The gel electrophoresis showed the interactions of gluten of wheat and guava seed protein isolate. The conclusion of this work was that the guava seed protein isolate affect the mechanical properties in wheat dough and loaf bread.

Functional properties of wheat, *Lupinus* and *Jathropa* protein concentrate mixtures

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Mixture of legumens and cereals allow the fortification of human consumption foods, enhancing the essential amino acids content. Since wheat is the base of all bakery products, addition of other flours is a common practice. Nonetheless, addition of a high amount of legumens can affect the functionality of wheat proteins, with a detrimental effect on texture and water binding capacity. Lupinus (*Lupinus albus*) is a legumen with high protein content and recently has been employed in bakery fortification, but with poor functionality. On the other hand, Jatropha (*Jatropha curcas*), an oil seed, has as well high protein content but their functional properties have not been

studied. The objective of this work was to study the functional properties of mixtures of wheat, Lupinus, and Jatropha protein concentrates (WPC, LPC and JPC, respectively) by a ten points three components simple lattice mixture design in order to determine the effect of legumens and oleaginous protein concentrations on wheat protein functionality. Gelification properties (hardness, cohesiveness and resilience) and emulsifying properties (emulsion capacity and emulsion work) were determined by a 10 points mixture design approach. LPC and JPC alone had no gelification capacity. Addition of proportions of LPC above 0.7 and JPC above 0.5 in the mixture decrease textural properties of protein concentrates gels. In emulsifying properties, JPC proportions below 0.6 and LPC proportions above 0.8 decreased emulsion capacity and emulsion work. At same proportions, as compared with JPC, LPC enhanced functional properties of the mixture. JPC cannot be incorporated at proportions above 0.5-0.6 without affecting gelification and emulsifying properties of protein concentrates mixture. The functional properties of the mixture of JPC and LPC affect the textural properties of the gels and emulsifying properties.

High antioxidant activity mixture from extruded whole quality protein maize and common bean for production of a nutraceutical beverage

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The objective of this investigation was to determine the best combination of extrusion process variables for producing extruded whole quality protein maize (EQPMF) and common bean (ECBF) flours to prepare a mixture (EQPMF + ECBF) suitable to elaborate a nutraceutical beverage. Extruder operation conditions were obtained from a factorial combination of extrusion temperature (ET = 95-195°C) and screw speed (SS = 80–240 rpm). Response surface methodology was applied to obtain maximum values for antioxidant activity ($A_{ox}A$) and acceptability. The experimental design generated 30 assays. Mixtures from each assay were evaluated for $A_{ox}A$. The best combinations of extrusion process variables for producing EQPMF and ECBF to prepare an optimized mixture (60% EQPMF + 40% ECBF) were EQPMF: ET = 100°C/SS = 211 rpm; ECBF: ET = 96°C/SS = 80 rpm. The optimized mixture had $A_{ox}A$ = 13,320 µmol TE/100 g sample (dw) and a calculated protein efficiency ratio (C-PER) = 2.33. A 200 mL portion of the beverage prepared from optimized mixture had $A_{ox}A$ = 2,997 µmol Trolox equivalents (TE). Nutraceutical beverage could be used as an alternative to beverages with low nutritional/nutraceutical value.

Solid state fermentation of maize (*Zea mays* L.): Effect of fermentation time on antioxidant activity

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The objective of this study was to evaluate the effect of fermentation time on the antioxidant activity of maize (*Zea mays* L.). Fragmented maize grains were soaked (25°C/16h) in acetic acid solution (pH 3.0). Fragmented grains were drained and then cooked in acidified distilled water (pH 3.0) at 90°C for 30 min, cooled (25°C/4 h), inoculated with a suspension of *R. oligosporus* NRRL 2710 (1 x 10^6 spores/ml), and packed in perforated polyethylene bags (15 x 15 cm). SSF was performed at 35°C and fermentation times of 24, 36, 48, 60, 72, 84, 96 and 108 h. The resulting fermented maize (tempehs) from each fermentation time were dried (50°C/12 h), cooled (25°C), and milled (80-US mesh = 0.180 mm). Fermented maize flours were packed and stored at 4°C. The fermentation time increased ($p < 0.05$) the total phenolic content (TPC) and antioxidant activities (ORAC value) of maize grains until 84 h of fermentation; after this time the TPC and ORAC value were not statistical differences ($p < 0.05$). The best combination of SSF process variables to obtain maize tempeh flour with the highest antioxidant activity was 35°C/84 h. Fermented maize flour produced with this combination of process variables showed higher ($p < 0.05$) ORAC value (+46%), TPC (+29%), and proteins (+34.9%) than the unfermented maize. Furthermore, this fermented maize flour showed higher ($p < 0.05$) dispersability and water absorption index, and lower ($p < 0.05$) water solubility index, pH and Hunter '*L*' value than unfermented maize flour. Fermented maize flour obtained with the best combination of SSF process variables might be considered for the fortification of widely consumed cereal based food products and also for the prevention of pathologies associated with oxidative stress.

Nutraceutical fermented common bean (*Phaseolus vulgaris* L.) flour with high antioxidant activity

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The objective of this investigation was to study the effect of fermentation time during solid state fermentation (SSF) on antioxidant activity of common bean. The grains were soaked (25°C/16 h) in acetic acid solution (pH 3.0). Grains were then drained and their seed coats removed manually. Seed coats were dried (moisture content 11%) and milled (80-US mesh = 0.180 mm), packed and stored (4°C). The cotyledons were cooked in acidified distilled water (pH 3.0) at 90°C for 30 min, cooled (25°C/4 h), inoculated with a suspension of *R. oligosporus* NRRL2710 (1 x 10^6 spores/ml), and packed in perforated polyethylene bags (15 x 15 cm). SSF was performed at 35°C and fermentation times of 24, 36, 48, 60, 72, 84, 96 and 108 h. The resulting fermented common bean (tempeh) were dried (50°C/12 h), cooled (25°C) and milled (80-US mesh = 0.180 mm). Fermented common bean flours from each fermentation time were blended with its corresponding milled seed coats and kept at 4°C. The fermentation time increased ($p < 0.05$) the antioxidant activities (ORAC value) and the total phenolic contents (TPC) of common bean grains. The best combination of SSF process variables to obtain fermented common bean (tempeh) flour with the highest antioxidant activity was 35°C/108 h. Fermented common bean flour produced with this combination of process variables showed higher ($p < 0.05$) ORAC value (+91) and TPC (+137%) than the unfermented common bean. Fermented common bean flour obtained with the best combination of SSF process variables might be considered for use as nutraceutical food.

Gluten detection with a next generation of monoclonal antibody

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Celiac disease is an immune-mediated enteropathy caused by the ingestion of gluten from grains such as wheat, rye, barley and, potentially oat. Recent discussions about celiac disease have moved from the concept of gluten detection to detection of the cereal protein fractions that are toxic to persons intolerant to gluten. In this work the monoclonal antibody G12, raised against the QPQLPY peptide from a toxic fragment called 33-mer of gliadin, was used to develop a sandwich enzyme linked immunosorbent assay (ELISA), AgraQuant® Gluten G12 and a lateral flow device (LFD), AgraStrip® Gluten G12. Studies on cross reactivity were performed on various grains, nuts, oils and starches. Positive and negative responses to oat varieties were obtained, suggesting that the G12 antibody may shed light on the debate concerning potential immunotoxicity of oats. The limit of detection of the ELISA test was determined to be 2 mg/kg gluten, with a quantitation range of 4 to 200 mg/kg gluten. The results obtained for spiked samples and processed food samples showed comparable performance with a Mendez R5 ELISA method. The lateral flow test allows for the on-site detection of gluten within 10 minutes with adjustable cut off levels of 5, 10 and 20 mg/kg gluten. The limit of detection was determined to be 5 mg/kg gluten in spiked commodities. When testing rinse water, variation in pH from 5 to 9 does not affect the results. In swabbing experiments from stainless steel and plastic a recovery of 4 mg gluten was achieved. Results obtained from immunochemical test systems based on the G12 antibody should be considered to be closer to the ideal of a food safety test as they establish the important link between celiac disease and detection of immunotoxic peptides.

Investigation to reduce the phytate content of rice flour

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This study analyzed the phytate content in nine rice cultivars that were bred in Korea, and investigated the effects of germination, fermentation, and fermentation additives on reducing the phytate content of rice flour. In paddy that was not dehulled, phytate content varies widely between different rice cultivars. The phytate content in paddy rice is around 8.2–10.1 g/kg. The highest phytate content was found in Goamibyeo paddy and the lowest content in Hanareumbyeo paddy. The phytate content in milled rice is around 2.1–6.3 g/kg. The highest phytate content was found in Suweon517 rice and the lowest content in Manmibyeo rice. Using Goamibyeo, which had a high phytate content both before and after milling, there was a significant reduction in phytate content when the paddy was germinated. The biggest phytate content reduction occurred when the germinated paddy was fermented at 50°C

for 24 hours. The effect was not ideal, but it was confirmed that germination reduces the phytate content of paddy. The phytate of paddy was completely removed when the germinated rice paddy was ground and fermented with yeast and sugar at 50°C for 24 hours after adding ammonium sulfate. Ammonium sulfate at a level of 0.5 g/kg (dry flour weight basis) was very effective as a fermentation additive to reduce phytate content of rice flour. Therefore, phytate can be completely broken down when bran, a by-product of milling rice, is powdered and fermented with the addition of ammonium sulfate, increasing its utility as a food material.

Consumption of wheat bran modified by autoclaving reduces plasma glucose and increases lean body mass at the expense of fat mass in hamsters

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A hypercholesterolemic hamster model was used to study the effects on circulating lipids and glucose, body composition and energy expenditure, of traditional and modified wheat bran (MWB) produced by autoclaving. MWB was shown in a companion study to have enhanced solubility of phenolic antioxidants, fibre and minerals. Syrian golden male hamsters (n = 45) were randomized into 3 groups and fed, for 28 days, a standardized hypercholesterolemia-inducing diet (control) or control diet supplemented with 10% traditional wheat bran or MWB, at the expense of corn starch. Primary outcomes were plasma total, HDL and non-HDL cholesterol, triglyceride and glucose concentrations. Secondary outcomes included weight gain, food intake, oxygen consumption and body composition measured by dual energy X-ray absorptiometry. Neither traditional bran nor MWB diets affected plasma lipid concentrations compared to controls; however, plasma glucose was lower ($p = 0.04$) in the MWB group (6.9 mmol/L) compared to controls (8.5 mmol/L), presumably due to higher level of soluble fiber in MWB. Animals fed the MWB diet had lower % body fat (49.8 vs. 53.4%; $p = 0.02$) and higher % lean mass (47.2% vs. 44.1%; $p = 0.02$) compared to controls despite no differences in food intake or weight gain over the 28 days. Oxygen consumption was also higher in the MWB group (2.2 vs. 1.6 ml/g lean body mass; $p = 0.01$) compared to controls, possibly due, at least in part, to the higher lean body mass. Results of this animal trial using hypercholesterolemic hamsters indicate that wheat bran altered to increase bioactive component extractability/solubility had different and favorable physiological outcomes compared to unmodified bran and a control diet without wheat bran. Consumption of autoclaved wheat bran may be an effective dietary strategy as needed to reduce plasma glucose, adiposity, and increase energy expenditure.

Time evolution of starch molecular and crystalline structures during in vitro and in vivo digestion of raw and cooked starch/grains

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Frequent consumption of rapidly digestible starch (RDS) has been linked to metabolic syndrome, especially pandemic obesity and diabetes. On the other hand, slowly digestible starch (SDS) and resistant starch (RS) have potential to prevent metabolic syndrome. Although several structures of starch on molecular, crystalline, and granular levels have been identified or proposed to be RDS, SDS, and RS, it is not well understood how these structures affect enzyme digestion. The aim of the study is to characterize structural changes during starch digestion to obtain a better mechanistic understanding of the relationship between starch structure and digestibility. The time evolution of starch molecules during *in vitro* digestion was investigated from raw starch granules, extruded starch, and cooked rice grains using size exclusion chromatography with refractive index detector, which showed molecules that were mostly linear with hydrodynamic radius of ~2.5 nm (DP ~50) after prolonged digestion. Similar results were observed from raw starch in the digesta of pig small intestine (*in vivo*). X-ray diffractometry showed that the crystallinity of raw waxy maize (WM) and raw normal maize (NM) granules, which are A-type starches, decreased with digestion time, whereas raw high-amylose maize (HAM) granules, a B-type starch, showed higher crystallinity after digestion. The digested WM and NM granules have higher gelatinization temperature (as analyzed by differential scanning calorimetry) than the undigested counterparts; however, that of HAM did not change after digestion. This suggests that the digested A-type starches can rearrange into crystallites that are more resistant to amylolysis during digestion than the native counterparts. This was not observed in HAM as the native crystalline structure of B-type starch granules is resistant to enzyme digestion (RS type 2).

Molecular structure of starch in dwarf rice and sorghum grains

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Dwarf and semi-dwarf rice varieties have higher grain yield than the tall variety because the short stature increases the lodging resistance of the plants and their response to fertilizer inputs. Dwarf sorghum varieties are also desirable for the ease of mechanical harvesting and lodging resistance. However, the effects of the dwarf mutation on starch biosynthesis in the grains have not been well studied. The objective of the study is to understand the biosynthesis of starch in dwarf rice and sorghum plants by comparing the starch structures in the dwarf and the wild-type or tall varieties. Calrose 76, a semi-dwarf variety due to the mutation in *sd1* gene, and its wild-type counterpart (Calrose), as well as isogenic dwarf and tall mutants from three sorghum varieties, possibly due to mutation in *dw3* gene, were used in this study. The molecular size distributions of whole (fully branched) starch and the branch-chain length distribution (after isoamylase debranching of starch molecules) were analyzed using size exclusion chromatography (SEC). These structures were found to be not qualitatively different between the dwarf varieties and their respective wild-type/tall varieties. It is likely that the hormones for plant height and grain development are controlled by different genes. For example, GA_{20} oxidase, a key enzyme in the biosynthesis of gibberellin, in leaf and stem is controlled by *GA20ox-2* gene in rice and that in the reproductive organs is controlled by *GA20ox-1* gene.

Antioxidant potential and phytochemicals content of desi chickpea (*Cicer arietinum* L.) cultivars

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Antioxidants are believed to play a very important role in the body defense system against reactive oxygen species, which are associated with the development of many chronic and degenerative diseases. Epidemiological and intervention studies indicated that legumes consumption is inversely associated with the risk of coronary heart disease, type II diabetes mellitus and obesity, and results in lower LDL cholesterol and higher HDL cholesterol. The antioxidant potential and total phenolic and flavonoid content, and condensed tannins of four (red, green, brown, cream) desi chickpea (*Cicer arietinum* L.) cultivars from the World Germplasm Bank were evaluated. The protein content of seeds varied from 20.12 to 28.85 % (dw), highest for Cream ICC3421. The seed weight, hectoliter weight, and seed coat percentage of the grains varied from 17.6 to 28.6 g/100 seeds, from 79.0 to 83.0 kg/hL, and from 6.4 to 15.6 g/100 g whole seeds, respectively. The water absorption capacity (WAC) and cooking time (CT) of the whole grains ranged from 97.73 to 117.5 g water/100 g seeds (ww) and from 109.5 to 193.5 min, respectively. The cultivar Cream ICC3421 had the lowest seed coat percentage and CT and the highest WAC. The total phenolic content (TPC) and total hydrophilic antioxidant activity (ORAC value) of desi chickpea cultivars varied from 746 to 1,286 µg gallic acid equivalents (GAE)/g sample (dw) and from 43.9 to 53.9 µmol Trolox equivalents (TE)/g sample (dw); Red ICC14782 and Brown ICC3512 showed the lowest and the highest ORAC value, respectively. The differences in antioxidant activity and phytochemicals content among the desi chickpea cultivars could be used in breeding programs of this important legume.

Effect of optimized extrusion cooking process on antioxidant and antimutagenic activities of pigmented desi chickpea (*Cicer arietinum* L.)

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The aim of this study was to determinate the impact of extrusion cooking on antioxidant and antimutagenic activities of four desi chickpea cultivars. The materials (ICC5383, ICC13124, ICC3761, ICC4418) from ICRISAT, and a

commercial chickpea var. Blanco Sinaloa 92 kabuli type (used as reference) were grown on Culiacán, Mexico. Extrusion process was performed using a single screw extruder; extrusion conditions (extrusion temperature = 127°C/Screw speed = 151 rpm). The total hydrophilic antioxidant activity of raw whole and extruded whole chickpea flours were evaluated using the oxygen radical absorbance capacity (ORAC) method. Antimutagenic activity of methanolics extracts was tested against 1-Nitropyrene (1-NP) in the Kado microsuspension assay using *Salmonella typhimurium* strain TA98. The ORAC of raw whole chickpeas varied from 5,011 to 5,756 µmol TE/100 g sample (dw); ICC5386 and ICC13124 showed the lowest and highest ORAC, respectively. Blanco Sinaloa 92 had an ORAC value of 4,443. Extruded whole chickpea flours retained between 91-94% of the ORAC present in raw whole grains. The methanolic extracts of chickpea flours were neither toxic for the tested strain. The antimutagenic activity (500 ng/tube) of methanolic extracts of raw whole and extruded whole chickpea flours ranged from 49 to 90% and from 42 to 72%, respectively. Among raw whole chickpea flours the highest and lowest % of inhibition of 1-NP corresponded to ICC13124 and ICC3761, respectively. Extruded whole chickpea flours retained between 80-85% of the antimutagenic activity present in raw whole grains. The high percentages of retention in both antioxidant and antimutagenic activities before extrusion cooking process were mostly influenced by the optimized conditions of extrusion cooking process used. Obtained results suggest a great potential of extruded whole chickpea in food products for human health promotion and disease prevention.

Impact of granular and molecular reaction patterns on the physical properties of starch modified within a model reaction system

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It is not yet fully understood how starch chemical reactivity at the granular and molecular levels ultimately relates to modified starch functionality. In this study, the impact of granular and molecular reaction patterns on modified starch properties was investigated as a function of the length of time allowed for reagent to infiltrate starch granules. A fluorescent cross-linking reagent, 5-(4,6-dichlorotriazinyl)aminofluorescein, was dispersed within a starch (normal corn or wheat) slurry for various lengths of time (0, 5, 10, 30, 60 min) prior to initiating reaction (by adjusting the pH to 11.5). After pH adjustment, reaction was allowed to proceed for 3 hr. For all starch derivatives, the granular locale of reaction was monitored qualitatively using confocal laser scanning microscopy (CLSM), while the extent of reaction on debranched starch chains (amylose [AM] and amylopectin [AP] long, intermediate, and short branch chains) was assessed via size-exclusion chromatography (SEC) equipped with refractive index (RI) and fluorescence (FL) detection. The Rapid Visco Analyzer (RVA) was utilized to characterize the pasting properties of starch derivatives. With increasing lengths of infiltration time, reaction progressed from external surfaces (including those of channels) inward into the starch granule matrix, gradually increasing reaction homogeneity within the granule matrix. A significant increase in reactivity was observed for AM (corn and wheat starch) and AP long chains (wheat starch), though the overall extent of reaction was minimally impacted. For a longer reagent infiltration time, a more inhibited (i.e., cross-linked) pasting behavior was observed. These results suggest that granular and/or molecular reaction patterns may be altered (by varying reaction conditions) to impact modified starch physical properties.

Effect of storage conditions of high moisture corn on dry matter loss and dry grind fermentation characteristics

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The effect of storage conditions of high moisture corn on dry matter loss and fermentation characteristics was evaluated using a conventional dry grind process. Yellow dent corn harvested at 37.4% moisture contents (w.b.) was processed and stored at five different conditions; frozen (stored at -10°C), cool (stored at 5°C), ambient (stored at 20-25°C), dried at 49°C to14% moisture content, and dried at 90°C to 14% moisture content. The dry matter loss determination and dry grind process were performed for the corn stored at 1, 5, 10 and 30 days. The dry matter loss of corn stored at ambient temperature was 4.3% during 5-day storage, and increased to 12.3% during 10-day storage. Corn stored at other four conditions resulted in negligible dry matter loss during 30-day storage. After 30-day storage, the final ethanol concentrations from corn samples stored at -10°C and 5°C were 16.8% and 16.6%, respectively. The final ethanol concentrations of corn samples dried at 49°C and 90°C were 16.0% and 15.4% and lower ($p < 0.05$) than frozen and cool corn samples. Frozen and cool storage are better conditions for short-term storage of the high moisture corn, compared with the traditional drying methods.

Novel evaluation index for breadmaking performance of bread flour during short-term storage, using ESR spectra

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White flour milled from grain of Canadian hard wheat in a Buhler test mill was used for this study. The flour was stored at room temperature for different terms. Each flour was measured with an electron spin resonance spectrometer (ESR), and used for bread making test (sponge dough method). When the flour was measured with the ESR (resonance frequency: 9.0 GHz, modulation frequency: 100 kHz, g value: 2.01, center field: 321 mT), a clear peak was obtained in the ESR spectra. With the progress of the storage period, the peak intensity increased remarkably. At bread making test, loaf volume of the bread was measured. Loaf volume increased after storage start of the flour until about 30 days. Then, we found a correlation between ESR peak intensity of flour and loaf volume of bread. We assumed that above-mentioned quality change of flour during short-term storage was a phenomenon that unsaturated bonds in flour were oxidized through radical intermediate compounds. Based on this assumption, we discussed the phenomenon.

Effect of ultrasound application on germination of two corn (*Zea mays*) varieties

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Ultrasound (ULS) has positive effects during germination of grains, such as the increase on enzyme activities. Phytase, a phytate-specific phosphatase, is already used as a supplement in animals' feeds to improve phosphate utilization from phytate, its major storage form in grains. This class of enzymes has been used in foods for human consumption, because the decline in food phytate results in an enhancement of mineral bioavailability. The aim of this study was to evaluate the effects of ULS application and germination times of two corn varieties on water uptake, germinated seeds, and total solid loss, reducing sugars content, alpha-amylase and phytase activities, and phosphorus availability. The corn varieties Dekalb 20-22 (Dk) and Asgrow Garañón (Ag) were stepped for 20 h, sonicated for 3 or 6 min, and kept under dark for 1, 3, and 5 days at 30°C. Non-sonicated seeds were included as controls. ULS positively affected water imbibition of both varieties (>30%), the percentage of germination, and increased the solid losses. Dk absorbed water more rapidly than Ag. Dk showed higher reducing sugars content and amylase activity independently of ULS application and germination times, except the non-sonicated 5-day germinated Ag sample. The highest alpha-amylase activity of Dk (44.2 Ceralpha Units, CU) and Ag (58.5 CU) corresponded to the 6-min sonicated 5-day germinated sample and the control, respectively. The highest percentage of available phosphorus of both varieties corresponded to the 6-min sonicated 5-day germinated Ag sample (45%), and the 3-min sonicated 5-day germinated Dk sample (45.6%). The application of ULS followed by germination stimulated the alpha-amylase and phytase synthesis as it was shown by the increase on reducing sugars and phosphorus availability.

Effect of semolina replacement with a raw:popped amaranth flour blend on cooking quality and texture of spaghetti

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The replacement of semolina (SEM) with raw:popped (90:10) amaranth flour blend (AFB) in spaghetti making at 0, 25, 50, 75, and 100% levels (flour basis, 14% wb) was carried out to evaluate the effects on cooking quality and texture of the supplemented pasta samples. Cooking quality was evaluated according to AACC Method 16-50, whereas firmness of the cooked pasta was measured with the texture analyzer TA-XT2. Significant differences on cooking quality characteristics and texture of the pasta samples were observed. The spaghetti solid loss increased, weight gain and firmness decreased as the AFB level increased. The semolina spaghetti showed the lowest solid loss (7%) and the highest weight gain (178.9%) and firmness (1.49 N), whereas the 100% amaranth blend spaghetti was the softer (around half of the firmness of semolina pasta) and lost the higher amount of solids

(11.5%). The raw and popped AFB was suitable for increasing the nutritional quality through dietary fiber and high quality protein and even to obtain gluten-free spaghetti with acceptable cooking quality (solid loss of 3.5% higher than that considered as acceptable for semolina pasta). The amaranth blend used in this study enables the partial or total replacement of wheat semolina in spaghetti-like pastas with acceptable cooking quality and texture.

Vitamin E and β-carotene contents in Korean wheat varieties

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Due to the increasing prevalence of the Western diet in Korea, about 30 kg of wheat per capita a year, more than approximately four million tons in national consumption terms, has been consumed in Korea. As Korea wheat import is rising, the National Institute of Crop Science in Korea has been concerned with breeding more nutrient and functional wheat varieties and researching their physicochemical properties. In this study, 32 wheat varieties grown in Korea were analyzed for the contents of vitamin E (tocopherols [T] and tocotrienols [T3]) and beta-carotene. Vitamin E and β-carotene were extracted by saponification and then analyzed by HPLC equipped with a fluorescence detector (Ex = 280 nm, Em = 325 nm) for vitamin E, and a photodiodearray detector (450 nm) for β-carotene. All 32 wheat varieties were shown to contain α-T (0.31-1.13 mg/100 g), β-T (0.23-1.08 mg/100 g), α-T3 (0.22-0.48 mg/100 g), and β-T3 (1.99-2.69 mg/100 g). Only 10 wheat varieties including Cheonggeimil, Hanbaek, Jinpummil, Joeunmil, Jokyoung, Jonong, Jopummil, Olmil, Sooan, and Tapdongmil showed r-T, ranging from 0.04-0.16 mg/100 g. The highest α-T content was shown in Namhaemil, but the lowest in Eunpamil. The β-carotene content was the lowest in Eunpamil (2.93 µg/100 g) but the highest in Jinpummil (5.15 µg/100 g). Precision and accuracy of the vitamin E and β-carotene assays were good, showing below 5% CVs. Analysis of SRM 1849 (infant formula) provided the acceptable analytical values falling into the range of the reference values. Quality control chart of vitamin E and β-carotene showed that all assays were under the control. This study provides reliable data on vitamin E and β-carotene in 32 Korean wheat varieties.

Effect of reduced sodium salt in bread baking

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Salt (sodium chloride) is an essential ingredient in bread. However, high sodium intake is associated with high blood pressure which is a major risk factor for heart disease and stroke. The objective of this study was to determine whether satisfactory bread could be produced using salt with reduced sodium content. Two commercial salts containing 57% and 64% less sodium than regular salt were evaluated. Control doughs contained no salt or regular salt. Dough mixing time was measured using the Mixograph. Dough strength and extensibility were determined using the TA.XTPlus Texture Analyzer (Texture Technologies Corp., Scarsdale, NY/Stable Micro Systems, Godalming, Surry, UK) with the SMS/Keiffer Rig. Dough viscosity was measured using the lubricated uniaxial compression test. Bread was baked using the standard AACCI 10-10.03 pup loaf procedure. Addition of salt significantly increased dough mixing time; however, there was not a significant difference in mixing time between salts with different sodium levels. Salt addition and sodium level did not affect resistance to extension or elongational viscosity of the dough. However, dough extensibility significantly increased as sodium content increased. The addition of salt significantly increased bread volume, but sodium content of the salt did not have an effect on bread volume. Overall, reducing the sodium content of the salt by 57% or 64% did not significantly change dough properties or bread volume.

Saltiness potentiation response in white bread by substituting sodium chloride with soy fermentation flavor enhancer

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With the 2010 National Salt Reduction Initiative encouraging manufacturers to reduce sodium content in food products, there is a need to better understand the sensory and functional impacts of this reduction, including the addition of sodium chloride replacers. A soy-derived ingredient made using a modified soy sauce brewing method has found applications as a natural flavor enhancer (NFE). This NFE has less soy sauce flavor and a lighter color profile than typical, naturally brewed soy sauce. In this study, the use of NFE as a sodium chloride replacement in white bread was investigated. White bread samples were made using sodium chloride and then replacing 25%, 50%, and 100% of the sodium with NFE. Loaf volume was statistically similar for samples made with sodium chloride and 100% NFE, but intermediate levels of NFE resulted in decreased loaf volume. Increased levels of NFE substitution caused darkening of loaf crumb and crust even at the lowest substitution level. Consumer overall preference and overall liking were statistically similar for breads made with sodium chloride and with 25% NFE replacement, while breads with higher levels of replacement were not rated as highly. A second experiment was conducted using only sodium chloride or NFE and reducing sodium content by ten percentage point increments up to 50%, including a control with no sodium reduction. A trained descriptive panel (n = 13) evaluated the salt intensity of these samples and found that breads made with NFE were consistently scored higher in salty taste than the corresponding treatments made with sodium chloride.

Understanding fructan properties in wheat

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Wheat has been reported to contain a considerable amount of low molecular weight dietary fiber that is soluble in a 4:1 ethanol aqueous solution. This fraction of fiber is traditionally discarded in the assays of AACC 32-07.01 / AOAC 991.43 and AACC 32-05.01 / AOAC 985.29. The recently developed fiber method AACC 32-45.01 / AOAC 2009.01 or AOAC 2011.25 includes this fraction in the total fiber determination. Among various non-digestible oligosaccharides, fructans or inulins are considered to be one of the components. Studying wheat and grain fructans helps support the inclusion of the LMW fiber fraction. In the literature, the amount of fructans has been reported to be 1-4% for wheat. To better understand the fructan properties, four commercial wheat samples (SRW and HRW) were analyzed for fructose and glucose released by inulinase from whole wheat and milling fractions. Fructan in whole kernels ranged from 1.8% to 2.8%. It was found that bran and shorts had 6.8-8.7% and 5.2-7.8%, respectively. Solubility was examined by water extraction at ambient and elevated temperatures, while molecular weight distribution and degree of polymerization (DP) profile were compared by SEC-MALS and HPAE-PAD, respectively. An SRW sample of whole wheat showed DP < 32 in ambient extract, while an 80C extract showed high MW fructan (about 1% w/w). Results suggested that wheat fructan is a contributor to its LMW fiber fraction, and should be included in total fiber determination.

Use of dynamic tests to determine the effects of sodium reduction on dough rheology and its correlation with tortilla quality

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Knowledge of the effects of sodium reduction on rheological behavior of wheat flour dough is essential to tortilla making process and quality. Standard rheological tests such as compression and stress relaxation may not effectively detect effects of modest changes in quantities of sodium on dough and tortilla texture. This study used the dynamic oscillatory frequency sweep test to evaluate effects of substitution of sodium bicarbonate (NB) with potassium (KB), calcium (CAL), and Mix (KB and CAL) bicarbonate leavening systems on tortilla dough viscoelastic properties. Three levels of substitution translating to 0% (Control) 50 and 100% NB reduction were used. Viscous (G″) and elastic (G′) dough properties were measured at increasing frequencies (0.01-10 Hz) within the linear viscoelastic region (5 Pa) obtained from a stress sweep test. Tests were done at 23°C. Amounts of KB and CAL were adjusted to produce similar carbon dioxide yield as NB. Tortillas were processed and evaluated for diameter, color, height, deformation modulus and flexibility over storage. Traditional dough compression ($p = 0.603$) and stress relaxation equilibrium ($p = 0.744$) forces did not detect treatment effects indicating poor sensitivity of the tests. Significant differences in dough storage (G′) and loss (G″) moduli ($p < 0.05$) were detected at frequencies above 0.03 Hz. Tortilla flexibility highly correlated with G′ ($r = -0.73$) and G″ ($r = -0.79$) at 10 Hz. CAL produced an elastic dough with the highest G′ while a decrease in NB increased G′. Increasing KB significantly decreased dough elastic property (G′), tortilla diameter (158 mm) and flexibility (<3.0). CAL produced the largest tortillas (169 mm) with superior flexibility (>3.0) over storage compared to control (diameter 161 mm, and flexibility 3.0). Dynamic oscillatory testing can distinguish effects of small changes in dough properties that impact tortilla quality, but are not detectable by traditional methods.

Thermal and functional properties of acha (*Digitaria* spp.) starch

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Acha (*Digitaria exilis* [white] and *D. iburua* [black]), consumed as whole grain, has been reported to be high in resistant and slowly digestible

starches but low in rapidly digestible starch. It is a grain of choice in the management of diabetes in Africa. Our objective was to investigate the thermal and functional properties of starches from two acha cultivars compared to wheat starch. Wheat starch (WTS) had the highest onset (To) and peak (Tp) temperatures 34.7°C and 74.5°C, although not significant. Black (BKAS) and white acha (WTAS) To and Tp were 25.0, 26.7°C and 68.2, 70.5°C, respectively. The gelatinization temperature range (Tc – To) for WTAS and BKAS were between 62 and 66°C whereas that of WHS was 61°C. Acha starches with lower transition temperature imply a low crystallinity with high amorphous regions. Temperature of retrogradation was 64.1, 67.0 and 64.8°C for WTS, WTAS and BKAS, respectively. The starches were similar ($p > 0.05$) in gelatinization and retrogradation temperatures. There was significant difference ($p < 0.05$) in peak viscosity and final viscosity between WHS and acha starches. There was, however, no significant difference ($p > 0.05$) between WTAS and BKAS for trough viscosity (3125 cP and 3137 cP) and setback viscosity (2332 cP and 2476 cP), respectively. Gels produced from the three starches did not differ significantly in hardness, resilience and springiness. All the starches produced highly springy soft gels. There was significant difference in the water binding capacity between WTS (0.83 g/100 g) and both acha cultivars 1.33 g/100 g for WTAS and 1.36 g/100 g for BKAS, a property that could be linked to appreciable amount of pentosans. However, the acha cultivars did not differ significantly in WBC. Acha can thus be utilized as an alternative to wheat starch in some applications where a thermal property such as gelatinization is important.

WITHDRAWN

Molecular structure of starch in developing wheat endosperm

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Starch biosynthetic enzymes in wheat endosperm exist in several isoforms and have different expression patterns, which potentially affect starch structure during development. In this study, the molecular structure of starch in large and small granules was studied in Eastern hard red spring wheat harvested at 7, 14, 28, and 49 days after anthesis. Amylose content was measured by debranching whole starch followed by subsequent analysis on Sepharose CL 6B. The amylose content increased with maturity in both large and small starch granules. However, small granules had lower amylose content at all maturities compared to large granules. The amylose chains were divided into long (eluting at the void) and short chains. Both fractions increased with maturity, but the ratio of long to short chains was lower in the large granules. Moreover, the ratio decreased with maturity in the large granules (from 1.3 to 0.9) but increased in the small granules (1.7–2.1), suggesting changes in the structure of the amylose fraction. The apparent amylose fraction increased also on Sepharose CL 2B but was different from the amylose content measured on Sepharose 6B, probably due to an increase in the size of the amylose molecules. Unit chain profiles of the amylopectin component (analyzed by HPAEC-PAD) showed that chains with DP 6-12 increased and those with DP 19-38 decreased with maturity. The latter are probably involved in the organization of building blocks in the macromolecule. Thus, small but significant changes in the structure of both amylose and amylopectin occurred during wheat starch development.

Granular architecture and molecular structure of pericarp starch from wheat

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In wheat grains, starch is found in both endosperm and pericarp tissues. In the pericarp, starch exists even before cell differentiation. Degeneration of pericarp tissue and loss of starch granules occur before the complete formation of endosperm. Different isoforms of the enzymes responsible for starch biosynthesis are expressed in these tissues. However, the structure of wheat pericarp starch (PS) is not yet studied. Therefore, the granular architecture and the molecular structure of PS from grains harvested at 3 days after anthesis (DAA) and endosperm starch (ES) from grains harvested at 49 DAA were studied. Both PS and small ES granules were spherical, whereas large ES granules were lenticular. Blocklets were observed by AFM in PS and ES (large and small) starch granules. The size of blocklets in PS and small ES granules was larger than that of large ES granules. WAXS data demonstrated A-type crystallinity in all three starches, but the relative crystallinity (RC) of PS was higher than that of ES. Granular architecture was further studied by exposing starch to iodine vapor. K/S spectra of iodine exposed starches demonstrated lower iodine binding for PS and small ES granules than that of the large granules of ES. Iodine did not change the polymorphic structure obtained by WAXS, but increased RC of all starches. Amylose content of PS was 13.3%, while that of small and large granules of ES was 33.6 and 28.4%, respectively. The unit chain profiles analyzed by HPAEC-PAD showed that amylopectin from PS had more short chains at DP 6-12 and less chains at DP 19-38 compared to ES. This suggested specific differences in the organization of unit chains within amylopectin clusters. It is concluded that both the molecular and the granular structure of PS in wheat are distinct from its ES.

WITHDRAWN

Effect of heat moisture treatment under mild acidic conditions on the physicochemical properties and digestibility of potato starch

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Heat-moisture treatment (HMT) provides a means for altering the physicochemical properties and digestibility of starch. The aim of this research was to investigate the impact of HMT conducted under mild acidic conditions on the structural characteristics, physicochemical properties, and digestibility of potato starch. Potato starch was heat-moisture treated at 120°C at moisture levels of 15, 20 and 25% for 3 h under mild acidic conditions (pH 5, 6, and 6.5 [control]). In general, HMT significantly delayed starch pasting and reduced overall paste viscosity, granular swelling, and amylose leaching relative to native starch. As a result of HMT, long-range crystallinity determined via X-ray diffraction decreased, while short-range crystallinity assessed by Fourier transform infrared spectroscopy increased. An increasing

level of moisture during HMT generally imparted greater physicochemical and structural changes to starch. However, slight acidic conditions during treatment further enhanced the noted physicochemical effects of HMT. The swelling factor of potato starch subjected to HMT at 20% moisture and pH 6 was extremely restricted (5.95) compared to both control and native starches (13.63 and 23.70, respectively); likewise, short-range crystallinity (0.77) of the same HMT starch increased relative to that of control and native starches (0.76 and 0.74, respectively). These noted changes reduced the in vitro digestibility of HMT starch (pH 6, 20% moisture), enhancing the resistant starch content (22.42%), even after cooking in excess water, compared to that of control and native starches (15.47 and 5.88% respectively). In short, mild acidic conditions during HMT appear to enhance the physicochemical properties and digestibility of potato starch.

Nanoparticle preparation from waxy maize starch using acid hydrolysis combined with ultrasonic treatment

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Starch nanoparticles with a narrow size distribution were prepared by a mild acid hydrolysis combined with ultrasonic treatment. Native waxy maize starch (44.07 g, dry basis) was dispersed in a diluted sulfuric acid solution (300 mL, 3.16 M) and hydrolyzed for 7 days at 40°C, with ultrasonication concurrently or sequentially. Ultrasonication during the acid hydrolysis (20% amplitude for 30 min) led to the increase of the formation of nanoscaled starch particles without affecting the yield (~15%) and crystal structure (A-type). The subsequent ultrasonication administrated to the dispersion at specified amplitudes (30 and 60%) over duration of 2-10 min. Ultrasonication at 30% amplitude caused some aggregation of starch particles, so the mean diameter was increased. However, ultrasonication at 60% amplitude showed a relatively well dispersed particle size about 30-40 nm, which corresponded to the reported starch blocklets. Furthermore, this ultrasonic process did not influence the inherent A-type crystal structure of the starch. This study demonstrates that combined treatment of acid hydrolysis and ultrasonication could be an efficient method for the preparation of starch nanoparticles with a good yield.

Soft wheat grain quality in United States germplasm

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Soft wheat (*Triticum aestivum* L.) quality is dependent upon both genetic and environmental factors, which work in combination to produce specific grain, milling, and baking characteristics. Wheat breeders select for high grain yield and local adaptation, in conjunction with perceived targets (or limits) of grain quality using a number of quality "phenotypes". This study surveyed all (132) soft wheat varieties (cultivars and advanced breeding lines) grown in cooperative regional trials in the United States in 2009. Quality parameters included kernel hardness, wheat and flour protein, break flour and flour yield, solvent retention capacity (SRC), and cookie diameter. High levels of variation were observed among varieties, regions and environments. The varieties were grown at four separate nurseries: Uniform Eastern & Southern Soft Red Winter Wheat Nurseries (East SRW, South SRW), and the Western Regional Soft White Winter & Spring Wheat Nurseries (West SWW, West SWS). Across all nurseries, location had a stronger influence on milling characteristics than did variety, but the baking characteristics were more strongly impacted by varietal differences. Nursery mean cookie diameter was the highest in the East SRW nursery (9.36 cm), and smallest in the West SWW nursery (9.25 cm), which also displayed the hardest kernels by a large margin (23.6 vs. 34.8). Notably, the East SRW nursery displayed the highest sucrose SRC (95.0%), whereas the West SWW nursery exhibited a markedly lower sucrose SRC response (90.7%). The influence of variety and location varied among nurseries and measured characteristics. Based on baking characteristics, the rank of nursery performance was: East SRW, South SRW, West SWS, and West SWW, which tended to be associated with kernel hardness, flour protein, and break flour yield.

Effects of soy protein isolate, calcium carbonate, and pregelatinized wheat starch on oil uptake and texture of soy based snacks

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Snacks are widely consumed and the acceptability of these snacks mostly depends on their textural properties. The texture of a product is mostly influenced by its microstructure, which varies with formulation and processing conditions. The effects of increasing levels of soy protein isolate (SPI), calcium carbonate ($CaCO_3$) and pregelatinized wheat starch (PGWS) on texture and oil uptake were investigated by studying the texture and dynamics of water and oil uptake during processing. Extruded dense savory snacks were produced with defatted soy flour and wheat flour at 50:50 (control) levels. SPI (4, 8, 12 % flour basis [fb]), calcium carbonate (0.2, 0.4, 0.6 % fb) and PGWS (4, 8, 12% fb) were also tested. High in-barrel moistures (38.6%) and low barrel temperatures were maintained to produce dense extrudates. Physico chemical properties like water holding capacity (WHC), oil uptake, crude fat, and texture of all the samples were tested. Addition of SPI, $CaCO_3$ and PGWS at different levels decreased WHC compared to that of control. At highest inclusions of soy protein isolate and calcium carbonate oil uptake decreased by 4% and 9%, respectively, whereas at 12% addition of PGWS oil uptake increased by 19.1%. Crude fat decreased by 8.3%, 14.8% and 1.1% with the addition of SPI, $CaCO_3$ and PGWS. WHC affected the amount of oil absorbed during frying however in samples with PGWS the degree of starch gelatinization influenced the amount of oil absorbed. Higher degree of gelatinization (89%) was observed in samples at 12% PGWS. Hardness of the products increased with SPI (14.4 N) and $CaCO_3$ (17.7 N), whereas with PGWS (13.1 N) it decreased compared to control (13.4 N). WHC and oil uptake were studied at different time intervals to study the relationship between moisture and on oil uptake during processing.

Effect of pre-treatment with tempering and high hydrostatic pressure on the properties of dry milled rice flour

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We investigated the effect of milling pre-treatments such as tempering and high hydrostatic pressure on the properties of dry milled rice flour. Water was sprayed on polished rice kernels at up to 30% of rice dry weight, and the rice was packed into a vinyl bag. The packed rice kernels were tempered at 40°C for 3 hr. After tempering, the packed rice kernels were subjected to a high pressure chamber at 100 MPa and 40°C for 1 hr. Then, the pre-treated rice (tempered or tempered with high hydrostatic pressure) was ground with a centrifugal force mill. The moisture content of the flour was decreased to less than 20% due to drying by blowing of centrifugal force. A centrifugal force mill made finer flour (<10 μm mean size) with a 4~20 μm particle size distribution. Starch damage and water absorption of flour increased and bread loaf volume decreased dramatically by using the centrifugal force dry mill compared to that of wet milling. However, tempered flour showed a significant decrease in starch damage and water absorption and an increase in loaf volume, which was almost similar to the properties of wet milled flour. The high hydrostatic pressure treatment resulted in the same properties as those of the tempered rice flour and helped the grinding process. In other words, it did not change the starch damage, water absorption, or RVA properties of the flour but helped increase milling yield by aiding the tempered water to penetrate the kernel under high pressure, and water did not leak out during grinding, which causes starch gelatinization and produces starch lumps during milling by heat generated from the machine. Water penetration into the kernel was confirmed by cryo-scanning electron microscopy. The morphological characteristics of the grain and hardness of different rice cultivars significantly affected the effectiveness of the pre-treatment.

Characterization of oat storage proteins

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Due to increasing health awareness and celiac disease the attention to *Avena sativa* is rising again. Oat exhibits a more favorable nutritive composition than wheat, with regard to lipids, dietary fiber and amino acids. While the proteins of oat prolamin fraction (avenins) are well known already, composition and function of oat glutelins and their possible similarity to oat globulins are still under discussion. Quantitation of extracted protein fractions from flours of five oat cultivars was conducted with an Osborne extraction/RP-HPLC method. Globulins were the major fraction (29 %) followed by prolamins (18 %). Albumins and glutelins accounted for less than 15 % each. However, the comparison of the crude protein contents of the flours (Dumas analysis; N x 6.25) to the sum of extracted fractions revealed, that about 30 % of crude protein had not been solubilized (R = 0.99). Extraction yields significantly increased by using sodium dodecyl sulfate solutions and by applying hydrostatic pressure (200 MPa, 40 °C). Under both conditions non-covalent interactions are known to be broken. Thus, solubilized proteins clearly resembled oat globulins, showing the typical SDS-PAGE pattern of 12S oat globulin with spots at molecular masses of the α- and β-subunit (32 and 22 k). Characteristic disulfide peptides of the known 12S oat globulin were

identified in both chymotryptic digests of extracted globulins and residual proteins by using LC-MS/MS with CID/ETD fragmentation. The same types of disulfide bonds were identified in the two fractions. Therefore, the poor solubility of the globulin-like residual oat proteins is more likely to result from hydrophobic interactions than from covalent interchain disulfide bonds. Further N-terminal sequence analysis is underway to examine if characteristic oat glutelin proteins with unique amino acid sequences do actually exist.

WITHDRAWN

Study on dietary fiber extracted from bean curd residue by enzymic method

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Through a single-factor and orthogonal design experiment regarding thermostable α-amylase on bean curd residue, the optimal enzymolysis conditions with consistence, temperature, and time were studied. The results indicated thermostable α-amylase, 1%; temperature, 100°C; and time, 2 hr. Through a single-factor and orthogonal design experiment regarding cellulose hydrolysis conditions with consistence, temperature, time, and pH, the optimal enzymolysis conditions to transform insoluble dietary fiber into soluble dietary fiber were studied. The results indicated cellulase, 2%; temperature, 60°C; time, 2 hr; and pH, 4.6. Under the optimal enzymolysis conditions, satisfactory results have been obtained for dietary fiber extracted from bean curd residue and for analysis on nutrient components within it.

Isolation and partial characterization of non-starch polysaccharides from quinoa and amaranth grains

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There has been increased attention on quinoa and amaranth grains, because of their high protein content and a better essential amino acid composition than cereals. Their dietary fiber content is comparable to that of cereals, but they have a greater proportion of soluble dietary fiber, which has certain beneficial health properties. The main objective of this study was to measure, isolate and partially characterize the non-starch polysaccharides of the insoluble (IDF) and soluble (SDF) dietary fiber fractions of quinoa and amaranth grain grown in South America. A standard enzymatic-gravimetric procedure was used to isolate each fraction from defatted whole grain flours of both grains. Enzymatic treatment for starch removal was done twice with water (IDF) and 80% ethanol (SDF) washes to decrease starch content to <1.5%. Quinoa (2.25% SDF, 7.69% IDF) and amaranth (2.54% SDF, 8.89% IDF) had approximately 1.5 times more soluble dietary fiber than wheat (1.68% SDF, 9.78% IDF). IDF fractions of quinoa and amaranth grain were analyzed for monosaccharide composition. The neutral sugars released by 2M TFA acid hydrolysis were measured as their alditol acetates by GC. Quinoa IDF was composed of rhamnose (8.9 g/100 g), arabinose (8.0 g/100 g), xylose (7.9 g/100 g), galactose (5.7 g/100 g), mannose (2 g/100 g), glucose (2.9 g/100 g) and fucose (0.8 g/100 g). Amaranth IDF consisted mainly of arabinose (14.8 g/100 g), xylose (7.2 g/100 g), rhamnose (6.3 g/100 g), galactose (5.6 g/100 g), glucose (3.6 g/100 g), mannose (1.6 g/100 g) and fucose (0.4 g/100 g). Both samples had high amounts of uronic acid. Total uronic acid content of amaranth IDF was 59.1 g/100 g and of quinoa IDF was 62.1 g/100 g. Glucose from cellulose was also determined for these IDF samples and was 1.8 g/100 g for quinoa and 1.3 g/100 g for amaranth. This information is relevant for the further study of fermentative and functional properties.

Perception of sensory properties of phenolic acids during repeated consumption

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Phenolic acids are thought to contribute to positive health outcomes observed with whole grain consumption through their antioxidant activity. However, research has demonstrated that phenolic compounds can elicit unwanted sensations of bitterness, sourness and astringency. This study investigated the sensory characteristics of phenolic acids found in whole grains and the effect of repeated exposure on perception of their sensory attributes during consumption. Following descriptive analysis, a trained panel of judges (n = 10) utilized sequential sipping time-intensity (TI) procedures to evaluate aqueous solutions of ferulic and vanillic acid (1 mM, 6 mM, 12 mM). Attributes were evaluated for each sample as follows: judges held the first of four 15 ml samples (sip 1) in mouth and expectorated after 10 s, followed by ingestion of the second sample (sip 2) 10 s later. This was continued for 4 sips. After expectoration of the fourth sample, panelists continued to rate the sensation until it had dissipated. Panelists continuously recorded their responses from sip 1 to sip 4 on a computerized 100 mm scale using TI software (Compusense 5). Maximum intensity (IMAX), time to max intensity, total duration of perception, and rate of increase from initial to maximum intensity (ROI) for each sip was extracted from the TI curves. Data were analyzed to determine significant differences in perception of each sensation across the four sips. Astringency IMAX continuously increased ($P < 0.001$) from sip 1 to sip 4. Bitterness and sourness IMAX increased significantly ($P < 0.001$) from sip 1 to 3 but plateaued at sip 4. These findings reveal that even small concentrations of phenolic compounds can lead to greater perception of astringency, bitterness and sourness after repeated consumption, and that differences the in phenolic acid profiles of whole grain varieties may impact sensory characteristics.

Effect of sodium selenite addition on selenomethionine generation during production of yeast-leavened sponge breads

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The effect of sodium selenite addition and fermentation times on production of selenomethionine (SeMet) during sponge bread production was evaluated. Sponge doughs were supplemented with SeO_3Na_2 and fermented with bakery instant yeast (*S. cerevisiae)* with minimum sulfur salt addition. The effect of sodium selenite on yeast activity measured as CO_2 production was evaluated using a pressurometer. SeMet concentration in breads was determined by HPLC-fluorescence method in samples treated *in vitro* with trypsin and pancreatin. Results showed that there were not statistical differences ($p < 0.05$) in CO_2 production and dough pH at all the sodium selenite concentrations tested. HPLC data showed that the selenized proteins production was benefited with the increase of fermentation times, while less significant effects were observed in the changes in concentration of SeO_3Na_2. The selenium-enriched bread has 5.6 more SeMet concentration compared to the control. The physical features (water absorption, bread weight, bread volume, color, density, oven spring etc.) and organoleptic evaluations for the enriched loaves of breads were evaluated. In all these parameters, the experimental enriched breads had practically identical attributes compared to the control bread. The breads rich in selenized proteins have potential to be used as functional foods because the selenized proteins are used to synthesize higher quantities of glutathione peroxidase, enzyme considered as one of the most protective mechanisms against oxidative stress and preventive of cancer and chronic diseases.

Optimization of Russian bread making test by analytical determination of hydration level

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Dough hydration level is a key point in bread making. Dough behavior, and consequently bread quality, change as dough is over or under-hydrated. Most

of the bread making procedures used around the world to evaluate flour properties are done with adapted hydration (constant dough consistency). Nevertheless, this adaptation is based on the baker's feeling of the dough. The objective of this study, based on GOST 27669-88 Russian standard, is to evaluate how the bread making test performances can be improved by using analytical and objective determination of hydration level. 48 flour samples are simultaneously tested with the exact GOST 27669-88 Russian bread making standard and also with an adapted procedure. With the standard procedure, initial hydration level is set according to flour moisture content, and then adjusted by the baker during kneading phase. With the adapted procedure, hydration level corresponds to the hydration to reach a maximum torque of 1.55 Nm on the Mixolab (Chopin+ protocol). The results show that adapted procedure increased the average bread volume (+3.0%), the grain of bread (+1.5%) and the organoleptic score (+2.2%). Instrumentation of one part of the bread making test improved performances and objectivity of this type of technical test.

Characterization of corn and duckweed starch for bioethanol production

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Research and development efforts for alternative energy have been significantly increased to meet the increasing demands of energy needs. Among them, corn-ethanol is produced commercially, which has caused an increase in corn price. Duckweed is an aquatic plant, which is a good resource for proteins and starch and can be used for animal feed and fuel ethanol. There are few studies reported in the literature on duckweed for ethanol production. The objectives of this study were to compare ethanol yields produced from corn and duckweed, to characterize starches isolated from corn and duckweed, and to understand the effects of starch structures and properties on the ethanol yield. Micrographs showed that both B73 corn and duckweed starches had spherical and polyhedral granules, but duckweed starch had smaller granules (diameter 5-8 μm) than B73 corn (10-15 μm). The total starch-contents of B73 corn and duckweed were 66.8% and 15.0%, respectively. The ethanol yields of B73 corn and duckweed were 35.7 and 10.9 g/100 g dry grain, respectively. Amylopectin branch-chain-length distribution of B73 corn starch had a larger proportion (23.4%) of short branch-chains (DP 6–12) and a smaller proportion (7.3%) of long branch-chains (≥DP 37) than did that of the duckweed starch (21.7% and 10.4, respectively). The gelatinization parameters (To, Tp, Tc, and ΔH) of B73 corn and duckweed starches were 62.9°C, 68.6°C, 75.6°C, 10.2 J/g, and 51.4°C, 57.6°C, 65.2°C, 10.1 J/g, respectively. B73 corn starch exhibited higher gelatinization temperatures, but duckweed starch displayed a broader gelatinization temperature range (13.7°C) than B73 corn starch (12.6°C). Results obtained from this study provided useful information on uses of duckweed starch for fuel ethanol production and animal feed.

Identification of an α-glucosidase control point for modulating initial high glycemic response from starch digestion

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For digestion of starch to glucose in the body, starch molecules first break down to α-limit dextrins by the action of salivary and pancreatic α-amylases. These are the substrates for glucogenesis by the mucosal membrane-bound α-glucosidases, maltase-glucoamylase (MGAM) and sucrase-isomaltase which have two catalytic sites each (C- and N-terminal). In this study, waxy corn starch (WCS, unhydrolyzed starch), maltodextrins (partially hydrolyzed WCS), and α-limit dextrins (fully hydrolyzed product of α-amylase) were applied to understand the function of individual mucosal α-glucosidases during starch digestion. Investigation with the differently α-amylolyzed starches revealed that the amount of glucose released was increased as size of starch molecules decreased by α-amylase reaction. Native WCS was not easily hydrolyzed by mucosal α-glucosidases without α-amylase treatment. Partially hydrolyzed starches (maltodextrin DE 10 and 18) were predominately hydrolyzed by glucoamylase (C-terminal MGAM), while fully α-amylolyzed WCS (α-limit dextrins) was hydrolyzed similarly by all four mucosal α-glucosidases. Considering the fact that high initial glycemic responses are due to rapid digestion of starch to glucose, the result suggests that glucoamylase has the additional capacity to hydrolyze large α-amylase products, and that inhibition of the glucoamylase reaction would lead to a delay in initial glucose production in the duodenum and proximal jejunum. This would modulate the early stage of glycemic response, and also extend digestion distally. Therefore, the concept of moderating blood glucose levels, by understanding the role of individual mucosal α-glucosidases during starch digestion, has relevance in regulating glucose delivery to the body.

Quality characteristics and diastatic power of barley cultivars related to enzymatic activity in malt

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Twenty-five barley cultivars of Korea and subsequently produced malts were evaluated for quality characteristics, diastatic power (DP) and enzymatic activity. Diastatic power, complementary actions of amylases in malt, had a wide variation (235.2-154.7°L). Acrospire length with the highest DP was 2.5 times longer than the length of grain itself. Alpha amylase activity increased continuously, and beta glucan content that was analyzed using a Megazyme kit was decreased during germination. Maltose, fructose, glucose and sucrose contents were analyzed by HPLC. Carbohydrate content was increased and maltose content was significantly increased during germination. Considerable amount of beta amylase was detected in raw barley. Potential diastatic power, an estimate of bound beta amylase in raw barley, was associated with DP in the final malt. Potential diastatic power ranged from 89.7°L to 169.3°L and it had a high correlation with DP of malt (R = 0.811) and beta amylase activity of raw barley (R = 0.977). DP of malt was significantly correlated with beta amylase activity of raw barley (R = 0.807). Potential diastatic power turned out to be an important factor predicting good malting barley with high enzymatic activity.

Application of Raman spectroscopy for detection of aflatoxin in ground corn samples

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Raman spectroscopy was applied for rapid detection and prediction of aflatoxin in corn samples with aflatoxin concentration range of 11-1206 ppb. The baseline corrected and normalized data were preprocessed mathematically using 1st derivative, 2nd derivative, and deconvolution algorithms. These preprocessed spectra data were employed for three chemometrics to develop classification and prediction models for discrimination of aflatoxin contaminated and uncontaminated corn samples. The best predictive model was obtained from multiple linear regression (MLR) analysis where the correlation coefficients of determination (R^2) were 0.96, 0.94, 0.93, and 0.97 for the preprocessed normalized, 1st derivative, 2nd derivative, and deconvolution data, respectively. Meanwhile, the values of R^2 for selected preprocessing methods were in the range of 0.76-0.86 in the principal component analysis (PCR) and partial least squares (PLS) regression. However, most samples with very low concentrations of aflatoxin, particularly less than the FDA action level of 20 ppb aflatoxin, were not properly predicted by any of these models. The predicted values of Raman spectroscopy were not statistically different with the results of reference HPLC, regardless of chemometrics and data preprocessing methods. When a ground corn sample less than 20 ppb was considered as uncontaminated with aflatoxins, the discriminant models developed using the preprocessed normalized and 1st derivative data correctly classified all uncontaminated samples from contaminated ones, showing better classification accuracy than other preprocessed data. The results obtained from this study demonstrate Raman spectroscopic technique is an excellent alternative for a fast and low-cost analytical method to detect aflatoxins in corn samples over conventional spectroscopic and standard wet chemical methods.

Effect of whole grains on markers of systemic inflammation

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Reducing subclinical systemic inflammation has been suggested as one potential mechanism to explain the favorable association between whole grain consumption and reduced risk for cardiovascular disease, diabetes and certain cancers. The objective of this study was to review the evidence derived from both epidemiologic (n = 13) and interventions (n = 5) on the effects of whole grain consumption on markers of systemic inflammation. Epidemiological studies provide reasonable support for an association between diets high in whole grains and lower C-reactive protein (CRP) levels. After adjusting for other dietary factors (fruit, vegetables, refined grains, fiber, fish and poultry, meat, fatty acids) each serving of whole grains is estimated to reduce CRP levels by approximately 7%. This translates to ~20% decline in CRP levels if one achieves the recommended 3 servings/d of whole grains. In contrast to epidemiology studies, intervention studies did not demonstrate a clear effect of increased whole grain consumption on CRP or other markers of inflammation. Issues related to the extent of dietary control, population

selection and types of whole grains may underlie these discrepant findings. Based on the existing evidence, it appears that ~40% of the improvement in CRP levels associated with increased whole grain consumption may potentially be through their favorable effect on adiposity and insulin sensitivity. Additional carefully controlled intervention studies are needed to confirm effects of whole grains on subclinical systemic inflammation.

Development of laboratory-scale method of producing whole wheat saltine crackers

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A laboratory-scale method of producing whole wheat saltine crackers was developed, including formulation and processing procedures and parameters. Flours of soft white-whole wheat (SW-WW), soft red winter (SRW), and hard red winter (HRW) were blended at five different ratios. The qualities of end products were evaluated for stack height, stack weight, specific volume, breaking strength, pH and color. The characteristics of saltine crackers were affected by different composition levels of whole wheat flour in the formula. Results showed that the stack weight and stack height of crackers reduced as the addition level of SW-WW flour increased. Crackers with higher level of SW-WW flour had smaller breaking strength and specific volume. It was found that higher ratio of whole wheat flour tended to produce an uneven puffing and more compact internal texture. It is believed that large-sized particles of SW-WW flour, especially the bran particles may impair the formation of protein film or cause discontinuous film which makes the dough too soft to expand and air bubble to break during baking. In addition, high water holding components like arabinoxylans in SW-WW flour may inhibit the hydration of gluten protein and refrain it from forming a proper network for gas retention, resulting in a reduced specific volume and inferior baking quality.

Flavor properties, phenolic profiles and antioxidant capacity of glabrous canaryseed

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Trichome-free (glabrous) canary seed cultivars have been specially developed in western Canada for the purpose of human consumption. Eighteen glabrous canary seed were classified according to their brown (CSB) and yellow (CSY) grain color. The flavor properties of groat samples produced from glabrous-hulled canary seeds were evaluated using electronic nose for their potential utilization as novel food sources. Flavonoid and phenolic acid compositions were determined using high performance liquid chromatographic and mass spectrometric (LC-MS/MS) techniques. The flavor distance ranged from 0.0043 to 0.5858 for eighteen groat samples, indicating very small differences in flavor. The flavor discrimination index (DI) values were 79 for the six groat samples (CSB1 to CSB6) in the brown group and 82 for the twelve groat samples (CSY7 to CSY18) in the yellow group, all indicating a good discrimination among the groat samples of each group. The brown and yellow canary seeds exhibited the same flavonoid profiles. LC-MS/MS analysis showed that the acetone extract was rich in flavonoid glycosides, with the bran being mainly composed of *O*-pentosyl isovitexin and the flour having a compound at *m/z* 468. Ferulic acid was the dominant phenolic acid followed by caffeic and *p*-coumaric acids. The whole meal obtained from the brown grains had significantly higher ferulic (>196 mg/kg) and caffeic (>96 mg/kg) acid levels compared to yellow grains. The bran was enriched in ferulic (593 to 766 mg/kg), caffeic (304 to 452 mg/kg) and *p*-coumaric (119 to 142 mg/kg) acids. Yellow canary seeds possessed higher antioxidant activities than brown varieties.

Studies on the glutaminase modification process of rice glutelin

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The glutaminase modification process of rice glutelin was studied. The influences of the ratio of glutaminase to protein, reaction temperature, and pH to the deamidation process were studied, using deamidation degree (DD) and solubility as indexes. The process conditions were optimized by orthogonal optimization on the basis of the results of the single-factor test. The results showed that the optimal conditions were as follows: pH 7.0, ratio of glutaminase to protein of 1:7, and 37°C. Under optimal conditions, DD reached 52.76%, and solubility of modified rice glutelin was 93.78%. This research project was funded by the Natural Science Foundation of China (Project No. 31101214) and Construct Program of the Key Discipline in Hunan Province.

Effect of hydrocolloids on the quality of rice dumpling skin

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Rice (*Oryza sativa*) is one of the most frequently used cereals in Korea and also it is good source of gluten-free product. Recently, many studies reported that rice can be used instead of wheat flour. However, one of problems of rice products such as dumpling skin and noodle is not to have strong network structure. Therefore, rice products need to be added food ingredient on hydrocolloids. The objective of this study was to investigate the formation of rice dumpling skin and to improve the textural properties of rice dumpling skin by adding various food additives. Rice (Millyang260 and Hanarum) was obtained from Rural Development Administration. Rice was milled by air classifying mill (ACM). Hydroxypropylmethyl cellulose (HPMC), xanthan gum, guar gum, carrageenan, and propylene glycol alginate (PGA) were used as food ingredients. Effects of hydrocolloids added singly and in association at different levels, on the investigated textural and mechanical parameters have been evaluated. Rice dumpling skin prepared with additives showed significantly higher values than control on cooking properties and texture. The presence of hydrocolloids in rice dumpling skin appeared to decrease weight and volume after cook. Texture properties of rice dumpling skin were similar to control regardless of cook. Water absorption and hardness of rice dumpling skin didn't change during freeze-thaw test.

Applying chicory root inulin to improve nutritional, functional, and processing properties of whole wheat tortilla dough

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Whole wheat tortilla has become a popular alternative to refined flour tortilla for health conscious consumers. However, whole and refined flours differ in chemical compositions and in how they are processed, thus needing process modifications and significant reformulation efforts to achieve desired product quality attributes. To obtain comparable textural properties of whole wheat tortilla, various ingredients (e.g., modified food starches, dough conditioners, emulsifiers, hydrocolloids, preservatives, etc.) have been used in commercial formulations. However, many of these food additives contain undesirable chemicals, making negative impact on consumer choices. We are presenting a novel approach to improve nutritional, processing and functional properties of whole wheat tortilla dough via fortification of chicory root inulin. Inulin extracted from chicory roots is a soluble dietary fiber with GRAS status that offers both health (prebiotic fiber) and functional (texture and taste improvement) benefits for a variety of food applications. Samples of whole wheat tortilla dough were prepared with addition of various amount (up to 6%) of chicory root inulin. Extensive tests of rheological, adhesive and stress relaxation properties, water adsorption and surface energy measurements were performed to evaluate effect of chicory root inulin on tortilla dough properties. Performed stress relaxation analysis has shown that incorporation of inulin improves dough pliability and extensibility. Use of chicory root inulin as a natural dough conditioner in whole wheat tortilla allows reducing production time and increasing dough tolerance to mechanical stresses applied in automated processes. It also helps to clean up ingredient declaration and increase dietary fiber content in tortillas up to 5 g per serving, which allows "excellent" source of fiber claim to be made.

Mammalian mucosal α-glucosidases may have a role in starch digestion beyond α-glucogenesis to assist α-amylase of granular starch digestion

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Contrary to the conventional view that starch is digested in a sequential step-wise manner beginning with α-amylase and followed by α-glucosidase, this report suggests the two enzyme types act synergistically to digest starch. Our previous studies showed mammalian recombinant individual α-glucosidase subunits, N- and C-terminal maltase-glucoamylase and sucrase-isomaltase, hydrolyze granular and gelatinized without the aid of α-amylase. The aim of this study was to investigate the role of mucosal α-glucosidases to digest granular starch. Pancreatic extract representing α-amylase and intestinal powder, representing a combination of α-amylase and mucosal α-glucosidase activities, were applied to three granular maize starches with different amylose contents in an *in vitro* system. Relative glucogenesis, liberated malto-oligomers amount, and structural changes of

digested residues were examined. Pancreatin-treated starches showed a limit to hydrolysis (≈ 20-80 mg reducing sugar/g starch) in 2-4 h, and over the 12 h period with undigested granules having a higher gelatinization temperature. The intestinal extract treated starch showed higher glucogenesis as expected, but also higher malto-oligomers amount (≈ 60-160 mg/g starch), indicating a greater degree of granular starch breakdown. Starch residues after intestinal extract hydrolysis resulted in more starch fragmentation, still higher gelatinization temperature (increased 3-5 °C), higher crystallinity, and an increase of intermediate-sized (9 nm) or small-sized fractions (7 nm) of un-debranched molecules. It did not generate a new type crystallite and did not have preferential hydrolysis on either amylose or amylopectin. Mucosal α-glucosidases not only passively convert dextrins to glucose but actually participates in the initial digestion of macromolecules of granular and removed the α-amylolysis end products that inhibit α-amylase activity. This study shows that mucosal α-glucosidase may have a big role on digestion to assist α-amylase in the initial stage of granular starch digestion.

The consumption behavior and consumer trends in dried Chinese white noodle in Beijing

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Dried Chinese White Noodle (DCWN) is widely popular as a traditional staple food that about 7.5 million tons wheat in China is for DCWN each year. In order to study the consumption behavior, psychology and demand of consumers for DCWN in Beijing, a consumer survey of DCWN was carried out in Beijing, with an attempt to provide information for improving the quality of products, developing new products and positioning various products for noodle manufacturers. The questionnaire method was used to investigate 1200 consumers living in ten districts under the jurisdictive of Beijing. The results showed that the most popular DCWN variety is egg noodles, followed by fine noodles, mixed grain noodles, vegetable noodles and ramen. The labels of "Fengda", "Biomate", "Xiangxue", "Kemen" and "Jinshahe" are the most popular brands in Beijing markets, and 27.78% of the surveyed consumers have no impression on any DCWN brand. Most of the consumers are in favor of the packaging style of 500 g cylindrical paper wrapped. 80.80 % of consumers choose to buy dried noodles in large and medium-sized supermarket chains. 64.41% of consumers consume dried noodles because of the convenience. The nutrition, taste and price of dried noodle are main factors influencing the purchasing decision of a consumer. Young consumers pay more attention to the nutrition, taste and color, while the seniors pay more attention to the price. The respondents with higher education are more influenced by brand name and nutrition, while respondents with lower education are more influenced by price. The average amount of DCWN consumed by a Chinese household was about 0.5-2.0 kg monthly in Beijing. According to the respondents, the main deficiencies or problems of the DCWN products are as follows: low nutritional value, abuse of food additives, easy to stick, easy to muddy soup and bad taste.

Preparation and partial characterization of corn starch-pectin microparticles

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Microparticles consisting of regular corn starch and high methoxyl pectin were prepared by spray-drying to create wall/matrix material for microencapsulation applications. The solutions (2% w/v) of regular corn starch and high-methoxyl pectin at ratios of 1:1, 1:2, and 2:1 were prepared by gradual heating to 80°C on a programmable, stirring hot plate. Microparticles were prepared by spray-drying the above solutions using a Buchi B-290 spray dryer. The operating conditions were: inlet temperature 105°C, aspirator rate 85%, and pump rate 12% (~5 mL/m), with a regular cyclone. The spray-dried samples were promptly collected, at the end of each run, and stored in air-tight containers at ambient temperature until use. Morphologies of the prepared microparticles were observed by both optical and scanning electron microscopy (SEM). Microparticles prepared from all three solutions showed notable surface indentations, while there were no obvious surface morphological differences among them. The sizes of the particles were in the range 0.5-25 µm, as observed by SEM. Thermal properties were investigated using differential scanning calorimetry (DSC). In contrast to untreated corn starch-pectin blends, profiles for spray-dried samples did not display any transition enthalpies, indicating complete starch gelatinization during the process. Viscosity profiles of the samples were obtained by a rapid visco analyzer (RVA), using standard 2 profile. All three samples showed a unique two-peak RVA profile. The 1:2 corn starch:pectin blend exhibited the highest final viscosity, while lowest final viscosity was observed for 1:1 mix. The results suggest that RVA final viscosity depends on the proportion of starch in the mixture. Increasing relative proportions of pectin result in higher first peak viscosities, and the second RVA peak viscosity, which appears during 95°C holding, depends on the proportion of starch in the mixture.

Impact of water availability on maize quality and ethanol yield

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The objective of this research was to study the effect of irrigation levels (five levels from 18 in. to 4 in. water) on the physical and chemical properties and ethanol fermentation performance of maize. Twenty maize samples with two crop rotation systems (grain sorghum-maize and maize-maize) were evaluated. Results showed that grain yield decreased as irrigation levels decreased and maize kernel weight, density, and breakage susceptibility were increased as irrigation level increased. Starch contents of maize samples grown under a high irrigation level were proximately 3.8% higher than those under a low irrigation level. Protein contents ranged from 9.23 to 11.41% and increased as irrigation level decreased. Maize flour thermal and rheological properties were analyzed by Differential Scanning Calorimetry and Micro Visco-Amylo-Graph-U (MVAGU). Starch gelatinization temperature was significantly increased as irrigation level decreased, while starch pasting viscosity was increased as irrigation level increased. Free amino nitrogen (FAN) was examined and significantly affected by irrigation level. Fermentation efficiency ranged from 90.45 to 93.34% and positively correlated with FAN. Irrigation level had positive impact on ethanol yield. The maize with full irrigation yielded about 4.7% more ethanol (2.87 gallons/bushel) than that these with lower irrigation (2.74 gallons/bushel). In conclusion, irrigation had a significantly positive effect on physical properties, chemical composition, and ethanol yield and fermentation efficiency of maize.

Physicochemical properties of bran starches and endosperm starches of soft wheat grown in Michigan

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During wheat milling, bran is separated from the endosperm, although a clean separation is not possible and there is always some starch adherent to the bran. Understanding the physicochemical properties of bran starch and its relationship with bran tissue is required to maximize bran utilization. The objective of this study was to characterize bran starch properties compared with its counterpart endosperm starch from the same wheat sample. Three varieties (Aubrey, Caledonia, and D8006) with relatively high crop yield and milling softness equivalence were chosen for this study. Bran starch and its counterpart endosperm starch were isolated by an alkaline extraction method, and their structures and properties were analyzed. Bran starch was found to have higher percent B-type granules, higher amylose content, higher crystallinity, broader gelatinization temperature range, higher enthalpy of gelatinization, less retrogradation rate, and less pasting peak and setback viscosity than its counterpart endosperm starch. A-type X-ray diffraction patterns were found for both bran starch and endosperm starch. Bran starch of variety Aubrey had highest crystallinity (21.75%) and gelatinization temperature (62.9°C). Bran starch of variety D 8006 had highest percent B-type granules and lowest retrogradation rate (21.7%). Pasting peak viscosity had a negative correlation with amylose content ($R^2 = 0.917$) for studied bran starches. Results of this study will provide a foundation for a better utilization of bran starch during whole grain food processing, and also provide valuable information for breeders to develop new wheat varieties that provide desired bran starch quantity and type for different applications.

Changes of amylase and some nutrients of polished rice with the germ left intact during germination

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Changes in amylase and some nutrients of polished rice with the germ left intact during germination were investigated, with brown rice as the comparison. The results showed that the activities of α-amylase and β-amylase increased to the highest value and then decreased gradually during germination. The α-amylase activities of polished rice with the germ

left intact reached the highest value after germination for 16 hr, which was shorter than that of brown rice. The activity of endoglucanase increased during germination, and that of brown rice was higher than that of polished rice with the germ left intact. The contents of total and reducing sugars increased and then decreased during germination development, and the content of reducing sugar of polished rice with the germ left intact was higher than that of brown rice during germination. The content of starch decreased during germination development, while the content of amylose having hot-water solubility increased continuously during germination. This research project was funded by the Natural Science Foundation of China (Project No. 31101214) and the Construct Program of the Key Discipline in Hunan Province.

Design of tray ration containers based on finite element analysis

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In this paper, structure of tray vessels was optimized for design by applying modern emulation techniques and methods. The technological problem of transmutation of a big tray vessel after being heated was resolved, and product stability was improved as well. Meanwhile, the sterilization techniques of tray rations were also studied, and a series of tray ration types was launched.

Konjac glucomannan and its derivative enhance the quality, cell structure, and moisture balance of bread

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Konjac glucomannan (KGM) is a high-molecular-weight, water-soluble, and nonionic glucomannan. Its derivative, konjac superabsorbent polymer (KSAP), produced by graft copolymerization of KGM and an unsaturated monomer, is highly hygroscopic and has high water-retention ability. The study tried to improve the quality of wheat bread supplemented with KGM (0.2%, w/w) or KSAP (0.05%, w/w). The effects of KGM and KSAP on the microstructure, quality, and aging of wheat bread were investigated. Moisture content (%) of breads was increased by 34.5 and 35.5% with addition of KGM and KSAP, respectively. Specific volume (cm^3/g) of breads was increased by 13.4 and 11.1%. The hardness (N) of breads was decreased by 30.6 and 33.7%. KGM and KSAP decreased the hardening rate of the bread crumb and retarded amylopectin retrogradation during storage for 24 hr at 25°C. The staling rate of wheat breads was hindered during the storage of wheat bread with the addition of KGM or KSAP during storage for 6 days at 25°C. Bread loaf quality with added KGM or KSAP was improved because of the prevention of collapse of gas cells during wheat bread processing. KGM and KSAP could be functional to enhance the quality of wheat bread.

Predictive determination for aflatoxin B_1 pollution

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Mycotoxins, such as aflatoxins, contaminate foods and feeds widely and cause serious disadvantages to humans. Epidemiology investigations showed that long-term aflatoxin exposure may shorten the life-span of HIV sufferers. Early awareness can be informative for both the consumer and the producer. It is important to develop predictive methods based on molecular levels to estimate the potential extent of pollution that will occur in a short time frame. Versicolorin A (Ver A), an important precursor of aflatoxin B_1 (AFB_1) containing a bisfuran group that confers genetic toxicity to AFB_1, is the first compound having the toxic bisfuran structure in biosynthesis of AFB_1. The feasibility of predicting contamination with AFB_1 by using Ver A as the indicator has been reported. We found that the original levels of Ver A (before storage) were statistically significant relative to the final levels of AFB_1 (after a certain stage of storage under certain conditions), with a corresponding negative exponential relationship between them. Ver A may exist prior to or concurrent with AFB_1. A high level of Ver A, greater than 70 ppb, for example, may indicate a high potential of AFB_1 contamination in the near future if storage is at 22°C with relative humidity of about 70% or higher. Concerns over Ver A mutagenic toxicity should be acknowledged, and requisite detection of Ver A is recommended to be considered in food and feed safety regulatory guidelines. The authors wish to thank the National High Tech "863" Project (2002AA213011, 2005AA213010, and 2007AA100605), National Natural Science Foundation of China 30270043 and 39970664 for financial support.

Development of a standard test for dough-making properties of oat cultivars

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There is an increasing demand for safe, healthy and good quality gluten-free products for people that suffer from celiac disease. Oat is a healthy alternative, but the technological quality of oat-based bread is lower in comparison to wheat bread. Baking applications are based on a batter system and the use of additives to improve quality, but this masks any technological difference that may exist among oat cultivars. We aimed to develop a sensitive test to detect differences in extensibility and resistance to extension of oat flours based on a dough instead of a batter system. Our approach was to replace increasing fractions of oat flour with vital gluten (from 0.8 to 25%) to standardise consistency and mixing time using Farinograph and Extensibility Rig tests. It was possible to obtain a dough system using pure oat flour just by adjusting water to a consistency of 500 BU (Brabender Units), but resistance to extension and extensibility improved with the addition of increasing amounts of vital gluten. We selected a combination of oat flour with wheat gluten that allows to test differences among oat cultivars. It behaves similar to wheat Patent Flour at 500 BU regarding extensibility and resistance to extension. This standard test will be used to compare oat cultivars but also to study how various oat components (avenins, beta-glucans, oil) affect properties of the dough system.

Prediction of AACC 10-11.01: "Baking Quality of Bread Flour—Sponge-Dough, Pound-Loaf Method" with AACC 54-60.01: "Determination of Rheological Behavior" as a function of mixing and temperature increase in wheat flour and whole wheat meal

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This is a co-operative work in order to correlate AACC 10-11.01: Baking Quality of Bread Flour—Sponge-Dough, Pound-Loaf Method with AACC 54-60.01: Determination of Rheological Behavior as a function of Mixing and Temperature Increase in Wheat Flour and Whole Wheat Meal. 100 samples were both tested at AIB according to AACC 10-11.01 & AACC 54-60.01. the aim of the study was to check whether the Mixolab could predict the test baking Sponge-Dough, Pound-Loaf Method results within the tolerances of the reference method.

^{1}H NMR and DSC studies of water mobility in dough system containing barley flour

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Water bound to wheat flour components either directly contributes to dough structure or acts as a free water phase responsible for the flow and mobility properties of dough, thus affecting dough processing behavior, quality and storage stability of final products. The aim of this study was to use ^{1}H nuclear magnetic resonance (NMR) spin-spin relaxation time (T_2) and differential scanning calorimetric (DSC) measurements of unfreezable water content (UFW), to assess water behavior in freshly prepared (25°C), refrigerator-stored (4°C, 1 day) and freezer-stored (-35°C, 1 day) doughs containing 5% and 10% wholegrain (WGB), air-classified beta-glucan-diminished (ACB-D) and air-classified beta-glucan-enriched (BGB-E) barley flours, respectively. Three populations of water were detected by NMR from most of samples depending on moisture content of dough, i.e., tightly (T_{21}, 2~5 ms), less tightly (T_{22}, 20~50 ms), and weakly (T_{23}, 100~200 ms) bound water. T_{22} peak was always detectable in any case and T_{22} relaxation time linearly increased with moisture content of dough in a range of 0.7-2.0 g/g dry base. Adding barley flour steadily decreased the water mobility in dough, and the reduction was more significant with adding BGB-E. Freezer-stored dough showed increased water mobility compared to the fresh and refrigerated doughs. The T_{22} value was also found to closely correlate to maximal consistency measured by farinograph ($P < 0.05$). The UFW capacity measured by DSC was in a range of 0.32-0.44 g/g dry base, similar to NMR data. It is concluded that T_{22} value is a more sensitive and applicable indicator of water mobility than T_{21} and T_{23} and that NMR has a potential online application in industry to produce dough with required properties.

On the mechanisms of bubble inflation and collapse during bread baking: An approach combining MRI and simulation

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Mechanisms resisting or limiting the expansion are multi-scale, from molecular scale (e.g., stiffening subsequent to starch gelatinization or protein aggregation), microscopic scale (e.g., ruptures in cell walls and opening of the porous structure) to macroscopic scale (e.g., pores connected to the exterior of the dough or setting of the outer layers of dough). Few studies did encompass these different scales, a clear explanation for controversial data and theories in the literature. This paper aims at proposing a framework for interpreting bubble inflation and squeezing as observed from Magnetic Resonance Imaging. This was carried out with the aid of a comprehensive model of baking, in which dough stiffening and rupture in the cell walls occurred at specific, yet well separated ranges of temperature in the course of baking. Crumb squeezing was observed when the crust setting occurred before the completion of bubble inflation at dough core; in the experimental conditions retained for the study, squeezing proceeded in an area located beneath the crust, where the pores were opened, but dough was not stiffened yet. From the theory implemented in the model, the instant at which the crust sets determines the in-depth of the thermal boundaries of stiffening and opening, and hence that of squeezing. Such inward displacement of the squeezing area was confirmed by MRI at artificially stopping the overall expansion after different baking times. Ruptures in the cell walls are associated to the cessation of bubble inflation on the assumption that the outlet flow is sufficient for subsequent release of pressure. Both simulation and experimental data showed that in the case of tin baking, gas exchange at the bottom is limited and results in the largest expansion—two to four times higher than that of other regions.

WITHDRAWN

WITHDRAWN

Effect of the addition of different fat blends formulated using an artificial neural network on the physical properties of pan bread

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In the production of pan bread, fat increases bread volume and softness. Physical analyses of bread help understand the influence of fat on bread characteristics. In this study, the effect of four different "zero trans" blends (BL01, BL02, BL03 and BL04) on the specific volume, crumb texture, crumb color and water activity of breads during seven days storage was evaluated. The blends were formulated using an Artificial Neural Network (ANN), combining two different soybean fat bases and soybean oil. The breads evaluated contained 4% fat and were compared to a control sample, without fat (C) and to two other formulations with commercial fats (hydrogenated – SHF, and low trans fat – LTF). Breads formulated with the blends showed greater specific volume – 11.5% higher than the control sample. On the other hand, when commercial fats were added, the specific volume of breads was 6% lower than the control, with no significant difference amongst them. The texture analyses were conducted using a texture analyzer (TA). On the first day of storage, the breads containing the blends were softer than those containing the commercial fats. This occurred until the seventh day of storage. The control sample (C), without fat, presented greatest firmness than all other samples (from 278.30 g on the first day to 843.59 g on the seventh day). In relation to water activity, until the fourth day there were no significant differences amongst the breads. On the last day, the control bread had slightly superior values (nearly 0.5%) for this parameter compared to the samples with added fat, but with no significant difference amongst them. The color analysis resulted in no significant difference amongst the breads and amongst the days of storage. All blends tested showed interesting potential as low trans fats, also having lower saturated fat contents than the commercial low trans fat.

Rheological properties of rice gels: Influence of the amylose content and of the thermal history

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Rice starches and flours have many unique attributes that make them interesting ingredients in the food industry: they are hypo-allergenic, gluten-free, bland in flavour and capable of imparting consistency. In particular, the rheological properties of the starchy matrix during food process and storage strongly influence the final product quality and shelf-life. This is the case of gluten-free bread. Even if several works in literature concern rice gels rheology, none of them deeply investigates the steps associated with the conversion of a slurry into a gel. This study aimed to explore the variations in the rheological properties of the slurries obtained from 2 rice flours (A and B) having a different amylose content (22.7 and 13.9% d.b.), subjected to specific thermal histories to convert them into gel. Rice flours were first characterized for their pasting properties (MicroViscoAmylographic test; MVA). Then, gels recovered after different times during the heating-cooling cycle performed in the MVA were submitted to fundamental rheological measurements: strain sweep, frequency sweep, temperature sweep, creep-recovery test. Additional evaluations were performed to follow gels behaviour during 4 days ageing at 4°C. The different amylose content of the samples strongly influenced not only their MVA peak viscosity (A = 975 ± 30, B = 1361 ± 15 BU) and setback (A = 738 ± 11, B = 442 ± 81 BU), but also the viscoelastic properties of the gels. In fact, all the gels obtained from A showed G´ (storage modulus) values higher than those obtained from B, and to different extents, in relation to their thermal history (i.e., heating at 95°C, heating at 95°C *plus* holding at 95°C x 30 min or cooling at 30°C). These differences were even more evident after 4 days of storage at 4°C (i.e., A: G´ = 1330 ± 127, B: G´ = 592 ± 23 Pa for gels obtained after heating at 95°C; A: G´ = 685 ± 19, B: G´ = 102 ± 7 Pa for gels obtained after a complete MVA cycle; data at 0.05% strain, 1 Hz frequency).

New procedure for evaluating pasta-making aptitude of durum wheat semolina

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Semolina with high protein content and strong gluten is recognized as the best raw-material for pasta-products with a good cooking quality, while little consideration has been given to semolina dough elasticity. None of the present techniques developed for evaluating dough elasticity seems to give satisfying information regarding pasta cooking quality. In this research, a new technique was developed by adapting the Glutograph (Brabender GmbH & Co., Germany) to measure the changes in elasticity induced by heating on a sheeted dough. The information obtained by this procedure was related to pasta cooking quality. Starting from semolina of six durum wheat varieties with differences in protein quantity and quality, dough samples were prepared in a Farinograph at a hydration level of 35%. Each of them was sheeted by a home-made pasta machine, obtaining disks of 5 cm diameter and 2.1 mm thickness. The pieces were stored at 30 °C for 40 min before analysis. Stretching (10 s) and relaxation (30 s) cycles were applied repeatedly during the test time, while dough temperature was increased from 30 to 90 °C at 1.2 °C/min. For each peak recorded, stretching and recovery values were calculated and plotted against sample temperature. Both stretching and recovery curves were integrated and the loss of elasticity was calculated. A number of critical variables were identified that, when controlled, provide consistent results. Results showed as high elasticity loss during heating is related to low firmness of the corresponding cooked pasta. Following testing with larger sample numbers, this technique has the potential to be a valid screening tool for durum wheat quality.

Effect of thermal treatments on rice flour and cooking behavior of rice pasta

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Starch is the key component in gluten-free pasta (GFP). Despite that, few studies have dealt with starch properties in GFP. In this work, two experimental rice pasta samples were prepared according to two technologies—conventional and extrusion-cooking—avoiding the use of additives. Pasta R was prepared from rice flour (RF) that was heated by steam (2.5 atm, 10 min) in a gelatinization tank. The pre-treated dough was subjected to a first extrusion at 120°C (cooking-extrusion) and formed into pellets which were transferred into a continuous extruder for semolina pasta for the second extrusion step at 50°C and 10 MPa. Pasta P was prepared from a pregelatinized rice flour (PRF) that was directly extruded in the continuous extrusion press at 50°C. Several physical indices were used to compare the properties of the two rice flours, and the relationship between starch properties in dried pasta and its cooking behavior was investigated. After pregelatinization, PRF exhibited a higher viscosity at 30°C, a lower pasting temperature, and a higher susceptibility to alpha-amylase hydrolysis compared to NF. As for pasta, both extrusion conditions promoted further changes in starch properties. When compared to Pasta R, Pasta P was characterized by a lower pasting temperature, by a greater swelling capacity, and by a higher viscosity during heating, resulting in a cooked product with higher firmness. However, both samples of rice pasta exhibited higher cooking loss and lower firmness than semolina pasta. Further studies will focus on the improvement of GFP quality by optimizing the cooking-extrusion conditions and/or by investigating the role of additional texturing proteins.

Grain hardness properties of maize hybrids and open pollinated varieties grown under high and low soil nitrogen conditions

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The development and selection of maize open pollinated varieties (OPVs) with acceptable milling quality is of economic significance and agricultural sustainability in poor resourced communities where hybrid seed is unaffordable. Grain hardness is the most important criterion for assessing milling yield and product quality. The study investigated hardness of OPVs and Quality Protein Maize (QPM) OPVs compared to commercial hybrid varieties. The varieties grown in high and low nitrogen content were evaluated using the Tangential Abrasive Dehulling Device (TADD), Near Infrared Transmittance (NIT), test weight, thousand kernel weight and kernel size (>8 mm). Open pollinated varieties were the hardest in terms of NIT milling index. There were no significant differences ($p > 0.05$) in test weight and TADD hardness of OPVs, QPM-OPVs and hybrid varieties in low and high nitrogen content. Hybrid varieties were superior to OPVs and QPM-OPVs in terms of thousand kernel weight, which was at least 27 % higher. Kernels size of OPVs and QPM-OPVs was lower under low nitrogen cultivation compared to hybrid varieties. Besides the low kernel size and thousand kernel weight of OPVs and QPM-OPVs, the results of this study show that the hardness of these varieties is similar to that of hybrids and have potential for milling.

Effect of thermal processing on the chemical and functional properties of whole yellow pea flour

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Pulses contain trypsin inhibitors, phytic acid and phenolic compounds having nutritional and antinutritional properties. Thermal processing effects the content of these compounds and improves nutritional quality of pulse flours as food ingredients; however, functional properties may fluctuate. The goal of this study was to test the effect of thermal processes: infrared heating and roasting using three temperature profiles (80, 100, 125°C) on chemical and functional properties of whole yellow peas (CDC Meadow var.). Peas tempered to 14% moisture were thermally processed and analysed for trypsin inhibitor activity (TIA), phytic acid (PA), total phenolic content (TPC), average particle size (APS), peak viscosity (PV), starch damage (SD) and water absorption capacity (WAC). 125°C processing significantly reduced ($p < 0.05$) TPC of infrared heated and roasted samples to 1.1 and 1.0 mg/g respectively. Significant differences in TIA due to processing temperature were observed with roasting ($p < 0.05$) (5.3, 4.7 and 4.1 TIU/g for 80, 100 and 125°C, respectively). Infrared heating at 80 and 125°C significantly reduced ($p < 0.05$) PA content to 8.6 mg/g from control value of 10.2 mg/g. APS of the control was 346.8 µm. Roasted and infrared sample APS, significantly affected by seed processing temperature, ranged from 80.1-152.4 and 148.4-241.7 µm, respectively. WAC of roasted and infrared flours ranged from 1.2-1.8 and 1.3-2.1 g water/g flour, respectively. Infrared heated and roasted flour PVs were respectively negatively and positively proportional to process temperature. SD of samples ranged from 89.7-96.8 Ai%, with control SD of 87.7 Ai%. These results indicate a significant effect of temperature on flour properties. The effect of temperature was strongly related to thermal processing method. Further work to assess the function of thermally treated flours in food products will reveal how these differences relate to end product quality.

Starch properties affecting water absorption of rice flour

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Water absorption, powder characteristics and starch properties of various rice flours were studied to understand the factors that affect the water absorption of rice flours. Rice flours were prepared from 3 rice cultivars using a swirling airflow (a type of jet) mill under wet and dry conditions, and roller mill. Flours were passed through a series of sieves to obtain fractions according to particle size. Water absorption rate and capacity was evaluated using an aluminum can with holes at the bottom. The water absorption capacity was positively correlated with the damaged starch content. The average particle size of the flour showed a certain association with the water absorption rate. Small particle size flours prepared by dry swirling airflow milling and roller milling contained more damaged starch than large particle size flours. However, molecular weight distribution of starch and amylopectin chain length distribution were not affected by grinding method or particle size of the flour. Flours that contained more damaged starch showed lower gelatinization enthalpies, which indicated disruption of crystalline structure in the damaged starches. Impact of starch crystallinity on the water absorption of flours is discussed.

Millet-incorporated bread and its significance for persons with type 2 diabetes

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Millets are under-utilized in the Western world, despite their better nutritive composition and benefits for those suffering or at risk of T2DM. The present study was undertaken to produce breads composed of finger millet or pearl millet, to evaluate their sensory quality and acceptability, nutritional value and glycemic index by comparing them with bread produced from refined wheat flour. The breads were prepared using 5 to 25% levels of millet flour replacement. All breads were acceptable to panelists; however, the overall acceptability scores did decrease with increased levels of millets. The millet-

incorporated bread had a higher protein, fat, crude fibre and ash contents with a simultaneous decrease in carbohydrates content. Finger millet-incorporated bread (25% incorporation) had the lowest GI of 67.5%, and this was similar to bread produced with pearl millet (also at the 25% level), which had a GI of 71.1%. Both these values were well below the GI of refined wheat bread (100%). A trend of decreasing GI values with increasing amount of millet in the bread was also observed. Millet-incorporated breads could be developed to create foods with low GI and be beneficial for those at risk or suffering from T2DM. Further studies are needed to determine long-term effects of consuming finger and pearl millet-incorporated bread on glycated hemoglobin in persons with T2DM.

Quality characteristics and shelf life of millet-incorporated breads
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Millet is a cereal crop, which has traditionally been grown in Africa and Asia and used to produce flat breads or porridges. However, millets are superior in nutritive components to wheat and have been shown to consist of numerous health benefits. This present study looked at the quality of breads made with different levels of millet flour incorporation. Bread loaves were prepared from refined wheat flour with millet flour substitution at 5%, 10%, 15%, 20% and 25% levels. The samples were tested for physico-chemical characteristics, textural and rheological properties, sensory analysis and shelf life. The water absorption of flour blends was directly proportional to the level of millet flour incorporated; as well the appearance and crumb grain of the bread became rough and the specific loaf volume decreased. The upper crust of bread was slightly reddish white and the crumb grain was dusty. The millet-incorporated bread decreased in carbohydrates, sugar and gluten, while the water absorption and dough development time increased with the addition of millet flour. Pearl millet-incorporated bread showed a higher fat content than the finger millet bread. During storage the bread hardened, but did had a high cohesiveness and showed recovery when compressed. Consumer acceptability trials indicated that the millet-incorporated bread was well accepted by the consumer. Finger millet-incorporated bread had higher overall acceptability scores than those incorporated with pearl millet. These results indicate that there is a potential for millet to be incorporated into bread with refined wheat flour and has a high market potential owing to its nutritive value.

Modeling of tempering effects on wheat at first break
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Dry milling of cereal grains is a critical step in enhancing the nutritive value of grain products. Tempering, the addition of moisture to wheat kernels prior to milling, is a key factor in the efficiency of this process, having significant effects on flour ash content and milling power demand. Currently these conditions are often selected arbitrarily by wheat class or the target final flour moisture content, rather than with an aim of optimizing milling yield in a systematic way. Most current mathematical models for grinding are focused on the grinding of uniform and often crystalline materials common in the mineral industry and often not appropriate for use with biological materials. The primary objective of this study was to develop a conceptual model linking wheat kernel hardness, tempering conditions, and milling conditions at first break (1BK), with input and output particle size and 1BK mill power demand. Four classes of wheat (Hard Red Winter, Hard Red Spring, Durum, Soft White) were tempered for 6 times (8-28 h) to 6 moisture contents (12-17% wb) prior to milling using a laboratory scale roller-mill configured to simulate 1BK milling conditions. Pre- and post-temper SKCS kernel hardness values, milling power requirement, break release, and particle size analyses were employed. Particle size distribution data were used to develop a model describing 1BK milling of wheat kernels as functions of single kernel size, hardness and moisture content. Developing an understanding of the factors affecting the fundamental breakage mechanisms in wheat kernels enables the optimization of break release and mill energy demand through the use of systematic tempering based on kernel size and hardness characteristics.

Effect of different contents and molecular weights of condensed tannins from grain sorghum (*Sorghum bicolor* [L.] Moench) on the enzyme activity of human salivary and porcine pancreatic alpha amylases
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This work investigated the effect of condensed tannin extracts on α-amylase activity. Methanolic-HCl extracts of 15 grain sorghum varieties containing 0.1–63.1 mg catechin equivalents of tannins/g dry sample were tested for their inhibitory effect on the activity toward porcine pancreas and human salivary α-amylases. Two approaches were used: 1) extract was incubated with α-amylase for 30 min prior to addition of substrate (cooked, waxy corn starch [0.5% w/v]) and 2) extract was incubated with substrate for 30 min prior to addition of α-amylase. Depending on the condensed tannin concentration in the extracts from the 15 sorghum lines, significant reductions in activity of human salivary α-amylase ($P < 0.05$; $R^2 = 0.77$) and porcine pancreatic α-amylase ($P < 0.05$; $R^2 = 0.83$) were observed when the enzymes were allowed to interact with the condensed tannin extracts before adding the substrate. Conversely, a slight but significant increase in the activity of human salivary α-amylase ($P < 0.05$; $R^2 = 0.61$) and porcine pancreatic α-amylase ($P < 0.05$; $R^2 = 0.64$) was observed when the extracts were allowed to interact with the substrate before adding the enzyme. Subsequently, two sorghums differing in their condensed tannin molecular weight profiles were selected and condensed tannin extracts were diluted to the same concentrations. The sorghum variety with a higher proportion of high molecular weight condensed tannins had a greater inhibitory effect on the two enzymes ($P < 0.05$) that the one with a lower proportion. In conclusion, condensed tannin extracts were inhibitory toward human salivary and porcine pancreatic α-amylase, but only when the tannin extracts were incubated with the amylase prior to the introduction of starch. Furthermore, high molecular weight tannins were more inhibitory to amylase than lower molecular weight. Thus, condensed tannins may have the ability to reduce starch digestibility.

Alfa-amylase/protease-treated wheat gluten: Thermo-rheological properties
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Vital wheat gluten was purified with α-amylase and treated with protease. The supernatant of the protease-treated gluten was quench cooled, aged for two weeks and analyzed using DSC, SDS-PAGE, reverse phase HPLC, size exclusion HPLC, capillary zone electrophoresis (CZE), and rheological properties. The DSC profile of the aged samples exhibited enthalpic relaxation beneath its glass transition (Tg) indicating molecular relaxation. Samples treated with 0.006 g protease/g gluten showed Tg at 49.11°C with Delta Cp = 0.12 (J/°C/g). Higher protease levels and longer aging time caused higher Tg temperature, Delta Cp, and Delta H of enthalpic relaxation. The SE-HPLC profile of the protease-treated gluten clearly showed differences in molecular size between the supernatant and the precipitate, while The RP-HPLC profiles signify more hydrophilic gluten molecules than the control. The little difference in gluten molecular size after protease treatments (0.024 g protease versus 0.032 g) appeared to have significant effect on the enthalpic relaxation, where the two treatments showed different degree of enthalpic relation. The CZE data confirmed the insignificant difference between 0.024 and 0.032 g protease/g gluten in regards to the size to charge ratio. The molecular interactions for protease-treated gluten were much weaker than vital gluten, where their networks were much weaker and sensitive to temperature, especially above their Tg as evidenced by higher G″ versus G′. This explains the fluid-like behavior of the protease-treated gluten.

Pasta products with potato flakes
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Potato is a potential additive to products with its protein content higher than in wheat flour, its fiber content and such microelements as potassium and phosphorus. The research aimed to increase nutritional and biological value of pasta through including potato flakes into a recipe, to elaborate a method of recipe modeling, and to investigate impact of production process and culinary treatment on product quality and food safety. Two pasta production technologies were studied. The first recipe included dough preparation, pressing and drying; the second included dough preparation, dough rolling, cutting and drying. Protein content in the flour and the pasta was measured with a Keltek device; lead, cadmium and arsenic were measured on an Atomno device—an absorption spectrometer; potassium and phosphorus were detected with an inversion voltammeter method on a STA polarograph. Fiber content was detected with the Kurschner-Hanak method. Mathematical processing of test data was done in Excel and Statistika 6. Pasta was produced on press LaMonferina at the dough humidity of 29%, 30%, 31% and 33% and the water temperature of 30°C, 65°C, 90°C. Drying was conducted in drying cabinets at 25°C, 90°C and 110°C until reaching a moisture equilibrium of 12.5%. With the first recipe the optimum humidity was 33%, the water temperature in the cooling jacket not more than 30°C; mixing duration not less than 10 minutes; vacuum 0.08–0.1 MPa; low temperature drying with following stabilization of the pasta product at the moisture equilibrium of

12.5%. The second technology set up the optimum dough humidity of 36%; mixing during at least 10 minutes; drying was conducted in mild and strong conditions with following stabilization. Results have proved that potato flakes included into the pasta recipe increased fiber, potassium and phosphorus content in the final product without an adverse impact on its cooking and organoleptic properties.

Protein-free and gluten-free bakery premixes

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Celiac disease and phenylketonuria require gluten-free and protein free diets. The objective of the research was to develop gluten- and protein-free premixes for bread baking. The recipe included corn starch, corn flour, rice or buckwheat flours in various proportions, dry yeast and salt. Water was added to reach humidity of 49%. Starch with a 0.5% protein content was used for baking protein-free bread. The final product was compared with wheat flour bread with 10.3% of protein. Structure formers in the recipe were a mixture of guar gum and xanthane gum (1:1) of 0.2% and pectine of 0.1%. Natrium and potassium carbonates (0.85:1) of 0.02% and natrium citrate (0.02%) were added as baking powder. Protein was measured on a Keltek device, protein fractions were determined by the Osborne method, bread volume and rheological properties of the crumb were analyzed by elastoplastic deformation on a structure meter. Experimental data were processed in Excel and Statistika 6. High correlation of protein content was detected in the premixes of rice flour (R1 = 0.51), corn flour (R1 = 0.59) and buckwheat (R1 = 0.61). Protein content in the raw materials varied from 5% to 8%. Protein fractions in starch, rice and buckwheat flours demonstrated that prolamine in rice and buckwheat flours amounts to 2-3% of the total protein, while in wheat and corn flours—to 50-60% of the total protein content. The protein of the starch contained only a water-soluble fraction. Prolamines of the corn flour were represented by zein—an alcohol-soluble protein, which does not cause atrophy of intestine fibres. Protein free bread was not any worse than wheat bread in terms of quality parameters. Corn flour that substituted a part of starch intensified the yellow colour of the crumb, rice flour—the white colour and buckwheat flour made the brown colour stronger.

High antioxidant capacity beverage based on extruded amaranth (*Amaranthus hypochondriacus*) flour

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Amaranth is an important ancestral cultivated grain in Mexico due to its agronomical, nutritional and nutraceutical properties. The objectives of this work were to produce a beverage with high antioxidant capacity from extruded amaranth flour (EAF) and to evaluate chemical composition, physicochemical, functional, nutritional and nutraceutical properties of EAF and the beverage. Amaranth grits were mixed with lime and water. The treated grits were extruded with a single screw extruder operating at 125°C and a screw speed of 130 rpm. These optimal conditions were obtained in a previous work, were the objective was to optimize the extrusion process to obtain flour with high antioxidant capacity (AC) and high water solubility index (WSI). The antioxidant capacity was measured on the ingredients. The beverage chemical composition and energetic content were 6.71 g of protein, 5.76 g of lipids, 1.23 g of minerals, 56.45 g of carbohydrates and 305 cal per 500 mL of beverage. The evaluation of the beverage was performed by a trained taste panel as rated as acceptable. The beverage had an antioxidant capacity of 1,337 µmol of TE/500 mL of beverage.

Comparison of resistant starch analyses using different standard methods

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This study aimed to compare resistant starch (RS) contents of starchy foods obtained using different standard methods and to better understand their mechanisms. RS Types 2, 4, and 5 (RS2, RS4, RS5, respectively) were used in this study. Starches analyzed in this study include normal corn (NC, control), raw green banana (GB), raw potato (PS), and high-amylose corn (HA, cooked and raw) starches (RS2), octenyl-succinic NC and HA starches (OSA-NC and OSA-HA, respectively, 3 and 10 wt%; RS4), and HA-stearic acid complex (RS5). Bread rolls were used as a model food system. Methods tested include AOAC methods 991.43, 2001.03, 2002.02, 2009.01, 2011.09, and the Englyst method for RS content analysis. RS contents measured in RS5 were in good agreement using AOAC 2002.02 (Megazyme RS Kit Method) and Englyst's method (28% and 26%, respectively) but differed from results obtained using AOAC 991.43 and AOAC 2001.03 (65% and 52%, respectively). Among RS2, raw PS showed the greatest RS content (57%) followed by raw HA (40%) and raw GB (27%) using porcine pancreatin (AOAC 2002.02). RS contents of OSA-HA starches decreased with increasing wt% octenyl succinic substitution (DS) (HA = 31%, OSA-HA (3%) = 16%, OSA-HA (10%) = 10%, AOAC 991.43; HA = 40%, OSA-HA (3%) = 31%, OSA-HA (10%) = 33%, Englyst method), which could be attributed to losses of amylose double-helices during the succination reaction. RS content of OSA-NC starches increased with increasing DS (NC = 1.0%, OSA-NC (3%) = 1.4%, OSA-NC (10%) = 1.9%, AOAC 991.43; NC = 8.5%; OSA-NC (3%) = 12%; OSA-NC (10%) = 15%, Englyst method). Soluble oligosaccharides of starch digestates were analyzed using high-pressure liquid chromatography. Starch granule sizes and distributions were determined using microscopy for correlation with RS contents.

Relationships between variety of rice and apparent viscosity of cooking water

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A quality of cooked rice grain was evaluated using the apparent viscosity of cooking water during cooking. In Japan, rice is cooked by adding water and boiling until the water evaporated. During the cooking, stored compounds in a cell, e.g., starch, are eluted into the water, because cell matrices and tissues are physically damaged due to boiling and/or expansion of gelatinized starch. As a result, the compounds, the cell wall fragments as extracted solubles, etc. are mixed within the added water, and the mixture is finally condensed and coated on the surface of cooked grain. Because the coated materials from the mixture connect to appearance, stickiness, etc., properties of the mixture must be one of the major indices for the evaluation of cooked rice quality. In this study, the relationships between the apparent viscosity of the mixture during cooking and contents of amylose and extracted solubles for three varieties of rice grain were investigated. Forty grams of polished grain were cooked with 60 g of water using typical rice cooker. An apparent viscosity of the water was measured by handy viscometer at the temperature of 30, 50, 70 and 85 °C, respectively. The viscosities at 70 °C for the varieties of Tsuyahime, Koshihikari and Nihonbareare were 0.72, 0.55 and 0.51 mPa·s, respectively. The extracted solubles were 0.95, 0.86 and 0.85 g/100 g, and the amylose contents were 12.9, 18.1 and 19.3 g/100 g (d.w.), respectively. These results indicated that the viscosity at 70 °C correlated closely with the amylose content of the grain and the extracted solubles in the mixture. Since the content of amylose and extracted solubles is concerning with the rice quality, the viscosity of added water during cooking could be regarded as one of the indices for quality evaluation of cooked rice grain.

Cold starch hydrolysis of corn and barley with different amylose contents towards bioethanol production

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The amylose/amylopectin ratio and crystalline structure of starch granules significantly influence quantitative conversion of starch into fermentable sugars in cold starch hydrolysis of bioethanol production. The objective was to study the enzymatic hydrolysis of corn and barley starches with different amylose contents (waxy, WX; normal, NM; high-amylose, HA types) at 15% solids, pH 4 and 55°C for 1 h followed by 30°C for 72 h using granular starch hydrolyzing enzymes (mixture of α-amylase and glucoamylase). Morphological changes of starches before and after hydrolysis were characterized with SEM. The effect of amylose (AM) content, relative crystallinity (RC) and proportion of small and large granules in each starch type on degree of hydrolysis (DH) were evaluated. AM contents of WX, NM, and HA types were 1.0, 24.4 and 69.7%, respectively in corn and 12.7, 23.6, and 46.3%, respectively in barley starches. RC values of starches were 33.8, 27.7 and 16.4%, respectively in corn, and 33.0, 24.3 and 20.1%, respectively in barley. The numbers of small granules were 80, 83 and 90%, respectively in corn and 81, 93 and 94%, respectively in barley starches. Overall, the DH (% db) of WX, NM and HA barley starches were 88.3-99.9, 85.9-93.4 and 62.5-91.4%, respectively. The corresponding values for corn starches were 77.2-98.9, 52.4-95.0 and 11.8-24.0%, respectively. A positive correlation ($p < 0.05$) was found between RC and DH in both corn ($r = 0.95$) and barley ($r = 0.99$) starches, and a negative correlation found between AM content and DH in both corn ($r = 0.96$) and barley ($r = 0.88$) starches at 72 h. SEM images of residual starches after 72 h showed that the degradation of granules was in the order of WX > NM > HA types for both corn and barley starches. The finding of this study may help to understand the relationship between starch structure

and DH to maximize the conversion of native starch into fermentable sugars to optimize the ethanol yield for a cost efficient bioethanol production.

Effects of temperature and precipitation on hard red spring wheat protein composition

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The objective of this study was to estimate temperature and precipitation effects on wheat protein composition using five Canada Western Red Spring (CWRS) wheat varieties (Katepwa, Laura, Lillian, Carberry, and CDC Kernen) representing a range in dough strength grown at each of 9 locations in western Canada in 2010. Proteins were extracted using SDS-phosphate buffer with and without sonication followed by SE-HPLC. The ratio of total polymeric to total monomeric protein was negatively correlated with Growing Degree Days-base 10 degree (GDD-base10) from seeding to maturity for each variety (r = -0.70, -0.76, -0.48, -0.52 and -0.61 respectively). GDD-base10 was also correlated with the ratio of extractable monomeric protein (EMP) to total protein for each variety (r = 0.59, 0.78, 0.45, 0.27 and 0.50, respectively) and negatively correlated with extractable polymeric protein (EPP) to total protein (r = -0.67, -0.35, -0.55, -0.84 and -0.42, respectively). The ratio of unextractable polymeric protein (UPP) to both total polymeric protein and total protein showed generally weak relationships with GDD-base 10 with the exception of a single variety that showed a strong positive (r = 0.60) correlation when UPP was expressed relative to total polymeric protein. Precipitation (April to harvest) correlated negatively with the ratio of total polymeric to total monomeric protein (r = -0.76 to -0.43) except for one variety which showed positive correlation (r = 0.39). Precipitation (April to harvest) was positively correlated with the ratio of EMP to total protein (r = 0.40 to 0.73) except for one variety. Precipitation had a stronger influence on the ratio of UPP to total protein than did GDD-base 10. The extent of response to temperature and precipitation varied among varieties. Generally extended GGD-base 10 and higher precipitation resulted in higher relative ratio of monomeric protein to polymeric protein.

Barley is a truly ancient grain with modern relevance to health

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Barley is a truly ancient grain with modern relevance to health. Why barley? Health benefits unique to barley as a single food are its dual effects of lowering LDL cholesterol and its low glycemic index value. These two characteristics can have a significant impact on prevention of cardiovascular disease and diabetes, two major diseases facing human populations. Barley contains β-glucans, a source of soluble dietary fiber in greater concentration than any other cereal grain. What is the best food barley? Waxy hull-less barley has the highest concentration of β-glucan, and its lack of a hull enables its inclusion in foods, retaining both aleurone and germ. Pearled hulled barley also contains significant β-glucan in endosperm cell walls. The waxy characteristic is correlated with high β-glucan content. What physical forms of barley are available? Processed forms include whole grain, pearled, stone ground or milled flour, grits, and flaked barley. What products can be made? Barley is often combined with wheat or other grains in granola, muffins, cookies, flat bread, pancakes, hot and RTE cereals, crackers, and snack foods. What are sources of barley? Many cereal grain companies carry barley inventories. Barley designated specifically for food barley can also be grown on contract. Why not barley?

Variations of flour amylose content in different milling streams and its effect on soft wheat baking qualities

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Flour amylose content is one of the important factors for soft wheat baking qualities, such as sugar snap cookie diameter, sponge cake volume and also solvent retention capacities (SRC). Wheat flour amylose contents of different milling streams of 3 soft wheat samples (Western White from U.S., Kitahonami, and Norin61), and its relation to soft wheat baking qualities were investigated. All wheat samples were conditioned to 14.5% moisture content and milled by Buhler test mill (MLU-202), and totally 6 flour streams (1B, 2B, 3B,1M, 2M, 3M), were collected from each wheat samples. The flour yield of the wheat samples were 73.8%, 75.1% and 69.0%, respectively. The amylose content of each milling stream was highest for 1B and lowest for 3M flour in all wheat samples. In contrast, the protein content of each milling stream was highest for 3M and lowest for 1B. The amylose content of each milling stream showed significant negative correlation to the protein content in all wheat samples. In the baking tests, the amylose content of each milling stream showed higher correlation to sugar snap cookie diameter than the protein content, as well as water SRC. From the result, the variation of amylose content in the milling streams may play an important role for the soft wheat baking qualities, and further investigation is required for the distribution of amylose in wheat kernel.

Effects of extrusion on physicochemical and functional properties of washed wheat bran

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The high demand for healthy foods by consumers has prompted the food industry to increase the amount of dietary fiber in processed food products. Wheat bran is an excellent source of dietary fiber and is used by the baking industry to increase the amounts of fiber in baked products. However, milled wheat bran contains significant amounts of residual starchy endosperm. This residual endosperm can easily interfere with the analyses that are used to determine bran's physicochemical and functional properties. Analysis of relatively pure wheat bran can provide reliable results. The objectives of the present study were to investigate (1) the effect of extrusion on thermal degradation of washed wheat bran (WWB) by differential scanning calorimetry (DSC), (2) the in vitro binding of bile acids by WWB, and (3) the quality properties of bread made from hard wheat flour substituted with WWB samples. Non-washed wheat bran (NWWB) milled from soft white wheat was washed with distilled water to remove most of the residual starchy endosperm, before it was extruded on a co-rotating and inter-meshing twin-screw extruder. The thermal properties obtained by DSC indicated that onset and peak degradation temperatures of NWWB were higher than those of WWB samples. However, degradation enthalpy of WWB was significantly higher than that of NWWB. Extrusion did not affect degradation properties of WWB samples. In vitro binding of bile acids was higher in WWB samples compared to NWWB samples. Bread formulations containing WWB resulted in breads with increased loaf weights and decreased loaf volumes relative to those containing NWWB.

WITHDRAWN

Biochemical and kinetic characterization of the digestive trypsin-like activity of the lesser grain borer *Rhyzopertha dominica* (F.)

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The lesser grain borer *Rhyzopertha dominica* (Coleoptera: Bostrichidae) is a primary pest of stored wheat and other cereals in many regions of the world. The insect uses digestive proteases for digestion of proteins present in the grains. The present work was carried out to isolate and characterize the digestive trypsin-like activity of the insect. The enzyme activity from insect midguts was isolated using hydrophobic interaction chromatography with phenyl-sepharose CL-4B. Eight bands (from A through H) with caseinolytic activity and molecular weights in the range 22 to 51.3 kDa were detected by zymography in casein-polyacrylamide gels. The strongest bands were D, G, and H, and showed estimated molecular weights of 33.6, 25.4, and 22 kDa,

respectively. In-gel inhibition of caseinolytic activity showed that the serine protease inhibitors SBTI and TLCK partially inhibited proteases A and B, completely inhibited proteases C, D, F, G and H, and partially suppressed E. In-vitro inhibitory assays showed that SBTI and TLCK suppressed the BA*p*NAase activity by 92.3% and 79.2%, respectively, indicating the presence of serine proteases. Wheat albumin extracts were highly effective in inhibiting all the proteolytic activity. The chymotrypsin inhibitor TPCK did not affect the BA*p*NAase activity, indicating that the proteolytic activity in *R. dominica* belongs to the trypsin-like type. With BA*p*NA as the substrate, the proteolytic activity was high across a broad pH range of 6-11 with two peaks of maximum activity at pH 8 and 10 with an optimum temperature of 50 °C. SBTI inhibited the BA*p*NAase activity with IC_{50} and K_i values of 0.02 mM and 1.17 ´ 10^{-8} M, respectively. The kinetic constants K_m and V_{max} were 0.07 mM and 2.8 mM/min, respectively. The activation energy (E_a) for BA*p*NA hydrolysis was 33.5 kJ/mol. The results of this study confirm that *R. dominica* rely on serine protease activity for food digestion.

WITHDRAWN

Interactions between hydroxypropylmethyl cellulose of varying degrees of hydroxypropylation and gluten proteins

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Although hydrocolloids are commonly used in the baking industry, it is relatively unknown how the structure of hydrocolloids affects their interaction with gluten fractions in a dough or bread system. Hydrocolloids vary in molecular weight, chain length, side group composition, charge density, and degree of substitution. Knowing which structural properties of hydrocolloids favorably interact with gluten proteins to create an optimum gluten matrix would be advantageous to the baking industry. In order to determine the nature of this gluten protein-hydrocolloid interaction, vital gluten and hydroxypropylmethyl cellulose of varying degrees of hydroxypropylation (MC, 0 % hydroxypropoxyl; HPMC, 7-12% hydroxypropoxyl; HPMC, 4-7.5% hydroxypropoxyl; HPMC, 9-12% hydroxypropoxyl) were combined and subsequently analyzed using SDS-PAGE. The selective interactions between gluten fractions were further investigated using commercial glutenin and gliadin fractions. The water holding capacity (WHC) and water solubility index (WSI) of hydrocolloids-protein mixtures were determined to study the effect of high water binding capacity of hydrocolloids on hydration behavior of gluten proteins. The use of optimum water hydration allowed for forming a more developed network due to the increased mobility of the gluten molecules as measured by small amplitude oscillatory tests. Presence of HPMC in the gluten dough resulted in shifts in storage and loss moduli. Temperature sweeps were conducted to simulate the molecular modifications and interactions happening during baking. Heating beyond 80-85°C resulted in dramatic increase in moduli indicating the formation of higher molecular weight products.

Improving waxy wheat flour yield and quality

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Waxy wheat flour, although not suitable for bread making alone, can be substituted in formulations to increase the sensory qualities of the product. Waxy starches were shown to have a higher peak viscosity and lower gelatinization temperature. Waxy wheat has many uses in the cereal food industry, including increasing loaf volume, creating a softer bread crumb, retarding staling, and thickening properties. However, when waxy wheat is milled it frequently becomes sticky, which leads to lower flour yields and lower quality flour compared to non-waxy wheat kernels of similar hardness. In order to improve the milling conditions of waxy wheat, tempering conditions were varied to observe any influences on the flour yield, flour quality and dough rheological properties. Waxy wheat and non-waxy wheat of similar hardness values were tested with the Single Kernel Characterization System, tempered under varying target moisture (14, 15, 16%) contents and tempering times (12, 18, 24 hr), and subsequently milled in MLU-202 Buhler Mill. A proximate analysis was performed on the milling fractions. Pasting and rheological studies were done by Rapid-Visco Analyzer and Mixolab. The color of the flour fractions was measured with a Minolta color meter. Tempering at 16% moisture for 12 h gave highest bran extraction yield, better total flour extraction as well as best flour color. Break flours had higher peak viscosity than reduction flours. Mixing and pasting profile of waxy wheat flours were significantly different than that of HRW wheat flour characterized by longer mixing times, very short stability and low peak viscosity values. Waxy wheat flours are to be subjected to test bake and corresponding characterization tests (loaf volume, crumb texture, and microstructure).

Effects of phytates on dough and bread characteristics of wheat flour

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Phytates constitute 1 to 2 % of whole wheat grain and mainly present in the aleurone layer. Considering the strong chelating capacity of phytates, we hypothesized that phytates of whole wheat flour interact with protein and affect dough mixing properties and, eventually, baking quality. To explore the influence of phytates on gluten development during dough mixing and subsequent bread baking, wheat flour of a hard red spring and a hard white spring wheat was added with either a sodium salt form of phytates (PAS) or phytic acid neutralized to pH 7 with NaOH (PAN) at 1% level, and determined for dough properties using mixograph and rheofermentometer, as well as bread baking quality. Changes in phytate and SDS-unextractable glutenin polymer content of dough added with both forms of phytates during mixing, fermentation and baking were also determined. The added phytates increased mixograph mixing time and mixing resistance. Mixograph mixing time was increased by 85 to 115 sec, and 195 to 415 sec with addition of PAS and PAN, respectively. Water absorption was not affected by addition of PAS, but increased by 5 to 6% with PAN. Dough rise and stability during fermentation increased with addition of phytates, along with delayed peak time. The maximum height of dough increased by 7.4 to 22.3 mm, and the weakening coefficient decreased by 9.0 to 36.0 with addition of both types of phytate, except for the hard red spring wheat added with PAN. The phytate content of dough decreased to 5.6-10.6 mg/g during fermentation and further to 3.3-7.8 mg/g during baking. Reduction in SDS-unextractable glutenin polymer content of dough with addition of phytate was observed during mixing and fermentation. Loaf volume of bread was reduced with incorporation of phytates, possibly owing to delayed dough rise during fermentation and reduced SDS-unextractable glutenin polymer content.

Distribution of B-vitamins & enzymes in newly developed spring wheats

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Wheat is a vital crop providing important nutrients for human diet along with certain B vitamins, i.e., B1(thiamin), B2 (riboflavin), B3 (niacin) and B6 (pyridoxine) as well as some enzymes which are very important for metabolic processes of body. The vitamins are concentrated in grain outer layer; thus, milling process affects these vitamins to a larger extent and may reduce their level, whilst enzymes are distinct biological polymers which catalyze chemical reactions and convert substrates to meticulous products. The current study targeted the extraction of B vitamins and enzymes from different spring wheats varieties, e.g., Lasani-08, FSD-08, Mairaj-08, Shafaq-06, Sehar-06, Bhakkar-02, Uqab-2000 and Inqalab-91 which proved to be helpful in determining their suitability and economy as commercial raw materials. For the purpose, different commercially available spring wheats were procured from Wheat Research Institute, Faisalabad-Pakistan. B-Vitamins were extracted and quantified by using high performance liquid chromatography (HPLC). Enzymes were extracted from alkali extraction method, and their activity was determined though spectrophotometer. Results showed that wheat varieties constituted about 2.4-6.90 µg/g thiamine, 0.78-2.27 µg/g riboflavin, 19.98-24.56 µg/g niacin and 1.3-7.5 µg/g pyridoxine. Moreover, the alpha-amylase activity in whole flours, bran, break flour, reduction flour and shorts of various wheat varieties ranged between 2.82 to 3.90, 2.68 to 3.12, 3.10 to 3.62, 3.44 to 4.18 and 2.34 to 2.78 mg maltose/3 min respectively. The protease activity in whole flours, bran, break flour, reduction flour and shorts of various wheat

varieties ranged between 128.69 to 157.29, 41.58 to 58.42, 10.04 to 15.62, 236.59 to 285.39 and 72.07 to 104.41 U/g, respectively. Moreover, adding enzymes in bread formulation resulted in significant increase in volume and texture of the final product.

Development of gluten free crepes with enhanced food functionality, nutritional traits, and consumer appeal

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An increased awareness of celiac disease and gluten sensitivity has led to the rapid growth of the gluten-free market. Global sales of gluten-free items are expected to reach $4.5 billion by 2015. Rice remains a prominent ingredient in gluten-free products. A rice-pulse crepe was explored as a vehicle for gluten-free ingredients. Instant dosa, a wafer-thin, crepe or pancake, indigenous to several Asian countries, was evaluated for compositional, food functional and organoleptic traits. The dosa batter is traditionally made from rice flour and black lentils flour. Long grain and parboiled rice flour were used in equal proportions to modulate starch pasting properties, dextrinization during cooking and fenugreek seed, cumin seed and asafetida powder providing sensory and nutraceuticals functions. Baking soda, salt and citric acid contributed to desirable porous texture and enhance food functionality. Three instant dosa mixes were developed by substituting black lentils (control) with garbanzo, yellow lentils, or black horse gram. Long grain rice, parboiled rice, and pulse flour were formulated in the ratio of approximately 1.5:1.5:1. Crepe was made on traditional gas burner using a nonstick crepe pan. Average dosa weight was 33 g. Crepes were subjected to biaxial extensibility tests using the tortilla burst rig fitted on the texture analyzer. The average burst strengths for dosas made from black lentils, yellow lentils, garbanzo beans, and black gram were 498.6, 427.2, 547.1, 292.9 g, respectively. Black gram mix dosa yielded a softer product and undesirable color with brown spots in it, while other has desirable golden brown color. Texture analysis suggested that yellow lentils, garbanzo beans or a blend of two are good candidates for use in dosa. In-house testing demonstrated acceptable products with no significant unfavorable flavor/taste.

Kernel-to-kernel variation in physicochemical properties of pureline and hybrid rice cultivars

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Asynchronous development of the caryopses at different positions on a rice panicle could instigate some variation in properties among individual kernels and consequently affect overall processing/functional quality. This work examined the effect of cultivar zygosity on kernel-to-kernel variation in quality traits using purelines (homozygous) and hybrids (heterozygous). Pureline cultivars, CL151 and Wells, and hybrid cultivars, CLXL729 and CLXL745, were obtained from the 2011 crop in AR. Dimension measurements on 100 individual head rice kernels showed that average kernel length varied from 6.35 mm (CL151) to 6.88 mm (CLXL745). Kernel width varied from 1.97 (Wells) to 2.12 mm (CL151 and CLXL729), whereas thickness varied from 1.62 (Wells) to 1.67 mm (CLXL729 and CLXL745). Kernel-to-kernel variation in length based on standard deviation (SD) was greatest for CLXL745 and least for CLXL729, with SD values of 0.43 and 0.33, respectively. The SDs for width and thickness were low and did not differ among the four cultivars. Average kernel mass was greatest for CLXL745 (21.9 mg) and least for CL151 (19.1 mg). Kernel-to-kernel variation in mass was greater for the purelines (SD = 1.71-1.93) than the hybrids (SD = 1.47-1.62). Alkali-soluble amylose (ASA) and protein (ASP) contents were determined on individual kernels soaked in 2.5% KOH for 24 h in microwells. ASA was greater for CL151 (19.0%); that of the other three cultivars was comparable (17.1-17.8%). Kernel-to-kernel variation in ASA was greater for the hybrids, with a SD range of 3.1-3.7 as opposed to 2.3-2.7 of the purelines. ASP was greater for the purelines (6.5-6.8%) than the hybrids (5.7-5.7%). Kernel-to-kernel variation in ASP was also greater for the purelines (SD = 0.95-1.23). Present findings need further validation with the use of a larger sample set of cultivars.

Flour from wheat cultivars of varying hardness affects textural and structural properties of semi-sweet biscuits

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Wheat (*Triticum aestivum* L.) kernel endosperm hardness is a key quality trait. The mechanism determining wheat hardness is still not fully clear, but a soft texture has been attributed to the presence of basic, cysteine rich puroindoline proteins. Wheat hardness influences many aspects of the supply chain such as milling behavior, the properties of the resulting flour and the quality of products made thereof. Flour from soft wheat is preferred for biscuit making based on its relatively low levels of protein and damaged starch, which mainly affect biscuit dimensions (both diameter and height). However, little information is available on the impact of wheat hardness (and hardness associated flour properties, e.g., starch damage) on cookie textural and (micro)structural properties. In the present study, semi-sweet biscuits of relatively high flour content were baked, thereby assuming that this would diminish the effect of sugar and fat on product quality. Such biscuits were prepared from flour from wheat cultivars of varying Single Kernel Characterization System (SKCS) hardness values (ranging from 22 to 92). To exclude the impact of protein level on biscuit properties, purified starch was added to those flour samples with higher protein levels, in order to bring the latter to ca. 10% (dry matter basis). The impact of water binding by damaged starch was diminished by baking to similar biscuit moisture content (ca. 3.0%). Biscuits prepared with flour from harder wheat cultivars, as reflected by their SKCS values, had a higher biscuit break strength, indicating a harder texture. Biscuit break strength correlated strongly with SKCS values (R^2 = 0.97). Internal biscuit structure was studied with X-ray microfocus computer tomography (μCT). This way, biscuit break strength was related to porosity, mean cell size and mean cell wall thickness.

Nonlinear quality modeling of Eastern Canadian winter wheat

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In recent years the wheat market is mostly driven not by agronomic values but by the end use. Modern breeding programs require screening new wheat crosses and parental candidates for quality in large numbers before selection. Functionality of dough is one of the most important properties for end product quality, and breeding programs of hard winter and spring wheat. Prediction of bread volume and farinograph parameters is not an easy task. It is desirable to develop rapid and technically simple method to predict end use quality based on the small sample (from one kernel to a few ears). There are generally two steps in the development of prediction method. First, is to define the best quality indicators, (parameters) which are easy to analyse, and next to apply proper mathematical or statistical method to build prediction model or regression equation. In our studies we attempted to develop quality models of Eastern Canadian winter wheat based on the Near-infrared spectroscopy (NIRS) combined with support vector machine (SVM) non-linear algorithms. For SVM we used WEKA program. The NIR spectra (400-2500 nm) from 422 Ontario hard winter wheat samples were used in our studies. The Quality models were built based on the original spectra, 1st derivative, 2nd derivative and wavelet transformed spectra. Each of these transformed data sets was evaluated using 5 machine learning algorithms: Decision Stump, LMT, M5P, Random Forest, Random Tree and REPT. This non-linear approach allows us to predict some grain and flour quality parameters with the following precision: Bread Volume – 85%; Peak Time – 76%; Farinograph Water Absorption – 78%; Stability – 67%; Quality Score – 86%. The effects of data pretreatments and applied algorithm were quality parameter dependent. The details of data preparation and steps of building the Quality models will be discussed.

Effect of pre-germination process on chemical and physicochemical properties of Thai waxy rice flour and starch

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This study aimed to investigate effects of pre-germination process on the chemical and physicochemical properties of Thai waxy rice (Rice Division6, RD6). Paddy was soaked in 30°C water for 12 h until reaching 30% moisture content. The soaked paddy was then incubated at 30°C. The results indicated that the pre-germination time (soaking time plus incubation time) at subsequent embryo growth length from each stage, 0.5-1 mm (minimum stage), 1-2 mm (optimum stage), and 2-3 mm (maximum stage) were 28, 32, and 36 h, respectively. The pre-germinated brown rice (PGBR) flour from each stage and its isolated starch were prepared and analyzed for chemical and physicochemical properties in comparison to the ungerminated brown rice (BR) and the white rice (WR). The fat content of PGBRF from each stage was not significantly different ($p \geq 0.05$) from that of brown rice flour (BRF) (3.28, %dry basis, db), but significantly higher ($p < 0.05$) than that of white rice flour (WRF) (0.90,%db). The protein content of PGBRF from each stage was not significantly different ($p \geq 0.05$) from that of BRF (5.62, %db), but significantly higher ($p < 0.05$) than that of WRF (4.25, %db). The fat content

and protein content from the isolated starches varied between 0.09-0.20 (%db), 0.42-0.86 (%db), respectively. In flour forms, the amylose contents of PGBRF from each stage as analyzed by using colorimetric method were found to be 5.55, 5.42, and 5.46 (%db), respectively. The amylose contents of PGBRF were significantly lower ($p < 0.05$) than that of BRF (5.65, %db) and WRF (5.92, %db) due to the amylase activity during pre-germination process. The amylose contents from isolated starches were higher than that of flour from all samples. The results also revealed that pre-germination process affected on pasting properties. The peak viscosity of PGBRF from each stage were significantly lower ($p < 0.05$) than that of BRF and WRF while its isolated starches showed higher values.

An assessment of the robustness of enzymatic digests in dietary fiber methods

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The assumption for dietary fiber methods commonly used for food labeling is that the enzymatic digests eliminate all non-dietary fiber material. To test this assumption, we have varied the concentration of the enzymes and digest times to determine whether a dose-dependent effect can be observed on the final fiber value. We have found that for certain matrices, the prescribed concentration of enzymes and digests times do not completely remove non-dietary fiber material resulting in higher values of dietary fiber. Resistant starch-containing matrices were found to be particularly vulnerable to incomplete digest under the conditions of the AOAC 991.43 dietary fiber method. In examining the thermo-stable bacterial alpha-amylase required by AOAC 991.43, it was found that the enzyme becomes inactive before the completion of the digest at 100°C when applied at the prescribed concentration. This is due in part to a reduced activity of the enzyme in the presence of Tris in the digest buffer which acts as an inhibitor. Additionally, the pH of the buffering, 8.2, is outside of both the optimum and stability range for the enzyme. A further contribution to the instability occurs from the absence of calcium ions and use of the enzyme above its upper temperature maximum of 80°C.

Determining the effects of storage and time on unreacted starch in the dry grind ethanol process

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When corn processed in conventional dry grind, a portion of the corn starch is not converted into ethanol. The amount of unconverted starch varies according to several factors including storage condition and storage time. To determine the changes in the amount of starch that remains unreacted, corn samples were harvested from the Agricultural and Biological Engineering farm at the University of Illinois during October 2011. Corn samples were stored in a 1°C refrigerated room and under a sheltered awning outdoors. The corn samples were monitored with temperature and humidity sensors, and samples were taken and measured for unreacted starch. This was accomplished by conducting liquefaction and saccharification and then performing a resistant starch assay to determine the amount of remaining starch. Results from the first three months of storage show that the unreacted starch content of corn decreased from 5.5% in late fall, to 1.5% for refrigerated conditions and 2.5% for ambient conditions. The minimum measurements occurred on January 19th when daily outdoor temperatures averaged -5°C. The unreacted starch contents then began to increase in both samples to an amount larger than the original, around 8% by the beginning of April, when outdoor temperatures averaged 16°C. Trends were similar over the first six months of storage, suggesting that storage time has a larger effect than storage temperature on unreacted starch content in corn.

Barley flour as a potential ingredient in wheat bread

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Among cereal grains, barley is considered to be a good source of bioactive compounds, especially β-glucan. The main objective of the present study was to investigate the nutritional and functional attributes of three barley flours (wholegrain [WGB], air-classified β-glucan-diminished [ACB-D] and air-classified β-glucan-enriched [BGB-E]) having different biochemical properties, in a wheat flour-water system. Barley flours were incorporated into bread flour at replacement levels of 10, 20 or 30%. As expected, the barley flours were higher in β-glucan (4.9, 9.8, and 24.9%, respectively) and total dietary fibre (10.6, 17.5 and 47.0%, respectively) for ACB-D, WGB and BGB-E, respectively, compared to control wheat flour (0.4% and 5.5% of β-glucan and TDF, respectively). Farinograph-water absorption was high for all wheat-barley composite flour systems (ranging from 66 to 91% when 10% ACB-D or 30% BGB-E were included in the system, respectively). With the incorporation of BGB-E (10-30%) farinograph-dough development time (DDT) was also significantly increased (8.0-18.0 min), compared to 3.0 min for the control. Extensibility of all composite doughs was reduced compared to the control, with 30% BGB-E causing a 50% reduction in extensibility. Incorporation of either ACB-D or WGB at 30% replacement levels resulted in reduction in viscoamylograph peak viscosity (PV; 101 and 145 cp, respectively) compared to 176 cp for the control, and final viscosity (FV; 239 and 323 cp, respectively) compared to 440 cp for the control. Incorporation of BGB-E increased PV and FV for the composite flour systems (PV = 245, 289 and 330 cp and FV = 525, 597 and 687 cp for 10, 20 and 30% replacement level, respectively). The results highlight the potential for barley flours as functional ingredients in the baking industry.

WITHDRAWN

Effect of fungicide treatment on functionality of wheat flour

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As technology has developed, fungicides have become a part of normal management practices, to control plant diseases. This study evaluated functionality of eleven wheat varieties (4 hard and 7 soft) grown in the presence or absence of fungicide. Positive effect of fungicide on postharvest quality of hard (HWF) and soft (SWF) wheat flours (2010 and 2011) was observed in terms of grain yield, test weight and thousand-kernel-weight. Reduction in rapid visco-analyzer set-back (SB) and final viscosities (FV) were not significant for most SWF except Branson (3.8% SB;10% FV) and SRW-170 (9.5% SB;11.2% FV), indicating significant effect of fungicide on retrogradation and reordering of starch molecules. No significant effect of fungicide was observed on cookie quality for all SWF. Farinograph test indicated reduction in dough-development-time for treated samples except for Keldin, which was not affected in both years. Protein contents (8.25-9.82%), Gluten Peak Tester (GPT)-torque (42.4-46.3BE) and loaf volume (302.5-356 cc) of all HWFs (2010) were significantly reduced after fungicide treatment as compared to protein (9.06-10.68%), GPT-torque (44.1-49.8BE) and loaf volume (307.5-451 cc) of control samples. Only four of SWF exhibited reduction in protein and GPT-torque ($p < 0.05$). However, when 2 hard and 2 soft wheats were planted in 2011 under same conditions, protein content increased after fungicide treatment resulting in higher GPT-torque and loaf volume in HWF than their corresponding 2010

flours. Interestingly, protein and GPT-torque of SWF (2011) were not affected with treatment, indicating that fungicide application had higher impact on protein of HWF, which conclude that fungicide is not the leading factor, but it depends on wheat class, as well as the cumulative effect of fungicide, soil and weather conditions causing changes in flour functionality.

Effect of treated effluent water on hydrolysis and fermentation for cellulosic ethanol production

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The bioethanol industry exhibits significant demands on water supplies. Currently, in corn dry grind ethanol plants, water is consumed at the rate of 3 to 4 gallons of water per gallon of ethanol produced and 6 to 10 gal water/gal of cellulosic ethanol. The main goal of this study is to examine the alternative use of treated wastewater effluent in place of potable freshwater for cellulosic ethanol production. The effects of two different types of treated effluent—Bloomington- Normal, IL (Residential type) and Decatur, IL (Industrial/Residential Mix type)—on the rate of fermentation and final ethanol yield from a pure cellulosic substrate were evaluated. Final ethanol concentration with Bloomington-Normal and Decatur effluent and our control study using de-ionized water were similar, resulting in 4.57 ± 0.22 % v/v (0.36 g/g, db), 4.74 ± 0.13 % v/v (0.37 g/g, db) and 4.55% ± 0.28 v/v (0.36 g/g, db), respectively. Residual glucose concentrations were <0.04% w/v at 48 hr in all cases, suggesting complete fermentation. These findings suggest that with proper characterization studies and under appropriate conditions, the use of treated effluent water in cellulosic ethanol production is feasible.

Influence of genotype and growing location on agronomic quality and nutritional characteristics of kabuli chickpea (*Cicer arietinum* L.) genotypes

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Effects of genotype and growing location of five breeding lines and four commercial varieties of kabuli chickpea (*Cicerarietinum* L.) grown at two different locations in the northwest of Mexico. Agronomic quality parameters (exportation and yield), physical characteristics (length, width, 100 seeds weight, caliber and total color difference) and also protein content were evaluated. The data revealed that commercial variety Jumbo 2010 showed highest values ($p \leq 0.05$) of seed size at both locations (Hermosillo, Sonora, and Los Mochis, Sinaloa). Breeding line CUGA 05-2479 grown at Los Mochis presented the lowest value ($p \leq 0.05$) in seed size at Hermosillo. The highest yield recorded by Blanco Sinaloa 92 (3,834 Kg ha^{-1}), while CUGA 05-1056 had the lowest (991 Kg ha^{-1}). Commercial variety Jumbo 2010 showed the highest 100 seed weight (78.81 g), and CUGA 05-2479 showed the lowest (55.05 g), both at Los Mochis, while HOGA-067 showed the highest (66.40 g) and CUGA 05-1056 the lowest value (32.60 g) at Hermosillo. Growth habit of plants not showed significant differences as a result of genotype and growing location. Protein content of chickpeas showed significant differences ($p \leq 0.05$) between different genotypes of chickpea at two locations. Highest concentration of protein (27.7%) was observed in breeding line CUGA-1056 and HOGA-012 showed the lowest (19.79%) at Hermosillo. However, at Los Mochis, Jumbo 2010 showed the highest protein content (24.45%) and MOGA-65 showed the lowest (18.33%). These results suggest that both environmental and genotypical characteristics have an influence in agronomic and quality traits and also nutritional parameters such as protein content, a parameter that is not considered by breeders and which represents a new strategy to improve seed properties.

Evaluation of alkaline pre-treatment of residual starch determination methods in distillers' grains with solubles (DDGS)

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A co-product of ethanol production, known as dried distillers' grains with solubles (DDGS), contains residual starch that has escaped hydrolysis during ethanol production, a fraction that includes enzyme resistant starch. The complexity of the various forms of resistant starch occurring within these samples creates challenges for accurate analysis of residual starch. We previously demonstrated that commonly used enzymatic hydrolysis methods underestimate residual starch in DDGS samples. The objective of this study was to analyze the effect of alkaline pre-treatments on DDGS to solubilize resistant starch prior to enzymatic hydrolysis. The potassium hydroxide (KOH) and sodium hydroxide (NaOH) were the alkaline solutions used to pre-treat the DDGS, followed by residual starch determined with enzymatic hydrolysis. 2M KOH pre-treatment caused significantly greater residual starch values (1–3.5%) than enzymes only control (<2%). On the other hand, NaOH (pH 7–12) pre-treatment exhibited destructive behavior towards free glucose in the DDGS samples and showed residual starch values mostly less than 1.5%. Hydrolysis of non-starch polysaccharides from compounds expected in DDGS was also investigated. The use of a chemical pre-treatment to improve enzymatic hydrolysis of resistant starch in DDGS is suggested to increase the yield of sugars thereby benefit the bioethanol industries.

Benchmarking residual starch analysis of distillers' grains with solubles (DDGS)

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The primary residual co-product of ethanol production, after ethanol separation and recovery, is dried distillers' grains with solubles (DDGS). DDGS contains residual starch that escaped hydrolysis during ethanol production; therefore, residual starch in DDGS contains enzyme-resistant starch. The various forms of resistant starch within these samples represent a complex mixture that requires further investigation. This investigation proposes that commonly used methods consistently underreport the residual starch value for DDGS samples due to the presence of enzyme-resistant starch. The current study aimed to benchmark three commonly used residual starch analysis methods reported in the literature on a broad range of DDGS types. The most common starch analysis methodologies such as enzymatic hydrolysis with and without using dimethyl sulfoxide (DMSO) and an acid hydrolysis with 2M HCl, followed by the quantification of glucose were compared for analyzing the residual starch in DDGS. A wide range of residual starch values were measured in DDGS samples from different grains (barley, corn, triticale, and wheat) generated using various processing conditions (jet-cooking or raw starch hydrolysis and freeze or oven-drying). The residual starch contents of DDGS analyzed by acid hydrolysis were significantly higher (3–16%) than the enzymatic hydrolysis methods (0.5–4%). Further detailed investigations were performed to help elucidate understanding on how discrepancies were introduced, including the quantitative analysis of glucose release from non-starch polysaccharides.

Research approaches in the development of texture stable multi-components bakery products: A quantitative high-throughput screening system for water migration combined with a predictive model

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The development of shelf-stable bakery products with a crispy crust and moist filling is technologically challenging due to water migration, which results in a rapid loss of the textural and sensorial properties of the product. The kinetics of the water migration are dependent among others, on morphology and composition of the multi-texture food components as well as on a_w gradients. In multi-texture foods, edible barriers are a suitable technological solution in order to limit the water migration process and hence extend textural stability. We present here a high-throughput screening system developed to gain quantitative information with regards to the kinetics of moisture diffusion in a bi-component food model representative of a real product. The kinetic parameters obtained on water diffusion through the food components and an edible barrier are combined together with key material properties of the components in a predictive model. The model provides information on the moisture/a_w profiles of the components during storage. The methodological approach presented combines fundamental insights in the influence of morphology, composition and a_w of multi-texture food components with applied relevance, thus enabling fast and efficient development of stable multi-texture bakery products.

Importance of fat-dough interactions in sheeted dough products

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Increased consumer awareness on health disorders related to high fat and saturated fatty acids (SAFA) intake has prompted continuous research efforts to reduce fat and SAFA contents in foods. Fat plays a key role in determining the overall quality of sheeted dough products such as pastry and croissants. In

these applications, fat characteristics cannot be limited to solid fat content only. In fact, the rheological behavior of fat and dough during processing provides relevant insights for pastry quality, due to the influence of gluten development and fat structure breakdown. The aim of this work is to relate variations in fat characteristics (i.e., consistency) and processing conditions to the rheological behavior of the pastry dough components (i.e., bulk fat and bulk dough) as well as of the pastry dough itself, and to the final pastry product quality. Both small and large deformation rheological tests were performed on pastry doughs from different steps in the sheeting procedure as well as on bulk fats and bulk doughs subjected to similar sheeting procedures. The rheological data gathered highlight a determining effect of bulk fat on pastry dough development, independently of the type of fat. The consistency of the pastry dough shows to be related to the consistency of the bulk fat during processing, except for the final sheeting step with soft fats. A dispersion model is suggested where bulk fat behaves as a solid in the layered dough structure. In such a model, pastry quality (i.e., standard baking tests) is largely independent of fat type for a defined sheeting program, until the layered structure is lost at a critical fat consistency. Microscopic analysis of pastry dough at different sheeting steps, as well as baking tests performed at intermediate and final sheeting steps corroborate the validity of the suggested model.

Glutenin molecular characterization of three transgenic high molecular weight glutenin subunit events in winter wheat

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Glutenin molecular characterization of three transgenic high molecular weight glutenin subunit (HMW-GS) events were established in advanced generation breeding lines of hard winter wheat (*Triticum aestivum* L.) in three Nebraska crop years. Two of the transgenic events studied, Dy10-E and B52a-6, overexpress HMW-GS 1Dy10, while the third event, Dx5 + Dy10-H, overexpresses HMW-GS 1Dx5 and, to a much lesser extent, 1Dy10. The molecular weight distribution (MWD) of glutenin polymers was determined using Asymmetric Flow Field-Flow Fractionation with multi-angle light scattering (AFFFF-MALS). The data showed that average molecular weight of lines derived from the third event Dx5 + Dy10-H was significantly the highest within groups. The results of some quality and agronomic parameters were correlated with molecular characteristics. Therefore, a strong correlation ($R^2 = 0.8$) between the grain hardness and the average molecular weight of glutenin was revealed. This result confirmed our previous study which showed a relationship between the grain hardness and the molecular weight distribution. Furthermore, farinograph tolerance index and mixograph tolerance were correlated positively with the molecular weight of glutenin polymers.

What is the accuracy—can NIR be more accurate than the reference method? An empirical review of global ANN calibrations for whole grain analysis

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Reference analysis plays a central role in calibration development, but developments in chemometrics and rapid NIR methods take the burden of routine testing with instrumental solutions performing comparable to or better than reference methods. According to the European Norm 15948 the global Artificial Neural Net (ANN) calibration for protein in whole grain wheat and barley must perform with a Standard Error of Prediction (SEP) lower than 0.27 % w/w. The SEP is primarily composed of contributions from three main elements: the NIR instruments (the spectroscopic data), the chemometric calibration model and the reference analyses. A protein ring test including twelve different wheat samples analyzed on ten different NIR spectroscopic instruments in the spectral range 850-1050 nm and by ten different reference laboratories made it possible to estimate the individual error contributions. Estimates of the instrumental error (Standard Error of Instruments, SEI) and the error related to the reference analyses (Standard Error of Laboratories, SEL) provide the possibility for obtaining an estimate of the model error by subtraction from the overall error (SEP). The overall SEP when predicting the ring test samples with the EN 15948 WB003034 model was 0.21 % w/w protein. The SEI estimate contributed with 24 % and the SEL estimate with 54 % leaving 22 % for the model. Averaging the protein estimates over the ten different reference laboratories for each of the twelve samples reduced the SEP to 0.10% w/w for a single instrument proving that the NIR predictions can perform comparable to or even with better accuracy than the reference method. This is an often overlooked advantage when using NIR and chemometrics for predicting composition of food-agri samples.

Effect of extrusion process on antioxidant activity and total phenolic content in mixtures from extruded whole grains for producing nutraceutical beverages

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The utilization of whole grains in food and beverage formulations is nowadays much recommended. The beneficial effects of including whole grains in the diet have been demonstrated by several authors. The cereal-legume mixture shows a better quality protein profile characterized by an improved balance of essential amino acids. The objective of this investigation was assess the effect of extrusion process on antioxidant activity and total phenolic content in two mixtures (60% cereal + 40% legume) from extruded whole grains for producing two nutraceutical beverages. Extrusion operation conditions [extrusion temperature (ET)/screw speed (SS)] to obtain Mixture 1 [60% extruded maize flour (EMF) + 40% extruded chickpea flour (ECF)] were: EMF: ET = 109°C / SS = 158 rpm and ECF: EMF: ET = 127°C / SS = 151 rpm. Mixture 2 [60% extruded maize flour (EMF) + 40% extruded common bean flour (ECBF)] was produced applying the follow extrusion conditions: EMF: ET = 100°C / SS = 211 rpm and ECBF: EMF: ET = 96°C / SS = 80 rpm. Antioxidant activity (AoxA) and total phenolic content (TPC) decreased 6-9% and 9-10%, respectively, in both extruded mixtures when compared with unprocessed whole grain mixtures. The mixtures 1 and 2 were utilized for producing two different beverages (Beverage 1 and 2) (Beverage = 22 g extruded mixture + 168 ml purified water + 1 g vanillin + 10 g fructose; the beverage were pasteurized, bottled, and refrigerated until use). Two panels of 30 judges (semitrained panelists) evaluated sensory the beverages). A 200 mL portion of nutraceutical beverages had 3-4 g proteins, 110-116 kcal, and were evaluated with and acceptability of 85-94 (between "I like it" and "I like it very much); this portion had an AoxA = 2,200-3,000 ORAC value and covered 44-60 % of the antioxidant requirements recommended by USDA to maintain a healthy body.

Effect of QTL associated to hardness on protein expression and starch physicochemical properties in quality protein maize

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Previous genetic analysis using quality protein maize (QPM) recombinant inbred lines (RIL) from the cross of K0326Y by W64Ao2 identified three quantitative trait loci (QTL) associated to endosperm hardness on chromosomes (chr) 1, 7 and 9. In this study, the effects of these loci on protein expression and starch physicochemical properties were evaluated using RIL contrasting in hardness (vitreous vs. opaque) and the genotype of the corresponding QTL flanking markers to investigate the biochemical basis of endosperm modification in QPM. The accumulation of 27-kDa gamma-zein protein was found to be higher in the endosperm of vitreous RIL for the three loci. The amount of total starch (66.3-72.2 mg/100 mg flour) and amylose (21.1-27.8 mg/100 mg starch) were only affected by the locus on chr 1; higher contents for these traits were observed in the vitreous RIL. Gelatinization enthalpy (5.18-9.53 J/g) was also higher in the vitreous RIL of all loci, suggesting the presence of more crystalline regions in the starch granules of these lines. A higher accumulation of granule-bound starch synthase I (GBSSI) was only observed in the vitreous RIL of the locus on chr 1, which corresponds to the higher amylose content observed in these lines. The results suggest that the vitreous phenotype of QPM endosperm is associated with more gamma-zein protein bodies and alterations in the structure of starch granules as a consequence of changes in the expression of starch biosynthetic enzymes.

Effect of fermentation time on antioxidant activity and total phenolic content of chickpea (*Cicer arietinum* L.)

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The objective of this investigation was to study the effect of fermentation time during solid state fermentation (SSF) on antioxidant activity and total phenolic content of chickpea. Chickpea grains were soaked (25°C/16 h) in acetic acid solution (pH 3.0). Grains were then drained and their seed coats removed manually. Seed coats were dried (moisture content 11%) and milled (80-US

mesh = 0.180 mm), packed and stored (4°C). The cotyledons were cooked in acidified distilled water (pH 3.0) at 90°C for 30 min, cooled (25°C/4 h), inoculated with a suspension of *R. oligosporus* NRRL2710 (1 x 10^6 spores/ml), and packed in perforated polyethylene bags (15 x 15 cm). SSF was performed at 35°C and fermentation times of 24, 36, 48, 60, 72, 84, 96 and 108 h (after 108 h of fermentation the tempeh showed off odor). The resulting chickpea tempehs were dried (50°C/12 h), cooled (25°C) and milled (80-US mesh = 0.180 mm). Fermented (tempeh) chickpea flours from each fermentation time were blended with its corresponding milled seed coats and kept at 4°C. The fermentation time increased ($p < 0.05$) the antioxidant activities (ORAC value) and total phenolic contents (TPC) of chickpea grains. At 24 and 106 h of fermentation time the ORAC values of fermented chickpea flours were 6,002 and 14,633 µmol trolox equivalents/100 g sample (dw), respectively. At these fermentation times the TPC of fermented chickpea flours varied from 260 to 836 mg gallic acid equivalents/100 g sample (dw). The best combination of SSF variables process to obtain chickpea tempeh flour with the highest antioxidant activity was 35°C/108 h. These results suggest a great potential for utilization of fermented chickpea flour with added seed coats in food products for human health promotion and disease prevention.

Effect of barley bagasse, feed moisture, and barrel temperature on the extrusion of corn grits

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Barley bagasse from beer industry also known as brewer's spent grain is commonly used in animal feed, but its use as an ingredient for food preparation would be an interesting alternative in formulations of rich fiber products, which are in high demand worldwide. Mixtures of corn grits and fine milled barley bagasse (15-30%) were processed in a single screw extruder at varied moisture content (18-22%) and final heating zone temperature (120-160°C). The sectional expansion index (SEI) and the bulk density (BD) of the cylindrical extrudates were measured. The paste viscosity and the water absorption (WAI) and solubility indexes (WSI) of the milled and sieved extrudates were analyzed. The SEI values decreased and the BD values increased with the increase of barley bagasse content and final barrel temperature ($P < 0.05$). The WAI values increased with moisture content ($P < 0.05$). The cold paste viscosity reduced with the increase of moisture and barley content ($P < 0.05$). The effect of temperature was not significant for the response analyzed variables. Although the addition of barley bagasse presented a negative effect on the expansion of the extrudates, by reducing internal air cells and diameter, the blended flours of high barley content showed binding properties capacity, which can be useful for preparing high fiber bakery products.

Novel wheat bran and extracts with enhanced nutrient and bioactive properties

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The health benefits attributable to whole wheat derive mainly from the bran fraction, which provides a significant source of dietary fiber along with a substantial complement of bioactive phytochemicals including those thought to have a role in reducing the risk of many chronic diseases. The low solubility/digestibility of wheat bran fiber presumably limits its efficacy as a functional food ingredient, which depends upon the bioavailability of constituent bioactive molecules. Presumably, if the solubility of wheat bran could be increased by pretreatment, its potency as a functional food would also increase. We studied the potential of autoclaving, along with other hydrothermal treatments, to enhance the extractability (in water) of selected bioactives including phenolic antioxidants, fiber and micronutrients. Radical scavenging based antioxidant activity of soluble extracts of autoclaved bran (AB) was increased 3 to 4 fold compared to corresponding extracts of untreated bran. Folate and niacin contents in AB extracts were significantly increased by 22% and 78%, respectively. Soluble fiber including resistant oligosaccharides in dried extracts of AB was increased by ~300% from a level of 12% in untreated bran extracts. Cell and animal model experiments have produced equally compelling results reflecting a range of important bioactivities for both AB and extracts. Results of an animal trial using diet-induced hypercholesterolemic hamsters indicated that AB supplemented diets reduced plasma glucose and adiposity, and increased energy expenditure compared to a control diet without wheat bran. Results as a whole suggest that the health benefits ascribed to wheat bran likely represent a fraction of its potential. Autoclaved bran appears to have considerable value for whole grain food and health applications far beyond what may be possible with traditional wheat bran.

Characterization of native and modified sweet potato starch for its physicochemical, thermal, and pasting properties

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Sweet potato starches were characterized to understand the changes upon modification by heat moisture treatment (HMT) with 28% moisture content at 110°C for different duration of 4, 8, 12 and 16 hrs in the physico-chemical, rheological (RVA), and thermal (DSC) properties of starch isolated from the sweet potato variety PSP-21 and to compare these findings with those of native sweet potato starch. The swelling power and solubility of modified starch decreased from 11.76 to 9.63% and 14 to 11%. The sediment volume decreased with longer duration of treatment in modified starches (11 to 6 ml) as compared to native starch (31 ml). The modified starches showed higher paste clarity as compared to the native one. Water binding capacity increased in modified samples (71 to 76%) as compared to the native one (63%) which may be attributed to the fact that the hydrophilic tendency of starch increases after heat moisture treatment. The amylose content decreased in modified samples with longer duration. The native sweet potato starch had a pasting profile characterized by a high peak viscosity (PV) (5484 cP) with a high breakdown (3511 cP). After HMT, there was a marked decrease in the PV values as compared to native starch and gradually decreased with longer treatment. The hot paste viscosity increased after modification but decreased with time. The cold paste viscosity increased after modification but decreased further with time of modification. The DSC characteristics were also affected significantly after modification. The gelatinization enthalpy decreased during HMT from 80.32 to 34.15 J/g but increased upon longer treatment. Further, the modified starches are characterized by the scanning electron microscopy to get an insight into the starch structure during the modification process. The modified starches can be used for specific products and different applications as per need.

Use of a new multitoxin clean-up column and fully stable ^{13}C-labelled internal standards for multitoxin mycotoxin analysis by LC-MS/MS

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The popularity of LC-MS/MS methodologies for analysis of mycotoxins is increasing. However, interferences from matrix components in these methods can lead to differences and difficulty in analyte ionization. Ionization efficiencies can vary between matrix samples and pure standard calibrants, causing the mass spectrum to show different signal intensities. Because of this, the sample analyte peak cannot be compared to the calibration curve (made from pure standard calibrants) for concentration values. ^{13}C isotope-labeled internal standards were used to help overcome this ionization effect by stabilizing the system to the effects of signal suppression and signal enhancement. Furthermore clean-up of the matrix was necessary to analyze complex sample matrices for a wide variety of mycotoxins, while reaching the low limits of detection necessary in the globalization of trade. A method utilizing this technology was developed for the simultaneous detection of 15 mycotoxins in cereal grains, mixed feeds, and corn by products. The mycotoxins included Aflatoxins (B1, B2, G1, and G2), Ochratoxin A, Zearalenone, Type A Trichothecenes, and Type B Trichothecenes. LODs ranged from 0.02 µg/kg to 0.16 µg/g for the aflatoxins and Ochratoxin A. LODs ranged from 0.28 µg/kg to 68.65 µg/kg for the various Type A Trichothecenes, Type B Trichothecenes, and Zearalenone. The %RSD of multiple repetitions of spiked samples was less than 15% overall, with most data showing %RSD less than 10%. Recoveries of the mycotoxins from spiked matrices varied by mycotoxins; however, all recoveries were greater than 70% for all included mycotoxins. The use of ^{13}C isotope-labeled internal standards in conjunction with the MycoSpin™ 400 Multitoxin Clean-Up Column allows for a method which is applicable to analysis of a wide variety of matrices, with no limitations by molecular mass, and a straightforward sample preparation.

Effect of damage caused by *Fusarium avenaceum* on durum wheat quality

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Depending on the year and region, *Fusarium avenaceum* can be the primary fungus associated with Fusarium head blight in major durum wheat growing

areas in western Canada. Unlike *F. graminearum,* which produce toxic trichothecene deoxynivalenol (DON), wheat kernels infected by *F. avenaceum* do not contain DON. However, little is known about the impact of *F. avenaceum* damaged kernels (FaDK) on the processing quality of durum wheat. The objective of this study was to investigate the implications of various levels of FaDK on durum wheat milling, semolina appearance, gluten strength, and pasta-making quality of durum wheat. To this end, a durum wheat sample solely infected with *F. avenaceum* was sourced from the 2010 harvest. FaDKs were hand-picked by an experienced grain inspector, and the causal agent was verified by fungal analysis. A series of composites (6) was prepared by adding FaDK to No. 1 CWAD base wheat to generate wheat samples with different FaDK levels (0.5, 1.0, 1.5, 2.0, 3.0, and 4.0%). Each sample was milled in duplicate, under identical and controlled conditions, to yield semolina, and the milling yields, ash, yellow pigment, semolina *b** (yellowness), dough sheet colour, and semolina specks were all determined. Semolina protein, wet gluten, gluten index and Alveograph parameters were also evaluated. The semolina was made into spaghetti for colour measurement and texture evaluation. Results showed that FaDK has no impact on semolina yield, total milling yield, and semolina ash content at all levels examined. A tendency of increased speck counts in semolina was noticed, but found not significant up to 2% addition. Total yellow pigment content and semolina colour was not affected. However, higher redness (*a**) in spaghetti was discernible by eye with the addition of FaDK at 1.5% or higher. A slight weakening effect on gluten strength was evident at addition level of 2% and higher, but cooked pasta texture was not affected by FaDK.

Low-calorie bread with charred cellulose granules/wheat flour and elimination of toxic dye (xanthene) in alimentary canal by charred cellulose granules

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The insoluble fibers of cellulose are linked through nondigestible β-1,4-bonds and are noncaloric. Synthetic toxic food dye (xanthene) is widely used in processed foods. The adsorption of the xanthene dye onto cellulose granules charred at 250°C for 20 min is known. The objectives of this study are to bake a low-calorie bread by a mixture of charred cellulose granules and wheat flour and to eliminate toxic food dye (xanthene) in the alimentary canal using charred cellulose granules in the bread. The size of cellulose granules plays an important role in determining good breadmaking properties (bread height [mm] and specific volume [SV]). Hence charred cellulose granules with diameters above 270 micrometer were blended with wheat flour at 10%, and bread with a lower calorie content (1020 kcal/gram of bread) than the control bread (1126 kcal) made solely from wheat flour was obtained. It was confirmed that the charred cellulose granules in the bread adsorb toxic food dye (xanthene), and toxic food dyes (xanthene) in processed foods taken into the alimentary canal would be excreted in the feces with nondigestible charred cellulose granules in bread.

Effect of different sprouting conditions on α-amylase activity and functional properties in wheat

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Enzyme activity increases rapidly during germination, most notably that of α-amylase. The extent of this enzymatic activity depends on the duration of sprouting, moisture, temperature, seed variety and the type of drying process employed. The aim of this study was to assess and quantify α-amylase activity during different sprouting conditions. Wheat cultivar *var.* Ava (soft white wheat) was steeped for 24 hours before sprouting at 70% humidity and 12°C or 20°C for 5 days. The sprouted samples were freeze-dried and milled before being analyzed by a gluten peak tester (GPT), rapid visco-analyzer (RVA) and farinograph. Endogenous enzyme activity and enzyme isoforms were also determined. In general, peak time for GPT was longer for 12°C as compared to 20°C, while peak torque remained similar until dropping at day 4 (5 BU) and day 5 (8.4 BU) for 20°C samples. Farinograph torque and time displayed similar trends as GPT for samples at both temperature treatments. RVA was more sensitive, detecting differences between samples at each day of sprouting with a remarkable decrease in peak viscosity at day 1 for 20°C (810 RVU) and at day 2 for 12°C (620 RVU) treatments. Endogenous α-amylase activity increased rapidly in the 20°C samples at day 3 exhibiting 5000 units/g by day 5, while only 1000 units/g was detected at day 5 for 12°C sample. Several isoforms of α-amylase were detected by zymography. In brief, results were consistent among GPT, farinograph, RVA and α-amylase activity tests, showing higher enzyme activity for 20°C sprouting as compared to 12°C. These results should help to identify optimal α-amylase activity in sprouted wheat for the development of functional whole grain products that are naturally shelf-stable and more nutritionally dense.

Use of a high temperature tandoor oven for production of white wheat naan with enhanced nutrition, sensory traits, and shelf life

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Naan is a high quality leavened wheat flat bread that is consumed fresh. Moderate to high protein South Dakota hard red winter wheat varieties and commercial white wheat varieties were used in product development. The focus of the study was to compare re-baked frozen cooked naan, par-baked naan and fresh-baked naan for textural and aesthetic traits. Flavor is imparted by yeast fermentation and high temperature processing. While yeast adds flavor, steam is the leavening agent. Tear-drop shaped Naan dough (2-3 mm thickness, 180-200 mm diameter) was applied to the inner walls of the Tandoor, where it was exposed to direct heat from the oven wall, radiant heat and heated air (200 ft/min). Cooking temperature and residence time were 680-700°F and 45 seconds, respectively. Higher temperature and short time yielded superior color, texture and flavor. Effects of conventional baking, par-baking and storage at two temperatures (ambient and -18 °C) were evaluated using a texture analyzer (TA.XT.Plus). Frozen naan could be baked directly or thawed before baking. Dough for naan was highly extensible with high moisture content. Stickiness of the dough was critical to Tandoor baking. Alice white wheat flour and commercial All Purpose Flour naans required 689.8 g and 427 g of force to tear for conventional naan. The par-baked products required 791.6 g and 661.6 g for Alice and APF, respectively. Five hours of ambient storage of conventionally baked naan required up to 1010 g owing to product hardening. Naan had 12-13% of protein, 11-12% of moisture, 72-75% of carbohydrate and less than 1% ash. Shelf life at ambient temperature was 6-7 days, and 6 months when frozen. A temperature gradient was also noted in the fully heated oven ranging from 722.5 °F at the bottom to 588.5 °F at the top of the cylindrical oven.

Effect of different wheat dietary fibre sources on sensory properties of pre-baked pizzas

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Pre-baked pizza disks are products that are available in the market at a relatively low cost and permit easy preparation at home. Wheat flour based products, including pizza doughs, have been used for the inclusion of fibre in the diet due to the positive acceptance by consumers. In this study, 4 samples of pre-baked pizzas were produced and subjected to 2 different acceptance and purchase intention tests. Part of the refined wheat flour (RWF) was replaced by different proportions of whole-grain wheat flour (WGWF) and white wheat fibre (WWF). C represented the control formulation with 100 % RWF; for F1, 84.9 % of the RWF was replaced by WGWF; for F2, 9.4 % by WWF, and for F3, by both WGWF (45 %) and WWF (5 %). In the first test, the pizza disks were evaluated only visually (as when purchasing), and the Tukey test showed that the samples did not differ in acceptance between each other ($p < 0.05$), with mean values of the attributes for all 4 samples ranging from 6.0 to 6.7. In the second test, the pre-baked pizzas were filled with tomato sauce, mozzarella cheese and oregano and then re-baked. The F2 and F3 formulations were as accepted by consumers as the C formulation (global acceptance scores of 7.0, 6.2 and 6.7, respectively), as well as being considered "high fibre products" (6 g fibers/100 g of product). It was possible to obtain a "high fibre" and "whole grain" pre-baked pizza dough, since the F1 formulation contained approximately 5.6% dietary fibre and more than 51% whole grain in its final composition, despite a slightly lower acceptance by consumers (global acceptance score of 5.6).

Quantifying gluten in beer samples with a competitive ELISA format—second generation

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Gluten is a mixture of storage proteins present in wheat, rye and barley. They can cause celiac disease in predisposed persons leading to mucosa damage in the small intestine. The only treatment is a lifelong gluten-free diet. Since beer is usually produced from barley malt, it also contains gluten. During the brewing process, the gluten proteins in beer are partly denatured and degraded. However, also small fragments down to a few amino acids can further bear a risk for celiac disease patients. Some beer producers offer gluten-free beer, in which the remaining gluten proteins are removed or almost completely degraded by special techniques. In order to control gluten-free beers, test systems have to measure intact gluten and its peptide fragments in a highly processed matrix. ELISA methods are the mostly utilized test system for gluten analysis. However, the risk to miss

most of the small potentially toxic fragments is very high when using the sandwich assay format for hydrolyzed samples. Therefore, it is imperative to apply the competitive format for the detection of small molecules since the assay only needs one binding site of the antigen. The hydrolyzed calibrator is the best approach that is currently available for this type of samples. The R5 antibody, used in both formats to measure the concentration of potentially coeliac-toxic structures, is mentioned as Codex Type I method, is AOAC-RI approved and got the status of an AOAC OMA.

Natural polyphenols are potential inhibitors of intestinal maltase-glucoamylase (ct-MGAM subunit) for control of glucose release from starch digestion

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Some polyphenolic compounds have been found to inhibit the intestinal alpha-glucosidases. The aim of this study was to analyze the potential of such inhibition to modulate the rate of glucose release from digestion of starches in the intestinal brush border membrane. Both commercial rat intestinal powder and a recombinant C-terminal subunit of mouse maltase-glucoamylase (ct-MGAM) were used. Gallic acid, caffeic acid, ferulic acid, *p*-coumaric acid, quercetin dihydrate, (+)-catechin hydrate and (-) epigallocatechin gallate (EGCG) were tested as inhibitors of maltase activity of a 20 mg/ml solution of rat intestinal powders, at the concentration range of 1 µM to 10 mM, using 50 mM maltose as substrate. Glucose release was determined by a modification of the glucose oxidase-peroxidase method using 2 min time intervals during a 60 min reaction period at 37°C. Among the seven tested polyphenolic compounds, gallic acid, caffeic acid and EGCG showed the highest inhibitory effect on the rat alpha-glucosidases. Enzyme kinetics analysis of the inhibition by gallic acid, caffeic acid and EGCG showed that it to be an uncompetitive inhibition with Ki and the concentration causing 50% inhibition (IC50) of 0.844 and 0.302 mM, 1.39 and 2.770 mM, and 0.297 and 2.162 mM, respectively. We compared these effects with that caused on recombinant ct-MGAM and found IC50 values of 2.882, 4.055, and 0.264 mM for gallic acid, caffeic acid and EGCG, respectively. The ct-MGAM glucosidase is the most active subunit in starch digestion, and its high inhibition by EGCG suggests that there is potential to control rate of glucose release during digestion.

Effect of corn bran particle size and substitution on pasting characteristics of wheat flour

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Dietary fiber in corn bran is known for its beneficial effects on human health and nutrition. Corn bran substitution has shown to affect batter viscosity, and volume, crumb grain, color, and texture of cakes. Purified food-grade corn bran (free of germ and endosperm) was milled to pass through 80, 100 and 120 mesh sieve, resulting in corn bran powder of 177, 149 and 125 micron particle size, respectively. Blends of cake flour and 0, 5, 15, 20, 25, and 30% corn bran powders were used in the study. Pasting and hydration properties were measured using Rapid Visco Analyzer. Pasting temperature and peak time of cake batters were not affected by the corn bran fortification or particle size. The peak viscosity of cake batters was significantly lowered by increasing levels of corn bran in blends. Reduction in particle size of corn powders increased the swelling capacity of the blends. This study will improve human health by characterizing the effects of functional ingredients in baked foods, and benefit the bakery industry by generating new understanding of products that offer healthy alternatives.

Implications of non-covalent interactions in zein-starch dough and bread quality

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A major limitation in the production of wheat-free breads is the lack of protein functionality in non-wheat cereals. Breads made from non-wheat flours such as rice, maize and sorghum must be made from thick batters and are of lower quality than wheat bread. The development of visco-elastic dough from non-wheat proteins would allow a wider range of gluten-free products to be made and improve the quality of such foods. Zein has been shown to form wheat-like dough; however, the mechanism is unknown. To identify the factors responsible for dough development in zein-starch mixtures and their influence on zein bread quality, a mixture of 20% zein-80% maize starch was mixed with water and different reagents known to alter zein protein-protein interactions. The salts NaSCN, NaCl and Na_2SO_4 were evaluated at concentrations ranging from 0 to 2M for their influence on the properties of zein-starch dough systems. The use of NaSCN at low concentrations made softer, more wheat-like dough. Urea and ethanol had similar effects on the zein-starch dough and produced softer more workable dough. With increasing concentrations of NaCl and Na_2SO_4 there was a coalescing of the proteins and no dough formation. The use of the reducing agent β-Mercaptoethanol had little effect on the mixing properties of zein-starch dough. As NaCl content in the bread formula was increased from 0 to 2M, the specific volume of bread decreased from 3.5 to 1 mL/g. Likewise, including 5% ethanol (v/v) in the bread formula was found to slightly increase specific volume and prevented crumb failure. This research demonstrated that unlike wheat, zein proteins are capable of forming visco-elastic dough due to non-covalent interactions, rather than disulfide linked high M_w proteins and that dough formation with zein was very sensitive to the presence of kosmotropic salts such as NaCl.

Whole grain consumption, body mass index, and body composition in older Australian women

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The Dietary Guidelines for Australian Adults recommends eating plenty of cereals preferably wholegrain due to the importance of carbohydrates in a healthy diet and the cholesterol-lowering properties of cereal fiber and contribution GIT health. In a study in Perth Western Australia, 217 women aged between 70 and 80 years completed a 3-day weighed food record on two weekdays and one weekend day. All the food eaten was recorded on consecutive days using electronic food scales or household measures. Interviews clarified types and amount of food or beverages recorded including wholegrain consumption. Nutritionists trained in dietary assessment analysed food records using the AUSNUT99 database (Foodworks Professional edition version 3.02). A whole body dual energy x-ray absorptiometry (DXA) scan (Hologic Discovery A, Hologic Corp., Boston, MA, USA) was used to measure body composition. Seventy-two women had a BMI (kg/m^2) of less than 25, 95 had a BMI of 25-29 and 50 had a BMI of greater than 30. Waist circumference ranged from 79.2 to 98.4 cm. Body composition data showed whole body lean mass was 37.4 ± 4.7 kg, whole body lean mass was 58.2 ± 5.6 percent, whole body fat mass was 26.1 ± 7.5 percent, whole body fat mass was 39.5 ± 5.7% and the ratio of fat mass to lean mass was 0.69 ± 0.16. Carbohydrate intake ranged from 143 to 229.5 g/day. The wholegrain foods consumed included rolled oats, Weetbix (wholegrain wheat biscuits), bran based cereals, muesli and whole meal breads.

A structural snapshot into the inhibition of barley limit dextrinase by the barley limit dextrinase inhibitor in turn controlled by thioredoxin with relevance in brewing

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The starch debranching enzyme barley limit dextrinase (LD) is exclusively responsible for the hydrolysis of alpha-1,6-glucosidic linkages in alpha-limit dextrins generated from amylopectin during seed germination. Recently, the crystal structure of LD has been solved at high resolution in complex with the endogenous limit dextrinase inhibitor (LDI) of the CM-protein family that inhibits LD activity with picomolar affinity. In addition several structures have been solved of LD in complex with carbohydrate ligands, i.e., alpha- and beta-cyclodetrin as well as various maltooligosaccharides bound at the active site. Site-directed mutagenesis has been performed as guided by the crystal structures of the LD/LDI complex and LD/carbohydrate complexes to provide insight into important structure/function relationships. LDI that has four disulphide bridges and

occurs in mono-glutathionylated form is sensitive to thioredoxin h catalysed reduction of disulphide bonds. Using two thioredoxin h isozymes (Trxh1 and Trxh2) active on LDI, thorough analyses by thiol group quantification and mass spectrometry led to the hypothesis that the thioredoxin control of LDI activity is not connected to reduction of a specific disulphide bond, rather loss of LDI activity progresses until all five disulphide bonds present in the mono-glutathionylated LDI are reduced. The various reactions have importance for industrial brewing processes. This work was supported by the Danish Free Research Councils for Natural Science and Technology and Production Sciences, the Carlsberg Foundation, DTU PhD stipends (to MSM, MBVC), and an Oticon M.Sc. scholarship (to JMJ).

Interactions between anthocyanins and cereal ingredients during extrusion

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Anthocyanins (As), red/purple bioactive components found in food, possess numerous health benefits including antioxidant and anti-carcinogenic effects. These compounds are sensitive to processing conditions; however, the degree to which they have been found to change has been variable. Use of suitable technologies, such as extrusion, might be a positive approach both to adding these bioactive components into food formulations and to characterizing their interactions within the food system components. In this study, Concord grape extract powder, a rich source of As (642.41 mg Cy-3-glc equivalents/100 g) was added to hard wheat flour and the blend extruded by a twin screw extruder under a low shear screw configuration, at a constant 360 rpm screw speed and at 25% feed moisture. Interactions of amylose with As (pH differential method), total phenolic compounds (Folin-Ciocalteu method), total flavonoids, and antioxidant activity (DPPH, FRAP and ABTS) were investigated in the control flour sample (S1), substituted (w/w) with 10% HYLON VII starch (S2) at different extrusion process temperatures (150°, 120°, and 90°C). According to the extrusion results, the anthocyanin contents of S1 samples were 31.72, 55.15 and 60.04 mg Cy-3-glc equivalents/100 g extruded at temperatures 150°, 120° and 90°C, respectively, whereas for sample S2, the respective contents were 50.05, 38.53 and 54.89 mg Cy-3-glc equivalents/100 g. Non-extruded S1 had an As content of 64.93 mg Cy-3-glc equivalents/100 g. Determination of total phenolics content and antioxidant activity in extrudates revealed that both were higher in S2 at 90°C than S1 at the same temperature. Thus, the amylose appears to play a role of preserving As during extrusion heating.

Determination of gallic acid in model systems comprised of either gluten protein or corn starch

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The phenolic compounds in foods have been investigated by numerous different extraction and detection methods. However, there is a lack of correlation among these methods, and the extent of their detection of the compounds of interest in food systems might be limited. The objective of this study was to determine the chemical behavior of gallic acid (GA), a very common phenolic acid in food matrices, in controlled model food systems comprised of either gluten protein or corn starch [HYLON VII, 70% amylose (A1) or MELOJEL, 28% amylose (A2)]. One ml of GA solution at four different concentrations (0.3-1.0 mg/ml water) was added to each system (1 g protein or starch in 15 ml water). The heated (at 80°C) and unheated systems were investigated for their total phenolics (Folin-Ciocalteu method) and antioxidant activities (DPPH and ABTS radical scavenging activity methods). When 1.0 mg GA was added into the model systems, the highest GA concentration detected was in the heated protein system (0.45 mg GA/g protein), with GA concentrations in other systems ranging between 0.15 and 0.36 mg GA/g sample. The GA levels were lower in unheated systems except for the A1 system (0.29 mg GA/g sample for heated and 0.36 mg GA/g sample for unheated systems). The DPPH radical scavenging activity results revealed that antioxidant activity detected in heated and unheated protein systems and both heated starch systems were similar to TROLOX activity of GA solution in water (0.973 mg TROLOX/g sample), whereas it was much lower in unheated starch systems (0.584 and 0.217 mg TROLOX/g sample A1 and A2, respectively). Results indicated the existence of different types of binding of GA in protein or starch, in native or heated forms, and this would greatly influence the determination of GA or phenolics in processed foods.

Identification of polyphenolics from different morphological parts of sorghum by UPLC-PDA-MS/MS

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Cereal Foods World 57:A72

Sorghum grain contains polyphenolics which were reported to have antioxidant and anti-cancer properties *in vitro*. Some phenolic acids and flavonoids have been identified in sorghum leaves, sheaths and glumes but many polyphenolics remained unidentified. Stalks, leaves, sheaths, and glumes of three types of sorghum based on secondary plant color (tan, red and purple) were analyzed to identify their polyphenolic composition using UPLC-DAD-MS/MS. Flavone glycosides were predominant in all leaves. The 3-deoxyanthocyanidins were identified only in red and purple plant leaves. In addition to flavone glycosides, chlorogenic and feruloylquinic acids were predominant in tan plant leaves. The flavones luteolin and apigenin were the major compounds in tan plant glumes, while the 3-deoxyanthocyanidins were predominant in the red/purple plant glumes. Phenolic acids were predominant in tan and purple plant sheaths, while the 3-deoxanthocyanidins, which include apigeninidin dimer, were predominant in red plant sheaths. The purple plant sheaths had 3-deoxyanthocyanidins, but their proportions were lower compared to the red plant sheath. Chlorogenic acid, feruloylquinic acid, and apigenin glycoside were detected in all stalks but their levels were very low. These findings suggest that leaves, sheaths, and glumes are good potential sources of polyphenolics.

Deposition of extracted solubles on surface of cooked rice increases with amount of cooking water

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Rice grains cooked in boiling water result in the extraction and deposition of grain components on the cooked rice surface. Although the stickiness texture of cooked rice is mainly determined by the amylose content and by the ratio of water to rice to achieve the desired texture, boiling disrupts the cell wall, resulting in the release of stored starches, proteins, carbohydrates and cell wall fragments eluted into the water. These components are deposited on the rice surface when the cooking water is absorbed by the grain and affect the sensory characteristics of the rice surface. In this study, a method to determine the amount or thickness of the extracted components on the surface of the cooked rice was developed, and the effect of water to rice ratio on the amount of extracted and deposited materials was determined. One hundred and fifty (150) g of polished rice was cooked with 150, 225 and 300 ml distilled water (ratio of 1.0, 1.5 and 2.0 [w/w]), respectively, in a home rice cooker. The cooked grain were sectioned and observed by fluorescent microscopy to capture the transmission and fluorescence images. The transmission image showed the optical shadow of the section including the deposited layers, and the fluorescence image showed exact grain size and tissue disruption. The composite image of them can, therefore, visualize the thickness of the deposited layer. The layer thicknesses were approximately 0, 2, 7 μm after cooking in 150, 225 and 300 ml water, respectively. The new method can be used to show the amount of cooking water affects not only stickiness but surface characteristics of cooked rice.

WITHDRAWN

Gradual deletions of group-1 chromosome influence the dough strength in common wheat

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Large-scale group-1 chromosome deletion (CD) lines have gradual deletions in each chromosome arm. The seed storage protein composition and dough strength of CD lines were studied. The presence or absence of genes and protein bands corresponding to glutenin and gliadin was assessed by using locus-specific DNA markers, sodium dodecyl sulfate-polyacrylamide gel electrophoresis, and acid-polyacrylamide gel electrophoresis. The physical positions of several glutenin and gliadin genes were mapped in detail. To evaluate dough strength, we examined SDS sedimentation volume and protein content in each CD line. Dough strength was affected by the protein composition. Dough strength was significantly increased in CD lines involving the absence of chromosome arm 1AL, which carries the truncated glutenin gene *Glu-A1c*, although the protein composition did not change when the size of the deleted chromosome region was varied. In contrast, dough strength was significantly increased in CD lines involving the presence of chromosome arm 1DL, which carries *Glu-D1a* (the gene for glutenin subunits 2 and 12). We did not find any known seed storage protein loci in any of the other chromosomal regions that significantly affected dough strength.

Rheological properties of gluten-free bread dough systems

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Bread is the one of the oldest processed foods and a major wheat based product. The basic process involves mixing of ingredients until the flour is converted into dough, followed by baking the dough into a loaf. A very important step in breadmaking is to know how to make good quality dough. However, the increasing knowledge of people being diagnosed with celiac disease (gluten intolerance) has encouraged scientists to develop healthier and better quality gluten-free products that would greatly improve the quality of life of celiac patients. The main objective of this study was to create a dough system composed of mainly maize proteins that would be able to reproduce same rheological properties as wheat gluten in breadmaking. The dough composites were made of Zein + co-protein + starch and were mixed at 25 and 35°C. Three types of starches (corn, wheat, and rice) were used to better understand the interaction between starch and the proteins. Also, four different co-proteins (casein, sodium caseinate, gliadin and glutenin) were added to the system to determine the effect in zein functionality and its contribution to the viscoelastic dough system. All dough composites were tested using the oscillatory squeezing flow to determine its T_g. Zein + co-proteins showed lower T_g than zein by itself. Moreover, composites using wheat and rice starches showed lower T_g than those made of corn starch. Also, the extensional viscosity of each composite was determined using a Universal Texture analyzer through the lubricated squeezing flow method. The results agreed with the T_g measurements from the previous experiment showing that the protein-co-protein interactions significantly change the viscoelastic properties of the dough samples.

Measurement of protein hydrolysates by competitive ELISAs: Problems, solutions and limitations

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After several years we now understand that allergens will never be measurable in a defined way like other analytes, e.g., mycotoxins. By nature, allergens are nearly always a mixture of proteins with different mass fractions of each single protein. Sometimes these mixtures are used fractionated (whey proteins and caseins), changed during manufacturing (lactosylation of β-lactoglobulin) or fragmented by processing (beer, sourdough). This led us to the intuition that a standard reference material is not possible to obtain from a classical point of view as described in ISO standards. But without such a material, the starting point for every standardization effort is senseless, because results are not comparable. Until today, mainly all calibrators available for standardization of allergen test methods are based on intact protein mixtures (e.g., NIST 8445, whole egg powder). For the detection of fragmented proteins, new calibrators closely related to the real conditions in processed food are necessary. Intact 3D-structured proteins such as gliadin are not comparable with fragmented and therefore mainly unstructured peptides. The measurement of gliadin peptides using intact gliadin as calibrator must lead to incorrect results. Therefore, reproducibly fragmented calibrators should be used, such as enzymatically digested gliadin. The competitive ELISA format is mandatory to detect fragments missing linked epitopes which would be necessary for sandwich detection.

Collaborative gliadin studies: Intact and hydrolyzed gliadins were detected with low LOQs and good precision

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Gluten is a mixture of storage proteins from wheat, rye and barley causing celiac disease in predisposed persons. The only treatment is a lifelong gluten-free diet. The Codex Alimentarius (and national legislation, e.g., in the EU) defines gluten-free food as less than 20 mg gluten per kg food. To validate reliable test systems, a collaborative study of the RIDASCREEN® Gliadin (using R5 monoclonal antibody) was performed in 2000. On the basis of the results of this first study, the R5 sandwich ELISA method was endorsed as a type 1 method by the Codex Commission (2006) and the RIDASCREEN® Gliadin approved as AOAC Official Method of Analysis (2012). An additional collaborative study was started in 2011. In this second study, the RIDASCREEN® Gliadin was tested with three different matrices (bread, corn flour and snack; unprocessed and processed) by 16 labs. In contrast to the older AOAC Official Method of Analysis (999.19) based on the monoclonal Skerritt antibody ELISA, the RIDASCREEN® Gliadin showed a better limit of quantification (5 ppm) and higher precision (RSD(r) 8.5–13.9 %; RSD(R) 17.6–26.5 %). Gluten proteins can be degraded during food processing (e.g., brewing of beer), resulting in small peptide fragments which can still induce celiac disease but cannot be detected in sandwich ELISAs. In the second part of this study, the RIDASCREEN® Gliadin competitive was tested with three different matrices containing fragmented gluten (beer, starch syrup and sourdough) by 16 labs.

Effects of salt on the rheological properties and structure of the gluten network formed during mixing

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Salt (NaCl) plays an important technological role in the processing of wheat flour based foods. It is believed that the interaction of salt ions with gluten proteins governs the functional rheological properties of the gluten protein network formed during the mixing of flour with water, which in turn affects the dough strength and dough-handling properties. However, effects of salts on gluten protein network during mixing at the molecular level particularly as these relate to rheological properties are still not well understood. In this study, gluten samples were obtained by mixing and washing the dough from two different flours in the absence or presence of sodium chloride (2% flour base). Both rehydrated dry gluten and freshly prepared wet gluten samples were subjected to dynamic rheological, microscopic and disulfide bond analysis, as well as size exclusion HPLC. The results show that the inclusion of NaCl in the mixing and washing of a dough resulted in the formation of gluten network with similar G′ but higher G″ and tan delta values indicating that the resultant networks with salt were less elastic than without salt. Typical fibrous networks were observed for both rehydrated and fresh gluten. The gluten prepared with salt had a higher ratio of monomeric to polymeric proteins, compared to those without NaCl. Although the free SH content decreased when gluten was prepared with NaCl, its disulfide content was quite similar to that without NaCl. This indicates that salt does not affect the disulfide content during mixing but may affect other interactions, i.e., hydrogen bonding and hydrophobic interactions within the gluten network.

Analysis of *Glu-1* deletion lines reveals the importance of high molecular weight glutenin subunits 7+9 at *Glu-B1* in wheat flour tortilla making

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High molecular weight glutenin subunits (HMW-GS) play a significant role in the functional properties of wheat flour. Wheat lines in which one or more of the HMW-GS alleles were absent from *Glu-A1*, *Glu-B1* or *Glu-D1* loci (deletion lines) were compared with non-deletion lines for dough and tortilla making properties. Flours from 40 simple cross lines were evaluated for HMW-GS alleles, insoluble polymeric protein (IPP) content and

mixograph properties. Dough properties were determined using a texture analyzer. Tortillas were produced by the hot-press method and evaluated for physical properties and textural change during 16 days of storage. Flour from deletion lines had lower average IPP content (38.4%) than non-deletion lines (41.9%). Doughs derived from deletion lines were highly extensible (44.8 mm) and required lower equilibrium force from stress relaxation test (4.91 N) compared to non-deletion lines (34.2 mm, and 6.56 N, respectively). Deletion lines produced larger diameter tortillas (177 mm) than non-deletion lines (165 mm) and had lighter color (L* = 82.3) than tortillas from non-deletion lines (L* = 81.0). Flour IPP content (r = -0.57) and equilibrium force (r = -0.80) were negatively correlated with tortilla diameter but positively correlated with flexibility scores at 16 day of storage (r = 0.72, and r = 0.68, respectively). In general, deletion at *Glu-A1* or *Glu-D1* or presence of 2+12 instead of 5+10 allelic pair at *Glu-D1* locus produced large diameter tortillas, but with poor 16 day flexibility scores. However, combination of 7+9 allelic pair at *Glu-B1* locus with deletions at *Glu-A1* or *Glu-D1* or 2+12 at *Glu-D1* consistently produced tortillas that had large diameter and retained good flexibility scores during 16 days of storage. The results indicate the presence of 7+9 at *Glu-B1* locus may play a crucial role in selection of wheat varieties for tortilla making.

Compositional, physical, and wet-milling characteristics of blue corn (*Zea mays* L.)

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Fifteen blue corn genotypes originary from Mexico were evaluated for proximate composition, physical and wet-milling properties and were compared with a commercial yellow corn hybrid. Great ranges in their chemical compositions were observed: proteins (7.7-11.3%), lipids (4.4-6.1%), carbohydrates (81.6-85.6%) and ash content (1.2-1.8%) suggesting considerable variability among genotypes. Such compositional differences had an effect on physical properties of the grains that varied widely as shown in their thousand kernel weights (227.5-429.7 g), test weights (70.7-83.3 kg/hL) and kernel densities (1.0-1.28 g/cm^3). Kernel size showed variation for length (7.8-11.0 mm), width (8.5-11.6 mm) and thickness (4.3-5.1 mm). Anatomical components of the kernels were evaluated by hand dissection and ranged from 80.6 to 87.3% for endosperm, 5.3 to 12.3% for germ and 5.3 to 8.8% for pericarp. Great differences in kinetics for water absorption properties were also observed. Starch yields of blue corn genotypes varied from 54.9 to 68.6%, while the commercial yellow corn hybrid Pioneer used as a control showed 65.5%, suggesting that blue corn genotypes show great wet milling potential as a source of starch due to their good millability and starch extractability. Gluten yields ranged from 6.89 to 9.48%. Fractions of fiber, germ and steepwater solids were also evaluated. Wet-milling fractions correlated with the physical and chemical properties of the kernels. Total solids recovery showed a mean value of 99.2%, indicating good efficiency of the wet-milling process. Results suggest that blue corn genotypes present characteristics that make them suitable and exploitable at an industrial level in different approaches, and it also opens a new possibility of end use for this type of corn, which has never been investigated or exploited before.

Comparison of wet-milling properties of yellow, white, and blue corn genotypes

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In order to evaluate the impact of corn quality characteristics of corn in its wet-milling potential, four different genotypes of corn including two varieties (white and blue corn) and two commercial corn hybrids (white and yellow) were investigated. Chemical composition of the four genotypes showed great differences. Protein content of corn genotypes varied widely from 8.49% in yellow corn hybrid to 12.00% in the white corn variety, while fat content ranged from 4.59% (yellow corn hybrid) to 5.09% (blue corn). Physical characteristics also indicated considerable differences among genotypes with great ranges of thousand kernel weight (349.6-424.43 g), test weight (74.17-85.8 Kg/hL) and kernel density (1.14-1.28 g/cm^3). Total color difference (ΔE) ranged from 11.13 to 34.0 due to the diversity of grain colors evaluated. Starch yields ranged from 54.36% for the white corn variety to 68.30% in blue corn, while no significant difference was found between white and yellow corn hybrids (64.40 and 64.64%, respectively). Residual protein levels in the starches were low, with a mean value of 0.44%, indicating high quality of the produced starches and an adequate starch-protein separation; however, this characteristic varied among genotypes and reached 0.62% in the white corn variety, which also showed the highest grain protein content (12.00%) and gluten yield (9.27%) a value that was significantly different from the other genotypes for this fraction (7.67-8.00%). These results suggested that chemical and physical properties of corn genotypes affected wet-milling properties. Correlation analysis confirmed that wet-milling yields were affected by the differences on the physical and chemical characteristics of the genotypes evaluated.

Is amylopectin internal structure a predictor of starch thermal properties?

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Starch granule architecture contributes to the different properties of starches. Most studies have been on the impact of average chain length (CL) of starch polymers on its functional properties. However, when a starch granule is heated in the presence of moisture, it undergoes a glass transition in the amorphous parts prior to the onset temperature of gelatinization. Amylose participates in the amorphous structure together with the branched, internal structure of the amylopectin, the latter being organized into intensively branched building blocks contributing to granular architecture. It is hypothesized that any observed correlation between chain length and functional properties would have to explain the organization of chains in the amorphous background as well. The objective of this study was to examine whether differences in granular architecture explain the different properties of starches. Gelatinization, granular swelling and amylose leaching properties of 17 defatted starch samples, which were classified into 4 different groups based on amylopectin internal unit chain profile, have been investigated. Correlation between structural parameters such as DP and number of building blocks in clusters, interblock chain length and DP of external chains and gelatinization parameters were tested. Onset gelatinization temperature negatively correlated with number of building blocks ($r^2 = 0.88$) and positively correlated with inter-block chain length ($r^2 = 0.92$). Enthalpy of gelatinization positively correlated with inter-block chain length ($r^2 = 0.74$) and external chains. Starches from group 1 (e.g., oat, rye, barley, Andean yam) showed rapid granular swelling within a narrow temperature range, whereas group 2 (e.g., maize, rice, sago), group 3 (e.g., arrow root, mung bean) and yam starch in group 4 showed gradual swelling over a wide range of temperature or two stages of swelling. These findings revealed internal segments of amylopectin play a possible role in determining the functional properties of starch.

Effect of breakfast cereals with varying doses of oat fiber on appetite and satiety

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To compare the satiety impact of oatmeal with the leading ready to eat cereal in both *in vivo* human and *in vitro* gastrointestinal models, 48 healthy individuals, ≥18 years were enrolled in a randomized controlled crossover trial. The participants were given Quaker Oatmeal (QO) {6.7 g fiber or Honey Nut Cheerios (HN) {4.5 g fiber. Both breakfasts contained 355 kcals (250 kcals cereal and 105 kcals milk). Visual analogue scales of hunger and satiety were completed at baseline, 30, 60, 120, 180 and 240 minutes. Subjects repeated the breakfast test at least a week later. Responses were analyzed as area under the curve (AUC) and significant differences from baseline. In addition, the same breakfast conditions were tested using an *in vitro* gastric gelling model**.** The AUC for fullness ($p = 0.005$) and stomach fullness ($p = 0.0073$) was greater with QO than HN. Hunger ($p = 0.0009$), desire to eat ($p = 0.0002$), and prospective intake ($p = 0.0012$) decreased with QO as compared with HN. Small differences were observed in gastric swelling between the breakfast cereal products. The way of preparing the cereals may have affected this timing of gastric swelling. QO suppressed appetite and increased satiety when compared with HN. The content of oat fiber and the vehicle of delivery are important components affecting the satiety process.

Combined impact of amylases and surfactants on wheat starch pasting properties

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Both amylases and surfactants largely impact starch pasting and retrogradation behavior and therefore affect the quality of cereal based

products. However, their combined effect on product quality is poorly understood. In the present study, the Rapid Visco Analyser (RVA) was used to monitor the effect of *Bacillus stearothermophilus* maltogenic amylase (BStA, 100 ppm of Novamyl® on wheat starch dry matter [dm] basis) in combination with either sodium stearoyl lactylate (SSL) or monoacyl-glycerols (MAG) (both 1.0% on starch dm basis) on starch pasting properties. The impact of amylase or surfactant addition on pasting varied with the starch dm level (from 8 to 12%). Addition of BStA released ca. 36 µmole maltose/gdm, the effect being postponed when BStA and SSL were added together. This suggests that SSL partly hinders starch hydrolysis by BStA, which was in line with its effect on the swelling power and carbohydrate leaching. Surprisingly, no such effect was observed upon addition of MAG. Furthermore, when firmness of the cooled starch gels was measured after 2, 6 and 22 hrs, gels produced with addition of BStA had higher initial firmness (2.01 ± 0.08 N) than control gels (1.54 ± 0.06 N), while adding SSL (0.76 ± 0.05 N) or MAG (0.60 ± 0.02 N) yielded softer gels. Combined addition of BStA with either surfactant yielded softer gels, indicating that the effect of the latter predominated. Equal levels of surfactants did not change RVA pasting profiles of waxy maize starch, demonstrating that their effect was merely on amylose gelation. In conclusion, amylose gelation determines starch gel initial firmness. Adding BStA increases gel strength due to more efficient gelation, while surfactants decrease gel strength due to restricted starch swelling and/or subsequent amylose complexation. The latter effects limit the impact of BStA.

Effect of bread dough storage conditions on the properties of β-glucans extracted from bread under in vitro conditions

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Bioactivity of β-glucans is thought to depend upon their molecular weights (MW) and the consequent viscosity development in the gut. Our previous work showed that different levels of endogenous β-glucanase activity exist in wheat varieties and flours, and depolymerization of β-glucan occurs within a few minutes of mixing in bread dough. The current objective was to investigate effects of dough storage on the viscosity, solubility and final MW of β-glucan upon its incorporation in bread. Barley flour rich in high MW (1900 kDa) β-glucans was used to fortify bread dough (composite bread dough [50 % bran, 40% refined flour and 10% barley flour] and white bread dough [90% refined flour and 10 % barley flour]) and was baked immediately or stored for 8 days at -18 °C or 2 °C and then baked. β-Glucan was extracted using an in vitro protocol designed to approximate the human digestion system. Using hot water extraction, we observed reduction of β-glucan MW in all breads. The lowest level of depolymerization (~58 %) was seen in white bread from frozen dough and the highest depolymerization (~92 %) was seen in composite bread from refrigerated dough. *In vitro* extracts from white breads had higher viscosities (7.6, 4.8 and 7.9 mPa.s) versus composite breads (4.1, 4.0, 4.8 mPa.s) for fresh, refrigerated and freezer-stored dough, respectively. As β-glucan was preserved in higher molecular weights in white breads, lower solubilities (4.6, 6.3, 5.3 mg β-glucan/ml) were observed versus composite breads (10.4, 10.7, 6.9 mg β-glucan/ml) for fresh, refrigerated and freezer-stored dough, respectively. This data suggests that frozen storage of dough is an option for preserving high MW β-glucans.

Analysis of starch damage production in flour streams with the amperometric method

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Cereal Foods World 57:A75

The SDmatic (Amperometric method—AACC 76-33) can be used to measure starch damage production in the flow diagram. The objective of this study is to know where damaged starch mostly comes from in the flow diagram of a mill producing flour with excessive damaged starch. 33 flour streams are analyzed: 10 break flours, 8 middlings flours, 11 reduction flours, 3 flours of drying parts and the total flour. Damaged starch content increases as flour progresses in the milling process to reach a final strong value: 27 UCD (Chopin Dubois units) in the total flour. Starch damage provided by each stream is associated with its proportion in the total flour. Critical points of the milling process can then be targeted. Flours from 1st sizings, 1st middlings, 2nd middlings and 3rd middlings have high values: 23.1 to 30.4 UCD. They provide 67.5% of total damaged starch. Flour from 1st tailings has the highest damaged starch (32.8 UCD) but only represents 0.68% of the total flour. The data can precisely identify which roller mill needs to be adjusted to improve flour quality. Starch damage is a key parameter when studying the flow diagram. This study shows that the SDmatic is a perfect tool to analyze starch damage production during milling and predict the starch damaged content in total flour. With the SDmatic, it is now possible to control and adapt the industrial milling process.

Validation of shorter enrichment time for *Salmonella enterica* subsp. *enterica* in peanut butter samples followed by a rRNA detection system

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Food-borne pathogen *Salmonella* is commonly evaluated in manufacturing of peanut butter and other food products. For the HybriScan***D*** *Salmonella* Test the ISO based enrichment method is recommended. That means sample pre-enrichment for 18 hours at 37°C in buffered peptone water (BPW) followed by a selective enrichment step in Rappaport-Vassiliadis (RV) Broth for 24 hours at 41°C. HybriScan***D*** *Salmonella* is an rRNA sandwich hybridisation detection system which needs at least 500 cfu/ml for the assay. *Salmonella enterica* subsp. *enterica* (ATTC 13311) was detected by the use of HybriScan***D*** *Salmonella* Test. The matrix to be examined was peanut butter (9 different brand codes with 12 different code dates). The enrichment time described in the protocol of the HybriScan***D*** *Salmonella* Test takes 42 hours. In our experiment the enrichment time was decreased to 24 hours in total. The cultivation time of the pre-enrichment BPW culture took 18 hours; the incubation time of the selective enrichment culture in RV Broth was shortened to 6 hours. In addition, all samples and the negative controls were tested and verified for *Salmonella* according to EN ISO 6579:2002. One hundred and six of the 107 inoculated with *Salmonella enterica* peanut butter samples were identified as clearly contaminated with *Salmonella* by the use of HybriScan***D*** *Salmonella* assay. The result of 1 sample was considered questionable. All negative controls gave negative results in the HybriScan***D*** *Salmonella* assay. 1-5 CFU of *Salmonella* spp. in 25 g peanut butter can be positively identified by HybriScan***D*** *Salmonella* assay after 24 hours enrichment time. The test results have shown the possibility to shorten the enrichment time of pre- and main culture for the HybriScan***D*** *Salmonella* Test from 42 hours to a total of 24 hours for peanut butter as matrix to be examined.

The molecular organization of large and small granules from developing wheat starches

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Cereal Foods World 57:A75

The purpose of this research was to study large and small starch granules in wheat endosperm at different developmental stages, focussing on the molecular organization of starch granules. Small and large granule populations were fractionated from hard red spring wheat starches isolated from seeds harvested weekly between 14 and 49 days after anthesis and studied for their morphology, polymorphic structure, and relative crystallinity (RC) by using scanning electron microscopy and wide angle X-ray diffractometry. The structure was also studied by exposing the granules to iodine vapor. Small starch granules had spherical shape throughout the maturity, while large granules were elongated but increased in thickness during growth. While both populations demonstrated similar polymorphic structure at all maturities, large granules had a higher proportion of B-type crystallites and lower RC than their small granule counterparts. The color development and K/S spectral data of iodine exposed starches demonstrated mobility of starch polymers in the granules. The λ_{max} was 540–550 nm, suggesting that mostly short chain segments of DP 35–40 formed complexes with the iodine. Clearly more glucan polymers interacted with iodine in the large granule population than in their small granule counterparts. Iodine did not change the polymorphic structure of starch but increased RC, which suggested that amylopectin chains, possibly inter-cluster chain segments, form inclusion complexes with iodine, affecting the lamellar organization in the granules. The extent of iodine interaction was, however, different between the small and large granule populations and depended also on the stage of seed maturity.

Effect of immature yellow pea on chemical composition and amino acid content of pea flours

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Yellow peas (*Pisum sativum*) are commonly consumed after cooking both in the form of whole seeds and decorticated splits in various types of food, while constituent products of yellow peas, such as flour, protein, starch and fiber,

can be used in baked goods, baking mixes, soup mixes, processed meats, health foods, pastas and purees. There are many factors that affect quality of yellow peas. However, little information is available on how immature yellow peas caused by cool and wet growing conditions affect the quality characteristics. The present study investigated the effect of immature yellow peas on chemical composition and amino acid content of flours from yellow peas. Three yellow pea samples were used in this study. Mature and immature yellow peas in each sample were manually picked, dehulled and then ground into flours. Chemical composition and amino acid content of the pea flours were analysed according to published methods. Results indicated that flours from immature yellow peas contained significantly higher mean protein (280.0 and 254.3 g/kg DM, respectively) and ash content (32.5 and 29.9 g/kg DM, respectively) but lower mean starch content (477.6 and 500.5 g/kg DM, respectively) as compared to those from mature yellow peas. Sucrose content was significantly higher, whereas stachyose and verbascose contents were significantly lower in flours from immature yellow peas than from mature yellow peas. Results also demonstrated that immature yellow peas displayed a significant effect on certain amino acid content in yellow pea flours. Alanine, aspartic acid, glutamatic acid, isoleucine, leucine, lysine, phenylalanine, proline, threonine, tryptophan and valine contents were significantly lower in immature yellow pea flours than in mature yellow pea flours.

Response surface methodology for the optimization of polished germ-retained rice germination

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Cereal Foods World 57:A76

Polished germinated germ-retained rice is a new rice product rich in nutrition and healthy function compositions. The aim of this work was to optimize the germination parameters of polished germ-retained rice. The optimum process parameters, including soaking temperature, soaking time, germination temperature, germination time, environmental humidity, and soaking solutions, as well as the ultrasonic pregermination condition, were identified using single-factor experiments and response surface Box–Behnken design. The results showed that the optimal process for germination of the polished germ-retained rice was as follows: polished germ-retained rice was soaked for 17 hr at 25°C using 0.5% $CaCO_3$ solution, followed by accelerating germination for 10 min with a 500W ultrasonic generator, and then maintained at 25°C and 90% relative humidity to germinate for 21 hr. Under these conditions, the germination rate of polished germ-retained rice could reach 94.2%. This work is the first study for production of polished germinated germ-retained rice and will establish a foundation for the development and popularization of this new rice product.

Effect of flavonoids from corn silk on hemorheological changes in mice induced by high-fat diet

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Cereal Foods World 57:A76

To investigate the effect of flavonoids from corn silk (FCS) on blood hemorheological changes in hyperlipemia in mice induced by a high-fat diet, 50 Kunming mice were randomly divided into five groups: negative control group, model control group, and low-dose (100 mg/kg BW), medium-dose (200 mg/kg BW), and high-dose (400 mg/kg BW) groups of FCS. The latter four groups were fed with high-fat feed. FCS was given by gavage for 4 weeks. At the end of the experiment, hemorheological indices and antioxidant characteristics of serum and liver homogenates were investigated. The viscosities of blood and plasma, fibrinogen, erythrocyte sedimentation rate, and erythrocyte indices of aggregation and rigidity were found to be significantly reduced ($P < 0.05$), and the erythrocyte index of deformability was significantly increased ($P < 0.05$). FCS supplementation significantly increased the serum and liver SOD, GSH-Px level, total antioxidant capability, and hydroxyl radical scavenging capacity ($P < 0.05$) and reduced MDA production ($P < 0.05$). These results indicate that FCS can effectively improve the fluidity of the cell membrane by regulating blood rheological traits and provide enhancement of the oxidation-resistance abilities of serum and liver in high-fat-diet mice, and thus it shows its excellent anti-hyperlipidemia effects. Among them, the group at the 400 mg/kg BW dose showed a relatively good effect. This study was financially supported by the Foundation for Returned Overseas Chinese Scholars, State Education Ministry (39th), Hunan Provincial Natural Science Foundation (Grant No. 11JJ6025), and the Construct Program of the Key Discipline in Hunan Province, China.

Advances in quality property improvement and study of winter wheat in China

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Cereal Foods World 57:A76

Wheat, being a third grain crop in China, plays a significant role in the Agriculture and food industry. In China today, economic and social development have greatly affected the living standard of consumers due to industrialization and urbanization of the food industry, which has developed rapidly. In addition, the food industry requires specialization and large scale (variety and quality) production of food products with a high standard level. Studying and proffering a solution to this problem poses a challenge for the sustainable development of wheat production and the food industry. This paper has reviewed existing literature in order to analyze the history, research advantages and recent problems of wheat quality breeding in mainly wheat production zone in China. The requirements of wheat quality for sustainable development of wheat production chain and food industry have been discussed. The recommendations proposed in this paper will be useful for departments of wheat production, storage and food industry as well as agricultural scientists.

A measure of minimum technical competence to use in hiring

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Cereal Foods World 57:A76

The AACCI Scientific Advisory Panel and CSAW have raised concerns about future agricultural and food industry employees. Such employees would replace around 50% of the current workforce in government and industry set to retire in the next decade. A significant number of the new employees are needed to address engineering and processing aspects to ensure safe food. One measure that has value for employers in the hiring process is performance on the NCEES Fundamentals of Engineering examination (FEE). The FEE, taken by over 50,000 examinees per year, is intended to measure minimum technical competence of engineers who are entering their professional careers. During its most recent administration in April 2012, examinees self-identified as agricultural engineers, biological engineers and biomedical engineers taking the Other Disciplines module had pass levels of 90%, 77% and 85%, respectively. Examinees taking Chemical, Environmental and Mechanical modules had pass levels of 85%, 82% and 86%. Beyond assessing individual examinee competency, numerous U.S. and international engineering colleges and degree-granting programs are using exam results of their graduating students as a part of their ABET Criterion 3 Outcomes a-k self-assessment process. From a 2010 survey of more than 375 institutions, only 36% indicated that some or all programs require students to take (but not necessarily pass) the FEE to graduate, yet 81% indicated use of the FEE for ABET assessment by at least some programs. In conclusion, while a measure of technical competence exists for use by employers for assessing minimum technical competence of individual potential employees, a comparison of level of performance of students from a particular school compared to its peer group of students is not possible since not all graduating students take the FEE and not all programs report their results.

Use of glucose oxidase to improve refrigerated dough quality

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Refrigerated dough encompasses a wide range of products including bread, rolls, pastries and pizza crust and is a very popular choice for consumers. Two of the largest problems that occur during refrigerated dough storage are dough syruping and loss of dough strength. The goal of this study was to evaluate glucose oxidase as an additive to refrigerated dough with the purpose of maintaining dough strength and retarding dough syruping. Glucose oxidase has been used as an oxidant in bread baking systems to increase dough strength and elasticity. The refrigerated dough was evaluated for the degree of dough syruping by centrifugation, dough strength using microextensibility, rheological characteristics and baking quality. Degradation of protein was found to occur during storage of refrigerated dough. The degree of dough syruping has negative correlation (r = -0.6 to -0.94) to the level of polymeric proteins and a positive correlation (r = 0.6 to 0.98) to the low molecular weight proteins. The loaf volume had a positive correlation (r = 0.6 to 0.85) to polymeric proteins and a negative (r = -0.6 to -0.93) correlation to low molecular weight proteins.

The addition of glucose oxidase at 10 ppm was able to significantly ($P < 0.05$) reduce dough syruping and maintain the strength of the dough. Addition of glucose oxidase at 5 and 25 ppm was not able to reduce the level of dough syruping at a satisfactory level. Overall, glucose oxidase at low levels can improve refrigerated dough quality by reducing dough syruping and maintaining dough strength.

Regulation of obesity and lipid disorders by ethanolic extract from black rice in high-fat diet induced obese rats

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Cereal Foods World 57:A77

This study is designed to investigate the effect of black rice ethanolic extract (BRE) on obesity and lipid disorders induced by high-fat diet in rats. Eight male Sprague-Dawley rats were fed normal control diet (NC); the other 32 rats were fed a high-fat diet (HF) with or without different proportions of BRE (BRE-1, 3%; BRE-2, 5%; BRE-3, 10%) for 6 weeks to examine feed intake; body and adipose tissue weight; concentrations of serum total cholesterol (TC), triacylglycerol (TG), high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C), and leptin; hepatic TC and TG levels; and the pathological changes in liver and epididymal adipose tissues. The results showed that feed intake of all experimental groups had no significant differences. Body weight gain was significantly lowered in the BRE-1, BRE-2, and BRE-3 groups compared with the HF group, and the BRE-3 group reversed to the level of NC. BRE also improved the lipid profile in serum and the pathological changes in liver and adipose tissue. BRE improved lipid profile by lowering serum TC, TG, LDL-C, and leptin concentrations as compared with the HF group. The HDL-C concentration and the ratio of HDL-C/TC of BRE-1, BRE-2, and BRE-3 groups significantly increased compared with that of the HF group. Our findings suggest that BRE has significant antiobesity and decreasing lipid profile effects.

WITHDRAWN

Substrate preference of human colonic bacteroides strains on cereal arabinoxylans with distinct structures

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Cereal arabinoxylans (AX) have great structural heterogeneity. As the main AX-degrader in the human colon, bacterial strains belonging to *Bacteroides* genus are hypothesized to have specific responses to the structural heterogeneity of cereal AXs. In this study, 24 substrates, including 22 cereal AX structures and 2 monosaccharides (glucose and xylose), and 8 human colonic *Bacteroides* strains were used to test this hypothesis. Based on the varying growth profiles, 2 strains and 4 substrates were chosen to do a competition experiment in order to further understand the interactions between different strains in response to different substrates. The results showed that different strains had their own characteristic growth pattern on the 24 substrates, an indication of their substrate preference. For example, *B. cellulosilyticus* DSM 14838 grew well on all substrates, while *B. ovatus* 3-1-23 only grew well on monosaccharides and those AX samples determined to have simple structures. These were also the two strains chosen for the competition experiment. Three types of competition behavior could be observed between them, based on four substrates including xylose, wheat water-extracted AX, debranched sorghum AX and debranched hydrolyzed corn AX, respectively as representatives of a monosaccharide, and simple AXs and complex AXs. In conclusion, different human colonic *Bacteroides* strains have obvious preference to different substrates, in respect to their chemical structures. Specific *Bacteroides* strains, when grown together in the same environment, would be stimulated when given a particular AX substrate that favors their growth, while others may be competed out or significantly suppressed.

WITHDRAWN

Stability of sorghum based pigments to thermal degradations

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Sorghum varieties with black pericarp are good source of natural 3-deoxyanthocyanin pigments, which are known to be more stable than anthocyanins. However, the thermal stability and degradation pattern of 3-deoxyanthocyanins are unknown. Five 3-deoxyanthocyanidins (apigeninidin, 7-methoxy, 5-methoxy-, and 5,7-dimethoxy-apigeninidin, 5,7-dimethoxyluteolinidin) were evaluated for their stability to high temperature treatment. Samples (5.94-6.84 mM) in aqueous pH 2.0 and 7.0 solution were heated to 121 °C for 30 minutes under pressure (113.4 kPa) using an autoclave. The color intensity of each compound before and after heat treatment was determined by UV-Vis spectrometry and the compositional changes were evaluated by UPLC-ESI-MS. Heat treatment generally decreased the color intensity of 3-deoxyanthocyanidins; the effect depended on structure and pH. The pigments were generally more stable at neutral pH (loss of absorbance at λ_{max} 3-29%) than at pH 2.0 (loss of absorbance at λ_{max} 23-70%). O-Methyl substitution (-OCH3) at C-5 position decreased pigment stability at pH 2.0 (58-70% loss of absorbance) compared to hydroxyl (-OH) substitution (23-39% loss). The degradation pattern of these compounds revealed that –OCH3 group at C-5 position was susceptible to thermal induced hydrolysis to respective –OH substituted compounds (loss of 14 amu); -OCH3 group at C-7 was not hydrolyzed. Additionally, thermal induced condensation of the 5-OH substituted monomers to their respective dimers was observed; 5-OCH3 monomers did not dimerize. The results indicate that the structure of 3-deoxyanthocyanidin pigments has a major influence on their behavior when subjected to high heat treatment. The 3-deoxyanthocyanidins are relatively stable to extreme heat treatment, particularly at neutral pH, and could find use in various food applications.

Ability of specific dietary fibers to normalize the gut microbiota in obese states

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Obesity has become a primary public health concern. Aberrant gut microbiota have been associated with obesity and other metabolic diseases. Dietary fibers are an important promoter of differences in gut bacterial diversity. Few studies have assessed the impact of specific dietary fibers on gut microbial communities. Little is known about the microbial ecology of dietary fiber. The objective was to assess the impact of dietary fibers on different gut microbiota community using pyrosequencing. Six dietary fibers (pectin, guar gum, inulin, arabinoxylan, β-glucan, and resistant starch-2 [RS-2]) were subject to in vitro digestion and fermentation using fecal samples from obese and normal weight individuals. Short chain fatty acid as well as carbohydrate utilization was also correlated with all the bacterial taxa. RS-2 caused the most dynamic change of the whole microbiota community. Bifidobacterium increased almost 10 fold on pectin substrate compared with the control. Ruminococcus was significantly higher on all substrates except RS-2 and pectin. Interestingly, Bacteroides exhibited positive correlation with the amount of propionate ($r = 0.52$, $p < 0.01$), while Ruminococcaceae and Faecalibacterium displayed a robust positive correlation with the butyrate production ($r = 0.39, 0.54$, $p < 0.01$). A negative correlation was detected between inulin utilization and Subdoligranulum ($r = -0.74$, $p = 0.004$), while a strong positive relationship was shown between β-glucan utilization and Firmicutes ($r = 0.73$, $p = 0.0019$). Furthermore, the obese and normal weight microbiota responded in different fashions within the dietary fiber, except no significant difference on RS-2 substrate. These data may help deepen our understanding of manipulating gut microbiota using diet.

Polysaccharide composition of triticale produced in the Great Plains of the USA

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Cereal Foods World 57:A78

Triticale, a cross between durum wheat and rye, is mostly used for animal feed. Its relatively low agronomic requirements make it an attractive grain for producers; however, the limited market for triticale can discourage many farmers from planting triticale. Characterizing the polysaccharide fractions in triticale may help to expand the triticale market to food or fuel applications. Nineteen experimental lines of winter triticale were produced on plots owned by the University of Nebraska in Lincoln, NE, U.S.A., in 2011. Lines were analyzed for total starch, β-glucan, and arabinoxylan. Total starch ranged from 49.8-58.4% (dry basis, db); lines NE03T416, NT07403, NT08425, and NT09423 contained the most starch. β-Glucan ranged from 0.525-0.880% (db); lines NT01451 and NT06427 contained the most β-glucan. Total arabinoxylan ranged from 3.19-6.47% (db); lines NT08414 and NT08425 contained the most arabinoxylan. Water extractable arabinoxylan ranged from 0.501-1.29% (db); lines NT01451 and NT08425 contained the most water extractable arabinoxylan. NT08425, along with NT05429, contained water extractable arabinoxylan with the highest degree of branching (arabinose:xylose ratios of 1.28 and 1.32, respectively; range: 0.778-1.32). These data may be helpful in identifying candidate triticale lines for functional food or fuel applications.

***In vitro* fermentation of selected whole grains using fecal microbiota from obese and normal weight individuals**

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Aberrations in gut microbiota have been associated with obesity and other metabolic diseases. One way that gut bacteria may influence metabolism is through their metabolites (mainly short chain fatty acids [SCFA]), which are absorbed and can influence hormones involved in energy absorption, utilization, and storage. Given that obese individuals generally consume less whole grains than normal weight individuals, whole grains may improve the metabolic function of the aberrant microbiota in obese individuals and thus improve health. Five whole grains (wheat, rye, corn, rice, and oats) were subject to *in vitro* digestion and fermentation using fecal samples from eight obese and seven normal weight people by leaving fecal samples separate and by combining all fecal samples from each group to make composite normal weight and obese microbiota. When fecal samples were kept separate, large differences were observed in SCFA and gas production among individuals, even within group. When fecal samples from each group were combined, from 0-6 h, bacteria in normal composite microbiota (NCM) produced more SCFA than the obese composite microbiota (OCM) (10.95 ± 1.82 vs. 0.83 ± 0.13 μmol/h/100 mg carbohydrate, respectively, $p < 0.0001$); whereas during 12-24 h, the OCM produced more SCFA than the NCM (12.15 ± 3.19 vs. 7.74 ± 1.41 μmol/h/100 mg carbohydrate, respectively, $p < 0.035$). Butyrate production from the NCM was significantly higher than from the OCM. Propionate production from OCM was significantly higher than NCM after supplying with whole grain substrates. These data suggest that OCM are less efficient at butyrate production, an important metabolite that influences human metabolic processes, and that OCM are less metabolically active than those from a normal weight individual, but that given sufficient whole grain substrates the bacteria can quickly become metabolically active.

Response surface optimization of extraction parameters of DPPH free radical scavenging components from cherry seed

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To optimize the extraction parameters of antioxidant components from cherry seed, the DPPH free radical scavenging assay was used to determine antioxidant activity, and the effects of three independent variables (ethanol concentration, extraction temperature, and extraction time) on the DPPH free radical scavenging activity of the extract were evaluated. The optimal extraction parameters for antioxidant components extraction were determined by Box–Behnken design and response surface methodology (RSM). The experimental results showed that the optimal extraction processing parameters were as follows: liquid/material ratio (mL/g), 20:1; ethanol concentration, 33% (v/v); extraction temperature, 60°C; and extraction time, 31 min. Under these optimal extraction conditions, the DPPH free radical scavenging activity of the extract from cherry seed was up to 92.58%, which was close to the predicted value. This indicated good feasibility of RSM in the optimization of extraction parameters of antioxidant components from cherry seed.

Effect of hemicellulase on physical properties of whole wheat flour cake formulations

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Hemicellulases may increase the machinability of dough, providing a homogeneous and soft texture as well as high volume in bread production. However, there is limited information on its use in cake formulations. The aim of this study was to investigate the effect of hemicellulase on rheological and textural properties as well as volume of cake formulations prepared with 3 types of wheat flour. In the study, strong white (SW), weak white (WW), whole wheat (WH) flour samples and their mixtures at certain ratios were used. Quality attributes including moisture, ash, protein, wet gluten, gluten index, and falling number were analyzed for all flour samples. Hemicellulase was added at three different concentrations (0, 25 and 50 ppm) to each flour type, and its effect on rheological properties of the dough was investigated by using Extensograph (EX) and Farinograph (FA). Cake dough was prepared by mixing sugar with egg and incorporation of previously mixed liquid ingredients (milk and oil) and dry ingredients (flour mix, vanilla, baking powder and hemicellulase) and then all ingredients were mixed and whipped. Cake doughs were baked for 60 minutes at 175°C oven temperature and then cakes were analyzed for volume and specific volume. Cakes were stored in plastic packages for 1 day and hardness, adhesiveness, cohesiveness, gumminess and chewiness characteristics were analyzed with texture profile analyzer. Results were analyzed statistically using SPSS 13.0 programme. The results indicated that hemicellulase addition (50 ppm) slightly increased the EX energy value, FA water absorption and stability values, but resulted with a decrease in FA softening degree. Addition of high level of hemicellulase increased the volumes of SW, WW and WH flour cakes by 9%, 3%, 8%, respectively, while low enzyme level decreased cake volumes made with weak white flour, but higher levels of enzyme did not affect this value. Hemicellulase showed a positive effect by decreasing the hardness values by 15% in SW flour cakes, whereas there was no significant difference in the formulations prepared with other flours. After storing the samples for 7 days, the lowest staling values were obtained for the cake formulation prepared by 50% WW and 50% WH flours and 25 ppm hemicellulase.

A better use of the old technique—Sample preparation for mycotoxin analysis using SPE

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Mycotoxins are toxic secondary metabolites produced by fungi, which can exist in food as a result of fungal infection of crops. Because of their strong

resistance to decomposition and digestion, mycotoxins tend to remain in the food chain in meat and dairy products. Their effects on human and animal health include death, cancer, weakened immune systems and as allergens or irritants. Therefore, most countries in the world have set limits for food-based mycotoxins permitted in food and animal feed. The analysis of mycotoxins in food and animal feed has been a challenge mainly due to the complexity of food matrices and desired low detection limits. Immunoaffinity SPE cartridges exist that have high selectivity for mycotoxins, but they are expensive and the procedure involves multiple steps during the cleanup. In this study, we investigate a line of new materials that are specially designed for sample preparation of mycotoxins including aflatoxins, trichothecenes, DON, ochratoxin and fumonisin in complex food matrices, such as grains and grain products. The materials are packed in standard SPE cartridges, which are stable and rugged under common laboratory conditions. The proposed methods require only a single step cleanup. Typically a sample extract, such as from cornmeal, is passed through the SPE cartridges. The effluent is collected and concentrated that is ready for chromatography analysis. The recoveries of the toxins from the matrices, such as peanut butter, cornmeal and wheat, are that aflatoxins including B1, B2, G1 and G2 are greater than 86%; trichothecenes including DON, NIV, FX, 3AC and 15AC greater than 75%; ochratoxin quantitative recovery and fumonisin including B1 and B2 greater than 81%. The reproducibility of the analysis (RSD) is typically less than 10%.

Preparation and characterization of aqueous CoQ_{10}-starch dispersions: Effect of preparative conditions on dispersion stability and yield

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Coenzyme Q_{10} (CoQ_{10}) is a fat-soluble vitamin-like substance that has an antioxidant effect and can act as a free radical scavenger in human body. However, due to the molecule's long side chain of 10 isoprenoid units, CoQ_{10} is extremely lipophilic and insoluble in water. In this study, the physical conditions were optimized to increase the dispersability of CoQ_{10} in water by using starch. The CoQ_{10}-starch dispersion was prepared in stirring in a water-bath by vigorous stirring at various reaction temperature (60, 80, 100°C) and reaction time (1, 3, 6 hrs), followed by a slow cooling process. To remove the CoQ_{10} agglomerates on the surface and starch precipitates during storage, a centrifugation (5,000 x g, 30 min) combined with a filtration (glass filter, pore size : 40~50 μm) was performed. The amounts of CoQ_{10} that was stably dispersed in the supernatant became greater at higher temperature, and longer reaction time with higher yield of CoQ_{10} (57.3 %), determined by UV-HPLC (275 nm). Dynamic light scattering data showed that the CoQ_{10} of nanoscale range (< 200 nm) markedly increased through sonication treatment (83.8 %) with the dispersion. Both the sonicated and unsonicated dispersions remained stable during a storage at room temperature for 2 weeks. Using starch, the CoQ_{10} can be well dispersed and more adaptable in aqueous media.

Improvement of the food safety of partially germinated grains

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Germination of grains has been proven to improve the nutritional, functional and sensory properties of different types of grains, both cereals, pulses and other grains. Unfortunately, the conditions—temperature, humidity and duration—of the germination process are also the optimal conditions for microorganism growth. This fact can cause issues for the food safety of the process itself and of the final products. A study has been done on the growth of different types of microorganisms, i.e., Aerobic germs, Enterobacteriaceae, Coliforms, *E. coli*, presumed *Bacillus cereus*, Yeasts and Molds during the different steps of the germination process: soaking the raw material in water, drain the water and let the grain germinate (or partially germinate) and including a final step of product stabilization with hot air drying. The assessment allows mapping of the food safety of the whole process and detecting the potential for improvement. On the basis of this assessment, different inactivation techniques have been tested, and their effect on the food safety of the final partially germinated dried grains has been studied. The different inactivation techniques, i.e., physical, chemical and biological have been applied in different points of the germination process, and the comparison allows selection of the best technique to reach the desired quality in terms of food safety of the partially germinated products, i.e., application in malting, bakery, other food products and feed.

The relationship between noodle color and kernel quality property of wheat

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White salted noodles, prepared from a simple mixture of flour, water and salt, are especially popular in Japan, South Korea and China. The noodles are manufactured in many forms including fresh, dried, boiled, and steamed and dried. Newer types include frozen and long-life noodles. Color of noodles is the key quality factor affecting the price and sensory quality of noodles. High quality noodles should be bright in color. In order to select the wheat kernel quality properties related with noodle color, wheat cultivars, which were collected from 2009-2010 harvest produced in Guanzhong area of Shaanxi province and Northern area of Henan province, were used as test materials. The characters of noodle color at 0 and 24 hr, the correlation of noodle color with wheat kernel quality property were investigated. The results showed that the fresh noodle L^* values were significantly decreased ($p < 0.05$), a^* and b^* values were significantly increased ($p < 0.05$) after being preserved for 24 hr in a constant temperature (25°C). There was a significantly positive correlation in L^*, a^* and b^* values of noodle color between 0 and 24 hr ($p < 0.01$). The final noodle color could be predicted by fresh noodle color. 57.5% of the variations in noodle color L^* values at 0 hr could be attributed to test weight, protein content, wet gluten content, flour color L^* values and softening degree. 19.8% of the variations in noodle color a^* values at 0 hr could be attributed to kernel color a^* values and flour color a^* values. 51.1% of the variations in noodle color b^* values at 0 hr could be attributed to flour color b^* values and resistance. Flour color, protein content and wet gluten content were the main influential indexes of noodle color.

Effects of insoluble solids content on evaporator fouling during thin stillage concentration

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We investigated effects of total solids content (TS), thin stillage bulk temperature (T_b) and Reynolds number (Re) on heat transfer fouling tendencies of model thin stillage. In ethanol processing, unfermented solids are removed from ethanol during dry grind processing, which can cause fouling. Fouling of evaporator surfaces causes increased energy consumption and reduces plant productivity. A limited number of fouling studies have been done for maize processing, and many variables affecting fouling behavior are not understood well. Limited research has shown that with increasing dry solids concentration, fouling rates will increase. Thin stillage flowing at Re = 440 had greater fouling rates and shorter induction periods than Re = 880. However, relationships among TS, T_b, and Re have not been quantified. In this study, using an annular fouling apparatus, 12 batches of thin stillage with varying TS (5 to 10%), T_b (40 to 60 °C) and Re (100 to 1000) were analyzed to determine fouling rates and induction periods. Model thin stillage was compared to commercial thin stillage.

Formulating with fiber: Considerations from an analytical perspective

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A number of considerations are needed when formulating foods and supplements with dietary fiber. One must not only consider the regulatory and marketing needs of a product, but the analytical testing procedures as well. In recent years, a number of fiber ingredients have been manufactured or isolated that can be added to increase the health benefits of a product and increase fiber content. Some of these can be used as prebiotics, and as replacements for sugars, starch, or fat. Choosing the correct ingredient for the food application is critical, as is understanding the analytical methodology involved with testing. The term "fiber" does not relate to a single analyte or entity, but instead comprises a multitude of components. This adds to the complexity of analytical testing. Currently, there are a number of AOAC and AACC official methods which have been validated and can be used. While methods have been developed for specific fiber ingredients, a number of methods have also been developed to capture just "fiber". The net result is that a variety of testing approaches may be used, but caution must be exercised in order to assure that the total fiber result is accurately determined. The correct method must be chosen to not only fully capture the fiber ingredients, but also to conform to the labeling regulations within the country of sale. A number of topics will be addressed including: 1) Results from the analysis of common food ingredients using AACC 32-

50.01 (AOAC 2011.25), 2) Fiber labeling regulations of the U.S., Canada, and other countries, 3) How to select the fiber source for your application, and what questions need to be asked of the supplier/manufacturer, 4) How to determine the most efficient analysis approach for your product, and 5) What to do when your analytical results do not agree with theoretical inputs.