ABSTRACTS

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2013 Annual Meeting
Abstracts of Symposia or Science Café Presentations

Abstracts submitted for presentation at the 2013 annual meeting in Albuquerque, New Mexico, September 29–October 2, 2013. 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: Wood, D. F., Miller, S. S., Williams, T. G., Glenn, G. M., and Orts, W. J. 2013. Structure and location of macronutrients in ancient and alternative crops. (Abstr.) Cereal Foods World 58:A1. http://dx.doi.org/10.1094/CFW-58-4-A

Ancient and Alternative Grains: Nutritional and Functional Benefits for Product Development

Structure and location of macronutrients in ancient and alternative crops
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Cereal Foods World 58:A1

Structure, histochemistry and composition of mature seeds of several ancient or alternative crops were studied by light and electron microscopies to localize specific macronutrients including protein, starch, non-starch carbohydrates and lipid. Botanically, these seeds fall into different classifications, some of them are cereals (channel millet, eel grass, perennial grains), others are pseudo-cereals (amaranth, quinoa, buckwheat) which are typically dicotyledonous plants that are consumed like a cereal and yet others (desert ironwood, mesquite, Illinois bundle flower) are legumes. Many ancient crops have small seeds due to limited selective breeding. The benefit of a small seed is that all of the essential enzymes and nutrients necessary for plant growth are packaged into a small space. Thus, the seeds are more nutrient-dense and contain densely-packed proteins and lipids with little corresponding starch compared to their commercial, large-seeded counterparts. The nutrient dense and starch-poor seeds make ancient seeds excellent choices for human health. Another benefit of these ancient crops is that some of them are tolerant to agronomic conditions which are less than optimal for the cultivation of commercial crops. Here, we note the distribution and relative proportions of macronutrients in various seeds that, together, we term alternative or ancient crops.

Fiber and nutrient profiles of ancient grains and their effect on health
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Cereal Foods World 58:A1

Ancient grains occupy an honored place in consumers' minds. These staples are viewed with nostalgia and are associated with health benefits ascribed to traditional diets, ethnic foods, and ancient peoples. However, in many cases the health benefits of these grains have not been documented by formal study. This talk will evaluate nutritional values of various ancient grains including wheat parents - spelt, emmer, einkorn, and kamut; amaranth; barley; canary seed; freekah; millet; teff; salba; sorghum; and quinoa. Their contribution to intake of fiber and nutrients and phytonutrients traditionally found in Western diets through consumption of traditionally consumed grains (rice, wheat, corn, rye and oats) will be compared. Any possible antinutritional factors associated with these grains will also be addressed. Claims of superiority of these grains in terms of aspects such as lower gluten toxicity or allergenicity, improved glycemic response or disease prevention or reduction will be assessed through an analysis of existing data. Places where data are insufficient will also be noted.

Janus and Argus: Multiple and opposite aspects of non-gluten proteins in ancient grains
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Cereal Foods World 58:A1

Many ancient grains such as sorghum, teff, and amaranth are main staples for the world's poorest and most insecure people, especially in the arid and marginal areas of the semi-tropics. However, they are gaining popularity because of their potential health benefits. All these crops are gluten-free cereals, and their nutritional properties are of interest to the food industry and the consumer. The major protein fraction in these grains are globulins, and therefore, the production of a protein network such as the one formed by gluten proteins in wheat-based products is strongly impaired when using untreated flour as the only (or predominant) component of dough. Thus, physical or biotechnological pre-treatment of grains/flours are required in order to modify in a suitable way the properties of macromolecular components (starch and proteins) relevant to the structure of the final product. The main focus of this presentation will be on understanding the various structural modification that proteins in the individual grains undergo in relationship to different types of the (bio)technological treatments used or proposed for their transformation. Peculiar aspects of the issues discussed here involve also the interaction among proteins, and between proteins and other components of the systems at various stages in the different processes. The effects of the loss/gain of these interactions as due to biotechnological processes is very grain-specific, and often has important consequences in terms of the ability of the processed materials to undergo a given transformation and in terms of the nutritional properties of the final product(s). Some of these issues will be addressed with reference to both "traditional" foods and to "innovative" ones that could be of interest also outside those countries where these grains are traditionally used.

Einkorn: A potential candidate for developing high-lutein wheat
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Cereal Foods World 58:A1

Lutein is the dominant carotenoid pigment in wheat but its content varies significantly among wheat species. Einkorn (ancient diploid wheat) has the highest lutein concentration followed by durum (pasta wheat) and Kamut (durum relative) with an intermediate level, whereas bread wheat and spelt

(bread wheat ancestor) exhibit the lowest. A body of evidence has shown the importance of lutein and zeaxanthin (lutein isomer) in human health and nutrition in particular the health of eyes. Lutein and zeaxanthin have also been linked with reduced risk of age-related macular degeneration and cataract. Our research has identified einkorn as a functional food ingredient and was employed as the basic flour with or without lutein fortification in the development of three high-lutein wholegrain bakery products, bread, cookie and muffin. The lutein-fortified wholegrain bread, cookie and muffin contain amount of lutein at 1.26, 1.15 and 1.21 mg per serving of 30g compared with 0.16, 0.10 and 0.10 mg per serving in the unfortified ones, respectively. Further we investigated stability of lutein and changes in bound and unbound phenolic acids (the main natural antioxidants in wheat) during baking process. We also studied bioaccessibility and bioavailability of lutein in bread, cookie and muffin as well as their antioxidant properties. The results showed that the products should be considered good sources of lutein and phenolic antioxidants, and would boost the daily intake of lutein and consumption of wholegrain foods. This presentation will highlight the key steps in the development of high-lutein wholegrain bakery products made from einkorn.

An obliging ancient grain: Sorghum
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Cereal Foods World 58:A2

Obesity and diabetes are among the most important medical problems in America today. Readily digestible carbohydrates lead to rapidly elevated blood glucose levels and insulin secretion, both of which contribute to the health complications caused by diabetes. Glycemic index (GI) ranks carbohydrate-containing foods on how quickly and how much they elevate blood sugar levels. Foods can be classified as having a low (<55), intermediate (55-70), or high GI (>70). Foods with a low GI and higher resistant starch (RS) help slow absorption of carbohydrates and prevent extreme blood glucose fluctuations. Sorghum [Sorghum bicolor (L.) Moench] is an ancient, drought resistant cereal grain grown around the world. In the U.S., sorghum ranks third between wheat and maize in production. Sorghum, a good source of dietary fiber and phenolics, is an important food staple for people in many parts of world. Phenolic compounds are well-known to complex with proteins and carbohydrates; generating insoluble compounds which are resistant to digestive enzymes. Specialty sorghum varieties contain various types of phenolic molecules, including condensed tannins (polymers of flavan-3-ols) and anthocyanins (luteolinidin and apigeninidin). Specialty sorghum varieties are relatively inexpensive sources of phenolic compounds, and because of their storage stability, drought tolerance, high grain yield, and high phenolic compounds, tannin and black sorghum varieties could be used to prepare functional foods that offer potential health benefits. This presentation will cover the effect of phenolic compounds of sorghum on starch digestibility of porridges which are popular staple food in some parts of the world. These compounds were studied as in sorghum bran matrix and extracted from their bran.

Antioxidants in Grains and Health: Is There a Linkage?

WITHDRAWN

In vitro antioxidant assays: Are they relevant?
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Cereal Foods World 58:A2

A large number of assays has been developed to evaluate activity of dietary antioxidants *in vitro* and these assays have been critically commented on multiple times by experts in the field. From these reviews it becomes apparent that there is a lack of correlation between the radical (or oxidant) scavenging activity measured by these "one dimensional" chemical assays and their performance *in vivo* or in food systems. As a result, the validity of these assays has been debated . In this talk, an overview is given on lipid peroxidation chemistry. Subsequently, a brief summary of existing antioxidant evaluation methods, their mechanisms, and scopes and limitations in the context of their correlation with biological and food lipid systems. Detailed accounts are also given on the recent fluorescent methods to evaluate radical scavenging capacity of antioxidant against specific radicals such as nitrogen dioxide.

Bioavailability and metabolism of grain antioxidants
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Cereal Foods World 58:A2

Hundreds of molecules with a polyphenolic structure have been identified in edible plants. Ferulic acid is the most abundant form of phenolic acid in cereal grains and may represent up to 90% of total polyphenols in wheat. Avenanthramides are unique polyphenols found only in oats, whereas wheat and rye are rich in alkylresorcinols. Once consumed, the various polyphenolic compounds share common metabolic pathways. Most polyphenols are present as esters, glycosides, or polymers and are esterified and bound to polysaccharides in cell walls. They must be hydrolyzed prior to absorption. Such hydrolysis occurs in the small intestine by esterases or xylanases or in the colon by microflora. After absorption, polyphenols are conjugated by methylation, sulfation, or glucuronidation in either the small intestine or liver. Conjugation is quite efficient, and most of the polyphenols in plasma are conjugated after ingestion. After they enter the plasma, polyphenols are bound to plasma proteins, primarily albumin, for transportation, delivery to cells, and elimination by biliary or urinary pathways. Ferulic acid and avenanthramides have similar values of time to reach peak concentration (T_{max}) and elimination half-life ($T_{1/2}$). Avenanthramides have higher maximum plasma concentration (C_{max}) compared with ferulic acid, even when intake is lower. The C_{max} values of alkylresorcinols are much higher compared with either ferulic acid or avenanthramides, and their rates of elimination are slower. Avenanthramides have higher antioxidant activities compared with ferulic acid by the oxygen radical absorbance capacity assay. The health benefits of polyphenols depend not only on the function of each compound but also on the amount consumed, their metabolism, bioavailability to different tissues, and the functions of their metabolites in the human body.

Diet antioxidant capacity: Relationship to oxidative stress and health
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Cereal Foods World 58:A2

Oxidative stress has been implicated in the etiology of many chronic and degenerative diseases, and in the aging process suggesting that antioxidants, both endogenously and exogenously, are necessary to protect cellular components from oxidative damage. Recent research studies have demonstrated that increased dietary intake of total antioxidant capacity is associated with reduced risk for ischemic stroke, hypertension, gastric cancer, endometrial cancer, and improved pulmonary function. Furthermore, consumption of antioxidant rich foods can reverse the postprandial oxidative stress resulting from consumption of an antioxidant free meal. Thus, consumption of dietary antioxidants is important with each meal. Sufficient research data to establish definite reference dietary intakes (RDI), as has been done for vitamins A, C, and E, is not possible for total dietary antioxidants

(measured by Oxygen Radical Absorption Capacity (ORAC) or any other antioxidant capacity assay). However, some recommendations can be made based upon recent epidemiological studies and studies of absorption of antioxidant phytochemicals and their effects on *in vivo* antioxidant status and their ability to prevent postprandial oxidative stress. ORAC intakes of at least 12,000 units (1 unit=1 micromole Trolox Equivalent)) or more may provide reduced risk for the diseases studied and intakes of less than ~7000 units of ORAC per day may lead to increased risk for some diseases. These recommendations are in line with a daily consumption of 7 to 10 servings of fruits/vegetables/grains with some of those foods containing higher amounts of ORAC. Because of differences in the ability of different phytochemicals to quench free radicals, consumption of a mixture of high antioxidant foods would be prudent to provide for this variability.

Food regulations regarding antioxidants and health

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Cereal Foods World 58:A3

Dietary antioxidant is a substance in foods that significantly decreases the adverse effects of reactive oxygen and nitrogen species, on normal physiological function in humans. Antioxidants are found in many foods, including grains, nuts, fruits and vegetables, and some meats, poultry and fish. Examples of dietary antioxidants include beta-carotene, lutein, lycopene, selenium , vitamin A, vitamin C, and vitamin E. Additionally, phytochemicals are compounds essential to plant life, like polyphenols, many of which have high antioxidant activity. This presentation will provide an overview of existing food regulations, in North American and Europe, around antioxidant messages and claims. For instance in the U.S., FDA regulates claims concerning antioxidants. These claims can fall into any of three claim categories—nutrient content, claims, structure/function claims or health claims. Another, more specific category of claims is a dietary guidance claim. FDA regulations permit use of the term "antioxidant" in nutrient content claims for conventional foods and dietary supplements. However, they are limited to nutrients that have an established Reference Daily Intake (RDI) and scientifically recognized antioxidant activity, such as , vitamin A, vitamin C, and vitamin E. Unlike nutrients with established RDI, certain phytochemicals are restricted from making nutrient content claims since they do have established RDI's. This presentation will highlight the challenges and opportunities for grain antioxidant messages and claims.

Best Student Research Paper Competition

Studies on the degradation of gluten with peptidases from different sources

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Cereal Foods World 58:A3

Gluten-free foods produced from celiac-safe raw materials often show poor textural and sensory quality as compared to their gluten-containing counterparts. In gluten-containing raw materials without need of the techno-functionality of native gluten an alternative approach is to eliminate gluten and to use the processed products as ingredients in gluten-free recipes. A maximum gluten concentration of 20 mg/kg has to be present after processing. Different peptidases capable of degrading gluten are available. So-called prolyl endopeptidases with the ability to cleave peptide bonds next to proline residues can be found in bacteria, fungi, and in germinated cereals. The aim of the present study was to compare the potential of peptidases from germinated cereals and a peptidase from *Aspergillus niger* (AN-PEP), to degrade gluten in raw materials. The gluten-specific peptidase activity of the peptidases was determined by using gliadin as a protein-based substrate as well as the two celiac-toxic peptides PQPQLPYPQPQLPY (α-gliadin) and SQQQFPQPQQPFPQQP (γ-hordein). The peptidases were also compared by testing their capability to degrade gluten in gluten-containing wheat starch and wheat bran. Food samples were incubated with the enzyme extracts, lyophilized and afterwards tested for their gluten content by competitive ELISA. All peptidase samples were active towards celiac-active proteins and peptides. AN-PEP, which was available in a more concentrated form, showed much better results than cereal peptidases. Wheat starch with initial gluten contents of up to 2,000 mg/kg was found gluten-free after incubation. The same result was obtained with wheat bran containing as much as 100,000 mg gluten/kg before incubation. In summary, the study showed that gluten-containing raw materials can be rendered gluten-free by means of gluten-specific peptidases.

Selection of hard spring and winter wheat with no polyphenol oxidase activity

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Cereal Foods World 58:A3

Wheat (*Triticum aestivum*) polyphenol oxidase (PPO) contributes significantly to the time dependent discoloration of Asian noodles and other food products. Wheat contains multiple paralogous PPO genes expressed in seeds. To date, wheat noodle color improvement efforts have focused on breeding cultivars containing *PPO-D1* and *PPO-A1* alleles conferring reduced PPO activity. A major impediment to wheat quality improvement efforts is a lack of known low PPO alleles at the *PPO-A2* and *PPO-D2* loci. The discovery of mutant forms of these two PPO genes is critical to further reduce PPO activity and improve noodle color stability. In this study, a very low PPO line, 07OR1074, derived from crossing PI 117635 and PI 134049 (Seaspray) was selected for study. We have found novel mutations in four seed expressed PPO genes in 07OR1074 relative to commonly grown spring and winter wheat cultivars. To examine the impact of each PPO mutation upon total PPO activity and noodle quality 07OR1074 was crossed with spring wheat cultivars Vida and Choteau. PPO activity was measured on $F_{2:3}$ plants grown under greenhouse conditions. Evaluation of progeny indicated there is a substantial genotypic effect on PPO activity with at least three of the four PPO genes contributing significantly to total PPO activity. The impact of each gene upon noodle quality is currently being assessed. The results are expected to show that mutations in each PPO gene are important to lowering overall wheat seed PPO activity to produce a more desirable and marketable product.

Relationships between strain hardening properties, extensibility parameters, and end product quality of wheat flour

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Cereal Foods World 58:A3

Wheat quality has become the main driver of the wheat market. Loaf volume (LV) is an important economic criterion. Evaluating the baking performance of the breeding lines is a critical step. Strain hardening is an important dough property. It stabilizes the gas cell walls allowing them to expand at larger volume, thus yielding higher LV. The training set consisted of 31 genotypes grown over 3 years for a total of 111 flour samples. The extensibility tests were performed using the Kieffer rig. The force-distance curves were derived into stress-strain curves which were then fitted using the Hollomon equation to obtain the strain hardening index (n). Stepwise regression was used to identify the extensibility parameters contributing to n. Three parameters were retained in the model; dough strength (Rmax), extensional delay (Ediff), and the slope of the extensibility curve at the beginning of the test (Ei). The model had an R-square of 0.90. Rmax was the largest contributor to n with a partial R-square of 0.60. Two validation sets were used. Set 1 consisted of 75 flours samples (N = 225). The correlation between actual and predicted values of n was 0.80. Set 2 consisted of 19 genotypes grown in 12 environments (N = 228). The dough was prepared using a different method, yet the correlation between actual and predicted values was high 0.87. The samples from set 2 were submitted for baking tests. LV and n were correlated across all environments (r = 0.30). The correlations were stronger when computed within years (2008; r = 0.40, 2009; r = 0.49) and environments. LV was correlated to n in 7 of the 12 environments (r = 0.52-0.64). There was a positive trend between n and LV in the remaining environments. N was correlated to LV more than any other parameter, suggesting that n or the linear combination of Rmax, Ediff and Ei may help screen lines more efficiently.

Modulating state transition and mechanical properties of viscoelastic resins from maize zein through interactions with plasticizers and co-proteins

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Cereal Foods World 58:A3

Viscoelastic properties have been demonstrated in maize zein above its glass transition temperature and the protein has been explored as a possible replacement for wheat gluten in gluten-free dough systems. This functional change is believed to result from the development of fibrous, β-sheet-rich protein networks with different rheological properties. However, current understanding of how these viscoelastic polymers can be further manipulated

for food applications is limited. This study serves to present a framework for the manipulation of state transition properties and viscoelastic nature of zein as driven by plasticizers and co-proteins. Using resins formed via precipitation from aqueous ethanolic environments, moisture sorption isotherms and glass transition profiles were constructed for zein, gluten, zein/oleic acid (at 20% and 30% oleic acid), and zein/casein (at 15% and 20% casein). Differences in the viscoelastic and extensional properties of these materials were assessed using small and large deformation rheological techniques. Oleic acid plasticization was shown to reduce water absorption and glass transition temperatures, and created low elasticity/high extensibility resins. Incorporation of casein yielded only slight increases in water absorption and glass transition temperatures, yet imparted a five-fold increase in material strength/elasticity. These findings demonstrate how specific protein-plasticizer and protein-co-protein interactions can impart fundamental differences to the behavior of zein in viscoelastic systems and could serve as a basis for improving the functional properties of this underutilized material. Plasticizers and co-proteins could be further applied to specific food and biomaterial systems for optimal performance with respect to moisture migration and/or mechanical properties.

Improving the nutritional quality of pasta: Rheological studies on pasta dough with nontraditional ingredients

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Cereal Foods World 58:A4

Semolina was fortified with whole wheat flour and/or flaxseed flour to improve its nutritional profile. A study was conducted to investigate the effect of non-traditional fortification and moisture content on the rheological properties of semolina dough with application to pasta extrusion. Semolina 100%, whole wheat 100%, semolina-whole wheat flour, semolina-flaxseed flour, whole wheat flour-flaxseed flour, and semolina-whole wheat flour-flaxseed flour were the dough formulations used. Dough was hydrated at 30, 32 and 34% moisture content and processed in a semi-commercial extruder. Pasta extrusion parameters, i.e. extrusion pressure, extrusion rate, and mechanical energy were recorded, and the specific mechanical energy, shear rate, and shear stress at which dough was extruded were calculated. Dough was also extruded in a capillary rheometer at four different piston speeds, and the information recorded was subsequently used to build a model that would allow for the determination of the apparent viscosity of pasta dough during pasta processing. Results showed that pasta dough behaves like a shear thinning fluid described by the Power Law model. Presence of flaxseed flour and the hydration level of the dough strongly affected the extrusion parameters recorded during pasta processing and the apparent viscosity of the dough predicted by the Power Law model. Both extrusion and rheological parameters displayed a strong positive correlation among each other. It was observed that the apparent viscosity of non-traditional dough could be similar to the one of optimally hydrated conventional semolina by adjusting the moisture content of the dough. Results of this study could provide pasta manufacturers useful information about the science behind the rheological behavior of non-traditional pasta doughs under extrusion conditions.

Study on the variation reasons of multi-element fingerprints of wheat kernel for geographical origin traceability

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Cereal Foods World 58:A4

The key to the successful application of the multi-element fingerprinting technique to discriminate the geographical origin of food is the selection of suitable elements mainly associated with geographical origin. The objective of this study was to analyze the effects of grown origin, genotype, year, and their interactions on wheat multi-element fingerprints to find the variation reasons of multi-element fingerprints, and select the elemental indicators closely related to geographical origin for traceability. Field plot experiments were conducted in three regions (Zhaoxian of Hebei province, Huixian of Henan province, and Yangling of Shaanxi province) in China, respectively. Ten different varieties were cultured in every region for two years. The experimental design was a completely randomized block for a total of 10 plots in each region. 30 wheat samples were collected from each region per year during the harvest period. The concentrations of Li, Na, Mg, Al, Ca, Sc, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Ga, Se, Rb, Sr, Y, Zr, Mo, Cd, Sn, Sb, Cs, Ba, La, Ce, Nd, Eu, W, Pb, Th, and U in samples were analyzed by high resolution inductively coupled plasma mass spectrometry (HR-ICP-MS). The obtained data were analyzed by multi-way analysis of variance. The results showed that the content variations of Ca, Mn, Zn, Rb, Sr, Mo, Cd, and Cs were mainly affected by geographical origin; the content variation of Cu was mainly affected by genotype; the content variations of Na, Mg, Al, Ti, V, Cr, Fe, Co, Ga, Se, Y, Zr, Sn, Eu, and U were mainly affected by year. Therefore, the elements Ca, Mn, Zn, Rb, Sr, Mo, Cd, and Cs were the suitable traceability indicators to develop robust discriminant model of geographical origin. This study could provide theoretic support for the study and application of identifying the geographical origin of food by multi-element fingerprinting technique.

Bioactive Components of Grains: Health Benefits, Effects of Processing, and Bioavailability

Overview of the effect of processing on non-nutritive phytochemicals in grains and implications for the health food market

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Cereal Foods World 58:A4

Phytochemicals are broadly defined as non-nutritive plant chemicals and have become of topical interest because they are hypothesized to offer potential health benefits due to their bioactive properties. Cereal and legume grains are important sources of phytochemicals such as phenolic compounds. A wide variety of foods are processed from cereals and legumes. Food processing does impact on quality aspects such as sensory and nutritional. Various chemical reactions, physical and biological processes are set in motion during food processing. The phytochemical quality of foods as affected by processing becomes important in this regard. Processing of cereals and legumes may enhance or reduce levels of phytochemicals in foods and this has implications for their bioactive properties and the potential health benefits they can offer. This paper presents an overview of the effect of various processing techniques on non-nutritive phytochemicals in cereals and legumes using phenolic compounds as an example. Such insight into the effect of processing on phytochemicals in grains is of importance for the health food market. This is due to the current drive within the food industry towards development of cereal- and legume-based products with healthful properties derived from phytochemicals in order to satisfy the health-conscious consumer.

Whole grains in colon cancer prevention: Estrogen-like activity of minor polyphenols

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Cereal Foods World 58:A4

Consumption of whole grains has been linked to reduced risk of colon cancer. The benefits of fiber, antioxidant minerals and vitamins are well recognized. The inherent estrogen-like activities of specific whole grain polyphenols also possibly contribute to colon cancer prevention. Estrogen is believed to protect damaged colonocytes from developing into malignancy. It has been proposed that protective effects of estrogen, such as induction of apoptosis and tumor suppressor genes, are mediated via estrogen receptor-β, the predominant estrogen receptor in the colon. We have demonstrated that phenolic extracts of some sorghum varieties are estrogenic in non-malignant colonocytes and are capable of inducing apoptosis in damaged colon epithelial cells. The phenolic profile of sorghum affects the estrogenic activity. Compositional analysis indicates that flavones and flavanones contribute most of the varietal differences in estrogenic activity of sorghum. Sorghum varieties high in flavones (apigenin and luteolin derivatives) and/or flavanones (naringenin and eriodictyol derivatives) showed estrogenic activity in colonocytes at physiologically relevant concentrations. The protective effect of sorghum extract high in flavones on colon carcinogenesis has also been observed in an *in vivo* mouse model. The latest evidence on estrogenic activity of these minor cereal polyphenols and possible mechanisms against colon cancer development will be discussed. Possible interaction or synergistic effects among different groups of polyphenols, as well as their implications on modeling bioactivity with isolated pure compounds will also be presented.

Chemical and cellular antioxidant properties of phenolic extracts from dietary fiber from selected whole grain cereals
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Cereal Foods World 58:A5

The present study investigated the antioxidant properties of insoluble dietary fiber (IDF) and soluble dietary fiber (SDF) extracts from selected whole-grain cereals (WG). In chemical model assays, the alkaline extracts of IDF showed better antioxidant capacities than WG and SDF in terms of total phenolic content (TPC), DPPH radical scavenging activity (DPPH), and total phenolic acid content (TPA). Excellent correlations found between DPPH-TPC and DPPH-TPA suggested that phenolic acids are the main compounds responsible for the antioxidant potential in cereal alkaline extracts. The most abundant compound found in alkaline extracts was ferulic acid, which accounted for > 57% of monomeric phenolic acids in WG, IDF, and SDF alkaline extracts. *Iso*-ferulic acid was identified and quantified as one of the major phenolic acids in a wide variety of cereals. Four ferulic dehydrodimers were detected in cereals as 8-5', 5-5', 8-*O*-4', and 8-5' (benzofuran) - coupled dimeric ferulic acids. Significant differences ($p < 0.05$) in TPC, DPPH, and TPA between IDF and SDF implied that the levels of phenolic acid hosts in DF, mainly cellulose, hemicellulose, and lignin, determine the degree of DF antioxidant capacity. High TPC, DPPH, and TPA made yellow corn IDF preferable among the studied cereals for cellular antioxidant assays. The cell model studies revealed the protective function of corn insoluble dietary fiber (C-IDF) alkaline extracts containing esterified phenolic acids in cultured human intestinal cells. Although C-IDF extracts performed differently in defending against various free radicals in two intestinal cell models, an efficient cytoprotection was observed in AAPH treated FHs 74 Int cells and xanthine-xanthine oxidase incubated Caco-2BBe cells. This effect is likely associated with the antioxidant activity of C-IDF linked phenolic compounds, particularly ferulic acid.

Whole-grain food structure, phytochemical bioavailability and potential health effects: From a reductionist to a holistic approach
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Cereal Foods World 58:A5

Meta-analyses show that whole grain product consumption is associated with significant lower prevalence of obesity, diabetes, CVD and some cancers. Protective mechanisms involved are complex, cereals being a complex package of bioactive compounds with various positive physiological effects and bioavailability percentages. The specific effects of food structure, fibre and magnesium, the antioxidant/anti-carcinogenic/anti-inflammatory properties of numerous compounds in the bran and germ are today recognised mechanisms in this protection. Yet, recent findings, exhaustive listing of bioactive compounds found in whole-grain wheat and their estimated bioavailability may lead to propose new hypotheses: Involvement of polyphenols in cell signalling and gene regulation, and sulphur compounds/lignin/ phytic acid should be considered in antioxidant protection; whole-grain wheat is also a rich source of methyl donors and lipotropes involved in cardiovascular and/or hepatic protection, lipid metabolism and DNA methylation; role of fibre for delivering *co-passengers* within colon, notably bound phenolic acids; and the potential protective effects of the B-complex vitamins on mental health, of oligosaccharides as prebiotics, of compounds associated with skeleton health, and of other neglected compounds would also deserve to be studied in more depth via a synergistic approach. In addition, most of these bioactive compounds are both in bound and/or free/conjugated forms, each exerting specific physiological effects; so that we propose the concept of *slow* and *rapid* phytochemicals, notably for phenolic acids and fibres. Nutrigenomics to study complex physiological effects of the whole grain package and interventional studies are now needed to move a step forward in the understanding of the mechanisms involved in the complex and synergetic whole grain cereal protection.

Health-promoting dietary bioactives: A trans-disciplinary approach to efficacy and cellular mechanism
M. DEY (1)
(1) South Dakota State University, Brookings, SD, U.S.A.
Cereal Foods World 58:A5

Our 'molecular-nutrition and nutrigenomics' based human-health research program designed to address current biomedical priorities has evolved around diet-gene interaction in inflammatory and chronic diseases. While chronic diseases are major health burdens, many are highly preventable, provided we understand and prevent the underlying aberrant cellular mechanisms. Diet is the most important and routine factor among various environmental influences on human life. Therefore, the central goal of our research is to elucidate how biologically active dietary components may help alleviate aberrant inflammation signaling that plays a critical role in onset/exacerbation of most multi-factorial chronic diseases. We have adopted a translational approach through inter-disciplinary collaborations, to study molecular mechanisms of action and efficacy of biologically active natural compounds in cell-based systems, animal models, and in humans. Currently our research team is working on several externally funded projects which will be discussed.

Cereal Food Processing: What Are the Benefits?

Benefits and challenges of food processing
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Cereal Foods World 58:A5

Food processing has been targeted lately as one of those "evils" that keep us from having healthy lives. For the cereal science community, it seems that this is one of those issues that will go away easily, since the benefits of food processing are very obvious to us. We can never be so wrong! The challenges in front of all of us are big and we need to do a better job of educating the consumer about the benefits of processing that allow us to have high quality food available all year around. However, we need to recognize those elements in our "processing culture" that need attention and can be subject to misinterpretation.

Structure of cereal foods: Impact on health outcomes
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Cereal Foods World 58:A5

Processing is a prerequisite for consumption of cereal grains. Cereal food structure is formed in processing, and properties and interactions of biopolymers and other components form the structure from molecular to macroscopic scale. Food structure is critical for perceived texture. The first very important role of food structure on health is thus related to food choice – foods with appealing texture are those influencing health just because they are chosen for consumption. In addition, food structure largely determines the rate and site of absorption of nutrients in the gastrointestinal tract as well as bioavailability of bioactive phytochemicals. Breakdown of food structure during digestion has a large impact on physiological functionality. Food structure is definitely one of the criteria to be considered when engineering foods for health. The structure of bread, biscuits and other solid cereal foods represents a solid foam. The rate and extent of starch digestibility and thus glycemic response are largely determined by the density and porosity of the product, but also by the degree of starch gelatinization, the amount and form of amylose and the interactions of starch with other food components. Slow glycemic response is considered to assist in maintaining healthy glucose metabolism. Food structure also is important for the satiating effects of foods. Solid foods are more satiating than liquid, and the viscosity of food digesta is known to influence f.ex. gastric emptying rate and secretion of hormones related to food intake. The structural characteristics of dietary fiber are on the other hand important for the fermentation and bioconversions in the large intestine. Reduction of particle size and integrity of cell wall structures influence gut fermentation pattern and bioaccessibility of phenolic compounds in the plant matrix.

Processing to enhance ingredient functionality of whole grains
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(1) Cargill Horizon Milling, Plymouth, MN, U.S.A.; (2) Cargill, Inc., Plymouth, MN, U.S.A.; (3) Cargill Horizon Milling, Minnetonka, MN, U.S.A.
Cereal Foods World 58:A5

The addition of whole grains to products can be challenging due to their complex composition and architecture. Those formulating and manufacturing whole grain containing products have to adapt their formulations and processes to the components being introduced through whole grain materials. Technology has a critical role in influencing interactions of whole grain components for the production of acceptable and low cost whole grain foods. At this time a modest amount of information exists to explain the interactions of whole grain components on their functionality in food processing and finished product quality. Whole wheat milling practices have been the most prominent examples of the optimization of whole grain ingredients. Whole wheat optimization has been an exercise of balancing both material performance in food processes and consumer acceptance. Pretreatment of the

grain, heat treatment, and the particle size of the bran and germ all have implications on the physicochemical properties of the material. The properties of whole grain materials can be further modified through the use of enzymes during food manufacture in order to improve processing and finished product quality, or to help attain a nutritional goal. The objective of this presentation is to provide an overview of the functional characteristics of whole grain components, whole grain whole grain component interactions, and processes that can improve the functionality of whole grain materials in food applications.

Relationships between dry processing conditions and composition and functional properties of oat products
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Cereal Foods World 58:A6

Oat bran, rich in β-glucans is recognized for its role in lowering blood cholesterol. In this presentation the effects of roller milling conditions on the composition and functional attributes of oat bran products will be discussed. Millings were performed with a five-stand mill equipped with 25-cm rolls. The flow consisted of several corrugated roll passages with intermediate sifting, and an optional bran finisher passage. The disposition of rolls was changed from sharp/sharp to dull/dull, the first break roll gap was varied from 0.076 mm to 0.254 mm and the roll speed differential was adjusted from 1.5:1 to 4:1. Effects of milling parameters on the content and solubility of β-glucans and arabinoxylans in bran samples were determined. The particle size and shape, loose bulk density, porosity, water hydration, and structure-forming characteristics were investigated. The content of β-glucans in the bran fractions was strongly affected by the milling conditions; generally a higher content of β-glucan was obtained by dull/dull than sharp/sharp milling, and by increasing the roll speed differential. Increasing the roll speed differential decreased the size of bran particles, but changing the roll disposition only had a small effect. The bran particles obtained by sharp/sharp grinding were thin and elongated with higher loose bulk density, compared to those obtained by dull/dull. The particle porosity increased as roll speed differential increased and was higher for dull/dull than for sharp/sharp. Relationships between the water absorption of bran preparations and the β-glucan contents and the porosity of bran particles were established and the solubility of β-glucans was affected by the physical structure. The results of this study indicated that dry processing conditions can be designed to create oat bran with improved technological and nutritional functionalities.

Formulating whole grain foods: Overview of ingredient, processing and sourcing challenges
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Cereal Foods World 58:A6

Developing whole grain foods that meet consumer expectations has many technological challenges. While consumers state they want healthy choices, they will not compromise on taste, texture or appearance and they expect these options to be cost neutral. The addition of whole grain flours, flakes and particulates change the taste, texture and flavor of most food products. In addition, the length of time that these products remain stable (shelf-life) tends to decrease with the addition of whole grains. Examples of changes in bakery mixes, batters and dough as well as snack bars and extruded snacks and cereals will be discussed. Options available to mitigate some of these changes will be presented. A key challenge facing the food developer is a lack of whole grain ingredients that meet their specific application and process requirements at an affordable cost. This talk is intended to provide an overview of the challenges ahead!

Conflict of Interest in Science: Myth or Reality?

Conflict of interest – Myth or reality: Academic perspective
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Cereal Foods World 58:A6

For the field of food science, as an applied science that naturally has an interface with the food and related industries, it is not new or unusual for its academic research laboratories to have funding from industry as well as government and other sources. In the current rather poor public funding situation, it seems imperative more than ever that there would be an industry component to research funding to move important areas of investigation forward. Industrial funding into academic laboratories varies considerably based on type and needs, from rote analytical work where data is returned with little scientific input to more longer term research projects to understand the fundamentals of an problem with the aim of revealing new approaches towards their solution or development of novel materials for us in products. While there is the potential for conflict of interest issues to arise, the familiarity between academic labs in applied science and engineering and the food industry makes such problems uncommon. Adherence from both parties to basic codes related to keeping research unbiased and truthful is generally recognized, and rigor at the level of university sponsored program offices regarding the details of industry-sponsored grants is the norm. The aim of this talk will be to explain the process of developing academic-industry research projects, how the data is handled, and the findings disseminated with potential for conflict of interest kept in mind.

Building partnerships to address critical societal issues related to nutrition and health
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Cereal Foods World 58:A6

Food security, natural resources conservation, food safety, promotion of lifelong health, the prevention of chronic diseases are among the broad, complex and inter-related challenges facing humanity. There is mounting public awareness that science will provide answers to appropriate agricultural practices and dietary patterns that are conducive to these and other public health concerns. Scientific discovery points to multiple approaches with the potential effectiveness. Organizations in the private and public sectors often view the same public health problems through different lenses, yet have the expertise and resources unique to each sector and to help address these needs. Undeniably, human, financial, and natural resources restraints warrant the development of effective partnerships. It must be recognized that shared and divergent motivations exist for such collaboration, and thus open and transparent communication among partners is fundamental to success. Any partnership should: (1) facilitate discussions around the broad, complex challenges facing agriculture, food, and nutrition research, (2) identify areas of potential cooperation, and (3) explore and utilize various mechanisms for building research partnerships. Recent discussions by individuals at NIH and USDA reveal some common themes include enhanced research related to effective monitoring of dietary exposures, drivers for eating behaviors, the importance of the microbiome, and effective biomarkers for health, as well as disease conditions. To promote a public/private partnership related to food and nutrition, barriers must be addressed, and priorities must be approached strategically. To achieve these goals, several key elements need to be considered including public health impact, effectiveness, precompetitive space, risk/benefits, and regulatory implications.

Contract research organization perspective
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Cereal Foods World 58:A6

A Contract Research Organization (CRO) is a for-profit company specializing in the conduct of clinical trials. Originally, CROs provided clinical trial support services for the pharmaceutical development process, primarily in regulatory compliance to ensure human trials met the standards put forth by the Food and Drug Administration (FDA). Over time, CROs have expanded to include all aspects of clinical trial design and execution, while maintaining expertise in the stringent regulatory requirements for new drug development. CROs also offer the advantage of confidentiality as well as speed, due to efficiencies with respect to consolidation of resources and expertise in data management. As such, the use of CROs has extended beyond drug development to other industries, including food, with some CROs specializing in studies that aim to evaluate the safety and efficacy of food ingredients, packaged food products and dietary supplements. This shift in paradigm raises new issues with respect to conflict of interest and bias. For example, unlike most academic institutions, publication of study results is not a requirement, which may influence the integrity of study design as well as lead to bias in the scientific literature. Inherent to this issue is a lack of incentive to register the trial with a National or International registry, which is now a requirement of many peer-reviewed journals. Further, the CRO may be subject to be pressure from the sponsoring company to conduct multiple post-hoc analyses in an attempt to achieve more favorable efficacy or safety results than were determined by the *a priori* statistical plan. Adhering to clinical trial standards and following the principles of transparency and integrity minimizes the potential for conflict of interest in CROs, reducing bias and increasing scientific credibility for all stakeholders.

Industry perspective
S. JONNALAGADDA (1)
(1) Kerry Ingredients & Flavours, Beloit, WI, U.S.A.
Cereal Foods World 58:A7

International Life Sciences Institute (ILSI) defines conflict of interest as “a conflict between the private interests and official responsibilities of a person in a position of trust. A conflict of interest might arise when a person has to play one set of interests against another.” Industry sponsorship is a significant source of research funding which is essential for the advancement of science. Increase in industry sponsored research has fueled suspicion of systemic bias; respected scientists and organizations have been criticized due to their connections with industry. Sources of bias may be perceived, for e.g., in the research questions pursued, choice of research design, selection and retention of research participants, data collection techniques, interpretation and reporting of data, and decision to publish. The ultimate goal, regardless of funding source, should be to minimize bias and conflict of interest while upholding scientific rigor in the pursuit of scientifically valid research for the purpose of advancing science. With any research, transparency is critical; it is important to specify the roles of sponsors and authors in developing research protocols, funding support and role of sponsors in the conduct of the research and clarify individual author affiliations, associations, roles and potential financial conflict of interest. Industry sponsored research should ensure adherence to codes of ethics, such as, the code of research ethics of the Association of Institutional Research; conflict of interest guidance from ILSI; codes of ethics guidance relevant to specific professional societies; and follow guidelines to ensure humane and ethical treatment of animals and human subjects. Industry should continue to apply high scientific standards, maintain scientific integrity and rigor and minimize bias and conflict of interest.

Advancing science through public-private partnerships: Key to success
J. SLAVIN (1)
(1) University of Minnesota, St. Paul, MN, U.S.A.
Cereal Foods World 58:A7

In a perfect world, all good ideas would find research support and we would have evidence-based answers for all our important questions. Let's return to the real research world in 2013. Food science research has traditionally been supported by USDA; but much of this funding has gravitated toward larger project grants with a specific focus, for example, childhood obesity. The situation in nutrition is somewhat better since nutrition research can be supported by the National Institutes of Health (NIH). NIH research is competitive with less than 10% of submitted grants receiving funding. To write a competitive grant requires pilot results often obtained with small research grants from commodity groups or companies. Certain commodity groups have invested heavily in research, dairy, almonds, for example and as a result have a strong research base for dietary recommendations. A typical long research path would be to generate some epidemiologic studies that show disease protection with your ingredient and then conduct some strong clinical trials showing improvements in biomarkers. Even foods that we generally accept as "healthy" have a limited evidence-base for their protective properties. The cost of clinical studies is quite daunting and the best models pool resources to generate more research funding - checkoffs for agricultural products are in this category. In the past most of this research funding went to production agriculture, but increasingly these funds are being directed to health and nutrition. Public-private partnerships work well in our peer-review world, but are increasingly under attack. Science in the future will require partnerships among universities, the government, commodity groups, and industry to move our research agenda forward.

Designing Safe Grain-Based Food Products

Food safety: An integral part of product development
D. MCINTYRE (1)
(1) Cargill, Inc., Wayzata, MN, U.S.A.
Cereal Foods World 58:A7

Customers expect to be provided with safe food ingredients, supplements, product prototypes and applications. This cannot be done as an afterthought because it may then result in uncovering a safety concern that would necessitate a complete reworking of the concept. The most efficient and logical way to create a safe product is to design safety into the product as it is being developed. Just as one would design and develop a product's flavor and functionality, formulations and processes must be designed and developed to ensure product safety. A systematic approach using formalized food safety programs and practices must be followed in order to produce a finished product that is safe. Key components of a Product Development Food Safety program include implementation of prerequisite programs, as well as using a HACCP approach to understand the potential hazards and concerns of the product being developed. Cargill Research & Development has also implemented an internal online review and approval system for prototypes prepared in their global R&D Centers. Prototypes are reviewed for any food safety concerns and approved prior to sending the prototype to customers, using the prototype in sensory evaluations or providing the prototype to consumers at trade shows. When developing prototypes for consumption, food safety considerations must be viewed as important as any of the other steps in the Product Development process.

Sourcing safe ingredients
D. Akins-Lewenthal (1), R. LEGGE (1)
(1) ConAgra Foods, Omaha, NE, U.S.A.
Cereal Foods World 58:A7

Preventing food safety problems rather than relying primarily on reacting to problems after they occur is fundamental for protecting public health. One aspect of strengthening our food safety system is to understand the importance of sourcing safe food ingredients. Choosing a reputable ingredient supplier can be challenging for food manufacturers. The supplier must meet criteria based on product development, quality assurance, manufacturing, sales and marketing needs. This presentation, however, will focus on the food safety criteria needed to ensure safe ingredients are being sourced. Examples of topics to be discussed include meeting regulatory requirements, as well as the Food Safety Modernization Act’s Foreign Supplier Verification Program. The presentation will also incorporate information around understanding the supplier’s food safety programs and obtaining a sense of management commitment.

How to address microbiological safety concerns of high risk ingredients
J. D. MEYER (1)
(1) Covance Laboratories, Inc., Monona, WI, U.S.A.
Cereal Foods World 58:A7

Consumers continue to expand their palates and preferences for a wider variety of foods that will meet their gastronomical and/or nutritional expectations. To deliver against these expectations, food manufacturers are incorporating novel ingredients and utilizing existing ingredients in new ways. This may lead to the utilization of ingredients with increased risk of introducing microbiological hazards. Food manufacturers need to develop and implement strategies to effectively identify potentially high risk ingredients. They must also consider ingredients that may become high risk based on a new or unique product application. Once high risk ingredients are identified, additional controls may be needed to address any microbiological safety concerns and deliver products with minimal risk to the consumer. This presentation will review some of these strategies and controls and how they may be implemented.

Processing and its key role in assuring safety
A. BIANCHINI (1)
(1) University of Nebraska-Lincoln, Lincoln, NE, U.S.A.
Cereal Foods World 58:A7

While developing a new product attention must be devoted to the processing and how it will affect the quality and safety of the product. The process of choice must ensure the safety of the product, while delivering the desired quality attributes. Besides the technology applied, the whole processing environment where the product is made must be conducive to quality and safety, and that is true for products under development, as well as products already under production. Because pathogens and mycotoxins would be the two main concerns regarding safety of cereal based products, this presentation will focus on the role of processing to assure safety regarding these two hazards. This presentation will give a brief overview about these hazards and discuss in more details some control measures to address them. In general, control measures start with preventing pathogens and mycotoxins from coming into the production environment through the sourcing of high quality ingredients. Another important measure is the prevention of bacterial establishment or toxin production within the premises. During processing, some steps can be used to reduce contamination by pathogens; however, these may be less effective against mycotoxins because of their stability. For pathogens another very important area that will be discussed is the prevention of cross and post-processing contamination. And finally, the use of an environmental monitoring program (EMP) will be discussed to evaluate the efficacy of any measures adopted from a broad perspective.

Food Safety in the Global Supply Chain: Facts vs. Myths

WITHDRAWN

Are pathogens a food safety concern in a grain-based supply chain?
J. SHEBUSKI (1)
(1) Cargill, Incorporated, Wayzata, MN, U.S.A.
Cereal Foods World 58:A8

Grains are grown in open environments and subject to the possibility of pathogen contamination from those environments through contact with birds, rodents, deer, other wild animals, water and soil. The improper harvesting, transportation and storage of the grains can further contribute to this contamination. Therefore pathogens are a potential concern in a grain based supply chain and their possible presence should not be overlooked. However, recognition and awareness of these potential hazards makes it possible to manage these concerns. Proper handling of the grains and their resultant end products throughout the supply chain can minimize the possibility for an increase in pathogen numbers. This must then be coupled with a thorough understanding of the intended use of these products to ensure any pathogens present in the end products are eliminated prior to consumption. If the intended use is such that it cannot ensure the elimination of the pathogens then the product should not be produced and sold unless or until a safer alternative of the product can be developed.

GMOs: Are they a regulatory or food safety issue?
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(1) University of Nebraska-Lincoln, Lincoln, NE, U.S.A.
Cereal Foods World 58:A8

The term, GMO is applied to genetically complex organisms that receive one or more new genes inserted by laboratory methods to provide a new trait. The first GMOs approved for food and feed (1995) were insect resistant maize and cotton, herbicide tolerant soybean and delayed ripening tomato. Approval required evaluation of safety using scientifically sound tests designed to reduce possible increased risks of food allergy, toxicity or anti-nutritional properties. The Codex Alimentarius Commission (U.N.) developed a comprehensive safety guideline in 2003. Regulations in most countries follow Codex, although some add scientifically unproven tests. Newer GMOs include plants protected against specific viruses, insects and herbicides. Nutritionally enhanced crops (e.g. Golden Rice) are coming. There are no documented cases of harm to consumers (humans or animals) or unique environmental harm from approved GMOs. Agricultural species were selected over thousands of years based on safety, ease of production and nutrient content. A few species contain lectins and enzyme inhibitors that must be inactivated before eating. About 1% of the population must avoid wheat, barley and rye due to celiac disease and 2% to 6% must avoid specific allergenic foods. Insertion of a gene in these species is unlikely to produce a new hazard. GMOs are traceable (e.g. by PCR) and trade is restricted to countries that have approved each event. Some countries demand "GM" labeling, although without a scientific or practical basis. Trade issues due to country-by-country approvals add costs, which could be avoided by a global approval system. The current safety assessment process of Codex (2003) works well to prevent the introduction of unsafe GMO traits. Regulations, misinformation and consumer confidence have now become the dominant issues.

Commingling of grains: Does the adventitious presence of soy or wheat in grains pose a risk to allergic consumers?
J. BAUMERT (1)
(1) University of Nebraska - Food Allergy Research & Resource Program, Lincoln, NE, U.S.A.
Cereal Foods World 58:A8

Food allergen labeling laws throughout the world require that packaged food products containing directly added ingredients derived from commonly allergenic foods must be clearly identified on a package label. In the United States, the Food Allergen Labeling and Consumer Protection Act (FALCPA) of 2004 requires source labeling of 8 priority food allergens, however, Congress exempted raw agricultural commodities from source labeling provisions. Grains grown, harvested, transported and stored may contain the adventitious presence of allergens such as wheat or soy due to the use of shared equipment and facilities. The USDA Grain Inspection Handbook and other grain standards throughout the world allow for a certain percentage of commingled grains depending on the grade of the particular commodity grain so a low level of soy or wheat may be present in grains and products made with these grains as part of normal agricultural and grain handling practices. It has been debated recently if packaged food products produced from these commingled grains should include an advisory label (i.e. 'May contain') to advise soy or wheat allergic consumers of the possible presence of these grains in the food product. Clinical reports of allergic reactions occurring to due to the adventitious presence of soy or wheat are rare and it is uncertain at this point if low levels due to grain commingling pose a risk to the allergic consumers. Minimizing the level of commingled grain is desired for both safety and quality reasons, however, a zero tolerance level would not be economically or operationally achievable. The use of advisory labeling would drastically decrease food choice for soy or wheat-allergic consumers, thus decreasing their overall quality of life. Quantitative risk assessment can be used to evaluate the potential risk of allergic reactions occurring due to grain commingling.

Grain Processing: Impacts of Grain Flows, Sustainability, and Grain Production Goals on Ingredient Costs and Food Aid

Sustainability from grains to ingredients
F. LUCKEY (1)
(1) Field to Market, Omaha, NE, U.S.A.
Cereal Foods World 58:A8

What is the current state of agricultural sustainability in the United States? What do we mean when we talk about agricultural sustainability? What is driving the need for sustainable agriculture and how should we measure it? This presentation will discuss a bit of the history of sustainability and how the U.S. grower has done over the past 30 years. Measuring sustainability can be done but it is not without its pitfalls and difficulties. Avoiding regulation and certification is certainly desirable but the long term nature of measuring sustainability flies in the face of our short-term focused, instant gratification society. The bottom line: sustainability is about efficiency or doing more with less and wasting less. If we can do that, why wouldn't we?

Perspectives on the future of corn feedstocks
S. PETERSEN (1)
(1) Monsanto Company, Chelsea, IA, U.S.A.
Cereal Foods World 58:A8

Productivity gains are being realized globally; 1) Globally, corn yield advancements are following the U.S. trend, 2) Opportunities for further corn yield improvement are evident today, and 3) Higher yields mean more biomass (grain + stover) per acre. Economic models suggest that continued productivity gains in agriculture will allow food, feed and fuel needs to be met; 1) New demand sources require certainty of supply, 2) Environmental models suggest that weather extremes will reduce the certainty of supply, 3) Technology advancements to provide production resiliency play an important role in reducing risk, and 4) Improving the environmental footprint of corn opens up new markets and helps mitigate climate extremes.

The evolving quality of U.S. food aid—New formulations of fortified blended foods
Q. W. JOHNSON (1)
(1) Quican Inc., Rockwood, ON, Canada
Cereal Foods World 58:A9

Food Aid has been provided by the United States for many decades. Billions of dollars have been invested in the protection of life during conflicts and natural disasters and to enhance the diets of chronically undernourished people in development settings. In 2009 USAID commissioned a review of the quality of food aid which culminated in the publication in 2011 of a report titled "Delivering Improved Nutrition, Recommendations for Changes to U.S. Food Aid Products and Programs" prepared by Tufts University under the terms of a contract with USAID's Office of Food for Peace. These changes have had implications and in some cases, challenges for vendors of fortified blended foods in terms of food ingredients, vitamin and mineral premixes and processing technologies. Under the current fiscal constraints facing the United States, the provision of food aid effectively and economically delivered has become a major priority for the United States Government. This presentation will review the recommendations of the report covering the composition of fortified blended foods, the revisions that have been made to existing products and the introduction of new products. In addition, some of the key processing requirements for the production of fortified blended foods will be discussed. Finally a discussion on the need for revised programming processes and procedures will be provided to demonstrate the importance of effective food aid delivery to the most vulnerable of populations.

Tracing the food aid supply chain
P. B. GREEN (1)
(1) North American Millers' Association, Washington, DC, U.S.A.
Cereal Foods World 58:A9

The following Supply Chain will be explained in detail: U.S. origin food products are donated to food insecure individuals and families in developing countries through 3 U.S. Government programs: Food for Peace- Title II PL 480; Food For Progress; The McGovern-Dole Food for Education and Child Development Program. In each of these programs US food is procured by the Farm Services Agency of the U.S. Department of Agriculture, either on behalf of USAID or another part of USDA. Contracts to supply the food products are determined in monthly tenders where the least cost food manufacturer or trader's offers are matched with the lowest ocean freight offers to determine the least landed cost. Either manufactured or bulk commodities are prepared for shipment by the vendor, inspected and shipped to port where the predetermined ocean carrier takes care and custody. After shipment either directly to the destination country or to a prepositioning facility overseas, the cargo is delivered to an international Development NGO or World Food Program. In-country storage transport, handling and distribution to the beneficiaries is managed by these groups, who are also accountable for the food and its delivery to its intended use. The presentation will discuss accountability, efficiency, quality control and effectiveness measurement within each link of the supply chain. We will also briefly discuss some new trends and factors that challenge continuation of the U.S. food aid model in future years. Monetization, local and regional purchase, higher commodity prices, focus on higher nutrition, and more sophisticated product formulations are examples of these challenges.

Leveraging Innovation and Cost Management for Profitability

Leveraging continuous improvement for cost management, profitability and innovation
L. MURRAY (1)
(1) Bunge North America, St. Louis, MO, U.S.A.
Cereal Foods World 58:A9

The need for a Continuous Improvement program will be explored along with the elements of an effective Continuous Improvement process. Multiple continuous improvement approaches are being used by organizations to help achieve cost management, profitability and innovation. These various approaches and their application will be explored during this session. Then, Kaizen, a systematic approach to rapid improvement, which can be used as part of any Continuous Improvement program, will be discussed.

Using Lean Six Sigma to improve profitability in the food industry
K. M. Gardner (1), M. LINDSAY (1)
(1) Ingredion, Saline, MI, U.S.A.
Cereal Foods World 58:A9

Lean Six Sigma is the most widely used continuous improvement strategy in business today. This presentation will illustrate how Lean Six Sigma has been successfully applied in the food industry to lower costs, improve quality and enhance profitability. The basic concepts that form the foundation of Lean Six Sigma will be briefly covered. Subsequently, examples of how Lean Six Sigma has been successfully used to improve processes in both manufacturing and product development will be covered. The examples will illustrate how the variety of continuous improvement tools that are part of Lean Six Sigma can be successfully applied to different types of processes and problems to effectively and efficiently reduce costs, enhance productivity, and improve quality. Lastly, the discussion will conclude with some key considerations for organizations thinking about implementing Lean Six Sigma.

Challenges and opportunities in improving profitability by managing costs and innovation
T. S. COGSWELL (1)
(1) BakerCogs, Inc., Overland Park, KS, U.S.A.
Cereal Foods World 58:A9

Continually reducing the time from “concept to consumer” is vital in the world of consumer package goods companies. What issues come up time and time again to impact the innovation process? The attributes of the finished product, marketing expectations, production capabilities, ingredient pricing, procurement issues, supply chain, wholesale & retail pricing and the corporate profitability all work together in managing innovation costs.

Challenges and opportunities in leveraging innovation to improve profitability
J. BARTA (1)
(1) General Mills, Inc., Minneapolis, MN, U.S.A.
Cereal Foods World 58:A9

Challenges and opportunities in leveraging innovation to improve profitability: This presentation will give an overview of a number of innovation approaches to improve profitability at General Mills (GMI). Holistic Margin Management: GMI’s innovative Holistic Margin Management (HMM) strategy has been a crucial component of the company’s strong business performance. GMI currently has hundreds of initiatives underway to drive value by focusing on the things that matter most to consumers while reducing waste across its operations. Appleseed Ideation Tool: Appleseed is a proprietary tool developed by GMI to help business teams identify new potential ideas for cost reduction. Appleseed is an opportunity map of 30 unique strategies that may lead to HMM. Appleseed can serve as an ideation tool to come up new cost savings ideas across all facets of the business. Connected Innovation: In 2005 GMI began exploring what the concept of Open Innovation might mean in the food industry. In 2007 the General Mills Worldwide Innovation Network (G-WIN) was created to formally open the company’s doors to the technical talent that resides in universities, government research labs and companies of all sizes. Open innovation is now a key plank in their innovation strategy.

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

How schools train students to be productive professionals in the cereal food industry
K. SEETHARAMAN (1)
(1) University of Guelph, Guelph, ON, Canada
Cereal Foods World 58:A9

The basics of the need for education have not changed over the centuries, but how we engage students in the new century remains to be unraveled. For example, within the cereal-based industry, educators must train individuals to be critical thinkers who have the ability to diagnose problems and come up with creative solutions. The critical aspects are to be able to visualize a problem, usually via repetitive hands-on activities, and apply basic science principles to arriving at a solution. Moreover, for educators it is not what to teach but to communicate how to be critical of and creative with the information students have access to at their fingertips. That is, students are by default autodidacts, i.e., they seek access to easy knowledge and information from the internet be it Google or Wikipedia or other media options. The challenge, then, for academia is to develop forward thinking curricula and pedagogy that involves skills in

communication, writing and cross-disciplinary narrative that gets at the core of problem solving.

How NDSU prepares students to be productive professionals in the food industry
C. HALL (1)
(1) North Dakota State University, Fargo, ND, U.S.A.
Cereal Foods World 58:A10

The presentation will highlight the outcome based approached used by North Dakota State University to educate students to be productive professionals. Bloom's Taxonomy is used to guide our expectations for graduate education. At a minimum, knowledge and comprehension of the composition, functionality and utilization of cereals that will allow students to solve and analyze issues within their field of employment is expected for all graduates. PhD graduates must demonstrate the competencies of a MS graduate and be able to analyze, synthesize, and evaluate cereal based systems to meet the demands of their field of employment. The program has six core competencies that drive the program. These include cereal and food chemistry, grain composition, grain processing technologies, functionality and analysis of chemical components found in grain, experimental design, and interpretation and communication. The brief presentation will cover the outcomes associated with the six core competencies as our Cereal Science program moves away from course based approaches to education.

Opportunities for professionals in the cereal science and bakery industry
D. M. HAYMAN (1)
(1) Kellogg Company, Battle Creek, MI, U.S.A.
Cereal Foods World 58:A10

The transition from academia to industry is an exciting and challenging opportunity that many individuals choose to embark upon. Key elements and experiences during the time spent in academia are critical to developing the qualifications of individuals who wish to make that transition. The Research, Quality and Technology organization at the Kellogg Company is on a continuous search to hire 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. We seek to provide a high quality, focused onboarding program, key mentoring relationships, and developmental assignments that effectively challenge our new hires. A successful entry and onboarding provides the runway for a successful career with the Kellogg Company. We believe that cultivating the diversity of our talent base and allowing that to thrive in our global environment is what ultimately makes us truly successful in the market place.

Opportunities for professionals in the food industry
E. A. ARNDT (1)
(1) ConAgra Foods, Inc., Omaha, NE, U.S.A.
Cereal Foods World 58:A10

Congratulations on your recent graduation and new job! This is an exciting time filled with possibilities. Here is some advice. Learn about your company. Learn about the markets and companies that your company does business with. Learn from your colleagues. Listen and observe; ask a lot of questions. Know your products – try the foods made by your company and foods made with ingredients from your company. Become intimately familiar with your company's mission. Learn about your company's goals, programs and career paths. At ConAgra Foods, our overarching purpose is to deliver everyday food in extraordinary ways. We have a recipe for growth, a prescription for ways we win, and operating principles that we must follow. In our Research, Quality and Innovation department at ConAgra Foods we developed eight technical competencies that we follow. These include "Own the product", "Working backwards" and "Be curious and know your stuff" which provide a template for how we should work. We have a three year development rotation program consisting of yearlong assignments in three different departments. This program was designed to help new professionals increase knowledge and technical skills, as well as to help develop an understanding of our products, our consumers, and our competitors. It is important to build your individual development plan for growth by working with your manager, HR department and other team members and/or mentors. To take advantage of opportunities, it is important to work hard, take an active role, be knowledgeable about your company and to invest in building relationships within and outside of your company.

Interviewing dos and don'ts for young professionals & the ins and outs of negotiating your first salary!
T. S. COGSWELL (1)
(1) BakerCogs, Inc., Overland Park, KS, U.S.A.
Cereal Foods World 58:A10

There are easy tips that will help you in your interview process that will help you stand out from the rest of the candidates. There are also a few don'ts as well. After over thirty plus years of interviewing interns and professional food industry candidates, my experience can help you during your interview. "You are what you negotiate" and this is a skill you should learn before you enter your professional career. Enhancing your negotiating skills, right out of college, can greatly enhance your lifelong earning potential.

A recent graduate's experience in transitioning from school to work
L. R. BREWER (1)
(1) General Mills, Inc., Minneapolis, MN, U.S.A.
Cereal Foods World 58:A10

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 recent graduate just joining the ranks of working professionals. While completing my graduate requirements, I spent several months researching companies and interviewing. Searching for and applying to multiple career opportunities is a time consuming, but important commitment. There are many tips and key learnings I obtained during this transition that I would like to share with the attendees of this symposium. Students, and professionals, attending this session can ask questions and obtain perspectives on the opportunities and challenges in transitioning from school to work.

A post-doc's expectations in transitioning from academia to industry
J. E. BOCK (1)
(1) Brabender GmbH & Co. KG, Duisburg, Germany
Cereal Foods World 58:A10

Post-doctoral fellows are a unique category of potential hires for employers. They often develop strong analytical skills and expertise along with managerial and administrative experience during their fellowship, but may be passed over in the job selection process for new graduates or those with more industry or academic experience. This can leave post-doctoral fellows languishing in the gap that exists between their own expectations and those of employers. This presentation will provide an overview of what post-doctoral fellows expect and subsequently encounter in the job search, interview process, initial offer and negotiations, and on-boarding after hire. Key insights will be given to help post-doctoral fellows develop a more competitive presence in the job market, while potential employers will be given tips for how to spot and recruit top post-doctoral talent. Additional discussion will follow with the audience and panel speakers.

A student's expectations in transitioning from school to work
A. GOLDSTEIN (1)
(1) University of Guelph, Guelph, ON, Canada
Cereal Foods World 58:A10

Following graduation, the transition from academia to industry is a major milestone in a student's career. Students spend many years developing critical thinking, analytical, and communication skills while gaining knowledge in the area of cereal science. Upon transitioning to work, students expect to be presented with a variety challenges which they can approach and solve by utilizing the skills and knowledge attained through their academic experiences. This talk will be given from a personal perspective highlighting expectations and subsequent experiences of a MSc. graduate who transitioned to work as a research and development scientist in the food industry. The goal of the presentation is to provide insight to both academia and industry on the expectations of students transitioning from school to work. During the discussion period, the New Generation panel will also be present to provide further insight into this transition.

Overview of Health Risks Associated with Acrylamide and Mitigation Strategies in Carbohydrate-Rich Foods

Acrylamide: Health issues and resulting international attention
D. R. LINEBACK (1)
(1) JIFSAN/University of Maryland, College Park, MD, U.S.A.
Cereal Foods World 58:A11

Acrylamide was first reported in commonly consumed foods in April 2002. This announcement rapidly drew worldwide attention since acrylamide has been classified as a potential human carcinogen (IARC Class 2A, 1994). Due to a concern about potential adverse health effects, FAO/WHO rapidly convened an expert consultation that indicated this issue should be regarded seriously. A major lack of knowledge was identified in virtually all aspects of the issues involved and several recommendations were made which resulted in numerous research efforts worldwide. The major potential health concern involved has been whether the risk of cancer is increased from consumption of acrylamide in common food(s). Numerous epidemiological studies concerning acrylamide consumption from foods and cancer risks have indicated no increased risk in a number of specific cancers. A subsequent meta analysis of these studies indicated a lack of increased risk for any cancers studied. JECFA has conducted two risk analyses in 2005 and 2010. A major toxicological study in rats and mice, exposed to acrylamide in drinking water, also has been completed. The concern about potential adverse health concerns has resulted in significant efforts in mitigation and reduction of acrylamide in foods. So far no country has established limits for the acrylamide contents of specific foods, although some are developing guidelines and general recommendations. Codex has adopted a Code of Practice for the reduction of acrylamide in foods and an Acrylamide Toolbox has been developed and maintained by FoodDrinkEurope (formerly CIAA). The current status and implications of these efforts will be the focus of this presentation.

Mechanisms of acrylamide and acrylamide adduct formation
M. Granvogl (1), P. KOEHLER (2), P. Schieberle (2)
(1) Chair for Food Chemistry, Technische Universität München, Freising, Germany; (2) German Research Center for Food Chemistry, Leibniz Institute, Freising, Germany
Cereal Foods World 58:A11

After acrylamide was found in different kinds of processed foods in 2002, a lot of efforts have been undertaken to minimize the formation of this "food-borne" toxicant by industry and academic research. Acrylamide may be formed by the Strecker degradation of asparagine as well as via the Amadori compound of asparagine and reducing sugars or other alpha-hydroxycarbonyl compounds. In both mechanisms, 3-aminopropionamide plays a key role as a transient intermediate of acrylamide formation. Further, it is well-known that acrylamide is able to react with nucleophiles, such as thiols and primary amines, consequently leading to quite stable thioether or secondary amine formation. To elucidate the reactivity of acrylamide versus such functional groups, a number of food constituents, such as free amino acids (cysteine, lysine) and peptides (glutathione) were reacted with the unsaturated amide at different times and temperatures in model systems. After confirming the structure of the expected adducts, the respective carbon-13 labeled isotopologues were synthesized as internal standards to measure the efficacy of a given compound in acrylamide binding. In addition, it was checked whether the adducts were also able to re-liberate the bound acrylamide upon heating. Application of the newly developed stable isotope dilution assays on model systems (wheat flour) as well as on several food samples proved the presence of cysteine-acrylamide adducts in different processed foods for the first time. In the model systems, a clear dependence on the temperature as well as on the heating time was found. The varying amounts found in foods were also dependent on the processing conditions as well as on the food itself.

Process and recipe modifications to reduce acrylamide formation in bakery products
V. GOKMEN (1), B. A. Mogol (1), T. Kocadagh (1)
(1) Hacettepe University, Ankara, Turkey
Cereal Foods World 58:A11

Detection of acrylamide levels in processed foods has been an intensive area of research shortly after the discovery of acrylamide in heated foods by the Swedish researchers in April 2002. Several researchers have established that the main pathway of acrylamide formation in foods is linked to the Maillard reaction and, in particular, the amino acid asparagine. Thermally processed foods, especially bakery products encompass a vast range of different products with many ingredients, processes, recipes and scales of operation. The resulting acrylamide concentrations in these foods change with great deviations as influenced by product formulation and thermal processing conditions. In this presentation, recent research findings for acrylamide mitigation in bakery products are discussed in details. It is necessary to lower thermal energy input to limit formation of acrylamide, as well as other undesired compounds in bakery products during baking. However, lowering temperature requires longer cooking times in order to achieve desired product characteristics (color, taste, texture). As a potential strategy to shorten cooking time, conventional baking combined with radio frequency or with vacuum post-baking processes is exemplified to mitigate acrylamide formation in biscuits.

Improved breeding and variety evaluation methods to reduce acrylamide formation in potato products
C. YENCHO (1), O. Adedipe (1), P. Bethke (2), A. Bussan (3)
(1) NC State University, Raleigh, NC, U.S.A.; (2) USDA ARS, Madison, WI, U.S.A.; (3) University of Wisconsin, Madison, WI, U.S.A.
Cereal Foods World 58:A11

The U.S. potato industry has encouraged the development of new potato varieties to reduce the acrylamide content of processed potato products and minimize potential health concerns related to acrylamide consumption. With the support of the USDA Specialty Crops Research Initiative, an industry, government and academia partnership has been developed to address this need. The project, led by the University of Wisconsin, has 24 collaborators from 11 institutions. Research and extension specialists across the U.S. are working with potato growers, processing companies and end-users to address system-wide challenges related to new variety development, adoption and acrylamide mitigation. Areas of emphasis include research in potato breeding to manipulate the glucose, fructose and asparagine content of potato; work to improve potato quality, appearance, texture and taste; high through-put quantification of key biochemistries associated with acrylamide formation; and economic analysis focused on improving production efficiency, and profitability over the long term. The unprecedented level of participation across regions and disciplines in this project highlights the commitment of the entire potato industry to this important issue. This transdisciplinary approach is making rapid progress. In the long term, we expect that it will accelerate the commercial adoption of improved potato varieties and reduce the acrylamide content of processed potato products to as low as reasonably achievable. This talk will provide an overview of this project with an emphasis on breeding and variety development as a means to reduce acrylamides in processed potato products.

Applying enzymatic modifications to decrease acrylamide formation in foods
H. V. HENDRIKSEN (1), G. B. Lynglev (1), M. J. Baumann (1)
(1) Novozymes, Bagsvaerd, Denmark
Cereal Foods World 58:A11

Cereal and potato based food products, which have been prepared by baking or frying, can contain relatively high levels (30-7500 µg/kg) of acrylamide. Acrylamide is formed from the amino acid asparagine and reducing sugars by a Maillard type of reaction. Asparaginase, an enzyme that hydrolyses asparagine to aspartic acid, can reduce acrylamide formation in food products by lowering the amount of the essential precursor, asparagine, in the ingredients. A microbial derived asparaginase has been tested in a range of food production processes and resulted in 35 to 95% reduction of acrylamide content in the final food products. The effect of the enzyme depended upon type of ingredients, recipe, processing parameters and enzyme dose. In dough-based applications, the enzyme showed the highest effect reducing acrylamide formation by 75-95%, while in less homogeneous systems like French fries, sliced potato chips and green coffee beans effects were lower, typically ranging from 35 to 70%. Mechanistic studies looking at diffusion of substrate and enzyme, in various food matrices were made, enabling an evaluation of what is limiting enzyme performance. This presentation summarizes results obtained by implementing a commercial asparaginase in a range of food products, including biscuits, snacks, French fries and coffee, focusing on the effect on acrylamide formation in the final product. Results from lab scale, pilot scale and industrial scale testing are presented and discussed in relation to the mechanistic studies.

Pulses as Complementary Ingredients in Cereal-Based Products

Opportunities to capitalize on pulse protein quality
J. D. HOUSE (1)
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Cereal Foods World 58:A12

Pulses, the edible seeds of plants in the legume family including dry peas, beans, chickpeas and lentils, are globally important as a vegetable protein source. Pulses play significant roles in vegetarian and vegan diets and historically have been combined with cereals for a complete diet. The rich lysine content of pulses complements the lysine deficiency in cereal grains and these in turn complement the limiting sulphur amino acid content in pulses. Based on this complementary model, food developers have the opportunity to formulate products using optimal blends of legume and cereal flours that may result in the ability to market food products as a good source of protein. Various methods exist to measure protein quality. To date, protein quality for pulses range between 0.8 and 2.3 for cooked and dry pulses using the protein efficiency ratio (PER), and between 50 and 70% for dry pulses using the protein digestibility corrected amino acid score (PDCAAS). Factors, including processing conditions and anti-nutritional facts can also impact the quality of pulse proteins for the human diet. Very recently, a new method called the Digestible Indispensible Amino Acid Score (DIAAS) method has been proposed for measuring protein quality and its use may lead to both challenges and opportunities for the plant-based protein industries. The pairing of pulses with cereal grains has the potential to position blends of plant proteins that will meet and even exceed proposed cut-off criteria for regulatory claims related to protein quality.

Partial germination of pulses to produce novel, healthy ingredients
S. KAPPELER (1), E. Zamprogna Rosenfeld (1), S. Bellaio (1)
(1) Buhler, Uzwil, Switzerland
Cereal Foods World 58:A12

Germination is a natural way to improve the nutritional value, the functional and the sensory properties of grains, such as pulses and cereals. Particularly, pulses are a naturally rich source of protein, soluble and insoluble fibers, vitamins and minerals. This highly nutritious crop is unfortunately still underexploited at industrial scale and it is rarely used as an ingredient in processed food products due to nutritional and sensory issues. The presence of some indigestible carbohydrates causes in fact digestive discomfort for some people, while the presence of natural antinutrients reduces the bioavailability of several micronutrients. Moreover, the strong taste of pulses make it more challenging for food manufacturers to include them in food formulations. Germination is a known powerful process able to naturally reduce the antinutrients and remarkably augment the nutrients in pulses. Traditionally it is performed at household level in many countries, but now an industrial process, called Pargem, has been developed in order to apply the advantages of natural germination at an industrial scale, and therefore enable the development of innovative food ingredients. The chemical properties of several Pargem products have been extensively analyzed, showing a remarkable reduction in the antinutrients content, along with significantly increase of micronutrients. When integrated into food formulations, the Pargem ingredients show also peculiar functional and sensory properties, mainly related to the chemical and structural changes that take place within the grain during germination, such as improvement of the simple sugars and enzymatic activity. These results clearly indicate that that Pargem grains and flours have a remarkable potential as valuable, novel and fully natural ingredients with a high nutritional value and improved properties for novel food formulations.

Understanding the impact of pulse flour properties on product quality
L. Bourré (1), H. D. MASKUS (1), L. Malcolmson (1), Y. Supeene (1), E. Assefaw (1)
(1) Canadian International Grains Institute, Winnipeg, MB, Canada
Cereal Foods World 58:A12

When using pulse flours in food product applications it is necessary to understand how flour properties can influence end product quality. The objective of this study was to evaluate the physical, compositional and functional properties of pulse flours processed under different conditions and correlate the resulting flour characteristics to the end product quality of several food products. Both whole (W) and split (S) yellow pea (YP) (CDC Meadow) and red lentil (RL) (CDC Maxim) were processed into flour using 5 different milling methods; hammer (H), fine pin (FP), coarse pin (CP) roller (R) and stone (S) milling. The resulting flours were analyzed for protein, ash, particle size distribution, water and oil absorption capacities and foaming and emulsification properties. Flours were then used in food product formulations including extruded products, baked goods and pasta. Product quality was evaluated and correlated to the functional properties of the flours.

Optimization of extruded snack products using pulse ingredients
S. HOOD-NIEFER (1)
(1) Saskatchewan Food Industry Development Centre, Saskatoon, SK, Canada
Cereal Foods World 58:A12

Food extrusion cooking technology involves the manipulation of ingredients with temperature, pressure and shear conditions and forming through a restrictive die to generate a wide array of textured and shaped food products. The extrusion team at the Saskatchewan Food Industry Development Centre has worked extensively with a variety of pulse ingredients creating direct-expanded snack and breakfast foods, texturized vegetable proteins, co-extruded snacks, pasta and compact breakfast and snack products. Extruding pea or lentil flours milled using hammer, roller, pin or stone milling techniques generated pulse flours with a variety of particle sizes and functionalities. Pulse ingredient functionality, particularly water absorption and hot paste viscosity, influence final extrudate quality (air cell size, texture, mouthfeel, and flavour). Thermal history and/or pretreatment of the pulse flours will also alter functionality and, thus, extrudability. Optimization of extruded products varies based on type of product, consumer demands, type of pulse, milling method and functionality of the flours.

Applications of pulses as gluten-free ingredients
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Cereal Foods World 58:A12

The market for gluten-free foods and beverages reached $4.2 billion in 2012 and is projected to exceed $6 billion in 2017. With growing demand for gluten-free products there is a need to find ingredients that deliver improved end-product quality since many gluten-free baked goods tend to be bland, dry and crumbly with shortened shelf-life. For individuals who do not consume gluten, there is a need to provide healthier options since many gluten-free products have low levels of protein, fiber, iron and B vitamins. Pulse flours are ideal for developing healthier gluten-free baked goods since they are low in fat and high in protein, fiber, iron, folate, calcium and other minerals. Pulse flours also exhibit functional advantages including greater water absorption and foaming properties than other gluten-free ingredients. Pea, bean, chickpea and lentil flours were used to formulate a wide range of gluten-free bakery products including muffins, waffles, cookies, cakes, pizza crusts, and flat breads. In all cases, the nutritional properties and end-product quality was improved compared to products made with standard gluten-free ingredients.

Recent Advances in Starch Research

Synchrotron spectro-imaging of starch structure and properties
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Cereal Foods World 58:A12

Synchrotron techniques are being increasingly used on plant biopolymers for a better understanding of biosynthesis, structure or fractionation. This knowledge is essential to achieve a better use of agricultural resources. The presentation briefly describes some results obtained on starch at French synchrotrons SOLEIL and ESRF. Starch is made of two distinct glucose polymers (linear amylose and highly branched amylopectin) and has a complex semi-crystalline granular structure exhibiting size and shape dependence on botanical origin. Most uses of starch require the disruption of the granule through enzymatic or hydrothermal treatments. On native single starch granules, synchrotron was used for mapping both crystal orientation (x-ray microbeam diffraction), and phosphate groups or GBSS1, the enzyme responsible for amylose biosynthesis (x-ray microfluorescence) at the micron scale. A high resolution (0.13 nm) 3D model for A-type starch crystal domains has also been determined using x-ray microbeam diffraction on individual amylose micron-sized single crystals. The other examples concern starch materials and enzymatic synthesis or hydrolysis of starch molecules. The structural anisotropy present in shape memory starch-based materials was analyzed by SR polarized infrared micro-spectroscopy. The structure in solution of amylosucrase and the first stages of entanglement of amylose during its *in vitro* enzymatic synthesis were determined by Small Angle X-ray Scattering. Remarkable results were also obtained on enzymatic hydrolysis of

concentrated raw starch, taking advantage of new techniques implemented at SOLEIL. Synchrotron UV fluorescence was used for 3D mapping of amylases within single starch granules without staining, and synchrotron circular dichroism to approach the conformational changes of enzyme when adsorbed onto solid starch.

Use of octenylsuccinic starch in emulsion applications
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Cereal Foods World 58:A13

Native starch has limited industrial applications and often needs to be modified to enhance its functional properties. After starch is reacted with octenylsuccinic anhydride (OSA), a lipophilic starch is produced and has the ability to stabilize oil-in-water emulsions. One major application for OS starch is the stabilization of flavors in beverages. A stable emulsion also is critical when making encapsulated water-insoluble vitamins such as vitamin A and vitamin E (VE). The use of OS starch in those emulsion applications will be reviewed in this presentation and factors affecting the VE emulsion will be discussed in details. VE emulsions were formed by adding VE acetate in an OS starch solution with 50 g distilled water and homogenizing with a microfluidizer at 20,000 psi. A high-performance liquid chromatographic (HPLC) method was developed to analyze VE in emulsion, and the results were used to estimate the amount of surface VE oil. The effects of solid content, ratio of oil to starch, pH value, and free OS content on emulsion properties were examined. A stable emulsion of VE nanoparticles (0.1 μm) was produced using 20,000 psi, 12 passes, 5 g OS starch and 5g oil. Increasing the number of passes reduced the particle size of the emulsion but decreased the stabilizing ability of OS starch. For the same ratio of oil to starch (1:1, w/w), only emulsions with lower solid contents (6 g, 8 g, or 10 g) had small particle size (volume mean diameter was lower than 0.4 μm) and high oil load efficiency (nearly 100%) as fresh emulsion samples. The emulsion was little affected when pH value of the water was between 3 and 8. Increased free OS content (0.5, 1.0, 1.5%; based on the weight of OS starch) increased the particle size and decreased oil load.

Evolution of starch structure during wheat endosperm development
E. BERTOFT (1), D. Kalinga (1), R. Waduge (1), K. Seetharaman (1)
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Cereal Foods World 58:A13

The evolution of the structure of the starch components in wheat endosperm was followed through pre- to post-physiological maturity. At 7 days after anthesis (DAA) the developing endosperm contained small, lenticular starch granules, which later apparently became the population of large granules. Small granules had started to develop in the endosperm at 14 DAA. Starch granules from 7 DAA and 14 DAA already possessed an ordered crystalline structure and blocklets with a fuzzy contour were observed by AFM on the surface of the granules. Later, the blocklets obtained a more defined contour. Apparent amylose content was initially low but the structure of this component suggested that it in fact consisted of a material of intermediate type between amylose and amylopectin. The fine structure of the amylopectin component was very similar throughout the development with small, but distinct, differences between the large and small granule populations. Towards the end of the pre-maturity stage (28 DAA), the clusters consisted at average of 15–16 chains that were organised into ~8 tightly branched building blocks. It appeared that the external structure of the amylopectin was less organised at this stage. At the time of harvest maturity (49 DAA), some changes in the amylopectin structure had occurred, possibly due to trimming of the external chains by branching and/or debranching enzymes. This resulted in a slight decrease of the size of the clusters due to the loss of a branch chain in the form of a small building block.

How is the assembly of crystalline lamella influenced by the molecular structure of amylopectin?
V. VAMADEVAN (1), E. Bertoft (1), K. Seetharaman (1)
(1) University of Guelph, Guelph, ON, Canada
Cereal Foods World 58:A13

The structure of amylopectin is characterized by the unit chain length profile and the nature of branching pattern, which determines the alignment of glucan chains during biosynthesis. Numerous studies have investigated the unit chain profile of amylopectin and their impact on starch structure and functional properties. However, the structural basis for the functional properties of starches from different botanical origin is poorly understood. Internal unit chain profile of amylopectin from a different botanical sources have demonstrated that the nature of the branching pattern, which includes the distance between the branching points within the cluster (IB-CL), the number of branched building blocks (NBbl), and the size of the clusters, plays a crucial role in determining the architecture of the granule. The relationship between the internal unit chain profile and thermal and annealing behavior of starches from four different groups of amylopectin was investigated. Amylopectin clusters with a higher number of chains, more frequent branching, and shorter external chains showed lower melting temperature and enthalpy, and higher susceptibility to annealing. The results highlighted that (i) the NBbl and IB-CL within the clusters influence the packing of double helices within the crystalline lamellae (ii) shorter distances between the branching points within the cluster enhance the number of unpacked double helices within the crystalline lamellae and (iii) longer external chains increase the numbers of splayed double helices, which are not paralleled packed within the crystalline register. A model was proposed based on the backbone concept of amylopectin structure that explains how the organization of chains in the semicrystalline lamellae relates to the thermal properties. The validity of the model was tested by annealing.

On the gelatinisation and gelation of aqueous starch suspensions: Molecular, nanomorphological, and mechanistic aspects
B. GODERIS (1), S. Gomand (1), J. Putseys (1), C. J. Gommes (1), P. Van Puyvelde (1), J. A. Delcour (2)
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Cereal Foods World 58:A13

Starch consists of quasi linear amylose (AM) and the highly branched amylopectin (AP). The molecules are packed into micrometer-sized, semicrystalline granules containing nanometer-sized lamellar crystallites. The importance of the granule molecular composition and thermal treatment on the suspension viscosity during gelatinisation and pasting in the presence of shear was studied using calorimetric and rheological methods in conjunction with Small Angle X-ray Scattering (SAXS). Annealing tends to increase the crystallite thickness for AM-rich starch, whereas the crystal surface energy decreases for AM-free starch. In starches with intermediate AP/AM ratio, both mechanisms occur. These crystal stabilization mechanisms increase the gelatinisation temperatures and affect the pasting-related rheological behaviour. Usually, the viscosity starts to increase during heating at a given temperature and collapses again during further heating beyond the peak viscosity. Deviations from this classical behaviour are grounded in the presence of very stable AM crystals that survive the suspension heating-shearing treatment. Cooling of a sheared hot starch paste causes the viscosity to increase again and produces a gel. *In situ* SAXS experiments clearly point to the creation of finely dispersed, elongated nano-objects that are interpreted as aggregated AM double helices that provide the system with physical, intermolecular crosslinks. The gel storage modulus is proportional to the aggregate size and concentration. When shearing is stopped, the aggregates promptly grow and agglomerate into larger fractal objects, resulting in an increased gel stiffness.

Role of Extrusion in Improving Nutritional Profiles of Cereal Foods

Effect of processing on selected nutraceuticals in quinoa, amaranth, and buckwheat
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Cereal Foods World 58:A13

Effects of processing on key nutraceuticals in the pseudocereals amaranth, buckwheat, and quinoa were investigated. Amaranth is a good source of squalene and tocotrienols, buckwheat is a good source of polyphenols, and quinoa contains saponins, in addition to other micronutrients and minerals. Whole amaranth was roasted and puffed. A single screw extruder without a die was used to continuously puff amaranth grains. Ground amaranth flour was extruded using high temperature short time extruder with a die. Roasted, puffed, and extruded amaranth samples were analyzed for squalene content and ORAC value. Ground whole buckwheat flour and buckwheat white flour was roasted and extruded. Roasted and extruded buckwheat samples were analyzed for total phenolics content using DPPH assay. Quinoa flour was roasted and extruded. In addition, quinoa flour was subjected to nixtamalization. Processed quinoa samples were analyzed for their chemical profile and CLA content. It was found that Squalene was stable during puffing and roasting. A single screw extruder with tapered screw without a die could be effectively used for continuous puffing of amaranth with accurate temperature and residence time control. ORAC assay showed that squalene by

itself and raw amaranth extract have good antioxidant potential and the activity was found to be dose dependent. Dark buckwheat flour had about four times more phenolic content than white buckwheat flour. Roasting slightly reduced the antioxidant activity of dark buckwheat flour. The anti-oxidant activity of buckwheat flour measured by DPPH method did not correlate well with the total phenolic content. Roasting and extrusion had significant impact on the chemical profile of quinoa. Evidence suggested that saponins were degrading during extrusion and roasting processes. However, roasting and extrusion did not increase the CLA content while nixtamalization increased the CLA content, slightly.

Rye and oat fibers as extrusion ingredients
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Cereal Foods World 58:A14

Extrusion by direct expansion is used both to produce expanded starchy foods and to improve the functionality of food ingredients. Dietary fiber, especially insoluble fiber, is a challenging food component in terms of formulating foods with sensory quality appealing to the consumers. Rye and oat brans offer good sources of cereal dietary fiber, consisting mainly of cellulose, arabinoxylan and β-glucan. In addition to fiber, they are also sources of associated phytochemicals as well as protein and starch. The process-induced changes in the complex and partly very resistant aleurone structure should be elucidated at different structural levels in order to render bran preparations as part of food matrix with desired eating quality. Rye bran containing 30% dietary fiber and 38% starch was milled to reduce the particle size, and co-rotating twin screw extruder was used for extrusion with various process parameters. Decreasing the particle size to 28 μm gave more expanded (223-176 %), less hard (145−210 N), more crispy ($5.8–2.8\times10^{-4}$) and porous (83.9-65.1 %) extrudates as compared to those made of bran with particle size of 450 μm. Depending on particle size and processing conditions, some changes occurred in the amounts and ratio of insoluble to soluble fiber. Oat bran enriched in β-glucan, as well as solubilized and partially hydrolyzed oat bran β-glucan, was studied for enrichment of oat starch extrudates. The effects of the form of dietary fiber on the microstructure and physical properties (expansion, hardness, crispiness, pore size, void volume and microscopic characteristics) were studied. Reduction of molecular weight and increasing the solubility of oat β-glucan improved the structure of extrudates in products containing about 7–10% fiber.

WITHDRAWN

Precooked analog products using low-shear extrusion—A novel nutrition delivery mechanism
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Cereal Foods World 58:A14

Extrusion is a well-known process for producing expanded cereals and snacks. This process results in a highly-sheared, well-cooked final product. The cooked starches give excellent product integrity, but the high energy inputs often result in destruction of any included micronutrients. Extrusion is also utilized in the production of traditional pasta. This process is primarily a cold-forming operation involving little or no cooking. The product matrix relies primarily on the protein network formed during kneading for its resilience and strength after forming and drying. While this allows for excellent retention of micronutrients, the products are often quite brittle in nature. This presentation will describe a unique extrusion-based process involving cooking and forming. The process relies on thermal cooking of starch and then only a gentle kneading action in the extruder. 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 limited time for preparation, as only thorough hydration is required, not additional cooking. This processing technique can be used for a range of 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 natural rice, lentils or beans with the added benefit of reduced preparation time, fortification with and retention of bioactives and micronutrients, and cost-effectiveness due to potential use of less expensive alternate ingredients such as corn, wheat, sorghum, and soybean. Data will be presented related to degree of gelatinization, micronutrient retention, textural attributes, preparation techniques and sensory quality of these extrusion processed products.

Technologies & Issues for Rice Quality Determination

U.S. rice industry—Quality issues and potential solutions
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Cereal Foods World 58:A14

U.S. long-grain rice has historically been considered the quality standard of the world. In recent years, however, some domestic and international customers have complained about quality components of southern U.S. long-grain rice. A 2012 study evaluated differences in U.S. long-grain cultivars grown in similar environments for objective and subjective quality traits. In this project, 19 southern U.S. inbred varieties and hybrids were grown in 11 environments. Samples generated in these studies were milled to a consistent degree using near-infrared spectroscopy technology. The study also included imported milled rice samples from Uruguay and Thailand. Samples were evaluated by 10 southern U.S. commercial rice mills for bran streaks, chalk, kernel color, uniformity of grain length and overall appearance. Several other quality parameters were measured by the USDA Rice Quality Lab in Stuttgart, AR, and by the Rice Experiment Station in Biggs, CA. The study did confirm that there are inherent differences among the major commercially available pure line varieties and hybrids in all of the rice grain quality traits that were evaluated. Some varieties consistently scored more favorably for the important quality traits than did others. In order to improve the overall quality of the southern U.S. long-grain rice crop, there must be an economic incentive for rice producers to plant those rice varieties that have higher quality but perhaps not the highest yield potential. Some of the rice mills in the region have begun recently to offer price premiums to producers for varieties that typically display better grain appearance, improving quality in localized areas. However, it will take a similar price premium program across the entire southern U.S. rice belt to have a major impact on improving the overall quality of the majority of the long-grain rice produced in the region.

California rice—Capturing quality
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Cereal Foods World 58:A14

Commercial rice production in California was established 1912 along with the founding of the Rice Experiment Station near Biggs, CA. USDA scientists tested and identified a few plant introductions that successfully produced a rice crop in small plantings in the heavy clay soils of the Northern Sacramento Valley. Not only were the yields so high that their validity was questioned by rice producers elsewhere, but the grain quality was good enough to win awards at some agricultural expositions. Thus from the very beginning grain

yield and quality have been at the core of the breeding program. Two short grain introductions were grown until the 1950's when a break through medium grain variety, 'Calrose', was adopted and constituted 70% of the production by the 1970s. Grower funding for an expanded breeding program began in 1969 and has led to the release of 43 new California rice cultivars that include U.S. medium-, long- and short-grain market classes as well of specialty varieties. The breeding program has integrated quality selection procedures with selection for agronomic traits. Selection for rice quality includes visual selection for kernel characteristics, physicochemical testing, milling tests, and cooking tests. Elite experimental entries are provided to marketing organizations for evaluation and feedback that provides crucial input in determining their release for commercial production.

Weighing arsenic and other risks with the nutritional benefits of rice
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Cereal Foods World 58:A15

Recent news and media coverage regarding arsenic in foods such as rice has caused some consumers and wary health professionals to eschew certain foods, despite advice from the FDA and others not to make such dietary changes. This talk will highlight the current status of the arsenic controversy and assess the wisdom of dietary modifications that result in the elimination of foods or food groups. The latest FDA arsenic analysis along with other analyses will be discussed in light of arsenic speciation, sources, intakes, dose response and toxicity. The critical importance of a well-balanced and varied diet in order to minimize the effects of toxicants such arsenic will be shown in light of the risks posed by this natural toxicant. Finally, a risk-benefit analysis will balance concerns about ingestion of very small amounts of arsenic with the risks of omitting rice and brown rice and other arsenic contributors from the diet by showing rice's importance in the provision of nutrients for both children and adults and the relationship of rice and brown rice intake with lower chronic disease risk.

Chalkiness in rice—Can we beat it?
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Cereal Foods World 58:A15

Chalk is a key trait of rice quality that significantly reduces the amount of whole milled grains of rice, and the value of the rice along the complete supply chain from farmer to consumer. For many years, breeding programs have selected against chalk in new varieties, but none have succeeded in developing chalk-free varieties. This suggests that chalk is not a highly heritable trait, is strongly influenced by G × E, or is controlled by multiple loci. In order to determine whether chalk is heritable, and the genes of chalk, a mapping population derived from a low and high chalk parent was used. The 240 progeny and parents were grown in 9 environments around the world and different metrics of chalk were scored for each line in each environment. QTL analysis revealed a number of significant loci, and QTL near introgression lines were constructed, that carried each QTL in the same chalky background. We therefore show that each QTL has only a small, but significant effect on chalk, but when all QTLs are combined, chalk drops from around 45% (no QTLs) down to 1% (all QTLs). These findings demonstrate that there is a significant genetic component of chalk, and that particular loci control the environmental component of chalk. By ensuring that all significant loci are pyramided in one background, chalk can be beaten, which has significant financial benefits to growers and traders, both from chalk values and an increase in head rice yield.

Infrared heating for improved drying efficiency, food safety and quality of rice
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Cereal Foods World 58:A15

Because agricultural and food sector demands energy efficient and environmentally friendly processing technologies, the applications of infrared (IR) heating for rice drying, disinfestation, disinfection and enzyme inactivation have recently been extensively studied at the Western Regional Research Center of USDA-ARS, and University of California, Davis. IR drying, as an alternative to current drying technologies, has attractive merits such as uniform heating, high heat transfer rate, reduced processing time and energy consumption. Our research has shown that rough rice can be dried with IR heating at a temperature up to 60 degree C followed by tempering without compromising the rice quality. The high temperature drying allowed a large amount of moisture removal during a very short heating time period and the cooling after tempering. It also achieved disinfestation and disinfection and partial enzyme inactivation. The enzyme inactivation could eliminate using additional process for inactivating enzymes in rice bran after milling and extend shelf life of rough and brown rice. The latest research and development of IR heating for rice will be reviewed.

Value-Added Processing of Oats and Barley

Oats—It's not just for breakfast anymore: New products from oats
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Cereal Foods World 58:A15

Oats are an incredibly nutritious food yet they have limited applications in human foods, primarily used in RTE breakfast cereals, oatmeal, granola bars, and cookies. Oats also have a hearty, 'good-for-you' image. However, they are a challenge to work with because of how the proteins, starch, lipids & fiber are structured in the kernel. Oats do not separate into different functional streams when milled. Thus, all oat flours contain fractions of the grain that interfere with crucial properties to make baked products & other foods. Oats have the best amino acid content of all the common cereal grains & contain nutriceuticals compounds like β-glucans & antioxidants. At Oat Tech Inc., we have gone well beyond the traditional uses for oats and successfully made natural sweeteners, high protein powder and other products in a natural, non-chemical process. OatSweet syrup contains many of the nutrients from the original oat yet performs on a one-to-one basis with corn or rice syrups in most applications. OatSweet has a flavor profile that is devoid of the grain flavor defect. It is very sweet, with a clean profile, a slight caramel/ honey flavor, creamy texture, and, clears off the palate well with no aftertaste or burn. Applications as a sweetener include cereals, coatings, breads, desserts, ice cream, granola bars, confections, and beverages to name a few. Our Oat Protein 55 is a bland, slightly sweet powder with an average protein content of 55%. The amino acid content is excellent and PDCAAS score high with a little lysine added. It is excellent as a protein supplement in cereal products such as bars, RTE's, clusters, beverages, etc. Our approach yields numerous opportunities for many more applications of oats in food.

Fractionation of hull-less barley for the production of functional fiber ingredients
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Cereal Foods World 58:A15

Barley is an excellent source of soluble and insoluble fibre and contains antioxidants, vitamins, and minerals; however there are few barley-based food ingredients that are convenient to use. The non-uniform distribution of phytonutrients within the barley kernel creates an opportunity for their segregation by dry-fractionation. Common processing techniques, such as pearling and milling, can be used to obtain grain fractions enriched in specific components with unique technological and physiological properties. These fractions can be utilized in a variety of food products; but, some customization and optimization of these traditional processes should occur to improve the composition and functional attributes of the fractions. Pearling (removal of outer grain layers), can produce barley fractions enriched in arabinoxylans with variable arabinose to xylose ratio. Recent developments in milling of hull-less barley for food have been aimed at obtaining milling fractions enriched in the cell wall non-starch polysaccharides and other bioactive components rather than generating traditional flour products. Fibre-rich fractions obtained via roller milling, pin milling, and stone milling may contain between 10 to 15% arabinoxylans and 12 to 26% β-glucans and have the additional benefit of being an excellent source of other bioactives (tocopherol, tocotrienols, vitamins). The composition and functional attributes of fibre-fractions depend on the processing conditions. The size, shape, and surface properties of fibre particles can be affected by the milling procedures which in turn influence their water hydration, structure-forming properties and solubility of non-starch polysaccharides. It is important to establish relationships between the processing conditions and technological / nutritional properties of these fractions to enhance their functionality in food products.

Strategies to minimize the challenges attributed to oat and barley cereal beta-glucan utilization

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Cereal Foods World 58:A16

The demand for cereal beta-glucan (BG) continues to grow due to its health benefits that are attributed to its ability to form aqueous micelle networks. FDA, Health Canada & EFSA approved health claims exist for BG. Development of BG enriched foods with physiologically active levels of BG are actively underway in many food industries. Since BG content is low in oat & barley grains, crop breeding efforts have been focusing to develop high BG varieties. Also, several dry & wet grain processing technologies have been developed to produce BG concentrates for food use. However, oat/barley ingredients such as flakes & flours, as well as BG enriched flour, bran & fiber concentrates produced by simple dry processing technologies are the primary eligible sources of BG approved for health claims. Cereal BG is an excellent hydrocolloid that binds to lots of water during food formulation, creating considerable viscosity & present issues such as sticking to machinery, slowing gluten development in wheat dough, etc. Enzymes (beta-glucanase, cellulase, etc) can make BG less effective by depolymerizing the molecule into smaller poly/oligo saccharides. These enzymes occur naturally in grains, and are also present in food ingredients such as malt flour, fruits, etc. Molecular fragmentation of BG is also possible in high shear processing (extrusion) of BG enriched foods. De-polymerized or fragmented BG molecules would show suppressed ability to form aqueous micelle network, and thus compromise health benefits. Furthermore, studies have shown that BG in foods can become insoluble during freezing storage, and then cannot form into the required micelle network in the intestinal tract that is important for health benefits. The presentation will focus on food processing & formulation strategies that will mitigate the above challenges to successfully produce BG enriched functional foods.

Barley protein microparticles as nutraceutical delivery systems

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Cereal Foods World 58:A16

Incorporation of nutraceuticals into the diet provides a convenient approach to create functional foods to improve public health and/or reduce the risk of chronic disease. The effectiveness of such foods relies on preserving the nutraceutical bioactivities prior to absorption. This represents a great challenge given that a large proportion of these compounds are unstable during food processing, under storage conditions or in the human stomach. Furthermore, some compounds remain poorly bioavailable after oral administration. This research reported a novel nutraceutical encapsulation system using barley protein as a wall material. Solid microcapsules were able to form in aqueous solution by a pre-emulsifying step followed by a high pressure homogenization treatment. No organic solvent or cross-linking reagents were used in the preparation process. The oxidative stability of microencapsulated nutraceuticals was tested at both dry status and in aqueous solutions in an accelerated storage test. These cereal protein microcapsules possessed a strong ability to protect nutraceutical against oxidation, making them ideally suited for use in liquid/semi-liquid food systems. Food formulation tests confirmed their successful application in milk and yogurt for their respective shelf lives. In vitro degradation and release tests in the simulated gastro-intestinal (GI) tract revealed that these microcapsules can protect nutraceuticals in the harsh gastric juice, and deliver them to a simulated human intestinal tract intact, where they were degraded by pancreatic enzymes and steadily released the core ingredients. The results indicate that barley protein based microcapsules have high potential to be used as efficient nutraceutical delivery systems.

Effect of processing on physicochemical properties and efficacy of oat and barley beta-glucan

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Cereal Foods World 58:A16

Barley and oat, major cereal grains grown in Canada, are rich sources of beta-glucan (BG) and total dietary fibre, making them valuable ingredients for functional foods. BG from oat and barley is known for its cholesterol lowering benefits, which have been recognised by health claims throughout the world, and its role in improving glycemic response has been documented in numerous scientific papers. Characteristics of BG believed to be important for incurring these benefits include viscosity, which is determined by concentration, solubility and molecular weight (MW). Therefore external factors (e.g. genotype, growing location and processing) that effect a change in one or more of these BG properties have the potential to influence physiological efficacy. In this study a wide range of techniques used in commercial and laboratory scale processing of oat and barley were examined for their effect on viscosity, solubility and MW. Processing methods included oat milling and flaking, other hydrothermal grain treatments, food processing techniques such as extrusion and tortilla production, as well as modifications to food preparation protocol. In most cases viscosity was increased through moderate processing treatments. Based on the results obtained, we were able to create barley food products with specific BG viscosity and MW properties (3 and 5 g BG dose with low viscosity/MW; 3 g BG dose with high viscosity/MW), which were used in a clinical trial to test cholesterol lowering effects in humans. The initial results revealed that all three BG diets used in the study significantly improved the total cholesterol levels in human. More importantly, high MW BG was more effective in reducing circulating cholesterol levels. We also found that barley BG supplementation was effective in reducing blood pressure levels in a concentration dependent manner.

Wheat Improvement in the 21st Century

Wheat breeding: Past, present, and future

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Cereal Foods World 58:A16

Genetic estimates of per-annum wheat yield gains tend to hover around 1%, a figure that would appear to fall short of satisfying long-term global demands for food production from all cereal crops. Such estimates tend also to be biased downward relative to breeding program-specific advances, and their interpretation can be overstated relative to a perceived genetic plateau. What cannot be overstated is the scientific energy devoted historically to protecting yield potential rather than, or at the expense of, extending it. Wide variation among breeding programs in realized or expected gains is the norm, driven by the divergence and number of breeding objectives subordinate or parallel to grain yield, which in turn are pre-determined by the target environment and the intended use. Common to the success of any wheat breeding program—public or private—is a set of three elementary prerequisites: a well-grounded and rounded team of scientific expertise, the ability to access and use novel germplasm, and a healthy revenue stream that rewards and stimulates progress. All have experienced change over the course of a near-century of U.S. wheat breeding, but the one most subject to change in the present is germplasm access. The one most subject to change in the future will be the ability to use the germplasm that remains accessible. More specifically, new progress will depend, as always, on creating and capturing novel variability. The future has never looked as bright, as new methods and technology signal a rejuvenation of yield advances with no less emphasis on wheat functionality. Leading a much longer list are reverse genetic approaches, genetic engineering applications that do not necessarily rely on transgenes, emergence of synthetic derivatives, a reawakening of hybrid wheat cultivar development, and genomewide selection.

Wheat genomics for grain quality improvement

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Cereal Foods World 58:A16

Advances in wheat genomics are providing new opportunities to advance wheat quality. Genome sequence data and low cost sequencing makes the association of quality traits with specific genes and alleles possible. This knowledge provides tools for quality selection in wheat breeding removing a major constraint to rapid development of varieties and allowing increasing wheat productivity. New approaches to varietal identification are likely to emerge with the power to analyse complex mixtures. Improved wheat milling and end product processing will also be enabled by the improved understanding of the genetic and molecular basis of performance in these processes. Analysis of the transcriptome of the developing wheat seed has recently provided new insights into the molecular basis of wheat quality.

Increasing resistant starch in wheat using TILLING
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Cereal Foods World 58:A17

Wheat (*Triticum aestivum* L.) provides approximately one fifth of the calories consumed by the human population and is an important source of the carbohydrates, proteins, fats, vitamins and minerals that contribute to a healthy human diet. Since starch is the major component of the wheat kernel (~50-70% of its dry weight), any improvements in its nutritional composition have the potential to deliver benefits to many people. Starch in the wheat grain consists of approximately 70-80% amylopectin and 20-30% amylose. Amylopectin is a highly-branched, readily digested polysaccharide, whereas amylose has few branches and forms complexes that resist digestion and mimic dietary fiber (resistant starch). As with fiber, increased consumption of resistant starch has been associated with reduced risk of diseases such as diabetes, obesity, heart disease, and cancers of the colon and rectum. Down-regulation of the *starch branching enzyme II* (*SBEII*) gene by RNA interference (RNAi) was previously shown to increase amylose content in both hexaploid and tetraploid wheat. We generated ethyl methane sulphonate (EMS) mutants for the *SBEIIa*-A and *SBEIIa*-B homoeologs in the tetraploid durum wheat variety Kronos (*T. turgidum* ssp. *durum* L.). Single-gene mutants showed non-significant increases in amylose and resistant starch content, but a double mutant combining a *SBEIIa*-A knock-out mutation with a *SBEIIa*-B splice-site mutation showed a 22% increase in amylose content ($P<0.0001$) and a 115% increase in resistant starch content ($P<0.0001$). In addition, we obtained mutants for the A and B genome copies of the paralogous *SBEIIb* gene, mapped them 1-2 cM from *SBEIIa*, and generated double *SBEIIa-SBEIIb* mutants to study the effect of the *SBEIIb* gene in the absence of *SBEIIa*. These mutants are available to those interested in increasing amylose content and resistant starch content in durum wheat.

The changing wheat breeding industry
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Cereal Foods World 58:A17

Wheat breeding is responding to global climate change, population growth and greater demand for land use by investment in molecular breeding, information and sensing technology, and increasingly standardized germplasm development protocols. Wheat production increases globally but at a slower rate than observed from 1960 to 1990. Global production will not grow as fast as global population in the near term and demand for protein will continue to exceed production. Breeding programs increase in size and sophistication of data management to increase the gain from selection. The slowing growth in production is due in part to global climate change. To increase tolerance to abiotic stress, programs are developing high-throughput phenotyping to measure plant physiology. The most common high-throughput phenotyping uses remote sensing technology. The genetic complexity of wheat limits the application of high-throughput genotyping methodologies that are widely used in maize. Global initiatives and corporate investment are developing standardized molecular markers and genotyping by sequencing method. The cost and complexity of the molecular tools will cause standardization of breeding protocols and germplasm types. The impact for cereal chemistry may be mixed. Uniformity and reliability of product may be maintained in the face of increasingly variable climate. The cost increases associated with small carryover of wheat stocks will continue but hopefully mitigated by increased rates of grain yield improvement. However, grain protein concentrations will likely decrease. To increase yield more quickly, breeding should focus on quality per unit of protein. Procurement strategies to source wheat with high quality per unit of protein will be critical for maintaining reliable quality flour.

Whole Grains, from Evolution to Revolution

Trends in whole grains and market development
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Cereal Foods World 58:A17

Three major consumer trends are important to understanding continuing momentum in the market for whole grain products. The first is consumers' growing appreciation of the nuttier, fuller taste of whole grains; increasingly taste is being cited as a motivation for choosing whole grains, rather than as a barrier. This is leading to increased levels of whole grain in many products, moving us beyond the "starter" products of earlier years. The second trend, also related to taste, is a growing awareness that different grains offer different tastes and textures. "Whole grain" is not one monolithic taste. We understand intuitively that eating a wide range of vegetables is key to good health and enjoyment of our foods – but we are only now beginning to understand that the same is true with grains. Consumers are beginning to explore the many diverse and intriguing tastes of whole grains, and as they explore they want to know the backstory of each grain, to get familiar with its origins. For many, a vivid culture and history offer the assurance that these grains are part of traditional eating patterns, rather than something created through technology or processing. Health is the third trend and today, consumers' health concerns about grains center largely on the issue of gluten. This concern is valid for many people, as increased incidence of gluten sensitivity has been scientifically established. It's important, however, to remind consumers that gluten-free doesn't mean grain and in fact most whole grains are gluten-free and should be part of a healthy diet for those with a gluten sensitivity. This presentation will detail the three trends above, and show how these trends are impacting opportunities for whole grains at retail and in foodservice.

Regulatory update: Whole grains
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(1) American Bakers Association, Washington, DC, U.S.A.
Cereal Foods World 58:A17

Ms. Lee Sanders, CAE, American Bakers Association Senior Vice President for Government Relations and Public Affairs, will provide an update on whole grain regulatory policy including associated nutrition labeling requirements, labeling claims, guidance and fortification policy that impact the baking industry.

Supply and demand—Can we sustain the whole grain market? Milling operation redesign to deliver whole grains
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Cereal Foods World 58:A17

With increasing consumer demand for whole-wheat and other whole grain foods the flour milling industry has also needed to increase its capacity to produce whole grain flour. Although whole-wheat flour only accounts for roughly 5% of the annual U.S. wheat flour production, this segment continues to increase each year and will for the foreseeable future. In this talk I will discuss a pilot study done at Kansas State University in the Hal Ross Flour Mill, where we produced 100% whole-wheat flour by modifying our standard milling flow. The outcome of this study provides a strategy to produce 100% whole-wheat flour with existing equipment and without significant mill redesign. In addition to this study I will discuss alternative approaches and the challenges of meeting demand in a small but growing segment of the flour milling industry.

Challenges for developing whole grain baked goods—Impact of flour shelf life on baking quality, performance, and sensory
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Cereal Foods World 58:A17

To help consumers meet dietary recommendations for whole grain intake, continued progress is needed in increasing the availability and consumer acceptance of whole grain foods. Storage, packaging, and transportation of grain ingredients can affect their functionality and flavor, especially for whole grain ingredients. Generally recommended storage conditions for grain ingredients are <75 °F and <50% relative humidity. However, milled grain ingredients may encounter non-ideal storage conditions in the supply chain. Chemical changes begin once an intact kernel is milled to flour, flakes or other particulates. The effects vary based on factors including grain type, storage conditions and product formula and process. In this research, changes in chemistry, baking performance and flavor were monitored over time in whole wheat flours and whole wheat baking mixes held under different storage conditions. The effects of treatment with heat and antioxidants were also used as potential methods to increase the shelf stability of grain ingredients and baking mixes. Familiarity with the changes that occur over time and under different storage conditions are important to help manage the supply chain and help product developers maximize the consumer acceptability of whole grain baked goods and mixes.

Standard methods for whole wheat flour evaluation

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Cereal Foods World 58:A18

Breeders rely on numerous approved methods to provide objective data for the evaluation and selection of superior wheat varieties in various milling and baking end-uses. Millers rely on approved methods for the evaluation of wheat sources to insure they provide appropriate flour to satisfy specific baking needs. Bakers rely on approved methods to verify they receive flour of appropriate quality for their unique formulas. Cultivar development programs rely on approved methods to evaluate germplasm prior to release to growers. The universal use of approved methods throughout the supply chain has provided the means for continual improvement of wheat varieties and has also provide high-functioning flour at a relatively low price. However, this is not the case for whole-wheat flour. Very few methods have been developed for the specific use in evaluating wheat for whole-wheat utilization. Due to fundamental differences in flour performance due to variation in bran, lipids protein and particle size between refined flour and whole grain flour, current methods do not provide useful information in whole-grain applications. This is important because, for a baker to buy high-functioning whole-wheat flour today, they have to purchase the material for a miller who typically has contracted- grown a specific wheat variety, in a specific region (Identity Preservation). This presentation will review current methods that can be utilized and possibly expanded for use in evaluating wheat for whole-grain utilization. This includes any possible milling methods (or particle size targets) for whole-wheat flour, flour tests for evaluation of desired traits, and baking methods for both yeast leavened and chemically leavened whole-wheat products.

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2013 Annual Meeting
Abstracts of Oral Presentations

Abstracts submitted for oral presentations at the 2013 annual meeting in Albuquerque, New Mexico, September 29–October 2, 2013. 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: Aguayo, J., Gaxiola Cuevas, N., Mora Rochin, S., Perez Uriarte, J. H., Gutierrez Uribe, J. A., Serna Saldivar, S., Cuevas Rodriguez, E., Reyes Moreno, C., and Milan Carrillo, J. 2013. Anthocyanins in flours and tortillas elaborated from Mexican blue maize through extrusion lime-cooking process. (Abstr.) Cereal Foods World 58:A19. http://dx.doi.org/10.1094/CFW-58-4-A

Anthocyanins in flours and tortillas elaborated from Mexican blue maize through extrusion lime-cooking process

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Cereal Foods World 58:A19

Blue maize is an important source of anthocyanins a natural pigment with high antioxidant activity, which plays a vital role in the prevention of neuronal and cardiovascular illnesses, cancer and diabetes, among others. The effect of extrusion lime-cooking process on the levels and profiles of anthocyanins in flours and tortillas elaborated from five blue Mexican maize genotypes was investigated. The extrusion operation conditions of a single screw extruder were 85°C and 240 rpm of temperature and screw speed, respectively. The anthocyanins were identified and quantified using HPLC/LC-ESI-MS. The extrusion lime-cooking process caused a decrease ($p<0.05$) in the levels of total anthocyanins when compared to raw kernels; furthermore, a modification in anthocyanins profile was observed. Flours and tortillas prepared through extrusion process retained 36 to 78% and 9 to 33 % of total anthocyanins, respectively. Extrusion cooking process caused an increase in the proportion of simple anthocyanin (pelargonidin-3-glucoside) and a decrease in the acylated anthocyanins [cyanidin-3-(6"-malonylglucoside), cyanidin-3-(6"-succinylglucoside), pelargonidin-3-(6"-malonylglucoside) and cyanidin-3-(6"-disuccinylglucoside)] when compared with unprocessed kernels. Most of the tortillas kept a very desirable blue color.

Effects of the amount and type of fatty acid on the in-vitro starch digestibility and expected glycemic index of millet starch

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Cereal Foods World 58:A19

This study investigated whether the amounts and types of fatty acids present in millets played any role in their hypoglycemic property. The first part of the study consisted of complexing cooked pearl, finger, proso and foxtail millets with palmitic, oleic, linoleic and elaidic acid in the amounts present in their respective millet flours. The second part involved complexing the same amount (2 mmol/g of starch) of these fatty acids to the millet starches and subjecting the complexes in both parts of the study to in-vitro starch digestibility and calculating their expected glycemic index (eGI). The complex index (CI) of the fatty acids was also determined. The CI of the fatty acids increased with increasing unsaturation. Significant ($p<0.05$) reductions in the in- vitro starch digestibility and eGI of the millet starch-fatty acid complexes was observed. Reductions in the starch hydrolysis of the samples were significantly linked to the amounts of the fatty acids added. The addition of 2.29 mg palmitic acid and 23.8 mg linoleic acid/g of proso millet starch resulted in expected glycemic index of 63.6 and 53.1 respectively. Unsaturated fatty acids generally resulted in less starch being hydrolyzed. Oleic acid was the most effected in reducing the amount of starch hydrolyzed resulting in the decrease in the eGI of finger millet starch from 65.4 to 51.3 when 2 mmol/g of starch of oleic acid was added. Linoleic acid however resulted in slightly more starch being hydrolyzed as seen with trans oleic acid compared to the cis configuration. The amount and type of fatty acids therefore played a significant role in the hypoglycemic property of millet.

The structure of the starch granule affects cereal grain germination

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Cereal Foods World 58:A19

Cereal grain germination is central for plant early development and efficient germination has a major role in crop propagation and malting. Endosperm starch is the prime energy reserve in germination and in this study we hypothesized that optimized starch granule structure, not only the endosperm starch content *per se*, is important for germination and seedling establishment. For that purpose we used barley wild-type (WT) and specifically engineered degradable hyper-phosphorylated (HP) starch and more resistant amylose-only (AO) starch barley lines. None of the engineered lines showed severe phenotypic effects on germination and the WT and HP lines degraded the starch similarly having 30% residual starch after 12 days of germination. However, the AO showed significant degradative resistance having almost twice as much of residual starch. Interestingly, protein degradation was stimulated for both HP and AO lines as compared to WT and BG (BG) degradation was moderately stimulated. AT later germination stages, specific sugars were rapidly consumed in the AO line due to carbon starvation. α-Amylase activity was distinctly suppressed in both the HP and the AO lines. Pre-germination β-amylase deposition was low in the AO grains and was generally suppressed in both HP and AO lines over germination. Scanning electron microscopy of grain sections demonstrated differential patterns of degradation. The data conclude that correctly structured endosperm starch granules are vital for establishing correct initiation and maintenance of metabolic dynamics during grain germination and sub-optimal granule structure leads to temporal and compensating re-directions of starch, sugar and protein catabolism.

Acute human consumption of crystalline short-chain α-glucan
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Cereal Foods World 58:A20

The glycemic index (GI) is used to rank foods based on postprandial blood glucose response. Physiologically, starch escaping small intestinal digestion is termed resistant starch (RS). Available carbohydrate for the GI test is often calculated as total carbohydrate minus dietary fiber; yet, AOAC fiber methods do not always include RS. The objective of this study was to examine the effects of a starch product with high RS content but no total dietary fiber (TDF) content on glycemic response, GI, and fermentation. Using standard GI methods, 50 g available carbohydrate was compared in 10 adults to waxy maize starch (TDF: 0%; RS: 1.6%) and crystalline short-chain α-glucan (CSCAG) (TDF 0%; 75% RS) generated from debranching of waxy maize starch; alone and in mixed formulation. All volunteers had low postprandial glucose curves after CSCAG consumption. The rise in mmol/L glucose for CSCAG in mixed formulation was similar to the rise observed with glucose, yet the mixed formulation had reduced ($P < 0.05$) extension, and 100% of subjects returned to basal blood glucose levels at 2 h. CSCAG was considered available carbohydrate in the GI test, but was not fully available *in vivo*. Breath hydrogen testing showed CSCAG did not elevate H_2 production more than other trial samples and all 0% TDF samples were as likely to ferment. This study shows that RS content affects glycemic response and GI values and addresses functions of RS in the colon with noninvasive measures for carbohydrate metabolism.

Effect of nitrogen application on the physicochemical properties of selected rice varieties
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Cereal Foods World 58:A20

Rice with high amylose concentration (AM), low breakdown and high setback, as measured by the Rapid Visco Analyzer (RVA), is best suited for use by the parboiling and canning industries as these properties correlates with reduced starch solids loss and improved grain integrity after processing. This study was conducted to determine if varieties that have high AM differ for parameters associated with processing quality and if these properties are affected by the amount of fertilizer nitrogen (N) applied during field production. Nine rice varieties that have high AM along with one (reference) variety with intermediate AM were studied in replicated field trials conducted in Texas and Arkansas, using three rates of N application (standard, low, and high). Varieties were significantly different for all traits measured and, except for protein, there were no significant variety x N interactions. N rates significantly impacted AM and protein concentrations and all RVA parameters, but not starch gelatinization temperature (GT) parameters. Although the variety Cheniere had one of the highest AM, it had the lowest peak, trough, and final paste viscosities as measured by RVA and this type of paste viscosity profile is undesirable for parboiling. The varieties Jaya, Rondo, and Shu 121 were not different in AM from Cheniere or Dixiebelle, the highest ranking varieties. However these three varieties had significantly higher peak, trough, and final RVA paste viscosities and significantly lower onset, peak, and final GT than Cheniere and Dixiebelle. Among the varieties with high AM and intermediate GT, Bowman had significantly lower RVA setback 1 than Sabine and significantly lower onset and peak GT as compared with Zhe 733. This indicates that starch structure of high AM varieties may differ and impact processing quality.

Factors impacting the milling breakage susceptibility of raw and parboiled brown rice
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Cereal Foods World 58:A20

Rice (*Oryza sativa* L.) is one of the most important cereals in the world. In the production of white rice, the hull, bran and germ are removed from the paddy or rough rice kernel. White rice is available as either a parboiled or raw product. During processing rice kernels are subjected to mechanical stresses which cause some rice grains to break. A main challenge of the rice industry is to minimize the quantities of broken rice. The objective of our work was to determine the factors impacting the milling breakage susceptibility of brown rice, both before and after parboiling. The results showed that chalky, immature and thin rice kernels (< 1.7 mm) have a higher tendency to break when subjected to mechanical stresses before parboiling. Under optimal parboiling conditions, we were able to substantially reduce the rice kernel milling breakage. However, inappropriate parboiling conditions had the opposite effect, resulting in increased milling breakage susceptibility. Both the extent of starch gelatinization and kernel fissuring were critical in determining milling breakage of parboiled brown rice. The more homogeneous and compact microstructure obtained as a result of complete starch gelatinization made rice grains more resistant to mechanical stresses, while the presence of fissures had the opposite effect.

Bioactive compounds in pigmented rice bran inhibit growth of human cancer cells
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Rice bran contains both lipophilic and hydrophilic antioxidants. Our previous studies have shown that the pigmented rice cultivars contained several-fold higher total phenolic concentrations and antioxidant capacities than the non-pigmented cultivars. We investigated three rice brans (purple, red and light-brown) for their bioactivities in growth inhibition of human cancer cells using the microculture tetrazolium (MTT) assay. The compositions of phenolics in three bran extracts were also determined by HPLC. Based on the calculated IC_{50} values (concentration of freeze-dried extract that inhibited 50% of the cancer cells under the test conditions), the light-brown bran had no effect on the cells, the purple bran exhibited a minor inhibitory effect on two cell lines, bone marrow erythroid leukemia (HEL) and cervix adenocarcinoma (HeLa), and the red bran exhibited stronger inhibitory effects on HeLa, and stomach adenocarcinoma (AGS) cells. High concentrations of protocatechuic acid and anthocyanins in purple bran extract and proanthocyanidins in red bran extract were identified and might have contributed to the bioactivities against the cancer cells. The red-bran extract was further fractionated into three fractions sequentially on a Sephadex column. Fraction-2 and -3 had anticancer effects against AGS, HeLa and HepG2 cancer cells. Fraction-3, rich in oligomers and polymers of proanthocyanidins, had the strongest activity. As a follow-up study, we evaluated the concentrations of proanthocyanidin in red bran of a set of rice germplasm. Differences of greater than 4-fold in proanthocyanidin concentration were observed. This suggests that genetic resources exist that can be used to increase proanthocyanidin concentration using traditional breeding that will lead to new cultivars with enhance health beneficial properties.

Genotype and environment influences on the amylolytic breakdown of wheat starch
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Cereal Foods World 58:A20

The rate of amyloytic breakdown of starch is of interest for human nutrition, the formulation of animal feeds and industrial fermentations. Many factors are known to affect the rate of enzymic hydrolysis of starch, including granule size and intactness, amylose content, amylopectin fine structure, and the extent of starch gelatinization and retrogradation. However, there is limited information on the extent to which genotype and environmental factors during plant growth contribute to variability in starch digestibility. Therefore, starch was isolated from five commercial Australian milling wheat varieties that were grown in five locations in two seasons. Native starch granules and starch that was cooked and cooled were incubated *in vitro* with pancreatic alpha-amylase. The digestograms of the native granules showed significant variability between the five varieties, and also between the growth locations and seasons for each variety. There was less variability in the digestibility of starch that had been cooked. Statistical analysis of the data was performed to identify the contributions to variance from the effects of genotype, environment and their interactions. For native granules, genotype accounted for about 45% of the variance in the amount of glucose released in 2 hours, when about 5-10% of the starch was digested, but only about 15% of the variance at 24 hours (69-80% starch breakdown). Environmental effects, particularly temperatures during crop growth, were increasingly significant after 2 hours incubation. In comparison for cooked starch, genotype contributed about 60-70% of the variance in the amount of starch digested in 20 minutes and starch remaining after 2 hours. We conclude that temperatures during crop growth contributed to variability in the *in vitro* rate of breakdown of native granules after the initial stages of enzymic attack.

The long journey of spectroscopic methods in cereals analysis, from moisture to the intangible

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Cereal Foods World 58:A21

Edith Christensen Award for Outstanding Contributions in Analytical Methodology

Cereals quality measurement, be it by quantization or categorization, dates back to the founding days of AACC. A major breakthrough in measurement methodology for wheat flour occurred in the post World War II era of the 1950s when the technology of photodetectors became available for civilian use. At that time, engineers and scientists of the USDA Agricultural Marketing Service in Beltsville, Maryland pioneered the use of that forgotten region of the electromagnetic spectrum sandwiched between visible light and the infrared "fingerprint" region, known as the near-infrared, or NIR, region. This humble beginning involved the measurement of moisture in wheat flour. From this early work, combined with the later introduction of civilian computers to control these meters, an entire industry of near-IR analysis was spawned that today has reaches into the food, pharmaceutical, environmental, and chemical fields. The cereals quality work performed at Beltsville (later coming under the auspices of USDA-ARS) has continued over the decades up through today, taking advantage of advances in spectroscopy (visible, near-, mid and Raman), statistics, and concurrent advances in primary biochemical procedures, all of which has led to NIR spectroscopy being the mainstay for rapid measurement. As a scientist assigned for more than 20 years to the Beltsville lab that revolutionized NIR technology, I continue this lineage, with attention paid to rapid optical methods that examine macronutrients (protein, starch, moisture), functionality (dough handling, gluten quality), safety (scab, black tip), defects, and classification. The talk will focus on the basic research that explains the triumphs and limitations of vibration spectroscopies applied to grain, as well as on the applied research that has evolved into the release of approved methods of AACC International which are used worldwide.

Validating approved methods for the dietary fiber definition—Meeting the challenges of knowledge and definition changes

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Cereal Foods World 58:A21

Nutritionally, dietary fiber is unique. Its benefits relate to resistance to digestion as opposed to other nutrients that depend upon digestion and absorption. Consequently, dietary fiber consists of a complex mixture (mostly carbohydrate) of digestion resistant components that vary by source, environmental conditions, and processing. Research on dietary fiber in the 1950's and 60's resulted in a definition by Trowell et al in 1976. In response, AACC International validated Approved Methods 32-05, 32-06, 32-07, 32-20, 32-21, 32-25, and 32-41 to match that definition. As researchers have discovered and elucidated additional dietary fiber sources, there not only has been a perceived need to update the definition of dietary fiber, but to update the supporting methodologies. Scientific advances resulted in the physiologically based conclusion that additional components e.g. resistant starch and non-digestible oligosaccharides are validly included in definition, therefore AACC International validated Methods 32-28, 32-31, 32-32, 32-33, 32-34, 32-40, and 32-41. Recently, the CODEX Alimentarius Commission adopted an international, clarifying, single, concise, definition of dietary fiber recommended by the Committee on Nutrition and Foods for Special Dietary Uses (see ALINORM 09/32/26, 09/32/REP, 10/33/26, 10/33/REP) that reflects the scientific findings of the past 5 plus decades. AACC International scientists have validated two all inclusive methods (AACC Approved Methods 32-45, 32-50) commensurate with the CODEX definition. The importance and difficulty of matching in-vitro results to in-vivo results will be presented.

Structural characterization of arabinoxylan addition—Impact on protein microstructure formation of rye and wheat dough

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Arabinoxylan (AX) is the predominant non-starch polysaccharide fraction in wheat and rye flour. For protein network formation it is assumed that AX prevents protein crosslinking during dough development. This hypothesis is confirmed by decreasing dough and bread qualities with increasing AX content as observed for wheat (2-3 % AX) and rye (6-8 % AX) flour. Besides, AX addition affects the elastic properties of wheat and rye dough negatively. Detailed knowledge is still missing about possible AX responsibility for reduced protein network formation and, if so, to what extent AX affects the protein microstructure and rheological dough characteristics. To characterize the influence of AX on the protein network formation of wheat and rye dough, rheological and microstructural investigations with different AX concentrations (0.0; 2.5; 5.0; 7.5; 10.0 %) were performed. Protein structure was visualized by confocal laser scanning microscope and analysed with image analysis procedure (DoMiQ). Fundamental rheology measurements were performed. For wheat dough, an addition of 10 % AX increases the number of protein fragments by more than 300 % and decreases average size of the protein fragments by more than 30 %. AX addition of 10 % increases tan delta by more than 50 % whereby |G*| was kept constant—increases in tan delta are attributed to an increase in the viscous part. For rye, the results indicated similar trends even though overall dough firmness was lower. The results reveal reduced protein crosslinking and prove impressively the influence of AX on protein formation in dough. This study supplies detailed information of AX impact on wheat and rye dough microstructure and its functionality. The gained knowledge helps to understand the process of protein formation in more detail and present new ways to control dough quality.

A study to investigate the attitude of non-coeliac consumers towards gluten free products

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Cereal Foods World 58:A21

Absence of gluten has high influence on dough rheology and production process resulting with the imperfect quality products. Increased consumer demand of gluten-free products meant that people will no longer accept compromise on quality when purchasing these products. The research aim of this project was to investigate whether non coeliac's are willing to consume celiac products as part of everyday diet. British supermarkets were visited to identify the availability of gluten-free products, evaluating factors that might influence consumers. All participants were non-coeliac's over the age of 18. Fifty volunteers were asked to take part in a questionnaire establishing non-coeliac attitudes towards purchasing gluten-free products while thirty five volunteers in sensory evaluation comparing a number of selected commercially available gluten-free products to gluten containing counterparts. The sensory evaluation resulting data were analysed using Fizz software (Biosystems, Coutenon, France), image analyses using C-Cell analyser (Callibre Control International Limited, Warrington, UK) and firmness using texture analyser TA-XT2i (Stable Microsystems, Surrey, UK). The availability of gluten-free products in British supermarkets varied between supermarkets. Results revealed that factors likely to influence a non-coelac's willingness to purchase and consume a gluten- free products include: a low price, possible dietary benefits, sensory aspects similar to gluten- contain products and segregation within the supermarket. Considering these findings, results from the sensory evaluation, texture analyses and c-cell analyses showed that texture and structure of gluten-fee products were the modalities showing most deviation from the standard products; suggesting further improvement toward the texture and structure of gluten-free products is yet required.

Deficiency of wheat starch synthase II (SSII) affects starch structure and *in vitro* enzymatic hydrolysis

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Cereal Foods World 58:A21

Wheat (*Triticum aestivum* L.) is one of the major cereal crops around the world. In Canada, Saskatchewan and Alberta are two major provinces that produce most of the wheat. Starch is the major storage component in wheat grain, which accounts for approximately three quarter of its dry weight. In starch biosynthetic pathway, Starch Synthase II (SSII) is a key starch biosynthetic enzyme that extends very short glucan chains of DP≤10 to form amylopectin clusters. As normal wheat is an allohexaploid (2n=6x=42, AABBDD), SSII is encoded by three genomes. Six wheat genotypes consisting of a durum (AC Avonlea) and five wheat breeding lines deficient in SSII were used to analyze grain composition, starch structure and *in vitro* enzymatic hydrolysis of grain meal and purified starch. SDS-PAGE profile followed by protein immuno-blot (Western Blot) of starch granule bound polypeptides confirmed absence SSII in these variants. All the five variants showed SSII absence in A and D genomes (A-B+D-). The total starch concentration did not show significant differences among all the six genotypes. All the five variants showed reduced protein and lipid concentration compared to their parent (AC Avonlea). However, SSII deficient variants have relatively increased amylose concentration. Amylopectin chain length distribution revealed a decrease in glucan chains of DP 6-24, and an increase in chains of DP 25-50 in SSII variants compared to parent AC Avonlea. Based on the above results, an attempt has been to understand the effect absence of A and D genome specific SSII have in influencing starch structure and its digestibility using *in vitro* enzymatic hydrolysis study.

On the viscoelastic mechanisms in cereal proteins: How can we use structural models on gluten viscoelasticity to functionalize non-gluten proteins?
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Cereal Foods World 58:A22

Unlike numerous examples of elastic animal proteins, wheat gluten is the only plant protein to have elastic properties. Elasticity of gluten is attributed to a specific sub-group termed the high molecular weight glutenin subunits (HMW-GS). The elasticity of HMW-GS has been associated with its secondary structure. The repetitive central region of HMW-GS was found to play a key role in determining folding properties of gluten. They were shown to form beta-sheet and beta-turn structures and transitions between these structures were used to explain the stress/relaxation behavior of gluten. Corn protein, zein, can be made viscoelastic, but with inferior quality compared to gluten. Previous studies done in our lab indicated that the viscoelastic properties of zein can be improved in the presence of a co-protein, such as HMW-GS. Additionally, gluten and zein were shown to go through different structural transitions with co-protein addition. In gluten, the main transition was found to be between beta-sheet and beta-turn structures. On the other hand, zein was determined to go through alpha-helix to beta-sheet transition. Recent investigations done in our group on hydrated and solution state gluten indicated that there might be a link between specific types of beta-turns, such as type III beta-turns, and their folding to alpha-helix and beta-sheet structures. While two distinct peaks (1628 cm^{-1} and 1639 cm^{-1}) were determined in Amide I region for hydrated gluten, only one peak (1633 cm^{-1}) was observed for gluten in solution state which might be due to formation of beta-sheet and beta-turn structures differing in hydrogen bonding strengths. The purpose of this presentation is to discuss the role of specific secondary structural motifs on gluten viscoelasticity and how this information can be used in manipulation of other cereal proteins to obtain viscoelastic structures.

Relaxation and creep recovery tests on wheat kernels vs. doughs: Influence of glutenins on rheological and quality properties
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Fundamental measurements of viscoelasticity of wheat kernels and doughs using stress relaxation and creep-recovery tests are presented. A set of different wheat genotypes representing wide variability in grain hardness and gluten quality-related parameters was used to determine the relationship between viscoelastic properties of wheat. Stress relaxation and creep parameters on intact cereal kernels contributes importantly to cereal technology because it allows evaluating viscoelasticity directly from testing material without sample preparation that may alter its original properties. Testing viscoelasticity with texture analyzer TA-XT2 directly from the kernels renders information more readily associated to fundamental rheological properties than when gluten or flour dough is used. This is mainly due to the fact that linear domain of viscoelastic behavior of kernels is much larger (>17%) than that of its gluten or dough. In gluten the rapid relaxation process has been associated with LMW polymer molecules which relax rapidly, and the longer relaxation time with HMW polymers found within gluten. The data suggests that the specific Maxwell or Kelvin-Voigt elements describe mainly protein-like structures. The question is, if the specific proteins of HMW-GS or LMW-GS are associated with those elastic or plastic characters indicated by the Maxwell or Kelvin-Voigt elements. It appears that not only the total amount of protein is important but also the type of individual glutenin subunits. This methodology is reliable, easy and nondestructive, allowing rapid definition of potential end-use of commercial crops as well as rapid assessment of viscoelastic properties in breeding programs. The methodology discussed in the present work seems to be a promising tool for indirect measurement of wheat quality related to HMW-GS and LMW-GS composition as well as to non-gluten factors.

New technologies in cereal chemistry and related industries: From biochemistry to genome sequences
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Cereal Foods World 58:A22

Thomas Burr Osborne Medal Award

Cell walls are relatively minor constituents of most cereal grains, but they exert a disproportionately large influence on grain processing, food quality and human health. Wall polysaccharides are components of dietary fibre, which reduces the risk of contracting serious diseases, including type II diabetes, colorectal cancer and cardiovascular disease. In cereals, arabinoxylans appear to be the core wall polysaccharides of the starchy endosperm and aleurone, while (1,3;1,4)-β-glucans are abundant in walls of some, but not all cereal endosperm. Following chemical and structural analyses of these polysaccharides, attention turned to the enzymes involved in their biosynthesis, re-modelling and degradation. Hydrolytic enzymes were purified and characterized, and crystal structures enabled the detailed mechanisms of action of the hydrolases to be defined. With the advent of molecular biology, genes encoding the enzymes were cloned and expression patterns of individual genes were monitored in a range of tissues. In the case of the wall polysaccharide synthases, progress was considerably slower. The enzymes are membrane-bound and not amenable to purification or to in vitro assays. Without amino acid sequence information, it proved difficult to identify the genes that encode these enzymes. However, emerging methods of functional genomics, linked with molecular genetics and molecular breeding, together provided breakthroughs that led to the identification and characterization of genes encoding wall polysaccharide synthases, including (1,3;1,4)-β-glucan synthases. Functional genomics culminated in late 2012 with the publication of scaffold genome sequences for wheat and barley. Genome sequencing technologies are continuing to expand our understanding of cereal chemistry and will undoubtedly prove invaluable in cereal grain utilization and processing in the future.

Evaluation of structure weakening effects by quinoa bran in gluten-free bread
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Cereal Foods World 58:A22

Due to its high nutritional value and lack in gluten quinoa is a pseudocereal perfectly suited for people suffering from celiac disease. Whereas the milling of cereals is already standardized, the expertise in quinoa fractionation has yet to be established. Optimized milling of quinoa resulted in a flour and a bran fraction. The latter exhibited mainly the outer grain parts and therefore resulted in a high protein and mineral content (17.9% and 5.1% db, respectively). This nutritious by-product can be applied for the improvement of low protein flour formulations currently in use for gluten-free bread production. For dough preparation a standard recipe, based on a rice- maize flour mixture was replaced up to 40% with bran. Dough development was determined in a rheofermentometer and resulted in decreasing dough height. Sensory evaluation revealed an improved mouthfeel of the breads with a simultaneous increase in bitterness. Therefore, the impact of fermented quinoa bran, implemented by *L. plantarum* at 30°C for 24h, was determined, focusing on improved quality features. Specific bread volume decreased up to 8%. This structure weakening effect was evaluated after analysis of dough development and by oscillatory measurements. Fermented bran dough decreased up to 26% in G* and gas holding capacity was reduced. Sensory evaluation indicated that the quinoa-off flavor was less, when fermented bran was utilized. Based on the results, the application of (fermented) bran is a useful tool for targeted modification of gluten-free bread quality and nutritional enrichment.

Comparison of solvent extraction methods for analysis of wheat flour lipids and how lipid classes are changed by aging
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Cereal Foods World 58:A22

Lipids are minor components of flours, but are major determinants of baking properties and end-product quality. Therefore, the accurate determination of lipids is essential for the full explanation of the functional properties of flours. Nine solvent systems were compared for their ability to extract non-starch lipids from wheat flour (by lipid classes). The solvent systems that extracted the most non-starch lipids from wheat flour were Bligh and Dyer and a modified Bligh and Dyer (with HCl), whereas Bligh and Dyer modified using HCl improved the recovery of phospholipids. The functionality and lipid profile of aged flour (42 days at 30ºC) was compared to control samples (-20ºC). During ageing the total lipid content of flour sample reduced by 14.6%; this reduction in lipids was different for different lipid classes with a 27.3% reduction for non-polar lipids, a 37.4% reduction for glycolipids and a 20.3 % reduction for phospholipids. In addition, there was a 48.3% increase in free fatty acids. The reduction was driven by unsaturated fatty acids in the neutral and glycolipids fractions. From a functionality perspective the addition of Diacetyl Tartaric (Acid) Ester of Monoglyceride (DATEM) had no impact on the control flour but showed a significant enhancement in the functionality of the aged flour. It is believed that the control flour was already at the limits of performance and the changes occurring during ageing are driven partially by

modifications in the lipid components, principally the glycolipid fraction, due to its surface active contribution in bread making. Aging caused an increase in water absorption and a decrease in the degree of softening; this could be due to the loss of lipids that can coat starch granules and the gluten proteins. There was also a shortening effect, where the dough became stronger but less elastic i.e. tighter.

Health benefits from soluble cereal non-starch polysaccharides—Gastro-intestinal passage rate as a major determinant?

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Soluble non-starch polysaccharides from grains have been shown to have beneficial effects on both glycemic / insulinemic response and blood lipid / cholesterol levels, but the underlying mechanisms remain obscure. We now report that in vitro starch digestion studies show relatively small effects of polysaccharide viscosity on amylase action or product diffusion under efficient mixing conditions. Similarly, we show that in vitro studies suggest relatively weak non-starch polysaccharide interactions with bile salts, inconsistent with prevention of bile salt reabsorption in the small intestine. However, we also report that in vivo studies in pigs show large effects of 10% dietary levels of oat beta-glucan, wheat arabinoxylan, or a mixture of the two, on gastric residence time and small intestinal passage rate, suggesting that these may be key factors underlying the health benefits of soluble cereal non-starch polysaccharides. As passage rates are likely to be influenced by diet rheology, this could explain the previously-demonstrated benefits of high molecular weight beta-glucan on cholesterol reduction. Further in vivo data are required to test the relationship between passage rate and beneficial nutritional effects of soluble non-starch polysaccharides, as in vitro testing systems now available are not able to predict passage rate in the living gut.

The Cinderella of starch structure: Amylose fine structure and functional properties of starch-containing foods

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Cereal Foods World 58:A23

There have been extensive investigations of the effects of amylose content and amylopectin fine structure (the chain-length distribution, CLD) in starch-containing materials on functional properties such as digestion rate. The CLD of amylose has been a neglected Cinderella in this regard. While amylopectin CLDs can be obtained with high accuracy using FACE, amylose branches are too long for this technique, which instead must be measured using size-exclusion chromatography (SEC, also termed GPC) following debranching with isoamylase. The resulting CLD must be corrected for band broadening. The amylose CLD always shows at least two features, possibly because of contributions from two or more enzymatic processes. Our recent data suggest that certain characteristics of this CLD significantly affect in vitro digestibility of cooked rice. Extensive new data for amylose fine structure from a wide range of plant species (including rice, sorghum, wheat and maize) and varieties within these species, together with in vitro digestibility rates for using food-like products obtained by cooking the flour. In vitro data on digestion to glucose are fitted with multi-step kinetics. For each of the two (and sometimes three) features apparent in the CLD, the data could be fitted both empirically (height and degree of polymerization for each peak) and with new theory [extending to amylose our earlier model on amylopectin]. Correlations between the fine-structure parameters and digestion rates suggest new tools for developing plants with nutritionally desirable digestibility.

Understanding consumer whole grain bread acceptance segments using adaptive choice based conjoint with composite pictures

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Cereal Foods World 58:A23

It is important to understand how consumers currently perceive whole grain and white breads to determine what features of bread are most attractive. The objective of this study was to evaluate the utility of pictures of potential whole grain breads alone or in a conjoint survey to identify key consumer attributes. Commercial breads were photographed to make representative pictures of attributes and levels of crust (n=6) and crumb (n=6). All photos were formatted, sized, and composed for visual evaluation. Photos were presented to bread consumers (n= 863) in an online survey to determine their overall liking and purchase intent of each bread composite photo. Subsequently, bread consumers (n =1024) evaluated the pictured attributes in an adaptive choice based conjoint survey along with price, flavor, texture, and label attributes. Analysis of variance used to determine overall liking of pictures and to determine differences between average utility scores. Cluster analysis was used to segment consumers. Market simulations were conducted on the utility scores and compared to overall liking scores to determine agreement. Both surveys revealed crumb with seeds and flakes to be more appealing than a uniform crumb, and crust with flakes and oats was more appealing than crust with no topping. Price was the most important attribute followed by crumb appearance ($p<0.05$). Crust appearance and flavor/taste claim were at parity. Overall liking and purchase intent scores showed similar trends as average utility scores.

The intricacies of starch digestion and a view towards quality and health benefit

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Cereal Foods World 58:A23

Alsberg-French-Schoch Memorial Award

Though seemingly simple as a glucose polymer with only two bond types, starch digestion tends to be a complex affair. Not only is starch presented to the body as a range of molecular fine structures, associated or not, in granular form or not, within food matrices or not, usually with other food components; it is met in the gastrointestinal tract by an equally complex system to digest and extract glucose maximally from it. Our view of starch digestion and its importance has changed over the years and now focuses not only on rate of digestion, but also location and amount at location of glucose deposition in the small intestine. This is because intestinal enterocytes sense glucose and even alpha-amylase digested limit dextrins; and if distally delivered, even in minor amounts, glucose may elicit certain physiologic changes that are desirable to health, such as extending time of nutrient delivery to the body, appetite suppression, and even decrease in food intake. A challenge is to understand starch structures, molecular or supramolecular structures that drive digestion distally and improve starch quality. This lecture will cover our research on mechanistic relationships between granular starch and digestion, fine structures and differing behavior in gelatinized starch systems related to digestion rate, how different structures are received by human alpha-amylases and the four alpha-glucosidases, and ultimately how glucose delivery rate can be moderated and extended distally. A view towards what "carbohydrate quality" may be will be presented.

Retrogradation of dextrins during *in vitro* digestion of native starch granules

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Cereal Foods World 58:A23

The molecular and crystalline structures of native starch granules were monitored during an *in vitro* digestion to understand the changes in starch structure during digestion and the structure that contributes to slow digestion properties. Four types of native starch granules were used, which are waxy maize, normal maize, high-amylose maize, and normal potato starches. Size exclusion chromatography (SEC) was used to characterize the whole (fully branched) starch molecules and their individual (linear) branches after enzymatic debranching. X-ray diffractometry (XRD) and differential scanning calorimetry (DSC) were used to analyze starch crystalline structure. Waxy and normal maize starch granules were hydrolyzed almost to completion (~100%) after 8 and 24 hours of digestion, respectively, whereas high-amylose maize and normal potato starch granules reached 82% and 71% degrees of hydrolysis, respectively, after 48 hours of digestion. The SEC weight distributions of whole molecules show that amylose and amylopectin molecules in all starch samples were hydrolyzed to much smaller dextrins (R_h ~2.5 nm). The changes in the individual branches after digestion were less apparent. The XRD results show that the crystalline pattern did not change after digestion because of the substantial amount of remaining native crystalline structure. However, the DSC results show that the gelatinization temperature of waxy and normal maize starches increased with digestion times and the presence of retrograded starch with melting temperature > 125ºC became apparent after digestion, whereas these phenomena were less noticeable for high-amylose maize and normal potato starches. The results suggest that the small dextrins can retrograde into highly stable crystalline

structure during digestion and the amount of retrograded starch is greater in the rapidly digested starch granules.

Exploratory kids' perspectives of whole wheat bread
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Cereal Foods World 58:A24

A two part study was conducted to explore kids' perspectives of whole wheat bread. More than 170 kids from K-12 were asked for their conceptual preferences of whole wheat breads. The study consisted of a conjoint study where thirty-six (36) bread combinations were presented. These combinations consisted of different bread crust and crumb colors, crust toppings and inclusions. This study was followed by a Central Location Test where a hedonic test was conducted using twelve (12) different commercially produced whole wheat breads. The impacts of wheat class, whole wheat flour color and flour particle size on bread color, texture, flavor and purchase interest, were evaluated. Results indicate overall liking amongst K-12 spans a range of whole wheat flours, with stronger preferences for the white wheat's vs. red wheat's; and a softer crust and crumb texture (with no inclusions). Three age groups (elementary, middle and high school) showed similar liking trends with no significant interaction between age group and whole wheat breads.

Visualization of gluten, starch, and butter in pie pastry by fluorescence fingerprint imaging
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Cereal Foods World 58:A24

Gluten, starch and fat make up the structure of pastry doughs, and the texture of the product is strongly influenced by the way these constituents are distributed in the dough. For example, puff pastry and flaky pastry differ in the way fat is distributed in the gluten-starch matrix, and this changes the flakiness and crispness of the finished product. The objective of this study was to visualize gluten, starch and butter in puff pastry dough without any staining by use of a fluorescence fingerprint (FF). The FF, also known as a excitation-emission matrix (EEM), is a set of intrinsic fluorescence spectra acquired at multiple excitation wavelengths. Because the pattern of the FF is unique for each substance, constituents in a sample can be predicted by analyzing the FF pattern. The distribution of constituents can be predicted by using a digital camera to acquire fluorescence images of a sample at all combinations of excitation and emission wavelengths that construct the FF, thereby acquiring a set of data consisting of the FF of each pixel. Samples of 10μm thickness were made from puff pastry dough, gluten, starch, and butter, and fluorescence images of the samples were acquired. The FF of each pixel in the dough image was analyzed with non-negative matrix factorization (NNMF) and the amount of gluten, starch, and butter existing at that point was obtained. By showing the amounts of gluten, starch, and butter at each point in gradations of red, green, and blue, respectively, the distribution image of these three constituents was obtained. Finally, the imaging method was validated by double-staining the same dough sample with fluorescent dyes for protein and fat, and comparing the stained image with FF imaging method. The FF imaging method succeeded in visualizing the gluten strands and starch granules with high accuracy.

WITHDRAWN

The expression of gluten proteins measured by SE-HPLC and different mass spectrometer analyses following abiotic stress treatments
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Cereal Foods World 58:A24

The impact of drought, cold and heat stress on gluten proteins was studied on two irrigation (Kariega and Duzi) and two dryland spring (PAN 3471 and PAN3478) bread wheat cultivars. The plants (three replications, 15 pots per replication, three plants per pot) were grown under greenhouse conditions. Treatments (heat, cold and drought stress and a control) were initiated when the kernels on the main tiller were at soft dough stage. The main tiller in each pot at the time of treatment was marked for later gluten analysis. Cold treatment was performed by placing the plants in climate cabinets in the following cycle (5°C, 30 minutes; 1°C less every 30 minutes until it reached -5.5°C, left 3 hours; -2°C, 30 minutes, 0°C, 30 minutes; 2°C, 30 minutes; 5°C, 30 minutes; back to green-house). For the heat treatment, plants were placed in climate cabinets at 32°C/15°C day/night treatment for 72 hours and then taken back to the green-house. Drought stress was applied by withholding watering until severe wilting was visible and then watering resumed as normal. A control set of plants was left in the greenhouse. Size exclusion HPLC and quality analyses were done on three replications of each entry for each treatment. All four treatments with three replications of PAN2378 was further analysed with the Orbitrap mass spectrometer and with MALDI-TOF mass spectrometry. The four cultivars showed different reactions to the different stress treatments, and some of the cultivars were more sensitive to stress, indicating that tolerance levels were genetically influenced. There was a strong relationship between the polymeric proteins (both SDS soluble and insoluble) and baking quality characteristics in all the cultivars for all treatments. The Orbitrap analysis showed that stress treatments altered the expression of the high molecular weight gluten proteins.

Branch abundance and pattern of starch internal structure affect glucogenesis by mucosal Nt-maltase-glucoamylase
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Cereal Foods World 58:A24

Six digestive enzymes, two alpha-amylases and four mucosal alpha-glucosidases, are required to break down starch to free glucose. Four alpha-glucosidases digest alpha-limit dextrin (LDx) from various starch sources differently. The objective here was to reveal how the starch internal structure drives digestibility differently at the mucosal enzyme level. Seven starches and glycogen were maximally hydrolyzed by recombinant human pancreatic alpha-amylase, the residues were further hydrolyzed by N-terminal maltase-glucoamylase (MGAM) to glucose. During different times of alpha-amylolysis and Nt-MGAM hydrolysis, the abundance of alpha-1,6 glucosidic linkage was analyzed by NMR, the chain-length distribution was examined by size-exclusion chromatogram, and glucogenesis was analyzed by an enzymatic method. Statistical assays were carried out by one-way ANOVA. Our results showed that the branch abundance of alpha-LDx, especially the branches remained in the short chain fractions, is negatively associated with glucogenesis by Nt-MGAM. Three maize starches with similar genetic backgrounds had a coefficient of determination of branch abundance and glucogenesis of 1.0. Moreover, it was also revealed that alpha-LDxs with same branch abundance were not digested equally. Branch pattern of starch internal structure was speculated to be another factor to determine the glucogenesis. We previously reported that branched sugars with different branch patterns had different kinetic constants of Nt-MGAM. Here, computer modeling of branched sugars and the catalytic site of Nt-MGAM further

support the hypothesis. It was concluded that both the abundance and pattern of branch preserved in alpha-LDx determine rate of glucogenesis by Nt-MGAM. To manipulate glycemic response through choosing/designing starchy foods, it is important to consider the nature of the internal structure of starch.

Manipulating cross-linkages in noodle dough by *L*-cysteine and transglutaminase

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Cereal Foods World 58:A25

Balance of dough elasticity and extensibility is critical to Asian noodle-making for ensuring adequate dough strength to withstand sheeting without tearing, while not so much strong as to shrink back during successive roll passes, resulting difficulties in thickness reduction. This study aimed to improve dough machinability by selectively breaking disulfide bonds using *L*-cysteine during sheeting, followed by enhancing noodle texture by forming covalent cross-linkages with transglutaminase (TG). Two types of refined wheat flour, a Canadian western red hard spring (standard noodle flour) and Ontario soft red winter, were used. Flour characteristics, gluten aggregation, dough machinability, cooking property, tensile testing and texture profile analysis of uncooked/cooked noodles were studied. The results showed that, *L*-cysteine decreased disulfide bonds depending on dosage and flour type, diminished torque peak (5 BE) of gluten aggregation, shifted peak maximum time to ~30s for both flours, and provided improved dough extensibility and plasticity for sheeting and thickness control, but the noodles exhibited brittle texture and high cooking loss. In contrast, TG enhanced gluten aggregation (10 BE) while broadened aggregation peak, and resulted in a desired texture of cooked noodles, however, the dough was resistant to sheeting. When applied together, both improved dough machinability and enhanced texture of uncooked/cooked noodles were achieved, especially for soft flour. Covalent cross-linkages catalyzed by TG endowed soft flour noodles with significant lower cooking loss (1.8%), improved structural integrity and a hard-bite texture after cooked ($P < 0.05$). The synergistic effects were attributed to the timing of the fast-acting L-cysteine on enhancing dough extensibility during sheeting following by the slow-acting TG on strengthening dough elasticity after sheeting.

Developing a cholesterol-lowering bread based on oat beta-glucan fibre

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Cereal Foods World 58:A25

Oat and barley are naturally rich sources of water-soluble fibre beta-glucan. The cholesterol-lowering effect of oat beta-glucan fibre has been scientifically proofed and acknowledged by authorities in the USA and in Europe. Developing a delicious bakery product qualifying for the health claim is challenging, since beta-glucan is sensitive to degradation during the baking process. Many factors, e.g. enzymatic activity, oxidative reactions and processing conditions easily degrade beta-glucan. These may affect the solubility, molecular weight and/or viscosity of beta-glucan, thus weakening the cholesterol-lowering effect. Especially viscosity, formed by beta-glucan in the small intestine, is believed to be crucial for the cholesterol-lowering effect of beta-glucan. The objective was to develop a bread containing oat beta-glucan with viscous properties, thus with cholesterol-lowering ability. Different bread samples were prepared containing oat ingredients and/or other cereal ingredients. The concentration of beta-glucan in the bread samples was measured with AACC 32-23 enzymatic method. Beta-glucan was extracted enzymatically using in vitro method at 37 °C, with amylase and digestion enzymes pepsin and pancreatin. The viscosity of the extracted beta-glucan was measured and results reported at shear rate 10 1/s. The results showed that with careful selection of ingredients, it is possible to develop a bread containing viscous oat beta-glucan, with the ability to lower cholesterol. After developing a delicious product qualifying for the cholesterol-lowering health claim, another step is to have strong communication actions targeted at consumers, health professionals and other stakeholders. Clear communication on the health benefits of the product is essential because it is not possible to directly taste or perceive the health effect after consuming the product.

Structural approaches of starch Pickering emulsions for encapsulation of hydrophobic and hydrophilic substances

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Cereal Foods World 58:A25

There is a growing interest in controlled and targeted delivery through structural approaches of emulsion based systems in food and pharmaceutical industries. Starch granules have recently been used to create particle stabilized, i.e. Pickering, emulsions. The high stability of Pickering emulsions makes them suitable for encapsulation and delivery systems. Moreover, upon exposure to heat, starch granules partially gelatinize and form a cohesive barrier at the oil-water interface. The objective of the present study has been to investigate the possibility of encapsulation, protection and controlled release of hydrophobic and even hydrophilic substances (in context of multiple emulsions) through starch Pickering emulsions. Curcumin, vitamin B12, and dyes have been evaluated as encapsulated substances. Octenyl succinic anhydride modified quinoa starch was added as the solid particle stabilizing agent. Phosphate buffer and Miglyol 812 were used as water phase and oil phase. Emulsions were created using a high-shear homogenizer. To see the effect of starch gelatinization, some samples were then heated to above the onset of starch gelatinization. The encapsulation stability was evaluated using an in vitro model and measuring the release of encapsulated substance by spectrophotometer. Storage stability of samples was evaluated over 4 weeks and process stability further evaluated by freeze-drying. The stability towards coalescence during storage was excellent with no significant changes measured by drop size analysis. The encapsulation efficiency was >90% both in simple and double emulsions. High stability was obtained also in heat treated samples as a result of the better encapsulating layer formed by partially gelatinized starch. This starch layer enhanced hydration of the samples making this system applicable both in liquid and solid systems.

Effect of flour aging on oxidative gelation and absorption characteristics of soft-wheat flour

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Cereal Foods World 58:A25

Oxidative gelation is reputed to be an important trait in soft-wheat technology. A previous study in our labs indicated genotypic differences in the oxidative gelation capacity (OGC) of soft-wheat flours. As flour can experience oxidation during storage our objective was to observe OGC and flour absorption capacity after defined periods of both grain and flour storage. Our aim was to generate preliminary data that might determine whether OGC was "hard-wired" into kernel composition or whether it might be a result of oxidation during grain or flour storage. Grain of 4 soft-wheat cultivars with divergent OGC was milled to flour at 0, 3, 6, 13, and 24 weeks after harvest. Flour was tested at 0, 1, 3, 6, 13, 27, and 62 days after milling for all milling dates. OGC was quantified using an RVA-based method that observes the viscosity of a flour/water suspension after addition of hydrogen peroxide. SRC capacity was observed using AACC-I Approved Method 56-11. 3-way ANOVA indicated significant differences ($p < 0.05$) in OGC between cultivars and between milling dates. The differences between milling dates did not appear to be systematic. ANOVA also showed significant ($p < 0.05$) increases in OGC after milling. Increased OGC was observed for all 4 cultivars, regardless of their initial OGC baseline (high or low). ANOVA also indicated that SRC values changed with flour storage: water and sucrose SRCs showed small but significant ($p < 0.05$) increases during flour storage. Carbonate and lactic acid SRCs had significantly ($p < 0.05$) decreased values across the 62 days of flour storage. Conclusions: although milling time after harvest, storage time after milling, and genotype all affect OGC of flour, genotypic differences were observed from the beginning of the storage period suggesting that OGC is genetically determined.

An integrated procedure for the measurement of total dietary fiber—Challenges and updates

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Cereal Foods World 58:A25

In 2007, we published an integrated method for the measurement of total dietary fiber, which allowed accurate measurement of resistant starch and low molecular weight oligosaccharides as well as the high molecular weight dietary fiber traditionally measured. This method has been successfully subjected to interlaboratory evaluation through AOAC International and AACC International in 2009 and 2011. However, in applying this method to a broad range of samples, a need for minor modification to allow correct measurement of specific components has been identified. Particular attention has been directed to the overestimation of low molecular weight dietary fiber in high starch containing materials through incomplete hydrolysis of certain maltodextrins, and to the underestimation of partially hydrolysed inulin, specifically the trisaccharide, fructosyl-β(2-1)-fructosyl-β(2-1)-fructose. The reasons for differences in the determined dietary fiber values of phosphate cross-linked starches has also been studied in detail. Fructo-oligosaccharides can be specifically measured after hydrolysis to fructose and glucose using a mixture of exo-inulinase and endo-

inulinase. Measurement of trace amounts of these oligosaccharides in materials containing high levels of other sugars such as in baby formulations or in cereal grains has been complicated by the requirement for ultra-pure enzymes. It is difficult to produce enzymes of the required purity by traditional chromatographic procedures. This problem has now been resolved using recombinant technology and a eukaryotic expression system.

Wheat avoidance, gluten diagnostics, and novel gluten-free foods
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Cereal Foods World 58:A26

Avoidance of gluten containing foods is well recognised as an essential strategy for the management of celiac disease, however, recent studies have highlighted "gluten intolerance" as an additional, albeit less well characterised, condition requiring a reduction in the consumption of gluten containing foods. In Australia, some 8% of consumers report that they actively avoid wheat based foods, of whom approximately 1% is diagnosed celiacs. The symptoms reported by the remaining 7% are not consistent with undiagnosed celiac disease being the underlying cause of wheat avoidance. In addition to the consumer research cited, our research has focussed on two issues in barley. Firstly, the development of mass spectrometry based methods for the identification and quantification of hordein levels in beer. These studies highlight the inadequacies of the current ELISA based methodologies and provide the basis for the development of superior diagnostics for gluten quantification in foods. Secondly, we have used a non-GM breeding approach to develop barley lines with hordein levels in the flour reduced to 1-2 ppm (as measured by mass spectrometry) as the basis for the development of beverages and foods well below the 20 ppm gluten threshold.

WITHDRAWN

Impact of adding a second amyloglucosidase digestion to AACCI 32-45.01 (Total Dietary Fiber, Codex Alimentarius Definition) on fiber claims for rice products
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Cereal Foods World 58:A26

The CODEX compliant total dietary fiber assay AOAC 2009.01 differs from traditional dietary fiber assays such as AACC Method 32-05 (AOAC 985.29) and AACC method 32-07 (AOAC 991.43) both by utilization of mammalian α-amylase under more physiological conditions and by inclusion of low molecular weight material with DP >2 that is soluble in 78% ethanol. However the amount of fungal amyloglucosidase (AMG) specified in the original version of AOAC 2009.01 is not always adequate to achieve an actual digestion end-point for the low molecular weight fraction. To resolve this problem, a revised AOAC 2009.01 protocol has been proposed which includes a 2nd AMG digestion of the 78% ethanol soluble fraction. In this report, we specifically examine the impact of the proposed addition of a 2nd AMG digestion to AOAC 2009.01 on dietary fiber claims in different types of rice products. In a group of brown and milled prehydrated shelf stable rice products, for example, we found that inclusion of the proposed 2nd AMG digestion reduced the low molecular weight fraction from 2.4 ± 0.37% of the total dry weight to 0.57 ± 0.24%. This reduced the total dietary fiber value by 27 ± 7.2% for the brown rice samples in this group and by 35 ± 12% for the milled samples. Addition of the 2nd AMG digestion also caused substantial reduction in the amount of the low molecular weight fraction in standard dry rice. Without the 2nd AMG digestion, in some cases the low molecular weight fraction was the predominant fiber fraction in standard dry rice. To avoid substantial inflation of the total dietary fiber values in rice, it is thus important to add the proposed 2nd AMG digestion to AOAC 2009.01 to ensure that an actual digestion endpoint is reached for the low molecular weight fraction.

The impact of puroindolines on the quality of wheat-based products
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Cereal Foods World 58:A26

Classification of wheat cultivars is generally based on kernel endosperm texture. The basic and cysteine-rich proteins puroindoline a (PINA) and b (PINB) are at the molecular basis of wheat endosperm texture. When both puroindolines (PINs) are present in their wild-type form, the wheat kernel is soft, while hard wheat texture results from the absence or mutation of either PINA or PINB. PINs show *in vitro* foam forming and lipid binding properties. This potentially makes them attractive in the production of wheat based food products. Biscuits are preferably made from soft wheat flour and thus contain relatively high levels of wild-type PINs. We here reconstituted flour samples from starch and gluten fractions varying in PIN levels. Increasing PIN levels from 0.0 to 1.0 mg/g dry matter (dm) in flour yielded more tender semi-sweet biscuits (fracture stress decreased from 1.1 to 0.2 MPa), which was due to increased porosity and decreased matrix strength. Addition of exogenous PINs to bread dough recipes yields bread with a more homogeneous crumb structure with fine gas cells (Dubreil et al., 1998; Rouillé et al., 2005). However, the mechanism whereby PINs improve crumb structure is not understood. A role in gas cell stabilization has been suggested. Components in the dough aqueous phase, *i.e.* the dough liquor, are thought to stabilize gas cells when discontinuities appear in the gluten-starch matrix. While PIN level in dough liquor isolated from unyeasted dough immediately after mixing was very low (0.2 mg/g dm), it was higher (0.8 mg/g dm) for yeasted dough fermented for 120 min. Foam made from the abovementioned dough liquor from fermented dough had higher stability than foam from dough liquor isolated from the unyeasted dough. Bread making with dough liquor from fermented dough yielded larger loaf volume and finer crumb structure than control bread.

Combined sound and force measurements to assess crispness of food products
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Crispness is perceived as a combination of touch and sound which has made it difficult to determine instrumentally, despite being a critical quality parameter for many food products. Currently the use of a trained sensory panel provides a means of quality assurance for crispness. The aim of this work was to investigate the development of an objective method for the assessment of products with crispy properties by coordinating the capture and analysis of sound and force data. Initially, crackers were used as a model system for this investigation with ten different commercially available crackers of recognisably different crispness selected and assessed for their crispness by a trained sensory panel. Sound and force data were then collected using a controlled test on a texture analyser fitted with an acoustic envelope detector and a range of parameters compared to the results of the sensory analysis. A new parameter was developed which considered the ratio between force energy and sound energy recorded under these controlled conditions. A Spearman's rank correlation coefficient of 0.745 (P=0.01) was achieved for the relationship between this new test parameter and the sensory analysis; a correlation which is a better than could be achieved by either force or sound data alone. A smaller range of crackers was then considered to explore the sensitivity of the test. It was shown that as few as 5 replicates were required to find significant differences between the crispness of samples. The test is shown to be applicable to a wide range of products with crispy properties and

can provide a useful measure for assessing the crispness of products with crispy properties, particularly in the realms of product development.

Predicting rheological behavior of wheat dough based on machine learning and front-face fluorescence spectroscopy on wheat flour

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Cereal Foods World 58:A27

The milling and baking quality of wheat dough is commonly measured by its rheological properties assed using internationally accepted standard rheological techniques such Farinographs, Mixoraphs, Extensographs and Alveographs. The drawback of these measurement methods is that they are time consuming and costly. Hence, there is a global thrust towards the development of more time and cost efficient methodologies for rapid and accurate determination of wheat flour dough and final products qualities. Front-face fluorescence spectroscopy provides a good alternative as it is rapid, timely, less expensive, non-destructive and straightforward. The aim of this work is to develop a fast and reliable devise for wheat and flour quality control. Rheological quality of wheat dough prepared from 130 cultivars wheat flour samples was assessed with Alveograph indices (W, P, L, P/L and G). Unsupervised fuzzy C-means clustering algorithm is then used to classify alveographic indexes data into four rheological groups based on similarities among the individual data items. Fluorescence excitation and emission spectra of all samples were measured on Horiba Jobin Yvon spectrofluorometer. Using a pattern recognition technique, MOLMAP approach coupled with Bi-Directional Kohonen network, rheological groups were predicted. Despite the small number of available training samples, the estimated correct classification rates were 67 %, 81% and 87 % when the samples were divided into four, three and two rheological groups respectively.

Improved identification of wheat prolamins through alkylation of cysteine residues and peptide-based mass spectrometry

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Wheat flour quality greatly depends on the composition of its prolamins and the presence and location of cysteine residues in most of them. Wheat prolamin detection and quantification is also relevant in the context of celiac disease, especially since the commonly used ELISA technique often produces inconsistent results. LC-MS/MS, which has greatly advanced in recent years, is very useful for protein quantification and structure identification, *e.g.* to analyze the ratio of thiol and disulfide groups as affected by processing. In addition, isotope coded affinity tags (ICAT) for cysteine residues are increasingly used for quantitative proteomics. However, in the case of wheat prolamins, these techniques suffer from the low solubility of prolamins in buffers typically used for sample preparation. Here, methods are presented for cysteine labeling of wheat prolamins with 4-vinylpyridine (4-VP) and iodoacetamide (IDAM), which significantly improve the detection of cysteine-containing peptides that can then be identified in enzymic prolamin digests by ESI-MS/MS. Optimal conditions for cysteine labeling, enzymic digestion of wheat prolamins, and detection of cysteine peptides are discussed. Finally, to the best of our knowledge, we were the first to label prolamins with a commonly used ICAT reagent. However, the extent of labeling was much higher with 4-VP and IDAM than with ICAT. The new protocol including alkylation with IDAM or 4-VP and LC-MS/MS of wheat prolamins offers perspectives for elucidation of the gluten structure and determination of gluten concentrations in (gluten-free) products.

Online monitoring of starch gelatinization with limited water content using CLSM

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Analytical instruments and applications are important tools to improve and understand processes in the food industry. Typical methods for analyzing the structural changes of starch during thermal heating are mostly working with water in excess. Considering that wheat dough is a complex system with limited water content an option to analyze starch gelatinization under actual product conditions is missing. In order to provide a solution a confocal laser scanning microscope (CLSM) equipped with an online heating plate which enables in-situ monitoring of the sample during the heating process, was developed. The present study shows a novel direct analyzing system of gelatinization parameters on the influence of different starch to water ratio (flour (db)/water: 1:0.30, 1:0.40, 1:0.50, 1:0.52, 1:0.54, 1:0.56, 1:0.58, 1:0.60, 1:1.00, 1:5.00, 1:5.14, 1:7,14). Image processing was implemented to receive information about mean granule area, perimeter, feret diameter and circularity. The granule parameters analyzed with image detection regarding to mathematical models reveal differences between A- and B-type. In all cases A-type granule were swelling faster. A typical increase of gelatinization was associated with a decrease of water content. Comparing the CLSM results with an approved method like differential scanning calorimetry (DSC) it revealed that structural granule changes are important for the gelatinization parameters. With different starch to water ratios a linear correlation between T-onset and start of granule swelling (R^2=0.92) as well as enthalpy and mean granule area were observed (R^2=0.89). This new analyzing system enables the monitoring of to monitor starch gelatinization in a limited water system. It allows a direct/visual measurement in a complex dough system and reveals its microstructural changes during heating.

Isolation and characterization of HMW-gliadins from wheat

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In gluten, gliadins act as plasticizers and play a key role for its functional properties. About 25% of the gliadin fraction consists of oligomers, which are called high-molecular-weight (HMW-) gliadins. To date there is little information about the proteins contributing to HMW-gliadins as well as about the linkages that connect these protein subunits. Therefore, the aim of this study was to develop suitable methods to isolate HMW-gliadins and to identify the proteins present in this oligomeric fraction. Firstly, wheat flour was extracted with a modified Osborne procedure, and the fraction soluble in 60% ethanol was referred to as total gliadin. Size-exclusion chromatography of total gliadin using a BioSep SEC-s3000 column yielded a monomeric and an oligomeric fraction. The latter (HMW-gliadins) was analyzed by two-dimensional SDS-PAGE (non-reducing/reducing conditions), RP-HPLC before and after reduction, LC-MS (ESI-QTOF), and N-terminal sequence analysis. Two-dimensional SDS-PAGE showed the presence of oligomers consisting of protein subunits with molecular masses of 31,000 – 50,000. LC-MS gave precise values of the molecular masses of the proteins, which ranged from 31,713 to 54,836. RP-HPLC under non-reducing conditions yielded no observable peaks, whereas after reduction protein peaks appeared. These peaks were collected and analyzed by automated Edman degradation. The analyses showed that HMW-gliadins contained all gliadin types and, in addition, low-molecular-weight (LMW-) glutenin subunits. HMW-glutenin subunits were not present. N-terminal sequencing and RP-HPLC also provided quantitative data on the protein composition of HMW-gliadins, which consist of LMW-glutenin subunits (60%), gamma-gliadins (14%), omega1,2-gliadins (13%), alpha-gliadins (7%), and omega5-gliadins (6%).

Diverse challenges in multi-textured foods and key approaches for shelf stability

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Multi-textured foods have also been called “multi-domain foods” and have different domains made up of different components, having unique texture and moisture content and arranged in one or more geometrical fashion-multiple layers in a planar or concentric manner or different domains dispersed in a continuous matrix. The difference in water activities of the domains determines the unique multi-texture and sensory experience for such foods. The differential in water activity also leads to moisture migration, loss of texture and sensorial perception over time. To overcome this challenge, most multi-textured commercial products in the market have been prepared with high levels of fat to reduce a_w and soften the texture at high solids level, high levels of sugar, salt, water soluble solutes like polyols to reduce a_w. Many of these foods are also refrigerated or frozen to overcome microbial stability issues and slow down the kinetics of moisture migration, like hot pockets etc. It is a monumental challenge to develop a multi-textured savory food product that is shelf stable in the intermediate moisture range, and prepared with less or no sugar, less fat, no preservatives or humectants like polyols. This paper highlights the challenges of shelf stable multi-textured foods, particularly in the savory category, and approaches that can address these challenges. The two key approaches to address moisture migration in multi-textured foods are inclusion of edible moisture barriers of very low water vapor permeability and preparation of bulk phases or multiple domains with low to intermediate water activity, with a smaller differential in water activity between them. The interplay between barrier efficacy and water activity plays a major role in shelf-stability of such foods. Both approaches have been discussed in this paper.

In-vitro enzymatic testing method and digestion mechanism of cross-linked wheat starch

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The objectives of this research were to study the *in-vitro* digestive behavior, progressive changes and the mechanism of the digestive enzymes on cross-linked (CL) wheat starch (0.38% phosphorus content) by AOAC Method 2009.01. Native and CL wheat starches were subjected to *in-vitro* digestion using AOAC Method 2009.01 with the α-amylase and amyloglucosidase cocktail, and the incubation time was extended to 24 h. The digestion of native wheat starch was leveled off after 6 h. In contrast, the digestion of CL wheat starch continued to increase almost linearly from 6 to 24 h. The residue of CL wheat starch was recovered after 1, 2, 4, 6, 8, 16 and 24 h of incubation. The phosphorous content increased with incubation time and the thermal properties were comparable at all incubation times. The method yielded 60% and 16% resistant starch content after incubation for 6 h and 24 h, respectively. The morphology of CL wheat starch showed progressive surface erosion with increasing incubation time, but some starch granules remained intact and retained crystallinity, as depicted by the existence of Maltese cross under a light microscope. This study offers insight into improving the *in-vitro* digestive method so it better reflects the *in-vivo* conditions.

Metabolic profiling in cereals: Analysis of secondary metabolites in wheat using LC-QTOF/MS

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Metabolomics is the study of the specific profile of small molecules, metabolites, produced by an organism. Metabolites can act as signals, growth regulators and plant defense agents. With respect to cereals, they can play an important role on many aspects of plant physiology, grain quality and processing, and nutritional aspects of grains as they constitute colors, flavors, aromas and antioxidants. In this project, we investigated the production of secondary metabolites as response to a plant disease called Fusarium Head Blight (FHB), which has been a persistent problem in small grains with worldwide outbreaks. For metabolic profiling of wheat, we used ultra-performance liquid chromatography – quadrapol time of flight (UPLC-QTOF) mass spectrometry. UPLC-QTOF is capable of detecting thousands of metabolites from a single plant extract. In one of our studies, the UPLC-QTOF has allowed for the detection of the co-occurrence of two important mycotoxins, deoxynivalenol (DON) and DON-3-glucoseide (D-3-G) produced during the FHB infection of wheat, barley and other cereal grains. In another research project, we focused on the identification and differentiation of metabolites produced by wheat in response to FHB. Wheat lines were inoculated with an isolate of *Fusarium graminearum.* The analysis of these samples was conducted with the UPLC-QTOF to sort and identify the compounds in wheat as a response to the disease. Preliminary experiments resulted in the differentiation of clusters of compounds in response to different treatments. Further analysis of the data will cover the metabolite interactions of the infection process, resulting in information that has not been reported before. Additional benefits of metabolic profiling of cereal grains could be the use of unique metabolites as biomarkers for FHB screening and the determination of other cereal quality traits.

Changes in rice kernel and starch during steeping in parboiling process

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The objective of this study was to systematically understand the changes of rice during the steeping process of parboiling. Isolated rice starch, milled rice and rough rice kernels of the same long grain variety (18% amylose) were examined after steeping at 60°C-75°C for different durations in excess water. Steeping increased gelatinization onset temperature (T_o) and narrowed the gelatinization range with increasing time and temperature as a result of annealing. Changes in gelatinization temperatures were greater for isolated starch then milled and rough rice flours respectively. Enthalpy remained unchanged over time when steeping temperature (T_s) <70°C and significantly decreased for starch when $T_s \geq 70$°C. Wide-angle X-ray diffraction revealed slight loss of crystallinity with increasing T_s for starch annealed at 16 h. Annealing above samples original T_o caused partial gelatinization, swelling of starch granules and loss of birefringence. However, starch granules in milled rice and rough rice flour, protected in protein matrix and other non-starch components maintained most of their birefringence. Gelatinized starch gels illustrated "true gel" characteristics. Gels from starches annealed ≥ 65°C had higher storage modulus (G') than starch annealed at 60°C and starch without annealing, suggesting increased granular rigidity. Internal microstructural feature of the rice kernel was studied by using high resolution X-Ray Microtomography (XMT). The steeped kernels had denser structures and fewer pores compared with non-steeped kernels. This study demonstrates that with steeping, rice starch granules and kernel characteristics have already altered significantly before the steaming process of parboiling and changes in isolated starch are different compared with those inside the rice kernel.

Structural features of XOS and AXOS determine their prebiotic and antioxidant properties as evaluated during *in vitro* fermentation

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While it is known that xylo- and arabinoxylan-oligosaccharides (XOS and AXOS) have prebiotic properties, the relation between their structural features and prebiotic properties requires more study. Also the antioxidant capacity of AXOS containing ferulic acid (FA), a powerful antioxidant, and the effect of FA on the prebiotic properties of AXOS is ill studied. To evaluate the impact of structural features on the prebiotic properties and antioxidant capacity of (A)XOS, *in vitro* fermentation experiments were performed. Two XOS samples, differing in DP (3 vs 12), and three AXOS samples, specifically differing in FA content (from 0.9 up to 7.2 %), were incubated for 6, 24 and 48 h with effluent of the Simulator of Human Intestinal Microbial Ecosystem. Samples were analyzed for substrate consumption, metabolite formation, changes in enzyme activity levels and microbial population and Trolox equivalent antioxidant capacity. Results showed that within the range of chain lengths studied, the length of the xylan backbone did not affect the fermentation rate. FA impeded the degradation of AXOS by gut microbiota. Although the highest activity of AXOS degrading enzymes was found for FA-rich AXOS (7.2% FA), only 23% of these AXOS were fermented after 48 h incubation while 34% of FA-poor AXOS (0.9% FA) were fermented. XOS fermentation changed the acetate/propionate/butyrate ratio in favor of propionate and butyrate, which are believed to have health-modulatory properties, from 71/21/8 to 65/24/11. The antioxidant capacity of the AXOS samples decreased proportionally with the amount of FA that was metabolized. In conclusion, the structural features XOS and AXOS affected both their prebiotic and antioxidant properties under the conditions tested.

Structural basis for activity regulation of the starch debranching barley limit dextrinase by the limit dextrinase inhibitor with relevance in brewing

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Barley limit dextrinase (LD) is the sole debranching activity in germinating seeds and has high activity for 1,6-branch points in alpha-limit dextrins produced from amylopectin. High resolution structures were determined of free LD and of LD in complex with the endogenous limit dextrinase inhibitor (LDI). K_d of the LD:LDI complex was 40 pM with pH optimum at pH 6-7, as determined by surface plasmon resonance. Protection of LD in the LDI complex raises the melting temperature by about 11 °C to 77 °C, however, during mashing at pH 5.0 LD:LDI dissociates resulting in loss of LD stability. Site-directed mutagenesis of two LDI residues guided by the LD:LDI structure resulted in 4.5×10^5 fold affinity loss. In addition, substitution of one LD residue led to 170-fold loss of affinity for LDI without affecting LD's activity. LDI belongs to a family of double-headed, dual target cereal protein inhibitors (CM-proteins), but LDI was found to inhibit only LD. LD is a multidomain enzyme of the alpha-amylase family and its N-terminal domain has remote relationship with a starch binding domain. Noticeably, two point mutations in this domain in sorghum LD improves starch digestability and LD activity. The structure of LD supports amylopectin is a poor substrate and one may speculate if the effect in sorghum reflects a role of LD in starch biosynthesis. The natural glutathionylation of LDI at Cys59 was not in contact with LD in inhibition. The LD and LD:LDI structures contribute to the understanding of the action in relation to brewing. This work was supported by DTU PhD stipends (MSM, MBVC), an Oticon M.Sc. scholarship (JMJ), the Carlsberg Foundation and the Danish Research Council for Natural Science.

Multidimensional benefits of consuming polyphenol-enriched sorghum grains

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Elevated whole grain consumption is suggested to protect against diseases including obesity, cardiovascular disease, diabetes, and colon cancer. The benefits are likely derived from high dietary fiber and biologically active polyphenolic molecule intake. The sumac and black sorghum varieties are known for their relatively high levels of bioactive molecules including condensed tannins and 3-deoxyanthocyanins. We have previously demonstrated that both the black and sumac varieties of sorghum are able to suppress markers of colon carcinogenesis and chronic ulcerative colitis in animal models of these diseases. Part of the benefit appears to be derived from the influence of the bioactive compounds on the colon microbiota. We have extended our work to determine how the condensed tannins in sumac sorghum affect the colon microbiota and their metabolites in overweight subjects. In a crossover, dose-response study with experimental periods that lasted for 4 weeks, we demonstrated significant modifications in the distribution of the intestinal bacteria. Importantly, we also found significant changes in the metabolomic profile of microbially-derived metabolites of polyphenolic molecules in the plasma that reflected a dose-responsive pattern. These molecules included hippurate, catechol sulfate and 3-hydroxyhippurate, which are known to be reduced in overweight subjects with poor glucose control. Collectively, our data suggest that consumption of sorghum varieties that provide elevated levels of bioactive compounds may help suppress several chronic disease states, including perturbed glucose regulation as occurs in pre-diabetes, as well as colon inflammation and cancer. Thus, recommendations for increased whole grain intake should include sorghum varieties containing bioactive compounds. Funded by: United Sorghum Checkoff Program R0031A-09 and R0002-11.

Mutant rice line which shows slower hardening of cooked rice and rice bread

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Cooked rice and rice bread that retain softness for a longer period are desirable to keep eating quality and extend shelf life. We have screened a novel rice mutant named '202', which shows easy gelatinisation of grain against urea solution. The aim of this study was to characterise and evaluate the mutant whether it has capability retaining the softness of cooked rice and rice bread. The gelatinisation temperature of 202 was 64.4°C, and was significantly lower than that of a Japanese leading cultivar with high eating quality 'Koshihikari' of 70.5°C. The chain-lengths distribution of amylopectin of 202 was enriched in short chains (degree of polymerisation (dp) 7 - dp 11) while middle-length chains (ca. dp 14 - dp 23) were depleted when compared to those of Koshihikari. The apparent amylose content of 202 (15.3%) was 2.0 points lower than that of Koshihikari. We have compared the hardening properties of cooked rice and rice bread between 202 and Koshihikari. The hardness of freshly cooked rice of 202 was 4.79 kgf, which was significantly harder than that of Koshihikari (3.53 kgf). However, after a 24 hour storage at 4°C, the hardness of 202 (6.78 kgf) was clearly softer than that of Koshihikari (8.37 kgf). In case of rice bread, the hardness was similar between 202 and Koshihikari at one day after baking, 134 g and 135 g, respectively. At three days after baking, the hardness of bread made from 202 was 169 g, which was significantly softer than that made from Koshihikari of 297 g. These results indicate that 202 would retain softness for a longer period than Koshihikari as cooked rice and rice bread. Using this mutant line, we are now developing commercial cultivars suitable for processed foods including rice bread, rice cakes and Japanese sweets (*wagashi*), which keeps softness with reduced amount of food additives.

Impact of wheat color and flour particle size on the sensory properties and adult hedonic scores of whole wheat breads

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Cereal Foods World 58:A29

There is an ongoing debate about the impact of red or purple wheat vs. white wheat and/or the fine vs. coarse whole wheat flour on the preference of whole wheat food applications. Twenty-five (25) commercially produced whole wheat breads covering a spectrum of sensory characteristics were fed to 360 adult consumers in a Central Location Test. Quantitative descriptive analysis was used to finger print the sensory profiles of all breads. While both the wheat color and flour particle size played an important role in influencing whole wheat bread hedonic performance, impact on purchase interest was minimal especially when other ingredients such as multigrain's and seeds were present. A variety of whole grain flours including purple wheat, sprouted wheat, whole corn flour and durum wheat were also evaluated in this study.

Impact of mixing time and sodium stearoyl lactylate on gluten polymerization during baking of wheat flour dough

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Heating wheat flour dough transforms the transient gluten network formed during mixing into a permanent network, which affects the quality of bakery products. However, the impact of dough gluten network structure on further gluten cross-linking during baking is insufficiently understood. We here mixed flour, water, and, in some experiments also sodium stearoyl lactylate (SSL, 1.0% on flour dm basis), for different times to obtain dough with varying gluten network structures. The effect of varying mixing times and/or addition of SSL on subsequent gluten polymerization during heating (at 110°C) was studied. The level of proteins extractable in sodium dodecyl sulfate containing media (SDSEP) in dough and at different stages during baking was monitored using size-exclusion high performance liquid chromatography. SDSEP values were fitted using first order kinetics, in which the exponential factor k indicates the rate of SDSEP decrease. Mixing for 8.0 min decreased both the extent (SDSEP loss = 80.6%) and rate ($k = 0.23\ min^{-1}$) of gluten polymerization during baking less than mixing for 2.0 min (SDSEP loss = 85.7% and $k = 0.30\ min^{-1}$). Similarly, SSL decreased the rate of gluten polymerization during heating ($k = 0.18$ and $0.24\ min^{-1}$ for 8.0 and 2.0 min mixing, respectively), even more than for control samples. This was related to much less gliadin incorporation in the network and explained by interaction of SSL with the gluten proteins, as observed after separating gluten from starch in the dough samples. During baking, part of the SSL formed amylose-lipid complexes as deduced from their melting enthalpies (2.6 J/g upon addition of SSL compared to 0.1 J/g for control samples). Finally, a higher degree of gluten polymerization during baking increased (R^2=0.84) the firmness of the baked products.

WITHDRAWN

The structure and chemical composition of plant tissues revealed by high resolution attenuated total internal reflectance imaging

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Detailed studies of plant cell microstructure are essential to inform our understanding of many processes for example, plant breeding programs, the effects of processing on plant cells and the behaviour of plant-based foods during digestion. Traditional methods for the study of plant cell microstructure involve sectioning for microscopical analysis. To provide contrast and identify specific features (e.g. DNA) staining is required, adding to the cost and degree of technical difficulty, and increasing the likelihood of artefacts. The last 15-20 years have seen the introduction of powerful infrared (both mid and near infrared) imaging techniques that allow detailed chemical structural data to be obtained with minimal sample preparation. A major limitation of infrared (IR) imaging has been the lack of spatial resolution due to the long wavelength of the IR region. In this paper, we use an optimised form of infrared imaging in attenuated total reflectance (ATR) mode to study the cellar microstructure of durum wheat grain (Triticum durum L.). Plant tissues were embedded in epoxy resin for ATR imaging. Tissue sections for light microscopy were also cut from the same block. The IR method was found to have sufficiently high resolution (1.5 μM) to identify individual cell walls. From the differences in IR spectra between cells of the wheat caryopsis, it was possible to identify individual cells belonging to endosperm, pericarp and testa, and show that these spectra were the same as those obtained by dissected wheat tissue. Furthermore, it was shown that the intra-cellular contents of wheat tissue could be monitored throughout an in vitro digestion process to investigate the role of cell wall encapsulation on digestion of plant tissues, the first in-situ imaging of such a system to be reported.

Synergistic and antagonistic effects of alpha-amylase and amyloglucosidase on starch digestion

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Cereal Foods World 58:A30

The influence of biomacromolecular physical structure on the kinetics of degradation with either exo-acting or a mixture of endo- and exo-acting enzymes was studied using three physical forms of maize and potato starch, amyloglucosidase (exo-acting) and alpha-amylase (endo-acting) as exemplars. For starch in granular form, all enzyme digestions followed first-order kinetics consistent with enzyme-substrate complex formation being rate-limiting, and there was marked synergism between the enzymes in the production of glucose. In contrast, although digestion of cooked starches was more rapid than for the granular form, there were antagonistic effects between endo- and exo-acting enzymes with evidence of first-order kinetics for only the mixed enzyme system. Study of the action of amyloglucosidase against starch oligomers suggests that antagonism was due to the rapid production of low molecular weight oligomers by α-amylase, which are less efficiently digested by amyloglucosidase than polymeric substrates. The rates of digestion of swollen granule ghosts cooked under low shear conditions were slower than for starches cooked under high shear conditions that prevent granule ghost formation. Furthermore, there was an enzyme-resistant fraction present in granule ghosts, in contrast to high shear cooked starches that were fully digested under the conditions used.

Characterization of bitter taste-active compounds in extruded refined and whole grain corn puffed products

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Bitterness in whole grain food products has been reported to result in poor consumer acceptability. The objective of this study was to identify the bitter taste compounds in extruded corn puffed products. Taste differences between refined and whole grain corn puffed products were determined using 2D offline HPLC sensory-guided fractionation. The compounds with the highest bitterness intensity were selected and structurally elucidated by accurate-mass spectrometry and 2D NMR techniques. Four main bitter compounds identified were L-tryptophan, riboflavin, hydroxycinnamoyl-spermidines (two isomers). This information provides a molecular basis to understand the negative flavor traits of whole gain corn samples and suggested strategies for flavor improvement.

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2013 Annual Meeting
Abstracts of Poster Presentations

Abstracts submitted for poster presentations at the 2013 annual meeting in Albuquerque, New Mexico, September 29–October 2, 2013. 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: Abbas, I., and Stephens, J. 2013. Potato-based resistant starch of RS4 type. (Abstr.) Cereal Foods World 58:A31. http://dx.doi.org/10.1094/CFW-58-4-A

Potato-based resistant starch of RS4 type

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RS4 type starch was subjected to various tests to demonstrate functional and health benefits when used in food products. Potato starch was chemically modified to enhance the dietary fiber content from <5% to >85%. Dietary fiber content of the resistant starch was tested using A.O.A.C. 991.43 as well as Codex Definition 2009.01 and 2011.25. Low water holding capacity (2 grams of water per 1 gram starch), minimal viscosity and high process stability were demonstrated. Due to the resistant starch's low water binding ability, it is well suited to replace up to 20% of wheat flour in bread with excellent cell structure, volume and shelf stability. This is ideal for manufacturers to produce high fiber products and make enrichment claims. Additionally, clinical studies were conducted to examine the glycemic response following ingestion of 30g of dietary fiber contributed by the resistant starch. This study exhibited that ingesting 30g of dietary fiber elicited minimal glucose response compared to dextrose. This minimal glucose response makes it an effective fiber source for diabetic products.

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Potential synergistic effect of combining sorghum and cowpea polyphenols

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Cereal Foods World 58:A32

Cereal and legumes are commonly consumed together to overcome protein deficiency and provide required vitamin and minerals to humans. Sorghum & cowpea are often produced & consumed together. They contain significant quantities of distinctly different polyphenols with known bioactive properties. The objective of this study was to determine potential synergistic effect of combining sorghum & cowpea polyphenols. Sorghum (black, high tannin, white, lemon yellow and bright red) and cowpea (brown, black, white & red) varieties were extracted individually in 70% aqueous acetone, and extracts were combined in a 50/50 ratio. Phenol profiles were determined by HPLC. The antioxidant capacity was tested using the end point based trolox equivalent antioxidant capacity (TEAC) and kinetic based oxygen radical absorbance capacity (ORAC) assays for each variety separately and in combination. HPLC results showed that flavonols derivatives were predominant in cowpea, while flavones, phenolic acids and 3-deoxyantho-cyanins derivatives were most common in sorghum. Combination of sorghum & cowpea extracts showed significantly ($p=0.0069$) higher ORAC antioxidant capacity than the additive effects of individual extracts. The black cowpea & black sorghum combinations showed twice as high ORAC values as additive effect of individual extracts (700 µMol TE/g sample versus 320 µMol TE/g sample). White sorghum & white cowpea combination revealed 3-fold increase in ORAC (180 µMol TE/g sample versus 60 µMol TE/g sample). The mixture of high tannin sorghum with brown cowpea showed between (1.5-2) times higher values in both assays. Significant synergistic effect was revealed in combined sorghum & cowpea extracts, indicating the consumption of food containing cereal and legume together might be more beneficial to health than predicted by either component alone.

Assessment of the influence of amylose-LPC complexation on the extent of wheat starch digestibility by size-exclusion chromatography

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Cereal Foods World 58:A32

Starch is a widely used component that provides functional properties in foods. It is considered as the major source of energy in human diet, supplying more than 50% of the caloric energy. Starch digestibility has a big impact on the human health. Rapid postprandial glucose increase in the blood stream, due to the rapid digestibility, is considered as a risk factor that causes obesity and diabetes type II; while a slow digestion rate can prevent metabolic disorders. Starch digestion is a complex process that depends on several factors, such as the source of starch and presence of other components. Since wheat starch is a basic ingredient of foods and LPC (Lysophosphatidylcholine) is the most prominent phospholipid in wheat starch, both components formed the core of the present study. 0.5, 1, 2, 3 and 5% LPC was employed in 9% w/w wheat starch suspensions. The effect on the starch susceptibility to amylase was studied through an *in-vitro* method. The suspensions were incubated with α-amylase for 15, 30, 60, 120 and 240 min and the reducing sugars were measured using DNSA (3,5 dinitrosalycylic acid) reagent. The remaining was freeze dried and dissolved in DMSO-LiBr. SEC (Size-Exclusion Chromatography) was used to analyze the molecular size distribution of the starch molecules after digestion. Suspensions with 3 and 5% LPC were more resistant to degradation at body temperature, due to a higher amount of inclusion complexes. Reduced amylasis during 60 min digestion supported our hypothesis, proved by higher amount of amylose molecules and lower amount of reducing sugars. Additionally, the degradation of amylopectin after 15 min digestion was strongly reduced. Furthermore, iodine complexation with the freeze dried residues, before and after defatting, revealed the degree of amylose hydrolysis of the samples, proving lower digestibility of inclusion complexes.

Characterization of starch isolated from bamboo-rice kernels and bamboo seeds

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Cereal Foods World 58:A32

Objectives of this study were to understand chemical structures, physical properties, and enzymatic-hydrolysis rates of starches isolated from two bamboo rice (rice × bamboo) varieties (Zhuxiang and Zhufeng) in comparison with that of japonica-rice, indica-rice, and bamboo-seed starches. Kernels of the Zhuxiang and Zhufeng rice consisted of 84.7% and 82.8% starch (db), respectively, which were less than that of the japonica (87.1%) and indica rice (85.1%) but greater than seeds of bamboo (68.2%). The Zhuxiang and Zhufeng starches displayed characteristics similar to the japonica-rice starch, and all had lower amylose-contents (13.8-14.4%) and more short branch-chains (DP 6-12) of their amylopectins (34.6-35.9%) than the indica-rice (18.1% and 27.2%, respectively) and bamboo-seed starch (24.1% and 29.5%, respectively). The Zhuxiang, Zhufeng and japonica starches showed lower onset gelatinization temperatures (56.4-59.3 °C), smaller gelatinization enthalpy changes (11.6-14.0 J/g) and percentages retrogradation (11.4-20.1%), but greater enzymatic-hydrolysis rates (64.8-67.3% at 24 h) than the indica-rice (71.9 °C, 15.3 J/g, 55.4% and 46.3%, respectively) and bamboo-seed starch (68.9 °C, 14.2 J/g, 57.1% and 50.6%, respectively). All the rice starches exhibited lower pasting-temperatures but higher viscosities than the bamboo-seed starch, which could be attributed to that the bamboo-seed starch had a larger amylose-content but smaller molecular-weight and radius of gyration of the amylopectin than the rice starches. The data obtained from this study will be valuable for the industrial applications of these two novel rice varieties and help us better understand how the introduction of bamboo genes affects the structures, physical properties and enzymatic hydrolysis of starch in rice.

Physicochemical characteristics of fermented doughs with isolated *Lactobacillus* of pulque for bread elaboration

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The preparation of sourdough bread conducted fermentation processes that gave better sensory and textural properties than non-acidified, which it is an alternative to the use of microorganisms extracted from natural products. The aim of this study was to determine if significant differences exist when using lactic acid bacteria isolated from the doughs of pulque *Lactobacillus plantarum* and *Lactobacillus paracasei paracasei* spp alone and combined with commercial yeast *Saccharomyces cerevisiae* in doughs and properties in the finished product. From a collection the best bacteria were selected by growth kinetics and statistical analysis with the program Sigma Plot 11. Physico chemical properties were determined (pH, acidity of dough %) and texture profile analysis during the fermentation of 5 h evaluated for significant differences. The finished product was performed physical tests (lift coefficient,% crust and crumb) texture profile analysis, image analysis of the crumb structure and sensory analysis. The results show that the most appropriate BAL 5 h to ferment in the dough were *Lactobacillus* spp *paracaseii* which low faster pH and increase acidity. The combination of *Lactobacillus* spp *paracaseii* more commercial yeast were those with better quality in terms of the attributes of texture, taste and image to the consumer.

Simulation of wheat milling system

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Cereal Foods World 58:A33

Milling equipment operational performance and flour output depends on the mill flow and initial grain characteristics. Optimized mill flow is important to maintain the ash and protein composition of flour other than maintaining a uniform particle size distribution. Since adjusting the mill flow depends on the millers' experience, there will always be chances of error in adjustments. Practicing the mill flow adjustments using a virtual software/model, based on grain initial characteristics, will be helpful in keeping the mill flow uniform across different conditions. In this work, a model is developed to simulate the mill flow from grain cleaning till flour load out at Hal Ross Flour Mill of Kansas State University. The model is developed with an aim of using the simulation to optimize the mill flow and also to use the model as teaching and training tool. The simulation model will also help understand the critical operational variable that affects the mill flow; allow users try extreme operational conditions that could lead to change in product quality and flour output, and will also allow users recognize the energy intensive flour mill unit operations. The specific objectives are to develop a toolset with a set of blocks to simulate the grain receiving, wheat milling, sifting, and handling systems of Hal Ross Flour mill. To develop simulation model, commercial software EXTEND was used. This software allows the use of custom images representing equipment in the mill. Using this software blocks that represent unit operation in a wheat flour mill was developed. Preliminary work indicate that EXTEND is an appropriate tool for developing flour mill simulation and the product stream flow within the mill can be simulated from the performance of unit operational blocks.

Development and characterization of flour, masa and tortillas made with nixtamalized-acetylated corn

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In Mexico, maize (*Zea mays* L.) is consumed as tortilla. High intake of this type of food has generated health problems such as diabetes and obesity. Furthermore, the consumption of modified starches decreases these problems, since they act as fiber rather than as a source of energy. The objective of this research was to modify the starch of nixtamalized corn flour (NCF) by the acetylation chemical method, to elaborate masa and tortillas. NCF was made by the traditional method and reacted with acetic anhydride. The evaluated treatments were: traditional flour (TF), acetylated (AF) and hydrolyzed-acetylated (HAF). The flours were characterized by their particle size index (PSI), water absorption index (WAI), water solubility index, color, paste properties and gelatinization enthalpy. The masa were evaluated by their cohesiveness, adhesiveness and moisture; and the tortillas, determining its tensile and cutting force. The PSI of TF showed the highest value, indicating a material more coarse than the rest. Also the WAI of HAF was higher and with significant differences compared with TF and AF. These differences were result of the introduction of acetyl groups into the molecules that make the starch granules (amylose and amylopectin), since they caused an intragranular derangement by steric hindrance, facilitating access of water to the amorphous region thereof. The enthalpy the AF was higher than those in other treatments, representing less damage of the starch granules during the entire process. Larger values of maximum viscosity and consistency were for the AF, so this masa was good during its formatting as tortilla. Tortillas elaborated with AF were softer (less tensile and cutting force) and more white than those elaborated with TF and HAF. In general the AF were the most suitable to produce masa and tortillas with quality characteristics similar to the traditional.

Fine structure and physicochemical properties of waxy wheat starch in comparison with other commercial waxy starches

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Waxy starch has been widely used in a variety of food and industrial applications; however, there is still a need to have waxy starch from a new botanical source to provide new functionality. In this work, the fine structure and functionality of laboratory-prepared waxy wheat (Ww) starch from a commercial source were examined and compared with those of commercial waxy corn (Cw), waxy potato (Pw), and waxy rice (Rw) starches. Scanning electron microscopy showed that Ww starch consisted of a mixture of large/discoid and small/irregularly-shaped granules; Cw and Rw were polyhedral, although smaller for the latter; Pw were a mixture of large/ovoid and small/spherical granules. Ww exhibited an A-type X-ray diffraction pattern similar to Cw and Rw; Pw showed a B-type pattern. High-performance anion-exchange chromatography revealed that the average chain length of debranched amylopectin was 20.8 for Ww, and 20.5, 22.0, and 22.4 for Rw, Cw, and Pw, respectively. Pw was noticeably high in the percentage of B3 chains (DP37-65) and low in the percentage of A chains (DP6-12). Similarly, high-performance size-exclusion chromatography indicated that the proportion of amylopectin long chains was in the order: Pw>Cw>Rw>Ww. Onset gelatinization temperature was 60.0°C for Ww, and 63.3, 65.4, and 67.1 for Rw, Pw, and Cw, respectively. The gelatinization enthalpy followed the trend of Ww=Rw<Cw<Pw. Retrogradation was slower for Ww and Rw. Pw had the highest paste peak and final viscosities, whereas Rw had the lowest. Breakdown viscosity was noticeably higher for Ww and the trend was Ww>Cw=Pw=Rw. Swelling power at 85°C was in the order: Rw>Pw>Ww>Cw. The results suggest that botanical origin influences the structural features and functional properties of waxy starches, and waxy wheat starch may provide new functionality to the food industry.

Formation of soluble amylose-stearic acid complex using chemical and enzymatic modifications

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Amylose-inclusion complexes can function as carriers for enhanced delivery and protection of bioactive compounds of low water solubility. However, upon complexation, amylose complex becomes insoluble because of its crystalline structure. Consequently, the bioavailability of the complexed bioactive compounds may not be improved because of the reduced solubility. The objective of this study was to increase the solubility of the amylose-inclusion complexes by modifying starch chemically via acetylation and/or enzymatically via beta-amylase hydrolysis after debranching. Stearic acid was used as the model compound and unmodified starch was the control. Both soluble and insoluble fractions were recovered and analyzed for stearic acid content by gas chromatography, acetylation degree, X-ray diffraction pattern, thermal stability by differential scanning calorimetry, and molecular size distribution by HPLC. When acetylation was incorporated, either at a low or high level, the amount of amylose-stearic acid complex significantly increased in the insoluble fractions. However, soluble amylose-stearic acid complexes were observed only when starch was modified by a combination of acetylation and beta-amylase treatment. The degree of acetylation was higher in the soluble fractions than in the insoluble fractions, and the soluble complex in the soluble fractions had an even higher degree of acetylation when combined with the β-amylase treatment. The melting temperature of starch complexes was lowered by acetylation. The soluble complexes had a greater proportion of low molecular-size molecules than the insoluble complexes. These results suggest a potential for improving solubility of amylose-inclusion complexes via a combination of acetylation and beta-amylase treatment, and this may ultimately improve bioavailability of the included compound.

Effect of kernel size and mill type on milling yield and end-use quality of hard red spring wheat

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Optimization of flour yield and flour quality is important in the milling industry. Flour yield from roller mills can be reduced by having a mixture of small and large kernels. Also, small kernels adversely affect the flour yield and refinement. The objective of this study was to determine the effect of kernel size and mill type on flour yield and end-use quality. A wheat sample was segregated, based on kernel size, into large (2.92mm), medium (2.24mm), and small kernels (1.65 mm), and an unsorted sample was also obtained. The four kernel size fractions were milled on three different roller mills: Brabender Quadrumat. Jr., Quadrumat. Sr., and Buhler type MLU-202 laboratory mills. Flour yield was determined after milling, and flour quality tests were performed. Twenty-five gram pup loaves were baked, and bread loaf volume was determined. Flour yield was significantly ($P<0.05$) different for large, medium, and small kernels across mills. Large kernels on Quadrumat. Sr. showed the greatest flour yield (73.1%), while small kernels milled on the Quadrumat. Jr. resulted in the lowest flour yield (46.6%). Bread

loaf volume was significantly (P<0.05) different for kernel size treatments and mill types. Bread loaf volume increased as the kernel size decreased within each mill. Overall, both the kernel size and mill type had significant effects on milling yield and bread loaf volume.

Quantitative analysis of isoflavones from soybeans and soy milk using superficially porous particle HPLC method and UV detection
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Cereal Foods World 58:A34

Isoflavones are part of the phytoestrogen class of compounds and are found in soy food products. Recently, a link between the intake of soy isoflavones and lower risks of breast cancer and heart disease has been proposed. Separation, identification and quantitation of isoflavones are often done using high performance liquid chromatography with either UV or mass spectrometry detection. Historically, long chromatographic methods (20-60 min) were required to achieve adequate separation of 6-12 isoflavone compounds. Here, an HPLC method for analysis of isoflavones using Fused-core HPLC column technology was developed. Complete separation of 7 isoflavone compounds was achieved with a total method run time of 10 min. Sensitivity of UV detection was sufficient to quantitatively detect the isoflavones in both soybeans and soy milk. The levels of isoflavones can vary widely depending on the processing of soy foods and the sample preparation technique. We quantified the levels of isoflavones in different brands of soybeans and soy milk with detection limits of 0.5 ppm for most of the compounds. The results will be presented and discussed.

Effect of molecular weight of sorghum tannins on resistant starch formation
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Cereal Foods World 58:A34

Inexpensive and healthy ways to prevent obesity are necessary due to its high incidence in the US and other countries. Condensed tannins or proanthocyanidins (PA) interact with starch more than other sorghum polyphenols, significantly reducing starch digestibility. This study investigated the role of sorghum PA molecular weight on resistant starch formation. Crude phenolic extracts from high tannin and sumac (type III sorghums), hegari (a type II sorghum), and a purified tannin extract, containing high levels of polymeric PA, were used. The extracts were mixed with amylose and amylopectin and phenol content was determined. Moreover, the extracts were cooked with normal and high amylose starches in an autoclave at 121°C for 30 min and stored at 4 °C overnight (3 heating/cooling cycles), ground and either freeze-dried (FD) or oven-dried (OD- 105°C/2h), and RS was determined. Purified tannin extract had the highest level of polymeric PA (525 mg CE/g) followed by high tannin (172 mg CE/g) and sumac (158 mg CE/g) extracts. The type II sorghum had only catechins and small molecular weight PA (dimers and trimers). Treatments containing extracts with high levels of polymeric PA had the highest difference in extractable phenols before and after mixing with amylose which indicated that the large molecular weight PA interacted more with amylose. Treatments containing purified tannin extract had the highest level of RS especially when cooked with high amylose starch and FD (43%), or OD (46%). Control and treatments with high tannin, sumac and hegari had RS of 26.5/28% (FD/OD), 38/42%, 33/35% and 28/30%, respectively. Type II and type III sorghums had different PA levels and molecular weight profiles, and the interaction with starch was stronger with the large molecular weight PA producing higher levels of RS especially when cooked with high amylose starch.

Role of condensed and hydrolysable tannins on resistant starch formation
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Cereal Foods World 58:A34

There is a need to reduce caloric impact of starchy/high carbohydrate foods. This study investigated the effects of condensed tannins (CT) and hydrolysable tannins (HT) on the formation of resistant starch (RS). Crude phenolic extracts from high tannin sorghum (high in polymeric CT), a commercial tannic acid (HT- gallotannins) and Pomella (HT- ellagitanins), an extract from pomegranate, were used. Total phenol content was determined before and after mixing the tannin extracts with amylose and amylopectin. In another experiment, the tannin extracts were mixed with normal and high amylose starches and cooked in an autoclave at 121°C for 30 min, stored at 4 °C overnight (3 heating/cooling cycles) and RS was determined. Treatments containing sorghum CT had the highest difference in extractable phenols before and after mixing with amylose and amylopectin (83% and 65%, respectively), followed by treatments containing ellagitanins (67%/30%) and gallotannins (47%/19%). Thus, both CT and HT interact with amylose more than amylopectin; however, CT had the strongest interaction, which could be due to the difference in structure and molecular weight of the tannins. RS reflected the magnitude of interaction between tannins and starch. RS was significantly higher in samples containing sorghum CT, especially when high amylose starch was used. RS reached 38% when high amylose starch was cooked with CT whereas RS of control and treatments containing ellagitanins and gallotannins were 27.9%, 33.3% and 31% respectively. Sorghum tannins (CT) interacted with starch to significantly increase RS more than HT extracts. Thus, tannin sorghum may be used to produce foods with higher RS content which would be beneficial to prevent obesity and other chronic diseases.

Innovative healthy ingredients from controlled partial germination of cereals
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Cereal Foods World 58:A34

Germination is a natural way to improve the nutritional value, the technical properties and the sensory quality of grains such as cereals and pulses. An innovative industrial process has been developed for controlled germination at industrial level. The process consists of partial germination under controlled conditions and stabilization by gentle heat drying. The resulting products are partially germinated, dry whole grains that are tradable as convenient products with long shelf lives. They can optionally be further processed into food ingredients, such as flours. Baking trials have shown remarkable improvements in technical key properties, such as an increase of up to 37% in loaf volume and a delayed staling of up to 5 days without the use of further additives. This may partly be due to a measured increase in mono- and disaccharides from 3.1 g to 10.0 g per 100 g of dry flour. We further found increased vitamin levels, from 0.16 mg to 0.50 mg e.g. for folic acid and from 0.90 µg to 2.00 µg for cyanocobalamin per kilogram of dry flour. The whole production process is done in a single unit with a capacity of ca. 10 tons per batch, which is integrated in a transportable container and designed as a plug-and-play solution for rapid integration and commissioning. One batch can be processed within 3-8 days, depending on the grains to be processed and the desired degree of germination. High food safety standards and homogeneous germination are ensured by state-of-the-art technology.

Addition of acid-treated unripe plantain modified the starch digestibility, indigestible carbohydrate and antioxidant capacity of semolina spaghetti
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Unripe plantain is a good source of indigestible carbohydrates due to the high resistant starch (RS) content. However, upon been cooked the RS is transformed into available starch. In order to keep the high level of indigestible carbohydrates in unripe banana flour, it was acid-treated and used for spaghetti preparation. Semolina was substituted at 50% with acid-treated plantain flour (MPF) and 50% native unripe plantain (PF) flour for spaghetti preparation, semolina was substituted with the native unripe plantain (PF) flour; control spaghetti (100% semolina), was used for comparison. Chemical composition, starch digestibility, antioxidant capacity, and sensory analysis were carried out. Substitution of semolina with MPF increased up to 300% the total dietary fiber content over that of the control sample and around 200% higher than the spaghetti substituted with PF. An important amount of the indigestible carbohydrates was RS. However, spaghetti with MPF presented lower slowly digestible starch (SDS) than its counterpart with PF. Spaghetti with MPF showed the lowest hydrolysis rate and predicted glycemic index. The acid treatment did not modify the antioxidant capacity of the spaghetti because similar values were found in the spaghetti substituted with PF. A slight decrease in the overall acceptability of spaghetti substituted with MPF compared with the control spaghetti was observed. MPF could be used for substitution of semolina in spaghetti preparation and to obtain pasta with a high level of indigestible carbohydrates, acceptable cooking quality and sensory characteristics.

Predicting tenacity, extensibility and bread volume with the Mixolab
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Cereal Foods World 58:A34

For breeders, knowing wheat properties as early as possible during the breeding process is very important. Within the FSOV (*Fonds de Soutien à l'Obtention Végétale*) program, CHOPIN Technologies developed an

alternative method to determine the alveographic and bread-making wheat characteristics. The Mixolab is used to characterize the rheological behavior of dough subject to a dual mixing and temperature constraint. With the Mixolab, it is possible to predict Alveograph and bread-making parameters on less than 50g of whole wheat meal. The objective of this study is to determine the mathematical models to predict these parameters, using the fastest protocol and a lower quantity of grain. 270 wheat samples from different locations and harvests were grounded and analyzed with the Mixolab. For all samples, Alveograph (AACC 54-30.02) and bread-making values (NF V 03-716) have been obtained by a certified laboratory. 240 samples were used to develop the mathematical models (G, P, W, P/L; Volume, hydration and dough, crumb, bread and total notes). 30 samples were used for validation. To evaluate the quality of the models, the percentage of samples predicted in the method uncertainty was calculated. For the Alveograph W parameter, 65.5% of the validation samples are predicted in the method uncertainty. For P 70%, for G 72% and for P/L 64%. Regarding bread-making, for volume and hydration, respectively 93.5% and 96.5% of the samples are predicted in the method uncertainty. The results are improved when hardness and protein content values are added in the prediction calculation. With white flour as matrix, it is also possible to improve the models accuracy. The Mixolab is an interesting device to evaluate the wheat rheological characteristics from a very low wheat quantity. This shows the Mixolab is a relevant tool to select new wheat varieties.

Microbial load reduction of wheat milled products through pre-milling interventions and milling

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The microbial flora of wheat grains is the primary contamination source for milled products; therefore reducing their load is desirable before or during processing. In this study, samples taken during the milling process of four wheat lines were analyzed for Total Plate Counts (TPC), yeasts, molds, *Enterobacteriaceae* (Eb), and lactic acid bacteria (LAB) to evaluate the effect of tempering solutions and reduction steps. Besides water, solutions of acid (acetic, lactic, citric) and salt (all of them at 1%) were used for the conditioning of the different samples. After tempering, the initial microbial load was reduced significantly by all the acid and salt treatments ($P<0.05$). Acetic acid was the most effective against yeast and mold ($P<0.05$) for all wheat lines, with an average reduction of 3.3 and 2.1 Log CFU/g, respectively. The milling process by itself was also evaluated for its contribution to the microbial reduction in the final flour as compared to the incoming wheat. When wheat from all four lines was tempered with water and milled, the microbial load was distributed into the different milled fractions. As the layers of the kernel were separated, surface contaminants were concentrated in the bran (TPC increased on average by 0.66, yeast and mold by 0.88 and 0.74, respectively, and Eb by 0.45 Log CFU/g); while counts remained the same in the wheat germ (shorts). The inner endosperm had a lower microbial load; since the fractions obtained after first and second reduction (first break and fine reduction) had counts substantially lower than the incoming wheat ($P<0.05$). When both fractions were combined to produce flour, the average reduction obtained for TPC was 1.33 Log CFU/g; LAB and Eb counts 1.54 and 1.82 Log CFU/g; and yeast and mold counts 1.01 and 0.14 Log CFU/g, respectively. Among the different microbial groups the least reductions were observed with molds.

Sulphur management strategies for improved field performance and flour functionality 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. This was the second year of a study 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 0, 5, 10, 20 or 40 lb/acre as SO_4 to the sulphur treated (ST) samples. Control and ST samples were assessed for milling yield, protein and ash contents, solvent retention capacity (SRC), gluto-peak tester (GPT) time and torque, farinograph parameters, Fourier transform infrared (FTIR) spectroscopy protein structure and baking performance. Differences between control and ST samples demonstrated fewer trends in the second year compared to the first year. This is likely due to differences in weather between the two harvest years: year 1 was cool and wet, whereas year 2 was hot and dry. This was also reflected in average yield gains (5 bu/acre in 2011 vs. 2.5 bu/acre in 2012). Regardless, significant site x sulphur interaction effects were observed both years, indicating that certain ON growing regions are more likely to be sulphur deficient than others. ST samples from S deficient regions demonstrated "softer" functional characteristics than the controls, such as decreased GPT torque (-3 BU) and increased GPT time (+1.6 min). Alterations in protein structure (-2% β-turns, +2% β-sheets) due to increases in S-containing amino acids may be driving changes in functionality and bake performance.

Lipid content and fatty acid profile of whole and decorticated millets

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This study investigated the fatty acid profile in whole and decorticated form of two varieties of little millet (CO4, CO3) and one variety of foxtail millet (Market). The fatty acid profile was studied for free and bound fractions of both millet types. Free lipids were extracted using the soxhlet apparatus with petroleum ether, whilst the bound lipids were extracted using hot water-saturated butanol (w/v, 1:5). Fatty acid methyl esters were analyzed by gas chromatography. The free lipids in whole grains millet types ranged from 31-44 mg/g flour whilst the bound lipids ranged from 1.9-11 mg/g flour. For the decorticated millets, free lipids ranged from 10-26 mg/g flour whilst bound lipids ranged from 0.2-1.86 mg/g flour. The main fatty acids found in the free and bound fractions of whole and decorticated millets were linoleic followed by oleic, palmitic then stearic acid. Linoleic ranged from 12-29 mg/g flour, Oleic from 9-15 mg/g flour and palmitic 3-7 mg/g flour in the free whole fraction. The whole grain bound fraction had Linoleic acid of 0.7-7 mg/g flour and oleic 0.7-2 mg/g flour. The decorticated bound fraction showed similar trends in fatty acid profile as the free with linoleic, oleic and palmitic acid being the major ones present. Linolenic, Arachidic, Behenic and lignoceric acids were also detected in trace amounts in both free and bound fractions of whole and decorticated millet. Whole and decorticated little C04, Foxtail market had higher lipid contents than little C03 however linoleic, oleic and palmitic were the major fatty acids in all. Moreover the whole and decorticated millets in free and bound fractions showed similar fatty acid profile but total percentage of long chain fatty acid (C20:0 and above) were higher in the bound fraction than the free. Due to the higher unsaturates in millet oil, it could be a good source of unsaturated fat in our diet.

Biopolymer interactions, water dynamics and bread crumb firming

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The molecular basis of bread firming is not completely understood. It is accepted that amylopectin retrogradation contributes to, but is not solely responsible for, crumb firmness. Concomitant with retrogradation, changes in crumb and crust water content and water redistribution between their constituents take place. Water redistribution between bread constituents is caused by water immobilization in the amylopectin crystals formed during storage. This water fraction is withdrawn from the amorphous networks, including the gluten network, which lose their plasticizing water. In addition, water diffuses from gluten to starch due to their thermodynamic immiscibility. In this way, the flexibility of the gluten network is reduced. This can contribute to crumb firmness. However, the relative importance of water redistribution and amylopectin retrogradation for bread firming is still under debate. The objective of this study was to investigate changes during bread storage, thereby distinguishing between the effect of crumb to crust migration and evaporation of water and the effect of amylopectin recrystallization with water incorporation into the resulting starch network. To that end, stored and dried bread and bread crumb were studied. The formation of starch crystals and changes in crumb firmness were monitored. Proton Nuclear Magnetic Resonance (^{1}H NMR) was used to analyze proton mobilities of the bread constituents. The formation of amylopectin crystals slowed down after a couple of days and largely contributed to the initial increase in crumb firmness. ^{1}H NMR analyses showed that redistribution of water from gluten to starch, together with crumb to crust moisture migration, resulted in stiffening of the gluten network which contributed to the increase in crumb firmness after a couple of days of storage.

Influence of milling method on the properties of pita bread made from whole and split yellow pea flours

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The nutritional value of pita bread can be improved by the addition of yellow pea flour but end product quality can be affected depending on the pea flour used and the level of inclusion. This study was undertaken to examine the effect of milling method on the quality of whole and split yellow pea flour and the properties of pita bread made from a blend of yellow pea and wheat flours. Yellow peas were commercially milled using four different milling technologies (hammer, stone, pin and roller). Flour quality was assessed for particle size, colour, protein, fibre, water absorption capacity and starch damage. Pitas were made following a standard commercial method using a 30% yellow pea/70% Canada Western Red Winter (CWRW) wheat flour blend. Colour of the baked pitas was evaluated using a Minolta chroma meter CR-130 using an L*a*b* colour scale and firmness was measured using a TA-HD Texture Analyzer. Significant differences ($p \leq 0.05$) were observed among the pitas for weight, diameter, pocket height and colour. No differences ($p \leq 0.05$) in firmness were observed. These findings can be explained by the differences observed in particle size, water absorption capacity and fibre content of the yellow pea flours. Flours with a larger particle size (stone and hammer) generally produced pitas that were larger in diameter with greater pocket height, and had higher a* values (redness) compared to pitas made from flour with smaller particles (pin and roller). This study has shown that the properties of the yellow pea flour can influence the final quality characteristics of pita bread. Thus, to successfully incorporate pulse flours into bakery formulations, careful consideration needs to be given to flour specifications, as different milling methods will produce flours of varying physical and functional characteristics which will in turn affect end product quality.

WITHDRAWN

Phosphorylated cross-linked resistant wheat starch (RS4) application in white pan bread

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Phosphorylated cross-linked resistant wheat starch (RS4) is a viable ingredient for increasing total dietary fiber content of baked products without the deleterious effect on quality. Bread flour was replaced with 0, 5, 10, 15, 20, or 25% RS4 and augmented with vital wheat gluten to maintain the flour protein content (11.77% mb) in flour blend/water dough and pup-loaf bread. Dough characteristics were evaluated by the mixograph, farinograph, and Kieffer extensibility test. Bread crumb grain quality was evaluated subjectively and using C-cell image analysis. A 14-day shelf life study and total dietary fiber content analysis were conducted. Mixograph water absorption remained the same as the control (62%) for doughs containing 5, 10, and 15% RS4; however, a significant increase in absorption (64%) occurred with 20 and 25% RS4. The 25% RS4 dough required the longest mix time (3.75-min). In general, the Kieffer test showed the force to break (dough strength) was not significantly affected until the addition of 25% RS4. No significant difference between RS4 levels for mean distance to break showed the level of RS4 had no significant effect on dough extensibility. Loaf volume was not significantly affected by addition of RS4 until 25%. The 20% RS4 bread crumb grain contained uniform evenly distributed cells. C-Cell data showed no significant difference in the number of cells between loaf treatments. The significantly smaller average cell wall thickness, diameter and volume of the 25% RS4 loaves, as compared to the control, was in agreement with the subjective crumb grain evaluation of a fine texture and small round cells. The depressed loaf volume seems to be a function of decreased cell expansion rather than cell coalescence. It appears that 25% RS4 incorporation is the threshold level for adversely affecting bread quality.

Properties of extruded chia-corn meal puffs

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Chia seeds contain about 30% oil, and about 60% of the fatty acid content is omega-3 alpha-linolenic acid. The objectives of this work were to examine the properties of extruded corn meal puffs containing chia. Mixtures of corn meal and chia seeds (0-20%) were processed in a laboratory-scale twin-screw extruder at different moisture contents (16-22%) and final heating zone temperatures (120-160 °C). Extrusion processing provides a simple method for grinding the seeds, which is necessary for making the fatty acids available. Furthermore, differential scanning calorimetry measurements showed that a large amount of the fatty acids were incorporated into helical inclusion complexes with amylose from the starch, which has been shown to help prevent oxidation. The expansion of cylindrical extrudates decreased with increasing chia content and with increasing final heating zone temperature. The hardness of the extrudates increased with increasing chia content. The fatty acid profile of oil extracted from the extrudates was not affected by the processing temperature.

Bran characteristics and bread-baking quality of whole grain wheat flour

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Bran provides nutritional advantages to whole wheat flour (WWF) over wheat flour, but negatively affects quality and sensory acceptance of whole wheat bread. Considering the genetic diversity of wheat and significant environmental influences on grain quality, characteristics of wheat bran could vary widely and differentially affect the baking quality of bread, depending on its sources. Bran of 18 wheat varieties of various classes was obtained from roller milling, characterized for composition and mixed with wheat flour for determination of dough properties and bread baking quality. The protein, fat, ash and insoluble dietary fiber (IDF) content were 12.9-18.3%, 3.8-5.4%, 6.3-8.2% and 46.0-51.3% in hard wheat bran, and 11.1-18.9%, 3.8-4.9%, 4.6-8.1% and 40.7-50.6% in soft and club wheat bran. Bran of various wheat varieties was blended with a hard red spring wheat flour at a ratio of 1:4 to prepare WWFs. WWFs with hard wheat bran generally exhibited higher dough water absorption and longer dough mixing time, and produced smaller loaf volume of bread than WWFs of soft and club wheat bran. IDF content and water retention capacity of bran exhibited a significant relationship to loaf volume of WWF bread, whereas no relationship was observed between protein content of bran and loaf volume of bread. Negative correlation between total dietary fiber content and changes in crumb springiness and cohesiveness during storage was found, indicating that fiber has adverse effects on the textural profile of WWF bread during storage. It appears that soft wheat bran, probably owing to relatively low IDF content, has smaller negative effects on mixing properties of WWF dough and loaf volume of bread than hard wheat bran.

Can high hydrostatic pressures modify the technological properties of gluten-free raw materials?

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Gluten-free (GF) baked goods contain a large amount of starch whose behavior during processing and storage greatly influences their quality and

shelf-life. Even if high hydrostatic pressures (HHP) are generally used to inactivate microorganisms and enzymes, they were here employed as a non-conventional treatment to modify the technological aptitude of corn starch (CS), rice flour (RF) and waxy rice flour (WRF), raw materials commonly used in GF products. The samples were pre-conditioned up to 40% moisture content and then treated with HHP. The following parameters were considered: pressure (400MPa; 600MPa), pressure holding time (5min; 10min) and temperature (20°C; 40°C). The untreated and treated samples were evaluated for their viscoamylographic features, solvent retention capacity (SRC), thermal properties, X-ray diffractive and ultrastructural characteristics. According to the pressure applied, different pasting behaviours and SRC were evidenced. RF-starch was partially de-structurated at both the pressures applied, as highlighted by the lower peak values obtained (650 and 620BU, respectively) in comparison to that of the untreated sample (756BU). Few differences were found for WRF, indicating a lower susceptibility to pressure. CS treated at 600MPa presented diminished pasting properties in comparison to the untreated CS and to CS treated at 400MPa: even if the gelatinization temperature of all these samples was around 70°C, a clear shift of the 600MPa treated CS viscoamylographic curve was evidenced. Furthermore, both CS and RF treated at 600MPa showed a higher retention capacity of carbonate and lactic acid solvents, respectively related to starch and protein properties. HHP treatments thus seem to be able to change the technological behaviour of RF and CS, and this potential positive effect has been actually evidenced in preliminary breadmaking trials.

WITHDRAWN

Tempering affects seed coat removal and particle size reduction of black beans

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Whole black bean (*Phaseolus vulgaris* L.) and dehulled black bean flour can be used to produce novel and nutritionally improved food products. Particle size is one of the biggest variables in flour quality and can affect the functional and physiochemical properties of black bean flour and the subsequent end product quality. It is important to gain knowledge on how different milling techniques will impact black bean flour composition and functionality. Experiments were conducted to determine the effect of tempering on seed coat removal and particle size reduction of black beans milled on a roller mill. Black beans were pretreated by traditional tempering to 10, 12.5, and 15% moisture or by steam tempering for 30, 60, and 90 seconds and milled on a roller mill 3 or 16 hours later. Seed moisture content, at the time of milling, affected flour yield. Flour yield decreased as moisture content increased from 8 to 15%. Separation of seed coat from cotyledon declined as moisture content increased with the biggest effect 3 hours after tempering. Particle size distribution was also affected by tempering treatment. Particle size reduction was greatest with 10% moisture content and 30 seconds with a 16 hours delay prior to milling. Flour color became lighter as moisture content increased. Proximate analysis of the flour showed no significant differences for ash and protein content after tempering. However, there was a small decrease in ash content when steam tempered. Best seed coat removal and flour yield occurred with seed that was tempering to 10% moisture content with a 16 hour delay to allow for moisture migration throughout the seed and with seed that was steam tempered for 30 seconds with 16 hours delay.

Effects of enzyme treatment and processing on the status of phenolics in bread and cereal containing wheat aleurone

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Cereal Foods World 58:A37

Wheat bran is an important source of biologically active phytochemicals such as phenolic compounds. In wheat bran, ferulic acid (FA) is the most abundant phenolic compound, and provides the aleurone layer within the bran with the highest antioxidant capacity of the wheat fractions. Ferulic acid has demonstrated anti-inflammatory properties in-vivo and may have protective effects against chronic diseases. However, most ferulic acid in aleurone layer is covalently bound to arabinoxylan, limiting its bioaccessibility. The objective of this study was to evaluate the effects of extrusion and the breadmaking process on the status of free ferulic acid in products containing wheat bran and wheat aleurone that had been enzymatically pretreated with exogenous xylanase and ferulic acid esterase. UHPLC/UV methodology was utilized to quantify free and non-starch polysaccharide associated FA in a direct expanded cereal and bread. Extruded cereals containing 20% untreated bran and aleurone contained similar amounts of free trans-ferulic acid (11.1 and 10.6 ppm, respectively), while the same quantity of enzyme treated aleurone resulted in greater increases in free trans-ferulic acid for extruded cereals (31.9 ppm) than bran (23.4 ppm). Likewise, breads produced with 25% replacement of flour with enzyme treated aleurone contained higher quantities of free trans-ferulic acid than breads containing enzyme treated bran or a whole wheat control bread (19.1, 9.9, and 8.0 ppm, respectively). Results demonstrate enzymatic treatment of wheat bran and wheat aleurone prior to processing can increase the free ferulic acid content of foods and their resulting health potential.

WITHDRAWN

Gelatinisation properties of 12 varieties of grains

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Grains are healthy food, and if we mix up different kinds of grains for cooking, the sensory and nutritional quality will be improved. This project aimed to determine the grains that can be cooked together according to the time and degree of gelatinization. 12 varieties of grains (white rice, black rice, red rice, green rice, purple rice, green foxtail millet, white foxtail millet, yellow foxtail millet, buckwheat, sorghum, little corn grits and large corn grits) were divided into two groups. The first group was soaked for 30 min at 25 ºC at the ratio of material to water of 1: 2, cooked for 30 min at the ratio of 1:1.5, and then kept warm for 20 min after stop heat. The other group was cooked directly for 40 min and then kept warm for 20 min. The gelatinization degree was recorded every ten minutes. The gelatinization degree of some varieties less than 85% is as followed: sorghum, buckwheat, large corn grits, green foxtail millet (without soaking), and little corn grifts (without soaking). The gelatinization degree of the soaked grains was higher. It turned out that in cereal production the green rice, purple rice,

black rice, red rice, white foxtail millet and yellow foxtail millet with no soak can be cooked together with white rice for the same time; after soaking, the green foxtail millet and little corn grifts will be processed together with white rice; the sorghum, buckwheat and large corn grits should be soaked and cooked for a longer time and then can processed with white rice.

Purification and characterization of xylooligosaccharides (XOS) from *Miscanthus x giganteus*

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Miscanthus x giganteus (MG), a perennial grass, is considered a potential bioenergy crop due to its high yield and ecological properties. Xylooligosaccharides (XOS) are sugar oligomers made of several xylose units. Due to their prebiotic functionality and other health effects, XOS can be a useful coproduct from the cellulosic ethanol industry. There is lack of information on production of XOS from *Miscanthus*. The objective of this study was to purify XOS from the pretreated liquid and further separate XOS into different degree of polymerization (DP) fractions. The XOS crude solution was produced by autohydrolysis in a steel pipe reactor (diameter: 1 inch; length: 7.24 inch) submerged in fluidized sand bath. The water/solid ratio was set at 9:1 and reaction condition was set at 180°C, 20 min. The initial XOS in solution was quantified by NREL procedure (TP-510-42623). The crude solution was first adsorbed with 1, 5, 10 and 20% activated carbon (w/v) and eluted with 5, 30, 50, 70 and 95% ethanol/water solution. Highest recovery (47.9% w/w) of the initial XOS present in solution was observed with 10% (w/v) activated carbon. Most XOS were eluted at 30 and 50% ethanol/water solution. Further tests were conducted using gel permeation chromatography (GPC) measuring the MW distribution in each XOS fractions. The results were indicative that higher ethanol solution could recover higher DP oligomers. In order to increase its purity, the XOS fractions were separated by centrifugal partition chromatography (CPC) using a butanol:methanol:water (4:1:4) solvent system. The CPC fractions were consolidated and six XOS samples were obtained with a relative purity of 94, 64, 65, 44, 43 and 61% of xylose, xylobiose, xylotriose, xylotetrose, xylopentose and xylohexose, respectively.

Evaluation of bioethanol production from pollinated and un-pollinated tropical maize

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Tropical maize is an alternative maize species for bioethanol production. It has a prolonged vegetative growth stage and accumulates large amounts of sugar and biomass. In previous study, we reported that the pressed sugar syrup from stalk can be used as feedstock for ethanol production. Increasing the sugar content in stalk is an important parameter for developing tropical maize as a new bioenergy crop. The tropical maize strain FR1064 x mo18w was planted at the experimental farm of University of Illinois. Treatments used were allowing tropical maize to pollinate naturally or prevent pollination by shooting bags. After harvest, the whole plant were dried and ground for analysis. Samples were collected at each developmental stage (R1-R6) and used for composition analysis and fermentation. The un-pollinated maize produced 4.1% (w/w) of starch compared with 32.1% (w/w) in pollinated maize. Sugar analysis showed that the total amount of sucrose, glucose and fructose increased in un-pollinated maize and the highest concentration of 30% (w/w) was obtained during milk (R3) to dent (R5) stages. In contrast, total sugars in pollinated maize decreased with development and reached 4.7% (w/w) at maturity (R6) stage. Ethanol yield were evaluated by fermenting sugars and starch for both treatments using conventional dry grind procedure. The result showed that the up-pollinated maize could provide 0.15-0.17 mL/g ethanol from blister (R2) to dent (R5) stage; however, the pollinated maize could attain 0.21 mL/g at maturity (R6 stage). The ethanol yield from lignocellulosic material was evaluated by fermenting hydrolyzed stover. There was not a significant difference observed between two treatments. Overall, the un-pollinated tropical maize was better feedstock for bioethanol production from milk (R3) to dent (R5) stage while pollinated maize was better at maturity (R6) stage.

Correlations between grain quality traits in quality protein maize cultivars grown under high and low soil nitrogen

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Quality protein maize (QPM) cultivars are promising for commercial use in South Africa's dry milling industry. Their selection is dependent on high milling performance, which is determined primarily by grain hardness. Fifteen white QPM cultivars were grown under dryland conditions in Potchefstroom, South Africa. Varieties were grown under both high (85 kg N/ha) and low (0 kg N/ha) soil nitrogen (N) conditions. Grain quality of QPM cultivars was determined using several methods including thousand kernel weight (TKW), test weight (TW), percentage kernel removed using a Tangential abrasive dehulling device (TADD), near infrared transmittance (NIT) milling index and kernel size (KS) in the two N environments. Correlations were performed to determine the relationships between grain quality tests and their value in maize grain quality selection, with respect to assessing grain hardness. In both high and low N environments TADD kernel removal was significantly ($P<0.001$) negatively correlated to NIT milling index ($r = -0.465$) and ($r = -0.419$), respectively. Similarly highly significant ($P<0.001$) correlations were found between KS and TKW in high N conditions ($r = 0.821$) and low N conditions ($r = 0.621$). Test weight was not correlated with other quality parameters. This could be attributed to similar TW of QPM cultivars in both environments. The study showed that TKW can be used as an indicator of kernel size while NIT and TADD would measure grain hardness. These grain tests would be applicable for cultivar selection of QPM grown in different N environments.

The role of barley starch structure in the process of brewing

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Starch and degrading enzymes (endogenous or exogenous) are among the key factors in the production of fermentable sugars during the mashing step. While the roles of starch hydrolytic enzymes in the brewing process have been extensively studied, the impacts of starch fine structure on the production of fermentable sugars have not been fully investigated. In this study, 4 varieties of unmalted barley grains and 5 varieties of malted grains were selected for the mashing and brewing processes. Nine wort samples and their corresponding beer samples were collected after mashing and fermentation processes, respectively, for soluble sugar analysis using HPLC. Starches were extracted from the unmalted and malted grains, and their whole (fully branched) molecular structure and the length of individual linear branches (from enzymatically debranched starch) were analysed using size-exclusion chromatography (SEC). The amylose contents were also determined from the SEC distributions of debranched starch, calculated as the ratio of the area under curve of amylose branches to that of the whole distribution. The results were compared between the unmalted and malted grains to investigate the impacts of starch fine structure on the production of fermentable sugars using exogenous and endogenous enzyme systems, respectively. For both cases, the production of fermentable sugars during mashing is positively correlated with the percentage of short amylopectin branches in the total amylopectin branches. Understanding the roles of barley starch fine structure in the brewing process will provide new insights for new methods of better beer quality control and lower production costs.

Quantitative determination of thiamine in grains and seeds by high performance liquid chromatography-tandem mass spectrometry

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Cereal Foods World 58:A38

A procedure for the determination of thiamine (vitamin B1) in maize (*Zea mays*) grain, soybean (*Glycine max*) seed and canola (*Brassica napus*) seed utilizing high performance liquid chromatography with tandem mass spectrometry detection (HPLC-MS/MS) was developed and validated. HPLC columns containing a pentalflurophenylpropyl (PFP) stationary phase provide an improved means of analyzing polar molecules by HPLC. Water soluble vitamins such as thiamine have been particularly troublesome due to silanol interactions which result in peak tailing. When coupled with tandem mass spectrometry detection, the PFP column becomes even more powerful due to sensitivity and selectivity advantages of MS/MS detection. Grain and seed sub-samples were extracted with aqueous acetic acid/trifluoroacetic acid,

filtered and diluted with water for HPLC-MS/MS analysis. Assay precision (relative standard deviation) was 4.77%, 7.82% and 9.10% for maize grain, soybean seed and canola seed, respectively. Mean spiking recovery was 92.5%, 96.5% and 90.1% for maize grain, soybean seed and canola seed, respectively. The validated method provides for rapid, sensitive and selective determination of thiamine in grains and seeds.

WITHDRAWN

Influence of genetic background on the anthocyanin and co-pigment content and profile of colored corn

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Cereal Foods World 58:A39

This study was conducted to identify differences in pigment and co-pigment content and profile of colored corn hybrids made from colored inbred lines. The six main classes studied were blue/yellow, red/yellow, red, purple, blue, and red/blue lines; the blue color is in the aleurone, the yellow in the endosperm, and red and purple in the pericarp. The pigments extracted from the corn samples were initially screened by HPLC. Structural identities were then elucidated using UPLC-MS. Total anthocyanin content was quantified using UV-Vis Spectrophotometry at λ_{max}. Results were expressed as cyanidin-3-glucoside equivalents, dry basis. The highest anthocyanin content was observed in the purple sample (5.96±0.02 mg/g), while the red sample contained the least, (0.24±0.01mg/g). The major anthocyanins present in purple, red/blue, and blue/yellow lines were derivatives of cyanidin, pelargonidin, and peonidin. Cyanidin-3-glucoside was a major pigment in all three phenotypes. In the red/blue phenotype, the more stable cyanidin-malonyl-glucoside was most abundant. Regarding co-pigments, the red/blue lines were high in phenolic acid derivatives, while the purple lines contained various derivatives of flavones such as luteolin and apigenin. These co-pigments play an important role in stabilizing the anthocyanins present and enhancing the color perceived by the consumer. There are major differences in anthocyanins and co-pigments among the colored corn samples, signifying the possibility of utilizing genetics to select for more stable lines to be grown for food applications. Future research will determine the effect of thermal treatment on the stability of these pigments and co-pigments.

Effect of high molecular weight glutenin subunits on flour rheological parameters and baking properties from different wheat genotypes

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The high molecular weight glutenin subunits (HMW-GS) are important determinants of wheat flour quality. The aim of this study was to examine the effect of the HMW-GS on flour rheological and baking properties from 16 Brazilian wheat genotypes. The HMW-GS were determined by SDS-PAGE and correlated with farinoghaphic and extensographic properties of flour and specific volume (SV) and firmness (F) of bread. Scores from 1 to 4 were calculated for each HMW-GS, and the Total Score (TS) was represented by the sum of the quality scores of Glu-A1, Glu-B1, and Glu-D1. The data were subjected to Pearson's correlation, and principal component analysis (PCA). HMW-GS of all genotypes showed 4 allelic variations in Glu-A1 [2*, 1, Null, and 1/2*], 5 in Glu-B1 [7+9, 7+8, and 17+18], and 4 in Glu-D1 [5+10, 2+12]. TS varied from 5 to 10 being the scores 9 and10 more frequent. There was a positive correlation between TS and development time (r = 0.51), resistance at 45, 90, and 135 min (r = 0.63, 0.68, and 0.63, respectively), and SV (r = 0.60), whereas TS negatively correlated with F (r = - 0.54). There were no significant differences in the SV, and F among the alleles in Glu-A1. The Glu-A1 quality scores were negatively correlated with mixing tolerance index (MTI) (r = - 0.50). In Glu B1, the alleles 17+18 and 7+8, which had score 3, were related to higher SV. The Glu-B1 quality scores showed negative correlation (r = - 0.51) with extensibility (E) at 135 min. In Glu-D1, the alleles 5+10, which had score 4, and the alleles 2+12, which had score 2, were related to higher SV and higher F, respectively. There was negative correlation between Glu-D1 quality scores and MTI (r = - 0.50). From PCA, it was observed that flours which had subunits of higher quality score had higher gluten strength leading to better baking quality. Financial Support: CNPq.

Evaluation of native wheat lipid fractions on structure and physical properties of bread

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Native wheat lipids play a key role in helping to maintain and prevent air cell coalescence within the dough matrix. In particular, the free lipids, which consist of the polar fractions, have the greatest effect on loaf volume and air cell distribution especially at the later stages of proofing and baking. X-ray microtomography (XMT) is a noninvasive technique that allows for the evaluation of cell structure and distribution within a complex system by creating a 3-D image of sample. The objective of this study was to evaluate the differences in air cell structure, distribution, loaf volume, and microstructural texture characteristics of dough and bread after the removal and reconstitution of free and bound lipids. Both fractions were separated from bread flour (11.53% mc) using hexane extraction (1:10 w/v), evaporated under pressure, and nitrogen flushed. Free (0.8%), bound (0.6%), and a combination of free and bound lipids (1.4%) where added back to the defatted flour and breads were baked following AACC method 10-10.03. Loaf volumes were determined and bread microstructure and physical properties were evaluated using XMT, C-Cell imaging, and texture profile analysis. Loaf volumes were the highest for the control (1023cc), with bound (853 cc) and the combination of free and bound (840cc) being the most similar. XMT imaging analysis showed that air cell size was largest for the combination of free and bound (2423 μm) followed by bound (2377 μm), free (2281 μm) and the control (2073 μm). Texture analysis showed significant firmness differences ($p<0.05$) between the control (152 g) and the bound (308 g) and free (392 g) breads. These results indicate that the addition of the lipid fractions influences both, the size and distribution of the cells within the dough matrix, which then affects the overall physical properties of bread.

Selecting wheat varieties for tortilla production

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Wheat flour tortillas are the second most consumed bread product behind white pan bread. Tortillas are formulated with highly viscoelastic hard wheat flours selected and grown for bread making. The inherent properties of these flours require costly reducing agents to enhance extensibility necessary for tortilla production. Previous research on wheat tortillas focused on formula additives, but little is known about the optimum tortilla flour chemistry. The objective of this study was to identify the biochemical and physical factors in wheat affecting wheat tortilla quality. Six Kansas hard winter wheat cultivars

(1863, Armour, Clara CL, Denali, Everest, Tiger) varying in bread making quality were grown in five locations. Flour properties were evaluated using AACCI approved methods. Flour samples varied widely in protein content (9.9 to 17.3%), water absorption (61 to 68%) and dough mix time (2.5 to 5.5 min). Wheat tortillas made with a laboratory hot press method were scored on quality parameters including dough machinability, opacity, appearance, specific volume and shelf-stability over 14 days. Everest and Clara CL produced better quality tortillas than the remaining varieties. Flour protein content correlated highly with tortilla opacity (r=-0.86), a-values (r=0.80), shelf-stability (r=0.76), L-values (r=-0.75), specific volume (r=0.65) and diameter (r=-0.65). Additional tests to characterize the starch and protein fractions are in progress. The impact of genetics, environment and their interaction will be examined.

Evaluation of gluten addition effect on rheological properties of alkaline noodles using high frequency ultrasound and stress relaxation techniques

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Cereal Foods World 58:A40

Uncooked alkaline noodles made from two different Canadian wheat classes, Canadian Western Red Spring (CWRS) and Canada Prairie Spring Red (CPSR), were studied by simultaneously employing high frequency ultrasound and stress relaxation techniques. Ultrasonic velocity and attenuation coefficient of the single raw noodle layer at 1.6 MHz were measured and longitudinal storage modulus and loss modulus and tan delta were determined. The objective was to understand gluten addition effects on the mechanical properties of noodles. Gluten extracted from CPSR class flour (variety 5701PR) was added back to the same CPSR flour (5701PR) and to CWRS class flours. Farinograph tests highlighted significant increases in dough stability when 2% of 5701PR gluten was added to CWRS flours. However, 5701PR gluten addition to the same 5701PR flour yielded minimal change as-dough stability decreased by 2 min. High frequency ultrasound investigation of uncooked noodles made from 5701PR flour with 2% 5701PR gluten addition displayed no difference in phase velocity, attenuation coefficient and mechanical modulus. No meaningful increase in stability was observed with 2% CWRS class flour gluten addition to CWRS class flour. Critically however, ultrasound results on raw noodles made from CWRS class flours incorporating 1 or 2% 5701PR gluten addition showed significant increases; by 8% and 17% respectively, in longitudinal storage modulus M' correlated with stress relaxation at 20% strain test (k1) results (R^2=-0.9). This suggests that noodle elasticity increased as 5701PR gluten was added to CWRS flours. Concurrently this highlights the capability and sensitivity of this ultrasound technique to characterize and quantify noodle dough rheological properties and provide complimentary information on noodle texture not attainable by traditional techniques.

Nutritional, chemical and functional properties of commercial quinoa

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Quinoa (*Chenopodium quinoa* Willd.) is a nutrient-rich pseudocereal potentially beneficial in the development of gluten-free baked goods. This research evaluated commercially available quinoa samples for their nutritional, chemical and functional properties. Four quinoa samples were obtained from supermarkets and quinoa producers. They included one commercially milled quinoa flour (CQF1), two lots of whole quinoa seeds (CQF2, CQF3), and one lot of germinated quinoa seed (GQF). Samples were analyzed in triplicate for proximate composition, polyphenols, fatty acid, starch digestion, pasting properties, and particle size. CQF1 and GQF had the same moisture content (7.6%; $p<0.05$), while the two whole quinoa samples had higher moisture contents (11.8%). Except for CQF2 (4.8%), no differences were found in fat content (5.7%). Protein content ranged from 14.6 - 15.9%; GQF was the highest and CQF2 the lowest. Fiber and carbohydrate content were the same in all samples (6.5 and 67.2%, respectively). Ash content was the same among non-germinated samples (2.3%), but lower in GQF (1.9%). Total phenolics using the novel Fast Blue BB method were highest in CQF2 and CQF3 (516 mg GAE/100g), followed by GQF (346 mg GAE/100g), and lowest in CQF1 (280 mg GAE/100g), while total phenolics from the Folin Ciocalteu method contrasted with the exception of CQF1, which remained the lowest (112 mg GAE/100g). Pasting properties showed the greatest variability, with peak viscosities ranging from 8201 - 12433 cP, breakdown between 968 - 5010 cP, final viscosities between 11641 - 14596 cP, and setback values between 4218 - 5935 cP. CQF1 had the smallest particle size (202 µm), while no differences were found among the other samples (801 µm). Greater understanding of differences among commercially available quinoa products is essential given the increasing interest in this unique pseudocereal.

Measurement of mixture levels of conventional wheat in waxy wheat by near-infrared spectroscopy of bulk and ground meal

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Cereal Foods World 58:A40

The breeding development of waxy wheat lines adapted to the North American climate has been underway for more than a decade, with releases of viable varieties imminent. With an anticipated premium expected for waxy varieties, a rapid and accurate method is desired to identify and quantify the 'contamination' of conventional wheat with waxy wheat, a condition that might occur at first point of sale. Our previous work demonstrated that lines pure in the waxy condition can be identified from non-waxy lines by use of near-infrared (NIR) spectroscopy applied either on a whole kernel or ground meal basis. However, mixture quantification by NIR techniques has not been examined until now. Using hard red winter wheat grown in two seasons (2011 and 2012) and two locations (Nebraska and Arizona), a series of mixtures ranging in proportion (conventional : waxy) weight percentage from (0:100) to (100:0) were formed from nine pairs of waxy and non-waxy varieties or lines, with year and location being consistent within a pair. Twenty-nine mixtures were formed for each pair. Regression models were developed using 1) single differences of wavelengths through searches of all (A_lambda1 – A_lambda2) combinations, 2) partial least squares regression, and 3) least squares support vector machine regression. Two sample formats were examined, these being bulk whole kernel and ground meal. Our results indicate that regardless of sample format and regression algorithm, the optimal models typically produce coefficients of determination (R-squared) in excess of 0.98, with standard errors of ca. 3-5%. Far more challenging in modeling efforts has been when the mixture concentrations are limited to not exceed 10 percent conventional in waxy, which so far has produced models with insufficient accuracy for field implementation.

Effect of durum cultivar and mill configuration on the textural and cooking quality of whole-wheat pasta

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The effects of cultivar and milling configuration on textural and cooking quality of whole-wheat pasta quality were investigated. Durum was milled using a centrifugal mill configured with either a 250 or a 500 µm screen. Cooking loss and cooked firmness were greater from pasta containing whole-wheat flour made using the 250 compared to 500 µm screen. The cooked weight of whole-wheat pasta was higher when whole-wheat flour was made using the 500 µm. Cooked firmness and cooking loss varied with durum cultivar. Protein content of durum wheat was especially important in determining cooked pasta firmness, as evidenced by the increase in cooked firmness from 4.23 to 5.83 g•cm as protein content increased from 12.2 from 17.6% using 250 µm mill configurations. Conversely, cooking loss increased from 7.9 to 10.1% and cooked weight increased from 26.6 to 28.7g as protein content of whole-wheat flour decreased from 17.6 to 12.2%. The mechanical breaking strength of whole-wheat pasta was not significantly affected by mill configuration or durum cultivar.

WITHDRAWN

Starch granule amylolysis in the presence of soluble fibres
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Cereal Foods World 58:A41

The *in vitro* amylolysis using porcine pancreatin (20 mg per gram of starch) and fungal amyloglucosidase (280 units per gram of starch) of granular (10 mg/mL) and cooked starch (10 mg/mL, cooked for 30 min at 95°C at stirring condition) and the diffusion of 0.1M glucose from dialysis tube (4000 Daltons molecular cut-off limit)) in the presence of 1% and 2% mixed linkage beta-glucan (BG) were studied under 0, 200 and 750 rpm mixing conditions. The viscosity of the hydrolysing medium was ca 0.001, 0.01 and 0.1 Pas for control (only buffer), 1% and 2% BG concentration respectively. Despite this large difference in viscosity (by ca 10x for 1% and 100x for 2%), measured digestion and mass transfer coefficients were only reduced by a factor of 1.5 to 2.7 (2.56×10^{-3}, 1.59×10^{-3}, 9.46×10^{-2} min^{-1} digestion rate coefficient, and 7.84×10^{-7}, 4.84×10^{-7}, 3.67×10^{-7} m/s mass transfer coefficient for buffer, 1% and 2% BG solutions at the same mixing speed. In contrast, introduction of shear (mixing) in the digesting and diffusing medium significantly increased the rate of digestion and mass transfer of the glucose, negating the hindering effect of the increased viscosity imparted by the presence of soluble beta-glucan. The cooked starch had the digestion rate coefficient of ca 4 times than that of raw starch in all viscosity and mixing conditions. Considering the modest reduction of *in vitro* starch hydrolysis and glucose diffusion at increased viscosity of hydrolysing and diffusing medium, the current results suggest that the beneficial effects of soluble fibres on post-prandial glycemia in terms of attenuation of the overall rate and extent of dietary starch conversion to blood glucose may not be related to the direct effect of viscosity on amylolytic digestion.

Starch granule amylolysis—Differentiating effects of particle size and crystalline polymorph
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Cereal Foods World 58:A41

The underlying mechanism of amylolysis of starch granules was investigated using isolated rice starch from wild-types, mutant and transgenic lines. The semi-compound granules isolated from mutant and transgenic lines were almost equally hydrolysed by amylases and have similar crystalline pattern and thermal properties compared to individual granules. Surface pores, a typical feature of A-polymorphic starches, were also observed in B- and C-polymorphic rice starch granules. Although the microscopic patterns of hydrolysis among polymorphs were apparently similar, the extent and rate of amylolysis was different suggesting that surface features alone are not the primary determinants for enzymatic hydrolysis of raw starches, and that B-type polymorphs are intrinsically more resistant to enzymatic hydrolysis than A-type. It is hypothesised that the longer chain length of amylopectin forms more stable double helical structures in mutant and transgenic B-type rice starches compared to their A-type parent counterparts and that this is the rate limiting parameter. Other factors such as granule size, surface pores and channels, and type of crystallinity have secondary roles in the enzymatic hydrolysis of rice starch granules.

Simple transfer of food and feed methods across different near infrared instrument platforms
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Cereal Foods World 58:A41

Transferring Near-Infrared (NIR) methods to a different instrument platform requires simple and accurate transfer procedures to avoid the significant time and cost involved with recollecting standard spectra for method redevelopment on the new platform. The logistics of transferring methods and concerns about loss in accuracy cause NIR users to be reluctant to transition away from their current NIR platform, even if there are benefits in doing so. The mechanism for transferring and validating NIR methods are poorly understood creating fear to switch instrument platforms. This fear is heightened when the two platforms use totally different technology, such as from a dispersive instrument to a Fourier Transform (FT) spectrometer. This presentation will show two case studies of how NIR methods developed on different instrument platforms were successfully transferred to a FT-NIR spectrometer. These examples will demonstrate best practices for quick and easy transfer of methods that retain their original model performance for further optimization on the FT-NIR platform. The first case describes transfer of a multi-component grain calibration from a dispersive NIR platform to a FT-NIR spectrometer. This case will describe the performance of the raw calibration on the dispersive instrument, the performance of the raw transferred model on the FT-NIR instrument, and improvement of that model with incorporation of a small number of additional calibration spectra from the FT-NIR instrument, improving the transferred model so that it performed better than the original model on the dispersive spectrometer. The second case describes transfer of a raw material identification model for food ingredients from one brand of FT-NIR spectrometer to another, with a test of the transferred model with validation samples from the new platform.

Rheological properties of gluten-free flour
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Cereal Foods World 58:A41

Celiac disease is a major health concern within human population. The only treatment for people suffering from celiac disease is to eliminate gluten from their diet. The food industry is intensively seeking solutions to create new gluten free products or to improve existing ones (appearance, palatability, taste, shelf life…). It is therefore necessary to replace wheat flour by other flour such as quinoa or millet flour in gluten free products without jeopardizing the dough behavior during processing of final product. The Mixolab analyzes the rheological behavior of dough subjected to a dual mixing and temperature constraint. The aim of this study is to evaluate with the Mixolab the dough rheological properties (Absorption, dough development, starch gelatinization, stability during heating and retrogradation) of gluten free flours. Different type of flour without gluten (Millet, fonio, teff, chickpea, manioc and quinoa) were analyzed with the Chopin Mixolab (Specific protocol). Results show important differences on the rheological behavior of these flours. During mixing at constant temperature, manioc, quinoa and teff flours have higher water absorption than millet, chickpea and fonio flours. When the dough is heated, millet and teff flour present the highest starch gelatinization (difference of consistency C3-C2 is around 2 Nm against 1,2 Nm for manioc and fonio flours). We observe also that starch retrogradation, directly correlated to the final product shelf-life, is more important for the manioc (difference of consistency C5-C4 is around 2 Nm against 1 Nm for the other flours). The CHOPIN Mixolab is a very interesting tool for evaluating gluten-free flour quality. The Mixolab is also a great help for R&D teams to determine the best performing gluten-free formula. It can be used either to improve or modify existing formulas or for developing new gluten-free products.

Dough rheological behavior: Fiber's impact
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Cereal Foods World 58:A41

The objective of this study is to evaluate with the Mixolab the rheological impact (Water absorption, dough development, starch gelatinization, stability during heating and retrogradation) of different fibers currently added on industrial wheat products. 5 soluble fibers (Main sources : wheat, corn, acacia

gum, chicory and apple) and 3 insoluble fibers (Main sources: apple, citrus and wheat) coming from different suppliers were incorporated at 5 different concentrations on the same common wheat flour and were analyzed with the Mixolab (standard protocol AACC 54-60.01, ICC173). For comparison, the reference flour was also analyzed without any fiber. The results show that soluble fibers reduce water absorption while the insoluble fibers increase it. 4 fibers (3 soluble and 1 insoluble), strengthen the gluten network resistance during dough heating when they are incorporated at a certain concentration (which is different for each fiber). Although most of tested fibers do not induce changes on starch gelatinization, 2 soluble fibers showed a negative action and 1 insoluble a positive action. 2 insoluble fibers showed the ability to enhance starch retrogradation capacity (thus potentially decreasing the end product shelf life) whereas 3 insoluble and 1 soluble were able to counteract the retrogradation speed. This study shows that every fiber has its own effect on dough rheological behavior. There is no common trend inside soluble and insoluble fibers but one specific behavior for every fiber. The Mixolab is an interesting tool for evaluating fiber's impact on dough behavior. It can be a great asset for R&D teams trying to determine the best performing fiber-enriched formula. It can be used either to improve or modify existing formulas or for developing new fiber-enriched products.

Effects of sorghum bran fortification on dough rheology, starch digestibility, and phenolic profile of wheat flour tortillas
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Cereal Foods World 58:A42

Phenolic compounds from sorghum bran have been shown to have beneficial health properties. However, their interaction and stability in the matrix of foods like processed tortillas have not been fully understood. Dough rheology, starch digestibility, and phenolic profile of wheat flour tortillas fortified with 25% (baker's) bran from wheat and white, brown, and black sorghum were investigated. Dough compression and stress relaxation were measured using a TA.XT2 texture analyzer. Total (TS), rapidly digestible (RDS), slowly digestible (SDS), and resistant starch (RS) fractions were evaluated in tortillas using *in vitro* digestion. Phenolic profile was determined by UV-Vis Spectroscopy and HPLC. Dough force to compress increased from 105 N (control) to 170-263 N with the addition of bran. Dough with black sorghum bran required the largest force to compress (263 N) and lowest relaxation time (1.3 s) compared to other bran treatments (1.5-1.6 s), suggesting increased water absorption. As expected, addition of bran significantly decreased TS and RDS compared to control ($P<0.05$). Bran decreased the RDS from 61% (control) to 49-51% (db). There was no significant difference in RDS among the brans. Brown sorghum bran tortillas had significantly higher SDS (11.3%) than the other brans (6.38-8.15%); this may be due to high levels of proanthocyanidins in brown sorghum bran. RS was not significantly affected. Addition of brown and black bran significantly increased ($P<0.05$) the total phenolic content of tortillas to 43.3 and 52.4 (mg GAE/g), respectively, compared to 9.46 (wheat bran) and 12.09 (white sorghum bran). HPLC analysis did not show changes in 3-deoxyanthocyanin profiles between bran and tortillas. Brown and black sorghum bran utilization in wheat flour tortillas may positively affect the starch digestibility while increasing polyphenol content.

WITHDRAWN

Properties of amylose complexes with hexadecyl amine and its hydrochloride salt prepared by steam jet cooking
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Cereal Foods World 58:A42

Steam jet cooking of starch is an effective, commercially scalable method of preparing amylose for complexing with a variety of ligands. Previous work has shown that dispersions of amylose complexes prepared with fatty acids (such as palmitic) formed a variety of spherulites when cooled under different conditions. Soluble complexes prepared with sodium salts of fatty acids exhibited characteristic viscosity changes in response to acidification. The present study was undertaken to determine the effect of the polar head group of the ligand on these phenomena. Complexes prepared with hexadecylamine (HDA) that were slowly or rapidly cooled formed toroidal spherulites or aggregates of micron-sized spherulites, respectively. The observed morphologies as well as the X-ray diffraction patterns of these spherulites were similar to those previously observed with palmitic acid as the ligand. This suggests that the alkyl chain, rather than the functional head group, of the ligand determines the mechanism of spherulite formation. Complexes were also prepared with the HCl salt of HDA. These soluble complexes exhibited viscosity changes similar to those observed with sodium palmitate complexes, but on addition of NaOH instead of HCl. The cationic nature of the complexes suggests possible applications as flocculating agents for water purification and as retention aids in papermaking.

Characterization of grain-specific peptide markers for the detection of gluten in food by mass spectrometry
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Cereal Foods World 58:A42

Analytical techniques for the detection of gluten in food are important to protect celiac consumers from exposure to gluten. ELISA is the most widely used technique for the detection of gluten; however, the different commercially available kits can respond differently to the gluten from wheat, barley and rye. In this work, we developed a bottom-up mass spectrometry-based (MS) proteomics approach to identify peptide markers for the differentiation of wheat, barley, rye and oat proteins. Three pure, single-grain flours from wheat (Duster), barley (Post90) and rye (Wheeler) as well as seven commercial flours were obtained for study. Prolamins were extracted with 70% ethanol (50% for oats) and then reduced, alkylated and digested with chymotrypsin. The resulting peptides were desalted and subjected to LC-MS/MS analysis and database matching. While wheat and rye had numerous peptides in common and wheat and barley had one peptide in common, no peptide markers common to all three grains were identified in the flours studied. From the many grain-specific peptide markers that were identified, a list of candidate markers representing each class of gluten proteins was compiled. These peptides are being used to develop a selected reaction monitoring (SRM) MS method for the quantification of gluten in incurred and commercial samples. Wheat, barley and rye flours were spiked into gluten-free flours at concentrations of 1-1000 ppm and analyzed to determine at what level the "contaminant" grain can be distinguished in the mixture.

Effects of pre-milling treatments of yellow peas on spaghetti quality
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Cereal Foods World 58:A42

Whole yellow pea flour when blended with durum semolina can be successfully used to produce high quality nutritionally enhanced pasta. It has been suggested that pre-treatment of peas prior to milling can improve the nutritional and functional quality of the pea flour. It is not known

however, if pre-treatment of the peas prior to milling will effect the end quality characteristics of pasta. Whole yellow peas were pre-treated using dry heat by roasting at 120°C for 20 minutes and by infrared/micronization processing. Untreated whole and dehulled peas and roasted and micronized peas were milled into flour using a Buhler lab mill and blended using a ratio of 30/70 pea flour to durum semolina. Blended flours were extruded into spaghetti using a Namad lab scale single screw extruder and dried at 85°C. Pasta quality was assessed by measuring dried pasta colour, optimal cooking time and cooking loss. Firmness of the spaghetti cooked for 10 minutes was also determined using a TA-XT2 texture analyzer. Higher L* and lower a* values were found for spaghetti made with the flour from micronized and roasted peas compared to the spaghetti made from whole and split pea flours (65.4, 63.0, 59.8, 60.7 L*) and (10.9, 15.0, 18.1, 17.4 a*) respectively. Spaghetti made with flour from the micronized peas was significantly less firm (1.7 kg) compared to spaghetti made from dehulled, roasted and whole pea flours (2.4, 2.1 and 2.1 kg) ($p \leq 0.05$). Overall, pre-treatment of the yellow peas by dehulling and roasting had little effect on pasta quality. Micronizing had the largest effect on the colour of dried spaghetti and firmness of cooked spaghetti. Notably cooking time and cooking loss were not affected by the type of pea pre-treatments. Spaghetti made from micronized peas had the most comparable quality to conventional 100% durum semolina spaghetti.

Screening for improved pasta colour: A micro high-throughput method based on durum whole meal

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Cereal Foods World 58:A43

The concentration of carotenoid pigments and the activity of lipoxygenase (LOX) are the two key intrinsic quality factors of durum wheat responsible for pasta colour. In Canadian durum wheat breeding programs, selection for grain yellow pigment content and LOX activity is conducted in early generations using NIR technology and DNA markers, respectively. Results based on markers are not always conclusive because of the complicated nature of LOX system. A micro-dough method has been developed in our laboratory to quantify pigment loss from semolina to dough due to enzymatic degradation in semolina. Attempts were made in this study to apply that method to whole meal samples to eliminate the need of semolina milling. However, little pigment loss (< 3%) can be detected in whole meal regardless of genotypes. Pearling to remove kernel outer layers (up to 50% weight loss) before grinding did not result in higher pigment loss, and there was no differentiation among genotypes. Linoleic acid at various amounts was then incorporated during micro-dough development. Significant pigment loss (15-25%) from whole meal to dough was observed for lines with the absence of LOX gene duplication at the *Lpx-B1* locus. Such loss remained very low (3-5%) for genotypes carrying the LOX gene duplication. Each analysis was conducted in a micro-centrifuge tube with a sample size of 0.2 g whole meal. With 2-5 g of grain sample, pigment content and pigment loss due to enzymatic oxidation can be determined in parallel in a high throughput assay format.

Physicochemical properties of Southern-style Chinese steamed bread enriched with calamondin pomace fiber

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Cereal Foods World 58:A43

Steamed bread is an important staple food in Asia. Individuals with high intakes of dietary fiber appear to be at significantly lower risk for many chronic diseases. Calamondin (*Citrus madurensis* Lour.) is a citrus fruit and its pomace, a byproduct of producing calamondin juice, contains some dietary fibers and phytochemicals. The objective of this study was to investigate the physicochemical properties of Southern-style Chinese steamed breads enriched with different amounts (0-9%) of calamondin pomace fiber (CPF). Texture analyzer was used to measure rheological and textural properties of steamed bread. Our results showed that both Peleg-Normand and Wiechert mechanical models were fitted well to the stress relaxation data of the steamed bread ($R^2 > 0.99$). k_1 values in Peleg-Normand model and λ_2 values (relaxation time) in Wiechert model decreased by increasing the amount of CPF in the bread. The hardness of steamed bread increased with the amount of CPF, and the cohesiveness, springiness and specific volume decreased by increasing with the amount of CPF. The steamed breads enriched with 3-9% CPF contained significantly higher free and bound total phenolic contents and DPPH-scavenging activities than control bread. These results suggest that the addition of 3 or 6% CPF can produce healthy steamed bread with acceptable elasticity, high dietary fiber and phytochemical contents. However, the obvious decrease in elasticity and poor quality of steamed bread by adding excess amount of CPF may result from the gluten dilution effect or negative effect on the formation of gluten network.

Optimizing the experimental design for using the house mouse (*Mus musculus* L.) as a model for determining grain feeding preferences

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Cereal Foods World 58:A43

There is little research evaluating flavor differences among wheat varieties. We previously demonstrated that mice exert very strong preferences when given binary mixtures of wheat varieties. We are utilizing mice to identify varieties and genes associated with preferred flavor, eventually relating this back to human preferences. Here we analyzed the effects of experimental design including the number of days (from one to four) and number of mice (from two to fifteen) in order to identify designs that provide significant statistical inferences while minimizing requirements for labor and animals. The experimental design utilized daily repeated measures on replicate mice. When mice expressed a significant preference between two wheat varieties, increasing the number of days (for a given number of mice) increased the significance level (decreased *P*-values) for their preference, as expected, but with diminishing benefit as more days were added. However, increasing the number of mice (for a given number of days) provided a more dramatic log-linear decrease in *P*-values and thus increased statistical power. When evaluating mouse feeding preferences in binary mixtures of wheat grain, experimental efficiency was improved more by reducing the number of days than by reducing the number of mice, thus shortening the experiment duration and reducing the overall requirement for labor and animals. The exact chemical basis for feeding preference among varieties remains to be resolved.

Characterization of the inclusion complexes using maize starches with different amylose contents and glycerol monoestearate

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Amylose-lipid complexes are resistant to hydrolysis. Inclusion complexes using normal (NMS), waxy (WMS), and high-amylose (HAMS) maize starches and different concentrations (1, 2, 3%) of glycerol monoestearate (GMS) were synthetized and evaluated by scanning electron microscopy (SEM), X-ray diffraction, differential scanning calorimetry and resistant starch content. The NMS-GMS and HAMS-GMS complexes showed faceted structures, which are typical of crystals and that were more evident when the GMS concentration increased. It was not possible to observe, by SEM, any crystal structure in the WMS-GMS samples. X-ray diffraction confirmed the formation of V-amylose in the NMS-GMS and HAMS-GMS complexes, independent of GMS concentration and in the WMS-1%GMS. Endothermic peaks of dissociation of these complexes, determined by DSC, were between 115-120°C, what classify them as II type complexes. Increasing GMS concentration reduced the peak temperature and enthalpy in the NMS-GMS, whereas these parameters did not change in HAMS-GMS. The diffractograms of the HAMS-GMS showed peaks much more resolved than those of the NMS-GMS, independent of GMS concentration. In case of the WMS, only the sample with 1% of GMS showed peaks, which had very low resolution. Relative crystallinity decreased from 28.81 to 24.75% and from 37.46 to 33.25% in NMS-GMS and HAMS-GMS, respectively, when GMS concentration increased from 1 to 3%. The resistant starch content varied from 43.9% in NMS-GMS to 89.5% in HAMS-GMS, when 1% of GMS was used. GMS concentration affected the formation of inclusion complexes. Crystals well defined and with high dissociation temperatures were formed when 1% GMS and NMS and HAMS were used. The high content of resistant starch in these complexes could make them useful to be used as an additive in starch-based food system. Financial support: FAPESP.

WITHDRAWN

Molecular and thermal characteristics of starches from African rice (*Oryza glaberrima*) varieties

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Cereal Foods World 58:A44

The molecular and thermal characteristics of starches isolated from five indigenous Africa rice (*Oryza glaberrima*) varieties (TOG 6784, IRGC 86764, IRGC 96926, IRGC 104355 and IRGC 105051) obtained from the African Rice Center were studied using wide angle x-ray diffraction scattering (WAXS), gel permeation chromatography (Sepharose CL 2B and CL 6B) and K/S (absorbance/scattering) spectra. Using differential scanning calorimetry (DSC), T_o (onset temperature), T_p (peak temperature), T_c (conclusion temperature) and enthalpy (ΔH) were determined. Amylose content estimated from fractionation of debranched whole rice starch on Sepharose CL 6B was 24.1%, 22.9%, 23.2%, 24.0% and 24.5% for IRGC 104355, IRGC 105051, TOG 6784, IRGC 86764 and IRGC 96926 respectively. The WAXS results indicated that all the five native starches displayed the typical 'A' type x-ray diffraction pattern. Similarly the starches (aw 0.97) exposed to iodine vapor in the dark for 24 h retained the native X-ray 'A' type pattern but peak intensities decreased at 15°, 17° 23° (2θ) and slightly increased at 20° (2θ) which reflects the iodine-amylose complex (V–type). K/S intensity values for the iodine treated starches were in the order IRGC 104355> IRGC 105051> TOG 6784> IRGC 86764> IRGC 96926 signifying that the IRGC 104355 may have more glucan chains available to form inclusion complexes with iodine as compared to IRGC 86764 and IRGC 96926, though all the three had similar amylose content. T_o and T_p of the samples were not significantly different from each other, however the T_c and ΔH of TOG 6784 were significantly different ($p<0.05$) from the rest of the starches. This indicates that TOG 6784 may have less number of double helices in the crystalline lamella.

Effects of *in vitro* gastrointestinal digestion on the bioaccessibility of wheat bran nutrients and the solubility of fiber

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Cereal Foods World 58:A44

A static in vitro digestion procedure was developed to evaluate the effects of modelled digestion on the solubility of wheat bran nutrients and fiber components that would be potentially bioaccessible and functional in vivo. Effects of gastric (GA) and combined GA + gastrointestinal (GI) phases of digestion were separately measured. Coarse wheat bran milled to similar particle size was prepared from three representative samples of sound hard red spring (HRS), soft white spring and durum wheat. Each sample was subjected to in vitro GA conditions without and with pepsin, (2.5 h, 37 oC, pH 2.0) and subsequent neutralization, and a second digestion with GA product followed by simulated GI treatment of neutralized GA digests without andwith pancreatin at pH 6.8 for an additional 5 h. Digests were vacuum filtered to remove hydrated bran, and filtrates were clarified by centrifugation and subsequently freeze dried. Digest solubles were analyzed for trace minerals, ash, protein, starch, pentosans, and β-glucan. For the HRS bran, soluble and insoluble fiber were additionally determined. Analyte content was corrected for NaCl product arising from the neutralization reaction. Compared to GA digests, dry matter yields for the GI treatment were consistently and significantly higher for all analytes except soluble dietary fiber. Overall digestibility of brans for GI digests ranged from ~ 28 to 48% which was considerable, given the highly insoluble nature of wheat bran. The average digestibility of bran ash, protein and starch was ~ 47%, 62%, and 40%, respectively. Much lower digestibilities were associated with fiber related analytes, i.e. soluble dietary fiber (2.5% in HRS), pentosan (2.3 to 3.8 %), and β-glucan (12.4 to 15.6%). Results indicated that the static in vitro digestion procedure was suitable and effective to study the bioaccessibility of wheat bran constituents.

Bioaccessibility and antioxidant activity of wheat bran phenolics following *in vitro* gastrointestinal digestion

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Cereal Foods World 58:A44

The phenolic compounds of wheat bran are found mostly in bound form associated with non-starch polysaccharides (NSP) of cell walls of aleurone and pericarp tissues. Accordingly, the bioavailability of bran phenolics is believed to be constrained by chemical bonds with NSP and the general insolubility of the bran fiber matrix. As bioaccessibility is the first step in digestion ultimately leading to bioavailability of food constituents, we explored the use of a static *in vitro* digestion procedure applied to wheat bran to gain a better understanding of its effects on the solubility of total phenolics and antioxidant activity of digests with potential bioactivity *in vivo*. Three types of wheat bran (hard red spring (HRS), soft white spring and durum) without and with autoclaving were subjected to gastric (GA) and combined GA+gastrointestinal (GI) *in vitro* conditions for 2.5 and 7.5 h, respectively. Filtrates of digests were centrifuged and subsequently freeze dried. Measures of antioxidant activity included total phenolic content (TPC), DPPH radical scavenging (RS) activity and iron chelating (IC) activity. Dry matter yields of TPC, RS and IC activities in GI compared to GA digests increased on average by ~ 33%, 44%, and 175%, respectively. Autoclaving of bran, depending on bran type, resulted in modest to nil enhancements of TPC and antioxidant activity of the soluble digest fractions. The highest concentration of phenolic antioxidants in GA or GI digests was observed for HRS bran which contained the least amount of adhering starch. Considering the absolute levels of TPC, RS and IC activities in GI digests, results suggest that wheat bran when digested, releases significant levels of bioaccessible phenolic compounds that should be available for absorption in the small intestine to promote beneficial health effects attributable to bran and its phenolic constituents.

Change in health ingredients of whole Tibetan hull-less barley after steam explosion and simulated digestion *in vitro*

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Steam explosion is a novel pre-treatment to break down plant biomass. Steam explosion is different from normal thermal treatments because of its rapid release of pressure in 0.00508 s ~ 0.00875 s, leading to complex mechanical reactions. This study examined the change in health-ingredient contents of whole Tibetan hull-less barley after being pre-treated with steam explosion and hydrolyzed by enzymes in a simulated *in vitro* digestive system. The steam-explosion treatment was performed at 180ºC with a residence time of 30s. Contents of post-digestive health ingredients, including total soluble carbohydrates (TSC), total amino acids (TAA), total phenolics (TP), total flavonoids (TF) and ferulic acids (FA), were determined. The scavenging abilities of 2,2-diphenyl-1-picrylhydrazyl (DPPH) and 2,2'-azinobis (3-ethylbenzothiazoline-6-sulfonate) (ABTS) free radicals and the reducing power of ferric ions were evaluated. In this study, significant increases in TP (420.23 to 447.28 mg gallic acid equivalents/g barley) and in TF (88.93 to 116.08 mg Rutin equivalents per gram of barley) were observed after steam explosion. The content of ferulic acid in the steam-exploded sample was twice or higher than that of the untreated sample. Additionally, TAA increased from 1.019 to 2.634 g per 100 g barley and TSC decreased from 0.423 to 0.340 g per 100 g barley. The antioxidant activity of digestive fluid——DPPH and ABTS free-radical scavenging ability and ferric reducing power——increased significantly after the steam explosion. The study demonstrated the benefit of steam explosion in release of the health ingredients from whole grain products.

A "stay-green"-like trait maintains starch quality of barley grain under water-stressed conditions

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Cereal Foods World 58:A45

The structure of starch in barley grain expressing "stay-green"-like trait (ND24260) was characterized for the first time and compared to a fast maturing, non-"stay-green" barley grain (Flagship). Expression of stay-green in sorghum has been shown to increase grain yield potential under drought conditions. This study evaluated the effects of "stay-green"-like expression on starch quality under water-stressed conditions during grain development. Four water stress treatments were applied at anthesis to randomly distributed barley plants (in triplicate). The treatments consisted of control (unlimited water supply), mild (50% of "field capacity" or FC), severe (30% of FC), and acute (10% of FC) water stress. Size exclusion chromatography (SEC) was used to characterize the length of individual (linear) branches of starch molecules, also known as chain-length distribution (CLD). The CLDs of starch of Flagship grain under the treatments could be divided into two groups, low water stress (the control and mild water treatments) and high water stress (the severe and acute water treatments). Higher proportions of long amylopectin branches and amylose branches (or amylose content) occurred with low water stress than with high water stress. The results suggest that high water stress induces earlier termination of grain fill for Flagship samples because the biosynthesis of amylose and long amylopectin branches has been proposed to be higher during the later stage of grain fill. The CLDs from ND24260 grain did not show much variation with the different water stress treatments. This suggests that the "stay-green"-like trait in barley can delay early termination of grain fill under water-stressed conditions.

WITHDRAWN

Analysis of oat varieties for gluten content using G12 monoclonal antibody based test kits

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Cereal Foods World 58:A45

There is an on-going debate whether oats can be tolerated by celiacs. On the one hand there is the issue that oats are often produced on shared equipment with wheat, rye and barley and therefore contaminated with these gluten containing grains. If the production of pure oats not contaminated with other gluten containing cereals is secured there are on the other hand still studies claiming that certain celiacs cannot tolerate pure oats. The structure of prolamins from oats differs from other gluten containing cereals. Latest research has shown a difference between oat varieties as well as differences in detection of gluten content. In vitro studies showed correlation of the reactivity of the monoclonal G12 antibody with the immunogenicity of prolamin extracts from different oat varieties. During the validation of Gluten G12 ELISA Test Kit about 100 different pure oat varieties have been analysed to check for positive or negative response. The positive results appear to be a specific reaction of the antibody with the toxic fragment, rather than a non-specific response. Therefore, the G12 antibody may shed new light on this debate by recognizing oat varieties that trigger a response in celiac patients. Validation data on different oat varieties are presented and conclusions for the use of Gluten G12 ELISA Test Kits to evaluate celiac safe oats are drawn.

Advanced ELISA test kits for detection of food allergens using a very fast and convenient extraction method

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Cereal Foods World 58:A45

Persons allergic to certain foods need to follow an allergen free diet and rely on product labeling for allergens. For food manufacturers, an important tool in any allergen management plan is testing for allergens. Besides qualitative on-site lateral flow tests, there are many laboratory-based test systems available that allow quantification of allergenic residues in environmental samples, rinse waters or finished products. Sample preparation and extraction, an important step of analysis, has traditionally been very time consuming and elaborate. A new development for very fast and convenient sample extraction has led to the development of a new range of sandwich ELISA (enzyme-linked immunosorbent assays) test kits. These tests can detect food allergens in a wide range of food matrices. A new technology for sample extraction has been employed in these kits, which uses only hot water and extraction capsules with powdered buffer for extraction. The samples are shaken for 15 seconds to extract the allergens. The method also uses three rapid incubation steps of 10 minutes each. The validation of the F.A.S.T. Peanut ELISA method showed a limit of detection of 0.5 mg/kg peanut and limit of quantification 1 mg/kg peanut. Recovery of incurred and spiked samples is comparable to AOAC approved Peanut ELISA Test Kit. Furthermore, validation data of ELISA test kits using the same convenient extraction method for detection of casein, egg, hazelnut, almond, macadamia, will be presented.

Effect of barley β-glucan on rheological properties of yeasted frozen dough

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Cereal Foods World 58:A45

In bread dough gluten proteins and starch granules are severely damaged by long frozen storage. The aim of this study was to investigate the effect of air-classified barley flour (ACBF) rich in β-glucan (23%) on rheological properties of yeasted frozen dough. Three dough formulations were prepared: control dough (100% flour, C), ACBF dough (10% ACBF) and ACBF+G dough (10% ACBF and 1.4% gluten). Doughs were stored at -18C for 4 weeks and examined weekly based on their rheological properties. Dough stickiness, adhesiveness and cohesiveness measured by texture analyzer increased for C and ACBF+G, while they dropped by about 11-20% for ACBF. Dough extensibility and resistance to extension increased for C and at a lower extent for ACBF. Extensibility also increased for ACBF+G, but no change was observed on its resistance to extension. Deformation rheology tests showed that C, ACBF and ACBF+G fresh and frozen doughs exhibited similar viscoelastic behavior and their G′ and G″ decreased as freezing storage increased. Doughs containing β-glucan had higher G′ by 75% and G″ by 40% compared with C dough after 4 weeks of frozen storage. DSC results indicated reduction in ice melting enthalpy and dough freezable water with increasing frozen storage for all doughs at various extents. The DSC data were confirmed by an increase in bound water content measured by NMR over storage with ACBF and ACBF+G had 9% more bound water than C dough. It can be concluded that incorporation of ACBF is capable of diminishing the changes in the rheological properties of frozen dough and minimizing its gluten network deterioration caused by separation of water that is intimately associated with the gluten network.

Effects of germination on milling and physicochemical properties of long-grain and medium-grain rice

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Cereal Foods World 58:A46

Germinated rice is nutritionally superior to conventional brown rice due to its high gamma-aminobutyric acid content. However germination weakens the rice kernel and may cause production concern. The objective of this study was to compare the effects of germination on brown head rice yield and gelatinization and pasting properties of long-grain (Wells) and medium-grain (Jupiter) rice cultivars. Rough rice was soaked at 25°C for 12 hr and then germinated at 30°C for three time durations. The optimum germination time was selected when 70% of rice revealed hull protrusion. Two more germination times, i.e. 8 hr before and 8 hr after the optimum germination time, were also included. Broken brown rice kernels are kernels less than three-quarters of their original length after dehulling. The optimum germination time was 26 hr for Wells and 40 hr for Jupiter. The percentage of broken brown rice was 13.7 for Wells and 3.2 for Jupiter before germination. Germination significantly increased the broken rice percentage for both cultivars with up to 16.8 for Wells and 5.8 for Jupiter. There were significant differences in broken rice percentage during the 3 germination durations for Wells, but no difference was noted for Jupiter. With increasing germination time, the peak gelatinization temperatures of germinated rice flour gradually increased from 80.4°C to 81.6°C for Wells and from 74.7°C to 75.8°C for Jupiter. The pasting viscosities drastically decreased with germination. The peak viscosity decreased from 2048 to 1025 cP for Wells and from 2653 to 282 cP for Jupiter at the optimum germination time. The results indicate that both germination duration and rice type affect milling and physicochemical properties of germinated rice. Further chemical analyses may provide more insight on the differences between Wells and Jupiter cultivars.

Effect of milling methods on the quality of crackers made with red lentil (*Lens culinaris* L.) flour

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Cereal Foods World 58:A46

Crackers are widely consumed and can be an important source of cereal grains. The addition of red lentil flour to wheat flour in crackers will enhance their nutritional profile; however, the end product quality can be affected due to differences in the compositional, physical, and functional properties of the flours. The purpose of this study was to assess the end-product quality of crackers substituted with ten red lentil flours milled using pin (PM), roller (RM), stone (SM), and hammer (HM) mills. The flours were further classified based on particle size distribution and presence of hull fractions. Weakening the gluten matrix by incorporating lentil flours was considered in the formulation to prevent breakage of the crackers. A 30% inclusion level was chosen for the study as the crackers with higher levels showed significant breakage. The crackers containing RM flours exhibited significantly higher average weight and height among the crackers. Colour profile of the crackers containing hulls showed significantly lower redness and brightness. Texture of the crackers showed a wide range of hardness, from 8.3N (SM cracker) to 21.0N (RM cracker). The lentil crackers were, in general, slightly harder than the control crackers but were not significantly different. Sensory profiles of the lentil crackers were similar to the control. The crackers containing hulls had significantly lower sensory characteristics except aftertaste compared to the crackers made with the dehulled or split flours. The crackers containing RM flour were identified as the least “liked” in all sensory characteristics. Variations in physical and sensory profiles of the crackers were affected by different milling technologies, the inclusion of hull fractions, and also particle size. In general, the flours milled using a pin mill without hull fractions demonstrated better acceptance of the crackers.

Effects of purified monoglycerides of varying fatty acid chain length on sponge and dough breadmaking quality

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Monoglycerides are widely used in baking industry because of their anti-staling effects. Commercial monoglycerides are prepared normally from hydrogenated fats with stearate (C18:0) being the most common fatty acid. In a previous study, monoglycerides such as monopalmitate had positive effects on Canadian short process (CSP) bread but almost no improvements on Sponge and dough (SDP) bread. The objective of this study was to investigate the effects of saturated monoglycerides of varying fatty acid chain length (C14:0 - C22:0) on sponge and dough breadmaking quality in detail using bread image analysis and texture measurements. Higher levels (1.0-1.5%) of monoglycerides (C14:0, C16:0, C18:0) significantly ($p < 0.05$) increased loaf volume. This could be attributed to larger cell diameter and thicker cell wall with increasing levels of these monoglycerides. Addition of monopalmitate (C16:0) and monostearate (C18:0) caused the largest increase in crumb softness with increasing monoglyceride levels but showed relatively low resilience. However, addition of blended monoglycerides (C14:0 + C16:0) caused increased crumb softness and increased loaf volume while partially retaining resilience. It was shown that each monoglyceride has different functions on breadmaking quality and has somewhat positive effects on SDP. In this presentation, we will introduce further investigation as to why they have different functions.

WITHDRAWN

WITHDRAWN

High-throughput micro plate vanillin assay for determination of tannin in sorghum grain

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Cereal Foods World 58:A47

Sorghum tannins are phenolic compounds that offer health promoting antioxidant properties. The conventional HCl-vanillin assay for determining tannin content is a time-consuming method for screening large sample sets as seen in association mapping panels or breeder nursery samples. The objective of this research was to develop a high-throughput 96 well plate micro-titer platform assays for use as a diagnostic tool for efficient screening sorghums for tannin content in large sample sets. A high tannin Sumac was selected to show proof of concept of the high throughput assay and a larger sample set of 25 sorghum containing tannin were used to validate the assay. As a point of reference the conventional HCl-vanillin assay and bleach test were included in the study. The high-throughput 96-well platform was more rapid than the conventional assay. Approximately 30 measurements per day were completed using the HCl-vanillin conventional assay compared to 224 measurements using the high-throughput 96-well platform. The 96-well platform correlated with conventional assay. The %RSD was 3.54% and 3.21% for the high-throughput 96-well platform and conventional HCl-vanillin method, respectively. The 96 well assay exhibited good reproducibility with the inter plate 5RSD between 2.77%-4.85%. The high-throughput 96-well platform method proved to be as robust and reproducible as the conventional method for determining tannin content in sorghum grain. The high-throughput micro-titer platform assays developed is usable for routine screening of a large sample sets.

Creep-recovery test on development dough and their relationship to rheological and breadmaking properties

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Cereal Foods World 58:A47

Nineteen samples of HRW wheat were used to investigate the effects of HMW proteins on creep viscoelasticity of full developed dough at large strains. Creep parameters explained which specific coefficients of Kelvin-Voigt model may affect quality indicators of baking, mixing and extensibility. Dough elasticity coefficients G1 and G2 of HMW-GS correlated with quality indicators while shear modulus G0 had lower effects. Glu-D1 5+10 showed more elasticity in G0, G1 and G2 compared to Glu-D1 2+12. Glu-B1 17+18 presented more elasticity for G0, G1 and G2 compared to 7+8 and 7+9. Dough viscosity correlated with quality data. Viscosity η0 of non-gluten components such as water showed higher correlation than protein viscosity (η1 and η2) indicating that the important factors to explain quality indicators are swelling capacity of HMW proteins η2 and viscosity of non-gluten components in fully hydrated dough. Viscosities η0, η1 and η2 were higher in Glu-D1 5+10 while 17+18 presented higher η0 viscosity. Creep viscosity η1 atributed to LMW and gliadin proteins had low correlation with quality indicators but are important in rheological extensibility, G and P/L. Starch damage and ash show low correlation with dough elasticity and protein and wet gluten were significantly correlated indicating that dough viscoelasticity coefficients are related to the size of the protein polymers and starch plays a minor role. The trend and magnitude of the coefficients of correlation are similar for creep and recovery, except for η0 absent in the recovery step.

Microwave energy significantly increases extractability of grain pigments

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Natural pigments are increasingly used as alternatives to synthetic colorants in food. Some pigmented grains have high levels of relatively stable anthocyanins, however, the grain pigments are bound to cell wall material and difficult to extract. Microwave assisted extraction may increase cell wall disruption and enable better extraction of the grain pigments. In this study, extractions of three pigmented grains (black sorghum, blue corn, and black cowpea) were carried out in an analytical microwave oven for 20 min at two different power levels (low: 300W and high: 600W) using two different solvents; 1% HCl in methanol (S1) and 1% HCl in 50% aqueous methanol (S2). Controls were extracted at 20 °C for 2 hr. UV-Vis spectroscopy was used to determine pigment concentration, and HPLC was used for pigment profile. Microwave assisted extraction resulted in 6-fold increase in 3-deoxyanthycyanin pigments from black sorghum (3.0-3.2 mg/g sample) compared to control (0.5 mg/g). Also, new flavone and 3-deoxyanthocyanin compounds were extracted using microwave. For corn, little change in total pigments was observed but microwave extraction resulted in 5 new flavone and flavonol peaks. For black cowpea, microwave assisted extraction in S1 increased extraction of anthocyanins 2-fold (1.4-1.2 mg/g sample) compared to control (0.6 mg/g). A slight decrease in S1 cowpea anthocyanin pigment extraction was observed at high power compared to low power; this is likely attributable to thermal degradation at the high energy level. In general, S1 resulted in higher yield of pigments, especially sorghum 3-deoxyanthocyanin. Acidified methanol in combination with microwave assisted extraction was effective in increasing the yield of pigments extracted from sorghum and cowpea.

WITHDRAWN

WITHDRAWN

WITHDRAWN

Effects of foliar spray of bamboo leaf extract on rice grain filling, yield and quality

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The effects of foliar spray of bamboo leaf extract (BLE) on grain filling, yield and quality of rice (var.Jiayou 5) were investigated in a field experiment during June to November of 2012. The experiment comprised two treatments in a complete randomized block design with four replicates and a plot size of 3m×8m. The treatments were water spray (as control) and BLE (0.1 mg/mL, 100 mL/m^2) spray at booting and flowering stages. Results showed that, during the grain filling period [8, 12, 16, 24, 32, 40, 48 DPA (days post anthesis)], the grain weight and the content of indole-3-acetic acid (IAA) and its amino acid conjugates (IAA-Asp, IAA-Trp) and abscisic acid (ABA) in the grains of both superior and inferior spikelets with BLE treatment were always higher than those of control, especially in those inferior spikelets at early and middle stages of grain filling. Application of BLE increased the percentage of filled grains,1000-grain weight and grain yield by 2.4%, 3.3% (p<0.05) and 5.8% (p<0.05),respectively, and reduced the percentage of chalky grains and chalky size by 7.0% (p<0.05) and 7.1%,respectively, while there were no differences in milling quality (the rates of brown rice, milled rice and head rice), cooking quality (gel consistency, alkali spreading value and amylose content) and nutritional quality (protein content) between BLE treatment and control. The primary study concludes that BLE may be able to improve rice yield and appearance quality, which might be related to its regulation of endogenous hormone levels in the grains during grain filling period.

Characterization of swollen cornstarch granules complexed with lauric acid by using different methods

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Cereal Foods World 58:A48

Fatty acids are intentionally added to starch products to improve the properties of starchy food. The characterization of starch-lipid complex has been extensively studied. However, its application in food industry is limited due to bad mouthfeel and high cost. In this study, a novel concept of 'granular starch-lipid complex' was applied. The effect of lauric acid (LA) and incubation temperature on the physicochemical properties of swollen cornstarch with different amylose contents was studied. The results showed that amylose content significantly impacts the complex formation. High-amylose cornstarch (Hylon V) and normal cornstarch (NC) were easy to form starch-LA complex. The X-ray diffraction patterns of Hylon V-LA and NC-LA complexes were changed to V-type polymorph, while waxy corn starch-LA complex still maintained A-type polymorph. Higher incubation temperature and amylose content were beneficial to the formation of starch-lipid complex. To understand the mechanism of starch-lipid complex and V-amylose complex distribution, swollen NC was complexed with LA by using two methods: adding the LA either to the heated starch suspension (method I) or to the starch suspension before heating (method II). The results showed that NC-LA complex prepared by method I seemed to be more swollen, and the V-amylose complex distributed throughout granules, while NC-LA complex prepared by method II was mainly distributed on the surface of starch granules. Method I was more beneficial to the formation of more crystalline structure than that of method II. And method II is favorable to protect starch granules. In addition, swelled NC-LA complex showed the ability of slowing hydrolysis rate.

Effects of storage temperature on physicochemical properties of dry- and wet-milled high amylose rice flours

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Cereal Foods World 58:A48

High amylose rice, the specific rice variety used for making many traditional processed rice products, is commonly aged from couple months to several years before using. In order to accelerate the aging process, the effects of high storage temperature (38°C) on the properties of dry- and wet-milled rice flours (DRF-38 and WRF-38) made from the aged paddy high amylose rice (TCS17, AM = 34%) up to 15 months were investigated and compared to the ones stored at 4°C (DRF-4 and WRF-4). After 15 months aging, the alpha amylase activity significantly decreased in DRF-38 and WRF-38. A lower peak viscosity (PV), higher final viscosity and lacks of trough and breakdown (BkD) could be found in DRF-38 compared with DRF-4. But the viscograms of starches isolated from DRF-38 and DRF-4 were the same. Similar pasting patterns were found in wet-milled rice flours (WRF-38 and WRF-4) over time, except the WRF-38 always had higher PV and BkD. These results indicated that the pasting properties of dry-milled rice flours were significantly affected by the aging temperature that significantly changed the characters of non-starch components in aged rice. Decreasing in protein solubility and increasing in degree of denaturation of oryzenin were found in DRF-38 that were determined by capillary electrolysis and differential scanning calorimetry, respectively. This indicated that the high temperature aging caused the protein polymerization and denaturation that responded to the low swelling power, total soluble solids and soluble proteins of dry-milled rice flour. The polymerization and denaturation of oryzenin caused the discontinuity of gel structure evidenced by SEM, resulting in a weak gel. While, the increase of gel strength made of wet-milled rice flours of high temperature aged rice was attributed to the most of non-starch components were removed through the wet-milling processes.

WITHDRAWN

Changes in functionality in hard and soft wheat flour blends
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Cereal Foods World 58:A49

In a commercial manufacturing setting hard and soft flours are typically blended depending on the type of product to control production and improve consistency. The most common specifications are protein and ash contents, and functional parameters, for example from either an alveogram or a farinogram. To the best of our knowledge, no study has looked at blends of hard and soft wheat flours and their functional properties using traditional techniques. The aim of this small study was to explore the relationship between hard – soft flour blends and their functional properties. Commercial hard and soft wheat flours were obtained and blended at 7 different hard:soft ratios (0:100, 25:75, 48:52, 50:50, 52:48, 75:25, 100:0). Data was collected for protein and ash contents; lactic acid solvent retention capacity (LASRC); farinograph, extensograph and gluto-peak tester (GPT) parameters; and bread baking performance. Functional relationships were studied using correlational analysis. Direct linear relationships were observed for protein content (R^2=0.997) and LASRC (R^2=0.994) with increasing hard wheat flour content. Additionally, farinograph water absorption (R^2=0.982), GPT torque (R^2=0.983) and extensograph energy (R^2=0.954) also demonstrated linear relationships. Farinograph dough development time (R^2=0.977) and stability (R^2=0.990), extensograph resistance (R^2=0.911) and extensibility (R^2=0.831), GPT time (R^2=0.922), and bread loaf volume (R^2=0.993) displayed increasing polynomial relationships. Although this study dealt with only one set of commercial flours, it can tentatively be suggested that linear relationships may be more closely linked with protein content whereas polynomial relationships may be more indicative of protein quality. This information may help end-use processors target specific functionality tests to predict the performance of hard–soft flour blends.

WITHDRAWN

Development of an analytical whole wheat bread baking method
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Cereal Foods World 58:A49

The whole grain food market has grown in recent years with the increased public awareness of the health benefits of consuming whole grains. Compared to white bread made from refined flour, whole wheat bread is known to have poor oven spring, low volume, and poor crumb grain. The current analytical test baking method (AACCI 10-10.03) was designed for refined wheat flour. Using this method, whole wheat doughs typically produce poor quality loaves; therefore, it is hard to evaluate the bread making quality of whole wheat flours. The objective of this study was to develop an analytical test baking method for whole wheat bread. AACCI 10-10.03 straight dough procedure was used initially to measure the effects of malt, flour moisture content, and vital wheat gluten on breadmaking quality of commercially milled whole wheat flour. Neither hydrating the flour to 13% moisture content nor malting the flour to 300 FN had a significant effect on loaf volume. Addition of gluten increased bread volume and crumb grain. The best level was 6% (fwb). The AACCI 10-10.03 procedure was then modified to evaluate the effect of dough weight, fermentation time, and proof height. Increasing dough weight increased bread volume. The best loaf was obtained when dough weight was increased by 120% (i.e. 120 g flour). Shorter fermentation times of 45 and 60 min resulted in smaller loaves with undesirable grain, thus 90 min was selected. Altering proof time to achieve proof heights of 6.5, 7.0, 7.5, 8.0 cm did not significantly improve loaf volume or crumb grain. Therefore, 7.5 cm proof height was selected.

Application of response surface methodology (RSM) in the development of gluten-free bread with yellow pea flour addition
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Cereal Foods World 58:A49

Yellow pea (*Pisum sativum* L.) flour is high in protein, fiber, and micronutrients, which is generally deficient in gluten-free cereal ingredients. The challenge of utilizing yellow pea flour is the undesirable pea flavors; therefore, pre-treatment or precooking of the flour is necessary. The objective of this study was to employ RSM to optimize yellow pea fortified gluten-free bread and evaluate shelf-life and acceptability. Treatments were baked according to central composite design and analyzed 24 hours after baking. A second-order model was fitted to the precooking temperature of pea flour (PTPF), water level, and proof time as the factors. Higher PTPF and lower proof time significantly ($P<0.05$) reduced the brightness of bread crumb. Crumb firmness was influenced by the PTPF, water level and proof time. According to the coefficient estimate, an increase in the amount of water increased the specific volume of the GF bread. This observation was further supported by the increased cell diameter of the crumb that accompanied increased water addition. The optimized parameters for PTPF, water level, and proof time were 156.9 °C, 523.8 g, and 18.0 min, respectively. The optimized bread had a brightness (L* value), specific volume, crumb firmness, and cell diameter of 68.2, 2.6 ml/g, 174.2 g_f, and 3.81 mm, respectively. The model accurately predicted the responses with 95% level of confidence, with the exception of specific volume. Specific volume was measured at 2.6 ml/g, higher than the high limit interval of 2.4 ml/g. Although the measured specific volume was higher than the predicted values, it is not a concern because high specific volume is a desirable quality characteristic. The optimized GF bread had longer shelf-life, softer texture, but had significantly ($P<0.05$) lower acceptance scores, at 5.8 compared to 6.6 out of 9, than the commercial premix bread product.

Genetic mapping of quantitative trait loci associated with arabinoxylan content in the soft wheat (*Triticum aestivum* L.) cross 'Louise' x 'Alpowa
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Cereal Foods World 58:A49

Arabinoxylans are non-starch polysaccharides found at low concentrations in wheat grain. These molecules influence end-use quality in wheat since they are able to associate with significant amounts of water via hydrogen bonding, and can form gels via ferulate cross-linking. Knowledge about the underlying

genetic architecture controlling quantitative quality traits, such as arabinoxylan content, is important for wheat breeders to develop cultivars with improved quality. A set of 131 recombinant inbred lines (RIL) from a soft white spring wheat 'Louise' x 'Alpowa' bi-parental mapping population was grown for two crop years in Pullman, WA and one crop year in Lind, WA to identify quantitative trait loci (QTL) associated with total arabinoxylan (TAX) content, water unextractable arabinoxylan (WUAX) content and water extractable arabinoxylan content (WAX). AX, WUAX and WAX were determined for white flour from a modified Quadrumat laboratory mill and for whole flour from a Udy cyclone mill. The linkage map was developed using 4,000 SNP markers. Significant QTL will be reported and presented. Resulting data will assist wheat breeders in developing wheat cultivars with better end-use quality and lower levels of TAX through the use of marker-assisted selection.

Determination of condensed tannins utilizing microwave technology

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Cereal Foods World 58:A50

Red anthocyanidins, which cause the various red shades found in many foods and plants, are produced by an oxidation reaction of proanthocyanidins, or condensed tannins. The red color caused by the oxidation reaction is commonly used to measure the amount of condensed tannins with a spectrophotometer at 550 nanometers. Currently, the procedure for extracting condensed tannins from canola seed and canola meal is lengthy and potentially dangerous. A new procedure utilizing microwave technology to defat and hydrolyze offers a wide variety of benefits to the determination of tannins. Samples are defatted with petroleum ether and acetone. After drying, soluble condensed tannins (SCT) are extracted. Solutions are added to the SCT extracts in a microwavable tube to allow for hydrolysis of the samples. These microwavable tubes eliminate the use of pressurized glass tubes which can be a safety concern. A similar process is used for the extraction and hydrolysis for insoluble condensed tannins (ICT). Converting these steps to utilize the microwave will eliminate overnight defatting and cut hydrolysis time to a third of what is currently required. Microwave technology results in better temperature control and even heating for more consistent and repeatable results. Results for 7 canola seed SCT samples show a mean of 0.0883% dry basis (DB) with a coefficient of variation (CV) of 8.04%. The 11 canola seed ICT samples had a mean of 0.201% DB with a CV of 8.78%. The 9 canola meal SCT samples averaged 0.106% DB with a CV of 2.96%. The 11 canola meal ICT samples produced a mean of 0.334% DB with a CV of 12.0%. The new procedure utilizing microwave technology can create faster, safer, and more uniform conditions for determining the presence of condensed tannins.

Prediction of tortilla quality using multivariate model of kernel, flour and dough properties

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Cereal Foods World 58:A50

Advances in high-throughput wheat breeding techniques have resulted in the need for rapid, accurate and cost-effective means to predict tortilla making performance for large number of early generation wheat lines. Currently, the most reliable approach is to process tortilla which is laborious, time consuming, expensive and requires large sample size. This study used a multivariate discriminant analysis to predict tortilla quality using kernel, flour and dough properties. A discriminant rule (suitability = diameter > 165mm + day 16 flexibility score >3.0) used to classify wheat lines for suitability in making good quality tortillas. Wheat varieties from Texas (n = 86) were evaluated for kernel (hardness, diameter, and weight), flour (protein content, fractions and composition), dough (compression force, extensibility and stress relaxation from TA-XT2i) and tortilla properties (diameter, rheology and flexibility). First three principal components explained 62% of variance. Multivariate normal distribution of the data was determined (Shapiro-Wilk p <0.4227). Canonical correlation analysis revealed significant correlation between kernel and tortilla properties (r= 0.83), kernel hardness contributed the highest to this correlation. Flour and tortilla properties were highly correlated (r = 0.88), Glutenin to Gliadin ratio (Glu:Gli) contributed highest to this correlation and can predict tortilla flexibility and deformation modulus. Dough and tortilla properties were significantly correlated (r = 0.91). Logistic regression and stepwise variable selection identified an optimum model comprised of kernel hardness, Glu:Gli, dough extensibility and compression force as the most important variables. Cross-validation indicated an 89% prediction rate for the model. This emphasizes the feasibility and practicality of the model using variables that are easily and quickly measured

Quality characteristics of aseptic-packaged cooked rice products made using rice cultivars bred for processing cooked rice

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Cereal Foods World 58:A50

Selecting rice cultivars for the specific purpose of processing enables food scientists to produce better quality products for consumers. The objective of this study was to compare the quality of aseptic-packaged cooked rice (APCR) produced using rice cultivars developed specifically for rice processing. Water content, water uptake, Toyo value, whiteness, and transparency were measured for three developing rice cultivars (SW29, SW38, SW52) and for the control cultivar (CC), which was the most popular cultivar in Korea. Springiness, adhesiveness, palatability, and consumer acceptance were measured after making APCR using each cultivar. Water contents ranged from 13.63 to 14.50%, and water uptake ratios were between 1.24 and 1.27. There was no significant different between the control and developing cultivars. Toyo values for CC, SW29, SW38, and SW52 were 59.7, 65.3, 64.0, and 76.7, respectively. Developing cultivars had a higher quality of rice, according to the values. However, SW52 had lower transparency than the other cultivars, meaning that it had a lower amount of head rice that affected its palatability. Springiness was higher in CC and SW52 than for SW29 and SW38. CC had higher adhesiveness than SW29, SW38, and SW52. CC also had more stickiness than the other cultivars. The palatability scores of CC, SW29, SW38, and SW52 from APCR products were 63.8, 72.5, 76.3, and 56.0, respectively. The mean overall acceptance and acceptance of the texture and glutinousness ratings of SW29 and SW38 were significantly higher than for CC. When considering the quality of rice, the quality of APCR, and the results from the consumer test, rice cultivars (SW29, SW38) had better quality than the control samples when the cultivars were processed for APCR. APCR made by SW29 and SW38 will therefore provide a higher quality of cooked rice to consumers.

Dietary fiber content and properties of cookies supplemented with different sources of resistant starches

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Cereal Foods World 58:A50

Resistant starch (RS) is the starch fraction that is not hydrolyzed in the small intestine but may be fermented in the colon. Due to its similar physiological properties, it is generally considered as a constituent of dietary fiber. RS can be more advantageous than various traditional fibers in terms of fiber fortification, as it is white and does not have negative impact on product taste and odor. There are four types of resistant starch; RS1: physically inaccessible starch; RS2: ungelatinized starch granules; RS3: retrograded starch; RS4: chemically modified starch. In this study, corn and wheat starches were chemically modified by using cross-linking reagents (a mixture of sodium trimetaphosphate and sodium tripolyphosphate). Cross-linked corn and wheat starches had very high RS4 contents (>80%, determined by enzymatic-gravimetric method) and seemed to be good sources of fiber. Each of these starches were incorporated into the cookie formulation at different levels (25-75%) to investigate their effects on the cookie quality and dietary fiber content of the final product. Wheat bran and different commercial RS samples (Hylon VII and Novelose) were also used for comparison. Among all RS sources studied, only the cross-linked wheat starch did not have a deteriorative effect on cookie quality, and the cookies supplemented with this cross-linked starch at the 75% level had the highest RS content. Hylon VII and bran addition caused the most deteriorative effect on the physical properties of the cookie samples. These results suggest that the cross-linked wheat starch samples produced in this study have great potential in the baking industry and can be used as an alternative RS source, instead of traditional fibers, in cookie production.

Evaluation of fenugreek (*Trigonella foenum-graecum* L.) germplasm for galactoamannan

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Cereal Foods World 58:A50

Fenugreek (*Trigonella foenum-graecum* L.) is an annual legume that has shown anti-diabetic and hypocholesterolemic properties in previous studies.

The major seed storage polysaccharide in fenugreek, galactomannan, may be one of the compounds that is responsible for these beneficial effects. Fenugreek is grown under conditions (mostly in India) similar to those found in western Nebraska. Therefore, fenugreek may be a new and industrially important crop in western Nebraska to promote health. The objective of this project was to evaluate global germplasm of fenugreek for galactomanann. A set of 84 fenugreek lines from 17 countries were grown in the field and the harvested matured seed was used. Seed galactomanann ranged from 3.48% to 19.3% with an average value of 12.0% among the 84 lines. The highest galactomannan content (19.3%) was in one of lines from Iran. These data will serve as a source for the development of high yielding fenugreek cultivars with high galactomanann content for western Nebraska and neighboring regions.

Kinetics of gluten aggregation—An indicator of refrigerated dough quality

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Cereal Foods World 58:A51

Four flours with different protein contents were selected for the study based on their differences in gluten aggregation time. GlutoPeak analysis revealed that Flours 1 and 2 had shorter gluten aggregation times (51 & 40.5s, respectively) than Flours 3 and 4 (144 & 130.2s, respectively). Further, doughs were prepared by mixing flours with 2% salt and 0.4% yeast using Farinograph at constant water absorption of 56.5% for all the flours to their optimum consistency (560-565 BU). Doughs were kept under refrigerated storage conditions for 24h. Flours 1 and 2 with shorter aggregation times showed increased Farinographic consistency from 561 BU (for both) to 730 and 761 BU respectively after 24h while for flour 3 it increased only from 565-620 BU. In contrast, Flour 4 showed a reduction in consistency from 560-478 BU. Also, flour 4 had reduced extensibility after refrigerated storage while the other three flours exhibited increased extensibility on Extensograph. Interestingly, Flour 1 had the lowest protein (9.8 %) and Flour 4 had the highest protein content (12.9%) but both the flours exhibited similar ($p>0.05$) torque (~ 45 BE). On the other hand, Flour 2 had lower protein (11%) content than Flour 3 (11.7%) still it showed almost 10 BU higher torque than Flour 3 (51.58 BE). Perhaps, the interactive forces like hydrophobicity and disulfide linkages responsible for the formation of gluten network, were weaker in flours showing longer aggregation times despite of their higher protein contents. This is the first study reporting gluten aggregation time could be a valuable parameter for prediction of refrigerated dough quality. Further studies with the extended refrigeration storage periods are underway to establish the correlation of gluten aggregation time with the quality of baked products prepared with refrigerated doughs and the phenomena leading to this behavior.

Modified GlutoPeak method for wheat flour additives

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Cereal Foods World 58:A51

GlutoPeak has been recently introduced as a sensitive and rapid way of testing wheat gluten quality. However, the flour is usually mixed with various additives like ascorbic acid, enzymes etc. to improve its performance suited for various product applications. The current study was designed to modify the standard GlutoPeak method to better differentiate the flours treated with different concentrations of ascorbic acid. Center composite design was employed to assess the influence of two independent variables – ascorbic acid (A, 29.5-170.5 ppm) and RPM (R, 877-1723) on GlutoPeak - torque and Peak Maximum Time (PMT). Response surface regression analysis revealed that PMT was only impacted by RPM while both the linear terms ascorbic acid concentration and RPM significantly affected the torque ($p\leq0.05$). However, interaction of both the variables was insignificant ($p>0.05$) for any of the responses. In the next step, prior to each experiment, flours with different concentrations of ascorbic acid were mixed with solvent (0.5M $CaCl_2$) for 1 min at 150 rpm and then rested for 2 min. Subsequently, all the experiments were run again following the same center composite design. Analysis of Variance revealed that kinetics of gluten network formation represented by PMT was impacted most by RPM and also significantly affected by concentration of ascorbic acid. Also, the interaction between the two variables was significantly positive ($p\leq0.05$). Ascorbic acid and RPM acted synergistically to govern the gluten aggregation time. Higher concentrations of ascorbic acid in flour at higher RPMs led to faster gluten aggregation. Current study suggests that modified GlutoPeak method can be advantageously used to better discriminate among the flours treated with different additives. Further results will be discussed for flours modified with different enzymes.

WITHDRAWN

Evaluation of indirect heat treatment method of whole wheat grain and whole wheat flour to improve functionality, shelf life and safety

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Cereal Foods World 58:A51

Wheat is third most important cereal and its flour is well-known for its ability to produce range of high quality baked products because of its unique gluten protein. During milling, three major components of wheat kernels, endosperm, germ and bran, are separated and recombined accordingly to achieve flours with desired end-use. Dough conditioners and other food additives or modified cereal starches are often added into baked and other cereal products to compensate for some of the lacking functional attributes of flour. Today, there is greater demand for whole wheat flour; however it is prone to quality deterioration because of high lipid content and enzyme activity. In addition, some of pathogens responsible for food safety hazards have been traced to flours, which have not traditionally treated to kill pathogens. In addition, increasing number of consumers demand for food products which are processed with little or no chemicals. To meet such challenges, there is necessity for newer processing technologies that improve the performance of flours with minimum or no addition functional ingredients and prolonged shelf life. The objectives were to evaluate performance of indirect heating in continuous system by evaluating influence of residence time (30-90s), hydration levels (12-20%) and temperatures (75-95°C) that enabled us to produce flours with improved functionality, to understand how these thermal processes alter functionality by studying physicochemical changes to flour constituents, gain better understanding in relating these changes to functionality, test for suitability in applications of such flour in making clean label dough and batter-based goods. The treated flours were examined for physicochemical changes to starch and protein using size exclusion HPLC, RVA, DSC, SEM, GPC, X-ray diffraction and starch swelling, as well as microbial and enzymatic assays.

Thermo-mechanical properties of gluten fractions in composite dough models

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Cereal Foods World 58:A51

Wheat gluten is unique functionality. It can form cohesive, stretchable and extensible protein network. Purpose of mixing is to disperse the ingredients, have coherent, viscoelastic dough with optimum mixing energy/rate input and within optimum mixing time. Rheological properties of dough can be used to describe physical characteristics, understand flour composition,

protein molecular and structural organization and therefore predict performance. Combination of empirical, fundamental rheological measurements together with SE-HPLC techniques can provide adequate understanding of gluten properties. The objective was to study effect of mixing speed on thermo-mechanical properties of composite starch-gluten fractions flour in presence of Hofmeister salts using Mixolab (Chopin, France). Composite flours at 85:10:5 (starch: Arise 8000:Arise 6000) were mixed at 80 rpm for 7, 14 and 20 min at 30°C. The treatment combinations included Na2SO4 or NaSCN at concentration of 0.5 and 1M. After mixing, the dough was immediately frozen in liquid nitrogen at -80°C and lyophilized. The lyophilized sample was ground with a mortar and pestle and stored at -20°C on a descant for subsequent analysis. After mixing; gluten protein in dough was extracted and evaluated using SE-HPLC. Surface hydrophobicity study was done only on gluten fractions. Small amplitude oscillatory measurements were conducted to quantify viscoelasticity. Dough development, consistency and stability highly depended on the type of protein and their proportion. More soluble protein was extracted in presence of 0.5M Na_2SO_4 than in 1M Na_2SO_4, and extraction levels decreased with mixing time. Less soluble protein was extracted in 0.5M than 1M NaSCN. Arise 6000 had lower surface hydrophobicity than Arise 8000 in control, mixture and in presence of 0.1M Na_2SO_4. In 0.5M NaSCN, Arise 6000 had even lower surface hydrophobicity.

WITHDRAWN

Effects of genetic variation in prairie cordgrass on ethanol yield
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Cellulosic ethanol is the renewable alternative transportation fuel made from agricultural residues, wastes, or biomass. Various feedstocks such as corn stover, switchgrass and miscanthus have been researched for biofuel. Prairie cordgrass (*Spartina pectinata)* is native to North America and has the potential as a feedstock for cellulosic ethanol. Prairie cordgrass is a tall rhizomatous, most northerly distributed C4 grass with strong rhizome and root systems. It grows well on marginal land with poor drained and/or salt affected soils. We used 12 natural populations of prairie cordgrass and studied effects of genetic variation in prairie cordgrass on feedstock composition and ethanol yield. Switchgrass was also chosen for a comparison of prairie cordgrass. First, feedstock composition of the 12 populations harvested at the end of 2011 growing season was analyzed. It showed large variation of glucose content among populations. The highest glucose level was 41.50% while the lowest one was 33.53%. Two samples with the highest (41.50 and 38.99%) and two with the lowest (34.54 and 33.53%) glucose level were selected for further ethanol production process: pretreatment, hydrolysis and fermentation. Pretreatment was conducted using 1% (v/v) sulfuric acid at 160 °C for 10 min with 10% solid content. Engineered *Saccharomyces cerevisiae* that can ferment both cellobiose and xylose simultaneously was used for simultaneous saccharification and co-fermentation. Sugar and ethanol yields for these four prairie cordgrass samples are competitive with switchgrass.

The characteristics of commercial wheat flour made of Korean wheat compared to those made of imported wheat in Korea
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To identify the quality characteristics of Korean wheat flour in comparison to those made of imported wheat, total 15 commercial wheat flours (8 imported, 7 domestic) were analyzed for the contents of moisture, ash, protein, total dietary fiber (TDF), and damaged starch, whiteness, color (L, a, b), solvent retention capacity (SRC) profile, pasting characteristics by rapid visco analyzer (RVA), Farinograph measurements and extensibility by Texture analyzer. Principal component analysis (PCA) was carried out to summarize the quality characteristics of Korean wheat flour compared to imported wheat flour. The Korean wheat flour samples were higher in ash and protein content compared to imported wheat flour samples. Korean wheat flour samples were lower in RVA characteristics (the viscosity of peak, trough viscosity, breakdown, Final, and setback) and SRC profile (sucrose carbonate SRC, sucrose SRC, lactic acid SRC, water RC) than imported wheat flour samples. The ash content had high correlation with whiteness (r=-0.946), color (L, a, b) and TDF. The protein content had high correlation (r=0.846) with dough extensibility. The SRC characteristics in imported wheat flour samples were highly correlated with dough extensibility (r>0.94) and Farinograph measurements and protein content. However, those correlations were not found in Korean wheat flour samples. The result of PCA showed different types (hard, medium and soft) of imported wheat flour could be classified by PC 1, while consistent trend was not shown in Korean wheat flour samples. The characteristics of Korean wheat flour samples by protein content were different from those of imported wheat flour. Therefore, further research on different types of Korean wheat flour is needed to match the consumer's expectation for wheat flour products.

Arabinoxylan content and availability throughout the bread baking process
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End-use quality of wheat (*Triticum aestivum* L.) is heavily influenced in a variety of ways by non-starch polysaccharides, specifically, arabinoxylans (AX). The evaluation of AX content and structure is often performed using flour and flour/water slurries, and extrapolated to determine the role they may play in baked products. Few studies have focused on the molecular interactions that occur throughout the baking process. The objective of this study was to track total and water-extractable AX (TAX and WEAX) throughout the baking process of five wheat varieties, using both wholemeal and refined white flour. The five varieties represent several different market classes to evaluate a broader range of AX variability. The TAX and WEAX contents were assessed in wholemeal and refined flour, mixed dough, proofed dough, and bread loaf, separated into crumb, upper crust, and bottom crust. The ratio of arabinose:xylose (A/X) was determined in order to understand the role of AX substitution in baking quality. The refined flour of hard wheat varieties exhibited the highest bread quality, as assessed by loaf volume. The content of TAX throughout the baking process differed between the wholemeal and refined flour samples, indicating a change in the TAX availability due to intermolecular interactions and baking. Most critical to loaf volume was the WEAX content and the substitution level of these WEAX molecules. High levels of WEAX with low levels of arabinose substitution were observed to be most beneficial to achieve high loaf volumes. The substitution level of WEAX molecules in particular was observed to be the most critical factor associated with the level of influence WEAX content had in enhancing loaf volume.

Generation of malt with high peptidase activity for the production of gluten-free beer
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Celiac disease is a small intestinal disorder triggered by storage proteins from wheat (gliadins, glutenins), rye (secalins) and barley (hordeins). Celiac patients adhering to a gluten free diet are allowed to drink only beer-

surrogates, which differ from wheat- and barley-based beers in terms of aroma and taste. As during germination there is a massive degradation of gluten by endogenous peptidases it is likely that peptidase-optimized malt might be used to degrade gluten during beer production to yield a product with a gluten content of <20 mg/kg and quality parameters comparable to conventional beer. Therefore, rye and barley grain was germinated under systematically altered parameters, the grains were kiln-dried, and peptidases were extracted with water. Celiac specific peptidase activity in these extracts was determined by RP-HPLC by using two celiac-active peptides as substrates (PQPQLPYPQPQLPY = P1 from alpha-gliadin and SQQQFPQPQQPFPQQP = P2 from gamma-hordein), and formed fragments were identified by LC-MS^2. Both P1 and P2 were degraded by the malt extracts. The peptidase activity of the malt was significantly higher than of non-germinated grains. For rye germination for four days at 18 °C at a humidity of 44 % gave malt with maximum peptidase activity and good brewing performance (activities up to 20 U/kg towards P1 and about 7 U/kg towards P2). In the case of barley germination for seven days at 14 °C and humidity of 48 % yielded the best result (activities towards P1 up to 27 U/kg and about 7 U/kg towards P2). The analysis of the fragments formed by partial hydrolysis of P1 and P2 showed that both carboxy- and aminopeptidase activities had been present. The malt extracts were able to cleave peptide bonds involving proline residues yielding fragments with less than nine amino acids, which are known to be no longer celiac-active.

Evaluation of a vacuum dough expansion system for wheat breeding programs

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Wheat breeding programs include baking studies in their evaluation programs as a final test of baking potential. However, large sample numbers generated by the programs and small sample weights available for analyses present problems to the Cereal Chemist. No single evaluation method can currently effectively predict loaf volume although numerous rheological and chemical methods exist that are highly correlated to bread making. A vacuum Dough Expansion system (VDE) was developed to evaluate dough systems prepared from real world breeding samples to explore the contribution of variety and growing environment to bread loaf volume. A VDE system has potential to evaluate the role of ingredients (enzymes, additives, etc.) in dough systems independent of ingredients and processes involved in baking bread. VDE was used to estimate dough expansion of Hard Red Spring (5 varieties, 5 locations) and Hard Red Winter (5 varieties, 8 locations) wheat grown in South Dakota in 2012. Optimally mixed dough (45g) was, sheeted panned and rested prior to VDE testing. Parallel baking of the 45 gram pup loaves was also done to determine baking volume (AACCI Method 10-09). Dough expansion was highly correlated to bread volume for cultivars when compared within growing environments (r> 0.7). When averaged across growing locations however, the predictive power for bread volume was weakened. In the combined data set (HRS and HRW), pellet weight (hybrid SDS/SRC test) had the highest correlation with bake volume (r=0.66) followed by seed protein (r=0.65). In spring wheat, Pellet weight had highest positive correlation with bake volume (r=0.44) followed by flour protein (r=0.43). In winter wheat, pellet weight had highest correlation with bake volume (r=0.66) followed by seed protein (r=0.57).

Ancient grains: Use as wholegrain flour in bread dough and starch properties

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It is well known that cereal grains from different botanical sources have large variations in starch characteristics as well as in their influence on dough formation properties. Starch granule size and apparent amylose content were determined in samples from einkorn, emmer, spelt, lymegrass, hull-less barley, hull-less oat, and millet. Differential scanning calorimetry was used to measure starch gelatinization and retrogradation properties, as well as the presence of amylose lipid complexes. The amylose content was highest in lymegrass and emmer (28-29%) and lowest in hull-less barley (17%) and millet (13%). Millet had the highest gelatinization temperature and transition enthalpy, whereas hull-less barley and lymegrass had the lowest gelatinization enthalpy. The retrogradation properties varied between grain sources. Bread dough was then prepared with 0, 20, 30 and 40 % of the white wheat flour replaced by wholegrain flour from emmer, spelt and lymegrass, respectively. Rheological and texture properties of dough were analyzed. In addition, the separation of dough into different phases (liquid, gel, gluten, bran, starch, and unseparated) upon ultra-centrifugation and the water content of each phase were evaluated. All the flours evaluated had significant effect on dough properties. As expected, the firmness increased, whereas the elasticity and springiness decreased. The volume fraction distribution and water content of phases differed between the grain sources. Spelt was the flour source that had least influence on dough properties. The effect of emmer was partially attributed to the bran phase. Lymegrass on the other hand could not be completely separated. Also dough color was affected by the selected alternative grain. All the effects measured are expected to influence the properties of baked bread, fresh and stored, when adding flour from ancient or alternative grains.

Hydrothermal and enzymatic solubilization of insoluble dietary fiber from cereal and pseudocereal sources

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The majority of dietary fiber from cereal and pseudocereal sources is insoluble. Thus, it is poorly fermentable and less likely to have a beneficial effect on the colonic microbiota. Enzymatically-isolated insoluble dietary fiber (IDF) from pearl millet, wheat, amaranth and quinoa was subjected to hydrothermal treatments and enzymatic hydrolysis to enhance and effect solubilization. IDF suspensions (10% w/v, in water) were subjected to microwave (MW), liquid hot water (LHW), and autoclave (Acv) treatments prior to enzymatic hydrolysis. Each treatment was for 30 min and controlled to reach a maximum of 120 °C. Freeze-dried pretreated-IDF (pT-IDF) samples were suspended (1% w/v) in water and treated with neutral protease (5 U/mg) for 4 h at 50 °C followed by feruloyl esterase (5 U/mg) for 4 h at 50 °C. Cereal pT-IDF suspensions were subsequently treated with endoxylanase and cellulase (5 U/mg ea.) for 5 h at 50 °C. Pseudocereal samples were treated with endopolygalacturonase and cellulase (5 U/mg ea.) for 5 h at 40 °C. Solubilized carbohydrates were quantified by the phloroglucinol method for pentoses for cereal samples and the Blumenkrantz method for uronic acids for pseudocereals. In general, LHW and MW pretreatments solubilized comparable amounts of fiber and were more effective than Acv pretreatment. For cereals, LHW pretreatment resulted in the highest increase of soluble fiber content. Wheat and pearl millet IDF samples had 11.4% and 16.7% increase in soluble fiber, respectively. In the case of pseudocereals, MW pretreatment resulted in higher solubilization for quinoa IDF (9.6% increase in soluble fiber) and LHW pretreatment effected a higher solubilization in the case of amaranth IDF (7.5% increase in soluble fiber). The optimization of hydrothermal pretreatments in combination with enzymatic hydrolysis proves to have potential in the solubilization of IDF.

Mechanical, microstructural, and antimicrobial properties of nanoenhancer-reinforced corn zein protein film

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Corn zein protein (CZP) based films, functionalized with core-and-shell titanium dioxide nanoenhancers, (NE, TiO_2@@SiO_2) were developed by casting 13.5% CZP solutions. CZP solution with 1.5% w/w of nanoenhancers was subjected to sonication at 0, 16, 80 and 160mm amplitudes for uniform distribution of NEs in the biopolymer prior to casting. Uniform distribution of NE is expected to improve properties of polymer film/coating, which were characterized by tensile testing, microbiological analysis, and TEM scans, respectively. The results show the feasibility of using nanocomposite technology to improve the properties of biopolymer films. Films with NEs showed better tensile strength than films without them, but almost at 50% elongation; films without NEs broke at higher elongations and lower tensile strength. Various microscopic scans showed the uniform distribution of NEs in films. Varied UV exposure to NEs caused the delay in cell growth in growth media. When UV exposure time of NE-incorporated CZP films was extended to 1 and 2 h, lag phase was extended to 8.5 h and 10 h, respectively; it also decreased the bacterial cell growth rate to 6.94×10^4 cell/h and 6.06×10^4 cell/h, respectively, compared to 8.78×10^4 cell/h for films without NEs. This suggested more damages to the bacterial cells caused by the more exposure time. When microbes were cultured under sunlight in the presence of NE-incorporated CZP films and a control film, microbial growth was significantly inhibited in the presence of NE-incorporated CZP film not attaining the log phase even after 7 h of exposure. Cell growh in no NE CZP control film peaked in 4 h with log-phase starting at 1 h. This work suggests that nano-enhanced biopolymers can potentially be utilized to make active antimicrobial surface coating or films to inhibit or slow down microbial growth during storage.

Impact of cooking on the levels of phenolic compounds and antioxidant activity in whole black, red and wild rice

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Total phenolic compounds, flavonoids, proanthocyanidins and anthocyanins contents were determined, before and after cooking, in 16 black and 9 red whole rice (*Oryza sativa*, L.) genotypes produced in Brazil and six wild rice lines (*Zizania* ssp., L.) imported from Canada. Antioxidant activity was determined by ORAC and DPPH• methods and anthocyanins were identified by HPLC-DAD-MS/MS. The mean levels of total phenolics for whole black, red and wild rice were 446, 372 and 215 mg ferulic acid eq./100g, respectively. The flavonoids contents were also higher in black rice, followed by red and wild rice and the mean values were 390, 217 and 106 mg catechin eq./100g, respectively. Cyanidin-3-*O*-glucoside and peonidin-3-*O*-glucoside were the predominant flavonoids in black rice and mean values were 365 mg cyanidin glucoside eq./100g. Contrary to black rice, the major flavonoids in red rice were proanthocyanidins which are responsible for the red pericarp color, and their total mean content was about 147 mg catechin eq./100g. Antiradical efficiency determined by ORAC method was higher in black rice and strongly correlated with the total phenolic and flavonoid contents ($r=0.940$; $p<0.05$). DPPH• method showed similar results. Rice cooking caused a 50% reduction of flavonoid contents in black and red rice. Anthocyanins and proanthocyanidins showed to be the most sensitive and rice cooking decreased their contents to 50% and 30% of their original values, respectively. The antioxidant activity showed a similar behavior and its reduction was proportional to the loss of anthocyanins and proanthocyanidins in black and red cooked rice. Cooking of wild rice did not affect significantly the contents of total phenolic compounds, flavonoid or the antioxidant activity. Nevertheless, black rice showed the highest flavonoid content and antioxidant activity even after cooking.

Functional and sensory evaluation of sugar-free biscuits enriched in barley beta-glucan according to the new EFSA's health claims

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The objective of this work was to evaluate the physicochemical, sensory and potential glycemic response properties of a biscuit containing isomaltulose as sweetener and barley beta-glucan at 6% w/w that is sufficient to satisfy the new EFSA's health claims related to cholesterol lowering and faecal bulk increasing. Comparing with sucrose-containing biscuits devoid of beta-glucan (control) made by a similar recipe, the diet product had darker colour, a higher moisture content (7 vs. 5%) and a_w (0.51 vs. 0.43) after 5 months of storage at 25°C. For the fresh products, the diet biscuits were significantly ($p<0.05$) softer than controls; however, differences in hardness values (puncture test) between the two sample categories greatly diminished during storage. An *in vitro* enzymic assay was used to assess the glycemic response of the products. Glucose release was expressed as percentage of the total digestible carbohydrates of the biscuits; after 5 hours digestion significantly ($p<0.05$) lower values were found for diet (16.4%) than control (26.4%) biscuits and white bread (25.6%). Sensory evaluation by two different target groups, general population (n=124) and diabetic individuals (n=22), gave high scores on a scale of 1 to 7 for the overall acceptability to the diet biscuits, 5 and 6, respectively. Diabetics were also more satisfied than the general population consumers concerning taste-flavour (90 vs. 79%), texture (80 vs. 61%) and sweetness (70 vs. 55%) of the product. Moreover, 80% of diabetics and 55% of general population group stated their intention to purchase the diet product even in higher price than a conventional item. This study suggests that sugarless biscuits fortified with beta-glucans can simultaneously provide various health benefits and be highly acceptable by consumers.

Enzymatic synthesis of 2-deoxy-glucose-containing maltooligosaccharides to test the location of starch digestion in the small intestine

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Ileal release of glucose from starch digestion has been found to induce physiological responses that may be beneficial to health. However, as of yet there are no studies on location of glucose deposition and absorption that guide development of slowly digestible glycemic carbohydrates that can be used by the food industry. 2-Deoxy-glucose (2-DG) can be used to test the location of glucose absorption due to its accumulative property in the small intestine enterocytes. Because monosaccharides are absorbed in the proximal part of the small intestine, we designed 2-DG containing maltooligosaccharides (2-DG-MOs) and used mammalian α-hydrolytic enzyme inhibitors so that digestion can occur distally and locational effect can be studied. Recombinant amylosucrase (5 U), which elongates α-1,4 glucosyl units to acceptor molecules, was reacted with sucrose (500 mM) as a donor and 2-DG (3%) molecules as an acceptor at 35°C for 48 h. High performance anion exchange chromatographic analysis showed that the ethanol-precipitated enzyme-synthesized product had an average of 10.6 glucosyl units with different retention times compared to homogeneous maltooligosaccharides. The 2-DG-MOs were hydrolyzed by mammalian α-hydrolytic enzymes (human pancreatic α-amylase and individual mammalian mucosal α-glucosidases) to test whether this product can be digested to monosaccharides in the GI tract. The 2-DG-MOs were hydrolyzed to maltose and maltotriose by α-amylase, and hydrolyzed to 2-DG and glucose by action of the individual mucosal α-glucosidases. The α-hydrolysis results indicate that 2-DG-MOs can be used with enzyme inhibitors to test the exact location of glucose release. In the future, we will produce ^{14}C-labeled 2-DG-MOs to study the location of starch digestion in test animals and to correlate with physiological endpoints.

Phytochemical composition and anticancer activity of germinated wheat

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Seed germination is a natural method to increase bioactive components that have beneficial effects on human health. Germinated wheat flour samples of a hard red wheat cultivar (Rampart) were prepared after germination of three and five days and investigated for phytochemical composition and anticancer activity. When molecular weight distribution of SDS soluble and insoluble proteins were analyzed by a size exclusion HPLC, the germinated wheat samples were found to contain higher proportion of SDS soluble polymeric and monomeric proteins than non-germinated wheat, indicating degradation of proteins and bread-making quality by germination. As proteins were degraded by germination, great surge of free amino acids was observed for germinated wheat samples. Glutamine, serine, threonine, and tyrosine which were not detected in non-germinated sample were detected in germinated wheat by GC-MS. Gamma-amino butyric acid that is known as a chief inhibitory neurotransmitter substance functioning to *relive anxiety in humans* was also detected in germinated wheat. Germinated wheat had significantly higher total phenolic compound concentration and antioxidant activity than non-germinated wheat. The concentrations of those components increased as wheat seeds were left to germinate longer. In general, total phenolic compound concentration and antioxidant activity were doubled after 5 days of germination. We also tested influence of a germinated wheat flour sample on human breast cancer cells. Specifically, the wheat flour sample prepared after germination of three days was effective in suppressing growth of estrogen receptor-positive and negative cancer cell lines *in vitro*. Suppression of the cancer cell growth was influenced by dosage and incubation time, and analysis using a flow cytometer indicated up-regulation of apoptosis of the cancer cells.

Application of Raman spectroscopy for qualitative and quantitative detection of fumonisins in ground maize samples

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The feasibility of Raman spectroscopy for qualitative and quantitative assessment of fumonisins in ground maize was investigated using the samples with concentration range of 2 to 99 mg/kg. Major Raman bands relevant to fumonisin effects on starch molecules and on increased fumonisin levels were observed in several Raman shift regions. The k-nearest neighbor (KNN) models achieved highest classification accuracies for both training (100%) and independent validation (96-100%) data. Three classification models (k-nearest neighbor, linear discriminant analysis, and partial least squares discriminant analysis) correctly classified fumonisin contaminated samples of >5 mg/kg. All chemometrics models for quantitative determination of fumonisins could explain >90% of variation in spectra data. Multiple linear regression (MLR) and partial least square regression (PLSR) models showed

slightly higher predictive accuracies and lower error rates. The statistical results showed no significant difference between LC-MS/MS (liquid chromatography-tandem mass spectrometry) reference and Raman predicted data, implying some models developed have the ability to accurately predict fumonisin levels in ground maize samples for rapid screening and identification of contaminated samples. This work characterizes the capability of Raman spectroscopy as a fast screening tool for high-throughput analysis of fumonisin contaminated samples to improve food and feed safety.

Improving the nutritional property of starch by targeted mutagenesis on starch branching enzymes

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A quantitative model of starch biosynthesis predicts that starch with longer chains can be produced by increasing the minimal constraints on starch branching enzymes (SBE), X_0 and X_{min}, which are the minimal number of glucosyl units remaining on the parent molecule after branching reaction and the minimal number of glucosyl units transferred to another molecule as a new branch, respectively. These chain-length constraints are most likely to be controlled by the binding site of SBE. In this study, five conserved amino acid sites in proposed active site of *Zea mays* SBEIIa were chosen for mutation to achieve a larger X_0 or X_{min}, designated as: Y332F, E493D, S329F, R343K, and R436K. These mutant SBEs together with the wild type SBE were expressed in *E. coli* and were used to branch linear chains obtained by debranching of amylose using isoamylase. The resulting branched molecules were debranched again with isoamylase and the lengths of the branches were analyzed using size exclusion chromatography (SEC). The results showed that only the wild type and R436K SBEs had considerable branching activity, whereas other mutant SBEs did not show detectable branching activities. The fitting of the chain length distribution (CLD) to the mathematical model allows the determination of the branching activities, X_0, and X_{min} of the two SBEs for comparison. There were also slight differences between the CLDs of the molecules branched by R436K and wild type SBEs. R436K SBE produced a larger amount of longer chains (~ DP 100), although the positions of all peaks in the CLDs from both SBEs were similar. This suggests that the R436K mutation does not change the two limitation parameters on SBE, but the affinity of SBE to bind the starch substrates is changed.

Effects of sorghum inbred variability on ethanol production

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Grain sorghum (*Sorghum biocolor* (L.) Moench) is a starch-rich grain and is primarily used as livestock feed in the U.S. The application of sorghum on bio-based products and bio-energy is limited due to poor wet milling property and lower starch and protein digestibility. However, lifecycle greenhouse gas analysis from U.S. Environmental Protection Agency (EPA) shows that bioethanol made from sorghum grain would meet the 20% threshold required by the Energy Independence and Security Act of 2007 for conventional renewable fuel. When sorghum ethanol is produced at plants powered by biogas and combined heat and power (CHP) technology, it could meet the 50% threshold for advanced renewable fuel (EPA, 2012). The objective of this research was to investigate the fermentation performance of various sorghum inbreds for ethanol production. Forty-eight grain sorghum inbreds (waxy and non-waxy) were evaluated with a laboratory dry grind process. The fermentation was conducted using a system that automatically detected CO_2 concentration, which can be converted into ethanol concentration. The final ethanol concentrations were compared to the ethanol concentrations from HPLC. Fermentation performance was reported as ethanol yields, which were in the range of 13.59 to 18.98% (v/v). Sorghum inbred variability had a significant effect on final ethanol yields.

Applying chicory root fiber (inulin) to improve nutritional and functional values for whole grain extruded cereal

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Whole grain extruded cereal is often considered as a healthy choice for people to increase their fiber intake. However, many of commercial whole grain cereal products are very high in sugars and low in fiber. We are presenting a novel approach to increase fiber and reduce sugars in whole grain extruded cereal via fortification of chicory root fiber (inulin), which allows "excellent source of fiber" and "reduced sugar" claims to be made and improve texture, taste and shelf life qualities of the cereal as well. Chicory root fiber (inulin) is a natural soluble fiber with GRAS status that offers both health (prebiotic fiber) and functional (texture and taste improvement) benefits for a variety of food applications. Two chicory root fibers were tested in this study. A powdered chicory root fiber [degree of polymerization (DP) of 10] was used to partially replace whole grain flour in a hot extruded cereal base, which was further coated with a sweet liquid chicory root fiber (DP of 5) to partially substitute sugar syrup in various levels. It showed that the two chicory root fibers help to significantly increase fiber and reduce sugars in the extruded cereal, and they fully retained inulin content after a hot extrusion process (Wenger TX-57 twin screw extruder was used). The cereals coated with the sweet liquid fiber also had a better bowl life and shelf stability compared to their sugar syrup coated counterparts. It was concluded that applying the chicory root powder to replace whole grain flour (up to 10%) in the extruded cereal base and using the sweet chicory root syrup to replace sugar syrup (up to 25%) in the coating can make a tasty and shiny extruded whole grain cereal which is high in fiber and low in sugars.

Effect of molecular size of polysaccharide gums on water vapor permeation and moisture uptake of films

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Cereal Foods World 58:A55

Agarose (AGA), κ-carrageenan (CAR), guar gum (GG) and konjac glucomannan (KGM) with various molecular size were prepared by treating within methanol containing 0.36% hydrochloric acid (v/v) at 25°C for different durations. Water vapor permeation (WVP) and moisture uptake (MU) of films prepared from gums were determined, and influence of molecular size on WVP and MU of polysaccharide films were discussed. Molecular size of gums studied were ranged from 332~22, 1639~241, 1170~294 and 842~42 kDa for AGA, CAR, GG and KGM, respectively. Results showed that WVP of GG films was obviously higher than that of other films. The WVP of CAR, GG, and KGM films decreased with decreasing molecular size of gums, and the most profound result was observed for GG film. The difference on WVP among AGA films with various molecular sizes was less obvious than that of other films. Film prepared by AGA with molecular weight 116 kDa had the lowest WVP among the AGA films. MU of films decreased with decreasing molecular size, except for AGA film. MU of AGA film with molecular size higher than 116 kDa showed increasing tendency with decreasing molecular size, while reverse tendency was observed for molecular size lower than 116 kDa. A quadratic correlation (r^2>0.940) was found between WVP and MU in spite of gum source or molecular size. As MU of films was less than 35%, the WVP of films was lower than 10×10^{-13} g/m sec Pa. However, WVP of films obviously increased with increasing MU from 35% to more than 55%. Results imply polysaccharide gum with smaller molecular size tends to align more tightly which cause the reducing WVP and/or MU of film. Furthermore, the WVP and MU of polysaccharide film can be regulated by changing molecular size of gums.

Effect of acid-ethanol pretreatment on the application of octenyl succinic anhydride modified corn starches in mayonnaise

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Cereal Foods World 58:A55

Octenyl succinic anhydride modified starches were prepared from native (OSA-N) and acid-ethanol pre-treated (OSA-AET) corn starches, starch pastes (10%, w/w) were then used to replace half the fat in mayonnaise and the change of oil drop size in mayonnaise was observed for elucidating the effect of starch molecular size on its application in mayonnaise products. Molecular size of native and AET starches were 384,809 and 4,081, 434,229 and 6,261, as well as 114,252 and 2,500 AGU (anhydrous glucose unit) for waxy, normal and Hylon VII corn starches, respectively. Result of microscopic observations showed that the oil drop in mayonnaise prepared without OSA starch (control) was less uniform than that of mayonnaise containing OSA-N or OSA-AET corn starches. The size of oil drop in mayonnaise containing OSA-N waxy corn starch was obviously smaller than that of control and OSA-AET samples, however oil drops aggregated and drop size obviously increased for the control and OSA-N samples after stored in 4 °C for 7 days. While no obvious change in oil drop size after storage was found for mayonnaises containing OSA-AET waxy corn starches. Mayonnaises containing OSA normal corn starch showed similar result to that of mayonnaise containing OSA waxy corn starch. Drop size of oil in mayonnaise containing OSA-AET Hylon VII was obviously smaller than that of control and OSA-N Hylon VII starch samples

either before or after storage. Results indicate that OSA-AET starch had higher emulsion stabilizing ability in mayonnaise, and that dual modified starch could be used as fat replacer in calorie-reducing foods.

Fractionation of barley into value-added ingredients enriched with protein, beta-glucan or starch

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Cereal Foods World 58:A56

Barley contains several nutritional components, including protein, beta-glucan (BG) and starch. A key strategy for value-added utilization of barley has been to produce fractions enriched with each key nutrient. Among reported studies on barley fractionation (dry or wet) methods, most focused enriching one or two components in terms of concentrations in resulting fractions but neglected recovery rates. In this study, a modified wet method was developed to simultaneously fractionate a hulless barley variety into three fractions, each enriched with protein, BG or starch, respectively. Using the method, the effects of alkaline concentration and solvent to flour ratio on compositions of resulting fractions and recovery rates of the three nutrients were also determined. Results showed that both factors had significant effects not only on the chemical composition of the fractions enriched with protein, BG and starch, respectively, but also the recovery rates of the three components. With increasing solvent concentrations, the protein content and recovery rate increased in both protein and BG fractions; the BG content decreased but its recovery increased in the BG fraction; and the starch content and recovery increased in the starch fraction. With increasing solvent to flour ratio, more BG was extracted into the BG fraction; more starch was enriched into the starch fraction; and the protein content remained unchanged but its recovery rate increased in the protein fraction. Overall, the method was effective in enriching the three major nutrients from barley. Under optimal combinations of the two factors, the contents of protein, BG and starch reached 72, 74, and 92% in their respective fractions. These fractions can potentially serve as value-added ingredients for food and feed.

Market surveys for dried Chinese noodle in Beijing: Market condition and trend

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Cereal Foods World 58:A56

Two market surveys were carried out in October 2012 and January 2010 respectively, aimed to learn about the market condition of Dried Chinese Noodle (DCN) in Beijing. In order to investigate brands, varieties, packages and price of DCN, 108 big and medium-sized supermarkets in the urban district and suburban county of Beijing were selected in 2012, and 50 supermarkets in 2010. The results showed that the number of DCN brands increased from 69 in 2010 to 94 in 2012. There were no leading brands in the market in 2010. But in 2012, some national brands, such as "Kemen", "Fengda", "Biomate", and "Arawana", accounted for a large market share, and high-brand superiority of some DCN producer, especially Wilmar, is increasingly rising. The average price of DCN products is ¥4.00/500g in 2010, and 66.07% of DCN was concentrated in the range of ¥3~5/500g; while the average price is ¥5.81/500g in 2012, and 52.03% was concentrated in ¥4~6/500g. Compared to 2010, the price of DCN products has been significantly raised, and the proportion of high-end DCN products significantly increased. According to the ingredients and the target consumer groups, the DCN products are divided into five categories, namely ordinary white noodle, egg noodles, mixed grains or vegetables noodles, DCN for children and DCN with seasoning bags. The 2012 survey showed that ordinary white noodle was the most common noodle varieties, followed by egg noodles, mixed grains or vegetables noodles. The variety has significant effects on price, DCN for children showed significantly higher price than other DCN products. The two surveys results indicated that "cylindrical paper package" was the main packaging types, and the proportion of box package significantly increased from 2010 to 2012. The package type has significant effects on price, and the noodles with better package have higher price.

Inhibition of lipid oxidation by formation of caseinate-oil-oat gum complexes

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Lipid oxidation, particularly oxidation of unsaturated fatty acids such as omega-3 fatty acids, has posed a serious challenge to the food industry trying to incorporate heart-healthy oil products into their lines of healthful foods and beverages. In this study, plant based omega-3 oil was dispersed into sodium caseinate micelles and then mixed with oat gum in a homogenizer under room temperature. The objective of this study was to see if the complexes formed between beta-glucan in oat gum and oil encapsulated caseinate micelles will protect omega-3 oil from oxidation without causing physical stability issue in healthy beverage formulations. Omega-3 oil-in-water emulsion (20% oil vol/vol) stabilized with 1.87% (w/w) sodium caseinate were formed from plant based omega-3 oil, sodium caseinate, and citric acid. The formulation was stabilized using Polytron homogenizer for 30 min after initial 2-minute mixing with a blender. The lipid oxidation was measured as lipid hydroperoxide concentration and the significant reduction of lipid oxidation was observed under shelf-life stress tests at both 40 °C and 70 °C. It was found that the lipid oxidation in caeinate-oil-oat gum solution was much less than in control A, an oil-oat gum only solution and about the same as in control B, an oil-caseinate only solution.

Factors that affect CIELAB and Hunter L*ab* color scales

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Cereal Foods World 58:A56

CIELAB and Hunter L*ab* are two color scales where L-value indicates brightness on a scale of 0 to 100 where 0=black and 100=brightness; a-value indicates greenness when negative and redness when positive; and b-value indicates blueness when negative and yellowness when positive. Color is an important attribute for determining the quality of semolina and pasta. Semolina color usually is characterized by CIELAB using a black cell with a quartz glass window, while pasta color is characterized by Hunter L*ab* using a black tile with 1 cm of depth. Experiments were conducted to determine the effect of background color and sample depth on measured semolina and pasta color scores. Six different spaghetti and semolina samples of poor, medium, and high color quality were used. Color scores of semolina and spaghetti were determined using a Minolta 410 colorimeter. Background colors evaluated were black, blue, green, red, white, and yellow. CIELAB values for semolina and Hunter Lab values for spaghetti varied depending on background color. For semolina, background color did not affect CIE L-value or a-value; but the b-value was greater with green or red than with black background. For spaghetti, Hunter L-value and *b*-value were higher with white or yellow than with black background; and the a-value was greater with red, yellow or white than with black background. As the depth of spaghetti increased from 0.25 to 1 cm, the Hunter L-value increased from 51.08 to 52.21, *a*-value increased from 2.13 to 3.79, and *b*-value increased from 23.34 to 24.32. These data demonstrate the importance of specifying the depth of spaghetti and the color of background when using the CIE or Hunter color scales.

WITHDRAWN

WITHDRAWN

WITHDRAWN

Mathematical modeling of flow behavior and cell structure formation during extrusion

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Cereal Foods World 58:A57

Expanded snack products have a large share in the market in terms of consumption and economic value. High oil content in snacks leads to obesity and cardiovascular problems. In order to reduce the amount of oil delivered by any product while maintaining its consumer acceptability, it is important to understand the parameters affecting oil uptake during processing steps such as frying. Cellular structure is an important parameter affecting the oil content in snack products. Cellular structure formation during extrusion of expanded snacks is dependent on the flow behavior of melt and dynamics of vapor induced puffing. The objective of this work was to develop and validate a predictive model for flow behavior of a biopolymer melt inside the extruder and formation of cellular structure during vapor induced puffing. The temperature, pressure and barrel filling ratio profiles inside the extruder were developed from input parameters like in-barrel moisture (15-25% wet basis) and screw configuration (low, medium, high shear), using one-dimensional modeling approach. Rheology of the flow was described using the non-Newtonian, non-isothermal viscosity model. The effect of variability of input parameters on the expansion of the extrudate was also modeled using stochastic methods. For validating the model, melt temperature (390–410 K) and specific mechanical energy were compared with experimental data obtained from twin screw extrusion of corn meal based expanded products. Cell structure (average cell radius = 260-350 microns) and expansion (sectional expansion ratio = 15-28) data were also validated using experimental results.

Aroma profiles of raw and cooked samples of selected rice varieties

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Cereal Foods World 58:A57

A comparison of the volatile compounds observed in the headspace of raw and cooked samples of some commonly grown rice varieties in Africa is reported. Aroma compounds were identified by solid phase micro-extraction followed by GC-MS. Aliquots of 1g of milled rice were placed in a 10 mL vial and sealed with twist cap. Samples were allowed to equilibrate for 24 hours at ambient temperature. SPME was performed using a carboxen/DVB/ PDMS fiber. Samples were preheated for 5 min at 65ºC. The fiber was then deployed and the headspace extracted for 15 min. The fiber was then desorbed for 1 min in the GC injection port at 270°C. The GC oven was initially held at 60°C for 1min then increased at a rate of 10°C/min to 300°C and held for 60min. Helium was used as the carrier gas at a constant flow rate of 1mL/min. A 30 m x 0.25mm column with a 0.25 um film of 5% phenyl 95 % dimethylpolysiloxane stationary phase, was used. The MS was operated in scan mode from m/z 40 to 550. For cooked rice, 2mLs of deionized water was added to 1g of rice and placed in a 10mL vial. The samples were then heated at 95°C for 25min. Subsequent analysis by SPME was performed as above. Compounds like α-pinene, decane, hexadienal, undecane and dodecane were found only on the uncooked samples. Nonanal, diisopropylnaphthalene 1 and diisopropylnaphthalene 2 were found at lower levels on all the uncooked samples but their intensities increased on cooking. Compounds detected only on the cooked samples were 2-pentylfuran, butyrate and linoleic acid. 2-acetyl-pyrroline was found in 5 samples and the levels of this compound generally increased on cooking.

WITHDRAWN

The way from a wheat- to a gluten free-sourdough up to gluten free breads
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The use of the sourdough is the oldest biotechnological process to leaven baked goods, and it has been proven to be ideal for improving bread texture, palatability, aroma, shelf-life and nutritional value. Even if these effects have been extensively studied for the traditional baking, few attempts have been made for producing and evaluate gluten free (GF) sourdoughs and the resulting GF breads. The aim of this study was the setting up of a GF sourdough starting from a wheat-based sourdough traditionally used for the production of Panettone, a well-known Italian sweet baked product. The isolated Lactic Acid Bacteria and yeast strains were inoculated into a GF matrix, containing corn starch, rice flour, pea isolate, hydrocolloids and fiber as main ingredients. The starter obtained was constantly and continuously propagated over a 30 days period, and its properties (number and type of microorganisms; dough consistency, pH, titratable acidity and capability to produce and retain CO_2) were regularly monitored. A stable association between microorganisms (*L. sanfranciscensis* and *C. humilis*) was obtained just after the second refreshment, and the microbiological population and technological properties of the developed GF sourdough (GFSD) remained constant and satisfactory from here onwards. Only at this point breadmaking trials were performed, to compare the quality of GF doughs and breads obtained using GFSD or compressed yeast (CY), or their mixture (GFSD+CY), as leavening agents. The higher crumb hardness value obtained for GFSD-bread was probably due to its lower development during breadmaking. However, CY-bread exhibited a crumbly behavior during storage (69h, 25°C, 60%RH), that was absent in SD-bread. In general, when GFSD was used in combination with CY a synergic effect was highlighted and an improvement of the overall GF bread quality and shelf-life was achieved.

Durum wheat semolina characterization by means of a rapid shear-based method
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Cereal Foods World 58:A58

Glutopeak test (GPT) is a rapid shear-based method, recently introduced by Brabender GmbH & Co. (Duisburg, Germany), for discriminating gluten quality. The instrument records the time to reach peak torque during the formation of gluten network. It has been successfully proposed for flour characterization, while no information is available for durum wheat products. Twenty-height durum wheat semolina samples were considered and characterized in terms of protein content, gluten index, and alveographic indices. Semolina (9 g) and distilled water (10 ml) were weighted into the sample cup of the GPT. Temperature was maintained at 35°C and the paddle was set to rotate at 2,750 rpm. Each test ran for 5 min and maximum torque, peak maximum time and the area under the peak were recorded. A significant correlation between the protein content and the peak ($r = 0.70$, $p < 0.01$) was observed, indicating strong aggregation properties. As for the quality of gluten, the statistical analysis showed a significant correlation between the area under the peak and the gluten index ($r = 0.76$, $p < 0.01$) and W alveographic index ($r = 0.70$, $p < 0.01$). In other words, the greater the energy required to form the gluten, the higher the gluten and W indices. On the basis of the conventional alveographic test, semolina samples were divided into three classes of quality: poor ($W < 180 * 10^{-4}$ J), medium ($180 < W < 250 * 10^{-4}$ J) and good ($W > 250 * 10^{-4}$ J) quality. The test was able to distinguish the samples of high quality (area> 2400 AU) from those of low quality (area <2400 UA). As expected, medium quality semolina exhibited an intermediate behavior. For this class, the time of maximum peak was the parameter significantly correlated to the quality of gluten ($r = 0.73$, $p < 0.05$). These preliminary results are encouraging to propose GPT as a rapid and reliable approach for semolina characterisation.

Influence of temperature and precipitation on protein composition of hard red spring wheat and their impact on sponge and dough baking performance
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The objective of this study was to estimate the effects of temperature and precipitation on wheat protein composition and the relationship with resulting baking performance. Canadian Western Red Spring (CWRS) wheat varieties (Katepwa, Laura, Lillian, Carberry and CDC Kernen) representing a range in dough strength grown in western Canada in 2010 (9 locations) and 2011 (8 locations) were tested. Proteins were extracted using SDS-phosphate buffer with and without sonication followed by size-exclusion HPLC. The ratio of extractable polymeric protein (EPP) to total protein was negatively correlated with Growing Degree Days-base 0 degrees Celsius (GDD-base0) from seeding to maturity for each variety. The ratio of unextractable polymeric protein (UPP) to total polymeric protein showed a generally positive relationship with GDD-base0. Variation from normal precipitation (April to harvest) correlated negatively with the proportion of total polymeric protein to the total monomeric protein ($r = -0.87$ to -0.54) except for a single variety. In turn, total polymeric to total monomeric protein ratio exhibited negative correlation with sponge and dough bake absorption and loaf volume for each variety for both years. It appeared that higher precipitation may have suppressed production of polymeric proteins thus affecting the balance between total polymeric to total monomeric protein necessary for optimum bake absorption and loaf volume.

Prediction of nutritional quality of corn for broiler chickens
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In broiler feed formulation, each ingredient is given predicted values for *in vivo* digestibility of nutrients. A 41d feeding experiment was designed to investigate quality of 6 corn samples from across the USA and evaluate whether predictions of quality predict animal performance. Samples of corn were obtained from 6 regions of the USA to represent the variability in corn available. Diets were formulated to reflect commercial practice and contained corn at a fixed rate. The 12 treatments were derived using corn source as the variable, with each diet being fed either with or without a feed xylanase at 16,000 BXU/kg. Corn samples were analysed for starch, protein, oil, fibre, protein solubility index (PSI), moisture and vitreousness using NIR (AuNIR, Towcester, UK). These values were used to predict the Apparent Metabolizable Energy (AME, MJ/kg) of the corn samples. The corn samples varied in composition as follows: starch 76.1-78.5%, crude protein 7.8-9.0%; oil 3.6-3.7%; crude fiber 2.4- 2.6%; PSI 36.0-45.5%; vitreousness 55.3-59.0%; moisture 12.39-15.17%. There were no interactions between corn source and enzyme inclusion ($P > 0.05$) on broiler production performance. There was a main effect of corn source on broiler body weight at age 34d ($P = 0.048$) but not 41d. There was also an effect of corn source on feed conversation ratio at 41d (FCR; feed intake/body weight gain; $P < 0.05$) which is a critical parameter for production. The main effect of enzyme was also significant ($P = 0.017$). Predicted AME and measured FCR were significantly correlated ($P = 0.018$, $r^2 = -0.79$), suggesting that prediction of quality may predict production performance at d41 (lifespan). Corn moisture appeared to be an important component (moisture and FCR $r^2 = 0.929$ $P < 0.001$) indicating a nutrient dilution effect or more likely, an interaction of moisture and heat during feed processing.

The effect of pH and protease on particle size breakdown of corn
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Cereal Foods World 58:A58

A previous experiment suggested that in an *in vitro* gastric simulation, pH and pepsin inclusion affected corn particle size breakdown. The effect of pH and inclusion of different proteases on particle size reduction of maize grits was investigated. A sample of maize was ground through a 5mm hammer mill screen to a GMD of 900µm and large particles were excluded by sieving through a 2.8mm screen. Samples were incubated with either water; pepsin (P) or one of two acid proteases (A or B; AB Enzymes, Germany). Each sample was adjusted to a target pH of either 0.8, 1.2, 1.4, 2, 3 or 4 through use of HCl, to reflect avian gastric pH. Samples were tumbled with ceramic beads at 42 °C and aliquots removed after 120 minutes and immediately frozen for storage prior to analysis. The particle size distribution of each of the samples was measured. Particle size is expressed cumulatively, as the particle size at which 10, 16, 50, 84, 90 and 99% of particles in the sample fall. As such, the smaller the number, the smaller the particle size of the majority of the particles within that percentile. There was no effect of protease or interaction between protease and pH on particle size in each percentile ($P > 0.05$). However there was a significant effect of pH on the particle size at which 10% of particles fell ($P = 0.032$); 16% ($P = 0.035$) and 99% ($P = 0.014$). Generally, as

pH increased particle size within each percentile increased, indicating fewer small particles. This response appeared to be linear with the exception of pH 1.2 suggesting that low pH assists in gross particle size reduction of corn in an *in vitro* gastric simulation.

Comparison of nutrient contents between whole black, red (*Oryza sativa* L.) and wild (*Zizania* spp. L.) rice

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Cereal Foods World 58:A59

This study describes for the first time a comparative approach of nutrient contents and fatty acid composition of 16 black, 9 red and 6 wild rice accessions. The black and red (*Oryza sativa* L.) genotypes were grown at two Agronomic Institutes in Brazil (Epagri and IRGA) from 2009 to 2011, whereas the wild rice (*Zizania spp.* L.) was from Canada. Pigmented rice is receiving increasing attention and economic importance due to their singular functional, nutritional and sensory characteristics. Wild rice, which is two or more times the length of the long grain Oryza rice, presented high and uniform mean protein (12.9±0.4 g/100g) and low lipid (0.9±0.1 g/100g) contents. Its fatty acid composition also showed significant differences from black and red rice by presenting 25% more palmitic and 13% more α-linolenic acid while oleic and linoleic acid were 27% and 33% lower, respectively. Statistical assessment of nutrient data revealed that the 16 black rice lines could be grouped according to their shapes. Among them, 11 were very long and thin-grained with an average length-width ratio (L/W) of 3.65 and had the highest protein and lipid contents (9.8±0.8 and 3.6±0.3 g/100g, respectively). The five medium-sized grains (L/W=2.24) had the lowest amounts of proteins (8.8±0.4 g/100g) and lipids (2.7±0.2 g/100g). Fiber and minerals contents also showed a tendency to be higher in very long grains. Red rice lines showed intermediary average L/W ratio (3.38) and nutrient contents. The superior nutrient contents in long and thin Oryza rice can be explained by their higher surface area and consequently higher amounts of bran. Thus, these genotypes may represent a new subtype of long grains. Besides the genetic background and agronomical traits, the shape of the grain may be important to increase the nutritional value providing new opportunities for breeders of pigmented rice.

Development of novel oligosaccharide substrates for the measurement of polysaccharide degrading enzymes

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Cereal Foods World 58:A59

Starch, cellulose, 1,4-β-D-xylan and 1,4-β-D-mannan are hydrolysed to oligosaccharides and ultimately to monosaccharides by the combined and concerted action of specific *endo*-hydrolases, *exo*-glycanases and glycosidases. Traditionally, *endo*-hydrolase activity has been determined by the hydrolysis of polysaccharides or dyed-, or dyed-cross-linked polysaccharides. Each of these substrates and methods has advantages in specific situations. In terms of comparison of the action patterns of *endo*-hydrolases, the ideal substrates are a set of defined oligosaccharides, and preferably colourimetric and colourimetric and non-reducing end-blocked oligosaccharides. Such substrates are available for the measurement of α-amylase e.g. benzylidene blocked 4-nitrophenyl maltoheptaose (in the presence of excess levels of pure α-glucosidase). In preparing similar substrates for the routine measurement of, for example, limit-dextrinase, *endo*-1,4-β-glucanase (cellulase), *endo*-1,4-β-mannanase, *endo*-1,3-β-glucanase and *endo*-1,4-β-xylanase, the biggest challenge is the preparation of sufficient quantities of the required oligosaccharide. Of course, the subsequent chemical modifications pose additional challenges, particularly in obtaining maximum recovery of the target compound. In this presentation, the preparation of alternative oligosaccharide substrates for measurement of *endo*-1,4-β-glucanase, limit-dextrinase and pullulanase will be reported.

Characterization of a proposed hydrolyzed prolamin digest standard for barley-based and gluten-free beers

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Cereal Foods World 58:A59

For millions of celiac disease sufferers, foods containing wheat gluten must be totally avoided. Intact gluten proteins can be reasonably quantified using commercial ELISA kits, but these assays may provide a less reliable measure of hydrolyzed or fermented gluten. One matrix of interest is barley-based beers. A protocol for digesting gluten to mimic hydrolysis and thereby generate a hydrolyzed gluten reference standard in competitive ELISA kits has been proposed, and characterization of this material is underway. The reference material studied here is composed of hordeins extracted from barley flour with 70% ethanol. After extraction, the protein content of the extract was measured, and 10 mg were quantitatively digested using pepsin and trypsin. The peptide digest (HBP) was analyzed by LC-MS/MS with 1 pmol/uL Angiotensin II as an internal standard and quantitative surrogate. MS/MS results were searched against the Pooideae subfamily protein database from NCBI using MASCOT and evaluated using Scaffold. The MS/MS data matched 34 total proteins with at least two spectral counts each, and four with at least 20 spectral counts. Of the peptides that matched confidently to hordein proteins, five of the most abundant peptides with good MS/MS spectra were identified as potential quantitative targets. A calibration curve was generated by diluting the HBP and injecting 200ng to 2ng on column. Recovery of HBP from a beer matrix was tested by spiking the material at 200ppm, 25ppm, and 5 ppm (w/w) in a sorghum-based beer and a barley-based beer. Hordeins from both beers were extracted using 70% ethanol or by filtering with a combination of C18 and graphite spin columns. Using the C18/graphite spin column protocol, the calibration curve had an LOD of 1ng and an LOQ of 9ng. Improvements to the MS method are currently underway, and should allow the method LOD to be improved.

WITHDRAWN

Quality characteristics of fiber rich pasta

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Cereal Foods World 58:A59

As interest for high fiber food grows, there is a trend towards using fiber rich materials such as wheat bran in traditionally low fiber food products. In this aspect, fiber enriched pasta is also gaining interest. However, there are number of drawbacks associated with fiber enriched pasta with respect to processing, storage, and consumer preference. Despite these difficulties, there is growing interest in improving the fiber content in pasta, owing to their health benefits that outweigh the challenges. The main objective of this research was to produce fiber enriched pasta using two commercial fibers. We aimed to identify the possible percentage of fiber addition with minimal effect on processing and end product quality. Two commercial fibers denoted PB, consisting of wheat middling, oat groats, barley malt and flax and OF, containing oat fiber were incorporated into durum wheat semolina at 3, 5 and 10% level. When evaluated for pasta color, as the fiber content increased, the yellowness of pasta decreased. Adding OF into pasta formulation has minimal affect the yellowness of pasta whereas PB gives darker surface color. The cooked weights of fiber enriched pasta ranged from 28.53-30.33 g while it was 30.37 g for control. Addition of 3-10% of PB and OF was possible without drastically affecting the cooked weight of pasta. However, 10% of OF showed an acceptable firmness in cooked pasta compared to other treatments. Thus, pasta enriched with OF had better cooking quality compared to PB enriched pasta at all levels of fiber enrichment. However, depending on the preference and interest of the customer, all the six

treatments we used can be used to produce pasta with higher nutritional quality compared to traditional pasta. Pasta enriched with PB can be developed to be a good competitor for whole grain pasta in the market.

In vitro fermentation of wholegrain sorghum flours using human fecal microbiota

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Wholegrain sorghum flours differing in condensed tannin content [Macia: 0 mg catechin equivalents (CE)/g, Shanqui red: 27.1±0.8 mg CE/g; Sumac:63.1±1.2 mg CE/g)] were digested using an *in vitro* procedure to remove digestible starch and protein. Digested flours were then fermented over a 96 h period using human fecal inoculum with inulin as a positive control. Condensed tannins, remaining carbohydrates, short chain fatty acids (SCFAs), and pH were quantified at baseline and after each 24 h period. Changes in the microbial community were monitored by denaturing gradient gel electrophoresis. Carbohydrates were extensively metabolized in all sorghums (>90% in each 24 h period). The sorghums induced greater production of acetate (18.5-31.6 µmoles/100 mg sample) and propionate (5.60-10.7 µmoles/100 mg sample) than inulin [acetate (9.8 - 18.0 µmoles/100 mg sample; propionate (1.9 - 5.4 µmoles/100 mg sample)]. Macia produced more butyrate than the tannin sorghums at 96 h [6.5µmoles/100 mg sample versus 3.1µmoles/100 mg sample (Shanqui red; $p<0.0111$) and 4.0µmoles/100 mg sample (Sumac; $p<0.0577$)]. Sorghums showed predominant enrichment of *Bacteroides*, while inulin was associated with growths of *Bifidobacterium*, *Collinsella aerofaciens, Roseburia*, and some *Bacteroides* species. In conclusion, all the sorghums were efficiently degraded by fecal bacteria, enriched for fecal *Bacteroides* species, and led to higher acetate and propionate production than inulin. The non-tannin sorghum led to enhanced butyrate production compared with the tannin sorghums after extensive fermentation (96 h).

Physical, chemical, and sensory evaluation of extruded wholegrain sorghum breakfast cereals

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Two sorghum cultivars, SC1351C (red, tannin) and Macia (white, non-tannin), were evaluated for their potential use in wholegrain, ready to eat (RTE) breakfast cereal. Varying levels of wholegrain sorghum flours (55, 62.5, and 70%) were extruded using a pilot-scale, twin screw extruder. A commercial wholegrain oat-based RTE breakfast cereal was used as a reference sample. White sorghum cereals (WSCs) had significantly higher starch, yellowness (b*), brightness (L*), and water absorption index (WAI) than red sorghum cereals (RSCs; $p<0.0001$). RSCs had higher bulk density, protein and lipid contents than the WSCs ($p<0.0001$). Starch, lipid, color (L*, a*, b*), cereal diameter significantly decreased as % sorghum flour increased ($p<0.05$) in both WSCs and RSCs. Bulk density and a* increased proportionally increased with % sorghum flour added. Extrusion cooking of sorghum cereal increased *in vitro* starch digestibility and decreased *in vitro* protein digestibility (IVPD; $p<0.05$). IVPD of the reference sample was significantly higher than WSCs and RSCs ($p<0.05$). Overall, the sensory attributes of RTE sorghum cereals did not differ significantly from the reference sample ($p<0.05$). Therefore, tannin and non-tannin sorghum cultivars have potential to be used in the breakfast cereal industry.

WITHDRAWN

WITHDRAWN

Whole grain in cereals-based foods: Current use, challenges and the way forward

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Some countries incorporate recommendations for increased consumption of whole grains (WG) into local dietary guidelines. WG cereals and pseudo-cereals are good sources of complex carbohydrates, dietary fibre, proteins, phytochemicals, vitamins and minerals. Intervention studies performed to support the health benefits resulting from diets rich in WG will be addressed. Cereals-based foods can play a key role in helping consumers to include WG in their diets, but there are several challenges in the development of novel products made with WG. Not only the regulatory status of WG, from definition to detection, is still not harmonized, but also their inclusion/transformation into final products presents various technological hurdles. This review addresses the technological processes, hurdles and solutions, which can be implemented for incorporating WG into food products, without compromising on taste and texture of the final product.

Investigation of retrogradation in long grain brown rice using multi cell differential scanning calorimeter (MCDSC)

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Retrogradation (re-association of the amylopectin) of starch is known to impact the textural properties of cooked starch gels, which can lead to an undesirable 'firming' in cooked rice. The firming of cooked rice can impact the finished product characteristics in terms of texture and eating quality. The extent of retrogradation has been tracked traditionally by quantifying the enthalpy of the retrogradation endotherm using a Differential Scanning Calorimeter (DSC). However, the very small sample size of traditional DSC instruments presents a challenge in analyzing the retrogradation behavior of long grain brown rice. This novel study describes the first known use of a Multi Cell DSC instrument (with sample volumes up to 1 mL) to investigate the retrogradation of cooked long grain brown rice. The effect of moisture content, storage time, and temperature were studied on samples of gelatinized long grain brown rice, several samples of cooked rice at a time, at controlled moisture contents. Results indicated that the kinetics of retrogradation varied at different temperatures. Upon storage for 4.7 hours at 4°C, no retrogradation was observed in rice/water systems with excess

moisture (>75% added water), while gels with 55% added water had retrogradation endotherm with an enthalpy of about 1.6 to 1.8 J/g. Further decreasing the moisture led to enthalpy values of the order of 3 J/g with 40% added water and 4 J/g for gels with 35% added water. Lowering added water to 28% or 25% led to retrogradation enthalpies of 3.2 and 2.25 J/g respectively. These results demonstrated that in gelatinized rice/water systems retrogradation of starch was highest at a moisture content range of 30% to 40 % (by weight) of added water.

Comparing the minimum level of transglutaminase on gluten, dough and baking properties

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The ability of transglutaminase (TG) to crosslink glutamine and lysine of protein is dependent on factors such as dose, source of the enzyme, compatibility of substrates and the enzyme, and time reaction. This study was aimed to elucidate the role of reaction time in determining the minimum dose of TG needed to bring effects to the gluten and dough rheological, fermentation and baking characteristics. A set of six commercial wheat flours with protein content 11±0.5% was treated with TG (0, 0.1, 0.2, 0.4, 0.8 and 1.6% w/w) using a Randomized Complete Block Design with 3 replicates. Gluten and dough rheological properties were determined including mixing and fermentation properties followed by baking characteristics. Two preparation methods for gluten were also compared: 1) standard gluten separation using a Glutomatic, and 2) dough mixed at optimum water absorption in a Farinograph, resting period 10 min, and followed by standard Glutomatic procedure. Data were analyzed using ANOVA and protected pair wise t-tests to determine the minimum dose of TG causing effect on gluten and dough characteristics. Average and range of minimum doses of TG to bring effects are 1% (0.8 -1.6%) for rheological properties; 1.3% (0.8 - 1.6%) and 0.5% (0.2-0.8%) for gluten properties measured by standard and modified method, respectively; 0.26% (0.1-0.8 %) for fermentation characteristics; and 0.12% (0.1-0.2%) for baking properties. Reaction time and level of TG shows a negative correlation (r= -0.8). This study suggests that minimum effects of TG are related to preparation and duration time of the test. Care must be taken when comparing data obtained from analysis with different reaction times.

Wheat-soy tempe flour: Preparation and potential as bread ingredient

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Cereal Foods World 58:A61

Indonesian tempe, a fermented food using *Rhizopus* sp inocula and soybean has functional properties attributed to bioactive peptides, isoflavones, vitamins and increased availability of minerals. We explored the potential of tempe flour made from wheat grain and soy bean fermentation. The functional compounds in tempe can broaden utilization of wheat and soy as new food ingredient and increase the consumption of these crops. The aim of this study is to prepare soy-wheat tempe flour and evaluate the effect of tranglutaminase (TG) and tempe flour in wheat dough properties. Tempe was prepared from wheat:soy (4:0, 3:1, 2:2, 1:3 and 0:4, w/w) and inocula, and incubated at 30±2°C for 36 h. Tempe with the best physical characteristics was selected in the flour preparation. Tempe was dried at 60°C for 12 h, milled, sieved, and stored at 4°C until used. Dough rheological and bread baking properties were evaluated with a range of tempe flour and TG treatments (0-40% and 0-0.1%, respectively). Tempe significantly influenced most of the mixing and fermentation properties; however TG only decreased mixing stability of composite flour. Increasing levels of tempe from 0 to 40% significantly increased development time (5.5 times), stability (96%), and time to breakdown (2 times), decreased the maximum (Hm) and final height (h) of fermented dough (95% and 98% respectively), time to reach maximum rise (T1, 65%) and maximum height of release curve (H'm, 32%). Tempe had a negative effect on the total volume of fermented dough (35% decrease), but it positively impacted the fermentation character by reducing CO_2 release during dough fermentation. The interest in its functional properties and potential of tempe flour commands further research of tempe-based ingredients.

A submerged chickpea fermentation extract used as leavening agent for improving quality of gluten-free breads

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The aim of this study was to investigate the incorporation of a fermented chickpea extract (FCE) into gluten-free bread formulations based on rice and corn flours, and milk proteins and to evaluate its influence on the quality parameters of baked products. Further to preparations containing merely yeast as leavening agent (control), breads were made with inclusion of FCE, made by a submerged fermentation (15h) of coarsely ground chickpea, into the gluten-free dough formulation; control and FCE breads were prepared using three different levels of added water into the dough (68, 73 and 80% flour basis). The mean values of specific volume of FCE breads were significantly ($p<0.05$) higher compared to those of control samples (2.60 vs. 2.38 ml/g bread); these values increased with increasing amount of added water, ranging from 2.17 to 2.76 ml/g. Breads with FCE had higher ($p<0.05$) crumb moisture content than controls. Furthermore, crumb moisture content increased with the water level of the dough, while crust moisture content was found to increase with storage time (5 days at 25°C). Compression tests revealed a significant ($p<0.05$) crumb softening with inclusion of FCE into the bread formulation (5.2 vs. 9.0N). Instead, a significant ($p<0.05$) increase of crumb firmness was observed with reduction of added water and upon storage. For the stored FCE breads, DSC thermograms revealed lower mean enthalpy (ΔH) values of the amylopectin retrogradation endotherm compared to control products (1.80 vs. 1.98mJ/mg); ΔH values were significantly ($p<0.05$) affected by storage time and the water content of the dough. Overall, incorporation of FCE into gluten-free baked products seems to be a promising alternative for improving their quality and shelf life; the latter effects might be attributed to enzyme action and gas formation during fermentation by the endogenous microflora.

Effect of the addition of soy products on technological quality of cracker biscuits

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Soy products are considered high added-value ingredients due to their nutritional and functional importance, along with their economical significance, since Brazil is the second largest world producer of soybeans. This study aimed to investigate the impact of replacing wheat flour (WF) by soy protein isolate (SPI) and soy fiber (SF) on the blends pasting properties and on technological properties of cracker biscuits. A 2^2 experimental design with four replications at the center point ($p<0.05$), using as independent variables the SPI (5-15%) and SF (3-9%) were utilized, besides the control with 100% WF. The cracker dough was fermented for 22 h (32°C and 80% RH), and the soy products were added in the second stage of fermentation. Results were analysed by analysis of variance using the software Statistica. SPI, SF, WF, their blends and the biscuits were characterized. Light scattering measurements exhibited a mean diameter (D50) of 55.85 µm, 53.50 µm and 73.97 µm for SPI, SF and WF, respectively. SF was more polydisperse than the other ingredients ($p<0.05$), with a span index of 15.29. The apparent density was 0.433 g/mL (SPI), 0.519 g/mL (SF) and 0.681 g/mL (WF), typical values of these products. The replacement of WF by SPI and SF decreased pasting properties of the blends (peak viscosity, trough, breakdown, final viscosity and setback), which showed a reduction of up to 45% as compared to the control. This result was probably due to the lower starch content available for gelatinization. In the crackers, the SPI and SF affected the specific volume (2.99 to 3.83cm^3/g), fracturability (1.12 to 1.61 mm) and color difference (1.63 to 5.40) but the values were close to the control. The results showed that it is technically feasible to obtain cracker enriched with fiber and soy proteins under the conditions studied. Grateful to FAPESP (2010/19025-5 process).

Effect of hydrothermal treatment (parboiling) on de-hulling and cooking qualities of kodo millet and barnyard millet

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De-hulling of kodo millet (*Paspalum scrobiculatum*) and barnyard millet (*Echinochloa colona*) is a cumbersome process since husk and bran layers are bound tightly on the endosperm and their removal needs a special treatment. To ease the milling process, these millets were subjected to hydrothermal treatment at different levels of soaking temperature (60, 70, 80°C), soaking time (6, 7, 8h), steaming periods (10, 15, 20 min.) shade dried and milled in a centrifugal de-huller. The milled samples were analysed for hulling efficiency, head rice recovery, degree of parboiling, hardness, colour, cooking time, water up take and swelling index using standard procedures. Increase in hulling efficiency (21.8 - 27.5%) was recorded over control in kodo millet and barnyard millet (20.8 – 26.2%) and the head rice recovery enhanced by 27.3% and 25.5% in kodo millet and barnyard millet respectively over the range of experiments conducted. The increase in temperature of soaking, soaking time

and steaming period increased the degree of parboiling, hardness (36.8 - 37.7 N in kodo millet and 44.7 – 47.3 N in barnyard millet) and cooking time (10.2- 10.5 min.) for both millets. Water uptake and swelling index decreased appreciably due to hydrothermal treatment. The treated samples were dark in colour compared to raw grains and the change in L*, a*,b* values were highly significant.

WITHDRAWN

Comparative studies on composition and distribution of phenolic acids in yellow corn and non-corn cereal botanical fractions

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Phenolic compounds like other nutrients are unevenly distributed across the cereal grain kernel. This study aimed to thoroughly investigate the composition and distribution of phenolic compounds in yellow corn and non–corn cereal botanical fractions relative to their whole grains. The fractions were produced by hand dissection. The pericarp (pericarp + testa), aleurone layer, germ, endosperm and whole grains were analysed separately, following microwave-assisted extraction, for phenolic acid composition by using high performance liquid chromatography (HPLC). The phenolic compounds were identified by LC-MS. The composition of phenolic acids in the pericarp and endosperm fractions was similar. However, distinct variations were observed in the aleurone layer and germ fractions of yellow corn and non-corn cereals. The major cinnamic and benzoic acids were ferulic acid (FA), *p*-coumaric, vanillic acid and syringic acid. Isoferulic acid was detected in some cereal fractions. In the pericarp fractions, *p*-coumaric, ferulic acid and syringic acid, respectively were 10 to 15–, 6 to 7- and 6 to 10-fold higher in yellow corn compared to non-corn cereals. On average, FA content in the aleurone layer of yellow corn was higher (4835.5µg/g) than in wheat (3364.5 µg/g) and barley (1329.4 µg/g). In contrast syringic acid content was 35-fold higher in wheat germ than in yellow corn germ. Overall, grain fractions had higher concentration of most of the phenolic compounds detected compared to their whole grains except for the endosperm fraction. Phenolic-rich fractions from yellow corn could be utilised as alternative functional ingredients in cereal food products to improve the intake of health-promoting components from natural sources.

Effects of particle size distribution and substitution ratio of whole-wheat flour on the quality of Chinese raw noodles

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Cereal Foods World 58:A62

The effects of particle size distribution and substitution ratio of whole-wheat flour on the thermodynamic and pasting properties of noodle flour as well as color, cooking quality, textural properties, and structural characteristics of Chinese raw noodles were studied. Four different mean particle sizes (125µm, 96µm, 72µm, 43µm) of whole-wheat flour were obtained by using superfine grinder and blended with straight grade flour with four different ratios (51%, 70%, 85%, 100%). Results of Differential Scanning Calorimetry (DSC) analysis and Rapid Visco Analysis (RVA) showed that decreasing particle size and increasing substitution ratio of whole-wheat flour significantly reduced the enthalpy of melting, Peak viscosity (PV), Trough value (TV), and Final viscosity (FV) of noodle flour. Color and cooking quality of noodles declined as the particle size and substitution ratio increased. Texture profile analysis (TPA) of cooked noodle revealed that smaller particle size and lower substitution level improved the springiness, cohesiveness, and resilience of noodles. However, excessive starch damage caused by the milling process exhibited significantly adverse effect on textural properties. Additionally, introduction of wheat bran interrupted the formation and connectivity of protein network, and decreasing particle size of whole-wheat flour reduced the undesirable effect on microstructure of noodle. The results suggested that it was possible to satisfactorily produce Chinese raw noodle by using whole-wheat flour with mean particle size ranged from around 72µm to 96µm.

Characterization of fermented wheat starch used for the Japanese traditional food "Kuzu-mochi"

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Cereal Foods World 58:A62

Fermented wheat starch is produced from the starch that is a by-product of gluten manufacture, and requires a period of one or more year for fermentation. This starch is utilized as a food material and paste. Kuzu-mochi, which is a traditional Japanese sweet from the Edo period, is made from fermented wheat starch. Kuzu-mochi has a unique texture, which is not found unfermented wheat starch. Therefore, it is assumed that the properties of wheat starch change during the fermentation process. The objectives of this study were to characterize fermented wheat starch and to evaluate the changes in wheat starch during fermentation process. Throughout the fermentation process, the pH remained in the range pH 3 - 4. Microorganisms such as bacteria, yeasts and molds were isolated during each fermentation period. From microscope observations, it was establish that there was no difference in the form of granules between fermented and unfermented starch. However, the granule size of fermented and unfermented starch differed, with that of fermented starch being smaller than that of unfermented starch. Pasting properties were measured using a Rapid Visco Analyzer. The highest peak viscosity and final peak viscosity of fermented starch were lower than unfermented starch. The gel of fermented starch was soft and elastic, and its transparency was high compared with that of with unfermented starch gel. These results indicate that the properties of fermented wheat starch, particularly the pasting properties, change during the fermentation process. Moreover, it is suggested that microbes influence the properties of wheat starch.

Influence of disulfide bond formation via PDI-Ero1 processing of proteins on baking quality

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Various intermolecular associations are involved in bread making. Disulfide bonds are important for protein structures in bread. Protein disulfide isomerase (PDI) and endoplasmic reticulum oxidoreductase 1 (Ero1) are key enzymes in the formation of disulfide bonds. We found that the quality of bread can be improved by addition of both enzymes. Therefore, we examined in detail the effects of both enzymes on improving bread making. The *PDI* and *Ero1* genes were cloned from wheat (*Triticum aestivum* cv. "Haruyutaka") and expressed in *Escherichia coli*. Recombinant PDI (TaPDI) and Ero1 (TaEro1) were expressed and purified using common methods. TaPDI (0.8 U), TaEro1 (1.6 nmol), and FAD (1.0 µmol) were added to the protein solution (0.1 M acetic acid extract from hard wheat flour) and analyzed by two-dimensional electrophoresis. The result of this analysis confirmed that addition of the enzymes to the sample led to the formation of disulfide bonds. In addition, intramolecular disulfide bonds were formed from gliadin. Both enzymes were made to act on commercial acid-soluble proteins (Glia A; Asama Chemical Co., Ltd., Tokyo, Japan) and surface hydrophobicity was measured. Compared with the control, surface hydrophobicity decreased by 33% following enzyme addition. Thereafter, acid-soluble proteins were treated with both enzymes, added to flour, and subjected to a baking test. No changes in the specific volume of bread were observed when acid-soluble proteins that did not undergo enzymatic treatment were used. On the other hand, the specific volume of bread increased by approximately 5% when acid-soluble proteins that underwent enzymatic treatment were used. Therefore, the baking quality improved probably because of the decrease in the protein surface hydrophobicity due to formation of disulfide bonds.

Effect of deep-oil frying on antioxidant properties of whole grain wheat donuts

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Deep-oil frying (DOF) consists of cooking foods by immersing them in edible oil at 160 to 190°C. The high temperature may affect the nutritional

quality of foods, including antioxidant capacity. Whole grain donuts formulation may be one option to improve the nutritional quality of donuts. The total phenolic content (TPC), phenolic acid composition, and *in vitro* antioxidant capacity of whole wheat donuts deep-oil fried (DOFd) for different lengths of time (1, 2, 3, or 4 min), and at different temperatures (120, 140, 160, or 180°C) were studied. Significant differences ($P<0.05$) between donuts fried for different lengths of time, and temperatures were recorded in TPC of donuts. TPC increased by 112.2% for hard red whole grain wheat meal donuts (HWD), 83.5% for soft wheat flour donuts (SFD), and 72.5% for soft whole grain wheat meal donut (SWD); and decreased with further increase in frying time. TPC increased with frying temperature from 120 to 180°C frying, by 73.7% for HWD, 59.4% for SFD, and 36.1% for SWD. The same trend was confirmed by data from HPLC, and ferulic was the predominant phenolic acid, followed by coumaric, vanillic, p-hydroxybenzoic, chlorogenic, catechuic, and caffeic acids. DPPH radical and iron chelating capacity of DOFd donuts increased with frying time of 1 to 3 min at 190°C, and frying temperature of 120 to 180°C. Lipid peroxidation inhibition capacity of donuts increased with up to 3 min frying at 190°C, and decreased with extended frying time in all donuts. Conversely, DOF at 120°C initially lowered lipid peroxidation inhibition capacity of all three types of donuts, and increased consistently from 120 to 180°C. In conclusion, moderate DOF time and temperature may increase the level and activity of antioxidants of foods. Hard wheat donuts showed lower volume and fat uptake, and future study may be needed to produce acceptable low fat donuts.

Maize processing to impart convenience to maize-based staples for the African market

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Maize is the basis for staple foods such as gruels and food ingredients such as thickeners, where starch acts as a macronutrient and a texture agent. Traditional maize processing requires long cooking times at excess water conditions to achieve tissue softening and starch gelatinization. There is a demand for processing maize in an efficient way into dry intermediate products with tailored functionality in terms of cooking behavior and texture. At the same time sustainable processing calls for minimal water usage, moderate temperatures and utilization of maize endosperm tissue rather than starch only. A process for maize processing based on steam cooking and flaking at limited moisture (20-25 %wb) followed by drying has been investigated at pilot scale. Maize was processed into flakes, and intensities of steam treatment, flaking and drying were varied. Milled flakes were characterized at different structural levels with such methods as RVA (Rapid Viscoanalyzer), gel compression testing and light microscopy. Melting of starch crystals was measured by DSC (Differential Scanning Calorimetry). We were able to generate different degrees of tissue disintegration and starch gelatinization (50 to 100 %) by adjusting the intensity of hydrothermal and mechanical processing, which translated into a broad range of paste viscosities and gel strengths. Drying was found to be crucial for adjusting the cooking behavior and texture. Rapid rehydration, short cooking times and good gel development were favored by drying maize flakes in the glassy state where the flakes are first cooled followed by temperature increase upon further drying. The knowledge on processing – structure – property relationships is valuable to design food processes for imparting convenience to maize products such as precooked maize flours for pap types with a short cooking time for the African market.

WITHDRAWN

Determination of the ratio of two wheat flours in noodle flour by analyzing protein composition with high performance liquid chromatography (HPLC)

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Cereal Foods World 58:A63

In our facilities in Japan, Australia Standard White (ASW) wheat is milled to produce salt-noodle flour and American Western White (WW) soft wheat to produce cake flour. The mill is run continuously. During changeover from milling WW to ASW wheat, off-grade noodle flour is produced for some time, because the eating texture of the salt noodle is very sensitive to contamination of ASW wheat flour. The stream of off-grade noodle flour is diverted into a set-off bin, but how long should that stream be diverted? We have found that the ratio of WW/ASW wheat flour in the off-grade stream can be determined by its composition of gliadin proteins. Testing for WW contamination in the flour stream by determining gliadin proteins was more sensitive than using the color of flour. Blends of WW and ASW flours were prepared with 0%, 5%, 10%, 20% and 40% of WW flour. Those mixtures were analyzed for gliadin composition by reverse-phase HPLC (C18 column, 4.6mm i.d. × 250 mm), and a calibration curve was derived. A noodle flour containing less than 5% WW flour could not be detected by its gliadin protein composition, but those with 10% WW flour or higher were detected (R^2=0.95). This study showed that analysis of gliadin protein composition in flour by HPLC is a useful tool to determine the presence of contaminating flour in noodle flour from ASW wheat. We can conclude that when flour from wheat is the standard for a given product, such as flour from ASW wheat is for the salt-noodle, then HPLC of gliadin proteins in flour provides a simple and easy method to detect the presence of contaminating soft or hard wheat at diverse stages of milling.

Functional properties of corn tortillas made from *Lupinus albus*

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Maize is the main food of Mexican population for tortilla consumption. Unfortunately tortilla has deficiencies about essential amino acids (lysine and tryptophan). An alternative to compensate these deficiencies is by using fortification strategies employing legumes such as sweet *Lupinus* species. The aim of this work was to study the physicochemical and rheological properties of corn tortillas elaborated with *Lupinus albus*. The alkaloids content in *Lupinus* flour without detoxification was 0.26 mg^{-1}, after detoxification low concentration to 0.11 mg^{-1}, which means the presence of a sweet specie. After that, maize doughs were elaborated with 2.5 to 20% of *Lupinus*, these were analyzed by adhesiveness and texture profile analysis. From, best formulations were founded, those between 2.5 to 7.5%. Tortillas made with 2.5 and 7.5 resulted in better texture properties and color, as well as protein content and lysine increment.

Effect of the addition of resistant starch on the physical properties of breakfast cereals processed using a twin-screw extruder

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Ready-to-eat (RTE) breakfast cereals are extruded products made primarily from corn, wheat, oats, or rice. Starch is the dominant polymer present in this food system and plays a major role in the expansion and technological features of the final product. Resistant starch (RS) can be used in formulations as a functional ingredient, besides contributing with improved expansion and texture. The objective of this study was to evaluate the effect of the substitution of corn flour by type II RS on the physical properties, bowl-life and RS content of a sphere-shaped breakfast cereal. Corn flour based RTE breakfast cereals containing 5, 10, 15, 20 and 30% RS were produced using a ZSK 30 twin-screw extruder (Werner Pfleiderer Corp.) and the samples were evaluated for density, expansion, texture, bowl-life and RS content. Compression force (N) and bowl-life texture measurements (N) were conducted using a TA-XT2 texture analyzer, with a p/100 probe. The content of RS in the extrudates increased by increasing the proportion in the formulation, with a significantly higher ($p<0.05$) value (15.7%) when 30% was used. The density of the extruded cereals was not affected by RS. Although density and expansion, in general, present a direct relationship, with

5% and 10% RS, the expansion ratio was significantly higher (3.87 and 3.43, respectively). Lower compression force was observed for the formulation with 5% RS (67.03 N), while no significant difference ($p>0.05$) was registered for the others levels. A significantly higher potential bowl-life was observed for the sample containing 15% RS. But, in general, the physical characteristics of breakfast cereals were not greatly affected by increasing the proportion of RS in the formulation, different to their functional quality.

Effect of the addition of resistant starch on the physical properties of breakfast cereals processed using a single-screw extruder

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Extrusion cooking is an important processing technique and has been used for processing breakfast cereals. This process causes gelatinization of starch among other physicochemical and functional changes of the grain components depending on extruder type (single or twin-screw) and operation conditions. The objective of this study was to evaluate the effect of the substitution of corn flour by type II resistant starch on the physical characteristics and bowl-life of breakfast cereals processed using a single-screw extruder. Ready-to-eat (RTE) corn flour based breakfast cereals with 5, 10, 15, 20 and 30% RS were produced using a Brabender single-screw laboratory extruder and the samples were evaluated for density (g/L), expansion index, texture (N) and bowl-life (N). Rupture force (N) and bowl-life texture measurements (N) were conducted using a TA-XT2 texture analyzer. No significant difference ($p>0.05$) was observed between 5, 15, 20 and 30% RS for the density (g/L), that presented values between 100 and 114 g/L. These results were lower than when 10% RS was used (128.4 g/L). The expansion index values observed ranged from 6.5 to 7.8, with no significant difference ($p>0.05$) between 5, 10, 15 and 20% RS and a lower value for 30% RS. The increase in RS incorporation up to 20% did not result in higher expansion of the breakfast cereals. The inclusion of 20 and 30% RS reduced the rupture force of the extrudates (955.5 and 1013.2N, respectively), with no significant difference between 5, 10 and 15% (1199.3, 1211.3 and 1245.9N). The bowl-life analysis, or texture after immersion of the cereals in milk, ranged from 996.7 to 1318.5N. However, the average values did not present a significant difference. Breakfast cereals with good physical characteristics can be produced with 10% substitution of corn flour by RS.

WITHDRAWN

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Parboiling properties of pureline and hybrid rice cultivars

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The acreage share of hybrid rice in the U.S. Mid-South rice region is rapidly increasing due in large of superior disease resistance and yield potential; however it is not clear whether hybrid and pureline cultivars perform similarly in parboiling applications. The parboiling performance of pureline (CL151 and Wells) and hybrid (CLXL745 and XP753) rice cultivars were evaluated using a pilot-scale parboiling unit. All rough rice samples were soaked under the same conditions, and then steamed under the same temperature and pressure, but for different steaming durations of 5, 10, or 20 min. After each treatment, the parboiled sample was divided into two lots: one for drying at ambient temperature (gentle drying) and one for drying at 60 °C (rapid drying). Bursting, which was characterized by splitting of hulls due to extensive kernel expansion and leaching of endosperm components, became prevalent as steaming duration increased. The duration required to attain a given degree of milling, as indicated by surface lipid content, was lengthened with increasing steaming duration and rapid drying. Head rice yield increased with steaming duration and was noticeably less for the rapidly-dried lots (5.9-50.7%) than the gently-dried lots (54.2-66.1%). The percentage of deformed kernels in head rice also increased with steaming duration and rapid drying. Wells was most susceptible to bursting/kernel deformation, and CLXL745 was least. Head rice yellowness (b*) increased with steaming duration. Yellowness was also greater for the gently-dried (24.1-28.3) than the rapidly-dried (23.8-27.8) lots. Cultivar-specific variations in parboiled rice properties

were observed, and the hybrid cultivar CLXL745 appeared to have the best parboiling characteristics out of the four cultivars tested.

The beta-glucan content, viscosity and solubility of Canadian grown oats as influenced by oat variety and growing location

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With the approval of heart health claims by Food and Drug Administration (FDA) of USA, Health Canada and European Food Safety Authority (EFSA) for oat beta-glucan (BG), the demand for this grain in food processing is fast growing. The BG content and physicochemical properties such as solubility and viscosity are important for its human health benefits, and the processing and sensory properties of foods. This study investigated the BG content, viscosity and solubility of different oat grain varieties grown in different Prairie locations for three consecutive years and evaluated how variety and growing location influence the abovementioned attributes. Significant variations were observed in oat grain properties and physiochemical properties based on growing locations and oat variety. It was found that BG content was primarily influenced by oat variety. On average, Hifi had the highest BG content (5.8%) followed by SW Betania (5.4%), Legget (5.3%), while Derby had the lowest BG content (4.4%). Growing location, oat variety and location by variety interaction had a significant effect on BG properties, solubility and viscosity. The highest BG solubility (36.5%) was in oats grown in Donnelly, while oats grown in Watrous had the lowest BG solubility (26.5%). On average, the highest BG solubility by variety was for Hifi (34.3%) and the lowest for Furlong (28.4%). BG viscosity was evaluated at shear rates $1.29s^{-1}$, $12.9s^{-1}$, $129s^{-1}$ and results show that both growing location and shear rates influenced the average viscosities. The influence of oat variety on viscosity showed similar results to BG solubility, on average, Hifi had the highest viscosities, while Furlong had the lowest viscosities for all shear rates. The results of this study would be useful to the oat food processing industry to select suitable oat flours in order to optimize the nutritional and sensory quality.

A dietary fiber assay modification which improves fiber yield while reducing the cost and complexity of the analytical method

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Dietary Fiber is an important nutrient which has positive physiological benefits of blood lipid/glucose lowering, laxation and probiotic balance. Many food products are supplemented with dietary fibers in order to deliver these health benefits and improve the marketability of the product. Since meeting nutrition labeling requirements and controlling ingredient costs are critical for the viability of these fiber-containing food products, accurate quantification of the dietary fiber becomes a priority. There are a number of different official methods for the determination of dietary fiber. The most widely accepted of these methods (e.g. AACC 32-05.01, 32-07.01, 32-45.01, and 32-50.01) isolates dietary fiber components by filtration. Unfortunately, the filtering method employed is not complete or consistent resulting in loss of dietary fiber. Further, because the filtering aid, celite is used in the process, duplicate samples must always be run for the purposes of measuring protein and ash. This is because the celite and fiber residue filter cake does not allow homogenous splitting of a single sample. We have developed a modification to the current fiber methods where high-speed centrifugation (>15,000xg) is used in place of celite filtration. Under the conditions and protocols which have been determined by this research, centrifugation more completely recovers dietary fiber from a food sample with average increases of 5 to 20% being observed depending on the matrix. Additionally, the centrifugation methodology allows for the direct isolation of dietary fiber in the absence of celite. This eliminates the need for duplicate samples and allows direct measurement of protein and ash from the isolated fiber residue. Additional structural and compositional analysis is now possible on the direct isolate from this modification to the dietary fiber determination.

The comparison of leaf and grain phytoglycogen structure and liver glycogen structure by SEC and TEM

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Phytoglycogen is a highly branched soluble glucan found predominantly in plants with an isoamylase debranching enzyme mutation. Phytoglycogen has been reported to have a structure similar to that of animal glycogen. Animal glycogen consists of a continuous size distribution of particles ranging from small β particles (20 nm) which are joined by an unknown mechanism to form larger α particles (50 – 200 nm). In a past study, type II diabetic animal models demonstrated impaired formation of glycogen α particles, therefore the size of glycogen may impact upon animal physiology. Neither the presence of these particles nor their importance in plant physiology has been reported for phytoglycogen; however, the particles can be observed through transmission electron microscopy (TEM) images. Limitations in previous techniques to extract phytoglycogen, such as incomplete extraction and degradation of molecular structure may have impaired the characterisation of these particles in phytoglycogen. The objective of this study was to develop an improved technique to extract and isolate phytoglycogen from grain and leaves of *su-1* maize with minimal degradation for characterisation. The optimal extraction condition for phytoglycogen from *su-1* leaves was found to be ice-cold buffer, whereas protease at 37 ºC was optimal for *su-1* grain. The extract from leaves needed additional purification to remove small molecular-sized contaminants from phytoglycogen, where the use of a sucrose gradient removed most (if not all) small molecular-sized contaminants. The structure of the phytoglycogen extracted from *su-1* maize leaves and grains were then analysed using size-exclusion chromatography (SEC or GPC) and TEM, then compared with the structure of glycogen extracted from pig livers. Phytoglycogen consists of a continuous size distribution of both α and β particles, with a majority of α particles.

A novel cleanup method and stable ^{13}C-labeled internal standards to improve accuracy and sensitivity of mycotoxin LC-MS/MS methods

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The need for multi-mycotoxin analyses is increasing, and laboratories are increasingly using LC-MS/MS methods in their routine testing operations. A concern with LC-MS/MS can be interferences from matrix components leading to differences in analyte ionization. To overcome this ionization effect, fully ^{13}C-labelled internal standards may be used to correct such mass signal intensities and ensure qualified analysis results. Stable ^{13}C-labeled mycotoxins have advantages over another alternative, deuterated (^{2}H) internal standards. Using ^{13}C changes the total mass of the atom only slightly, while using deuterium, the mass doubles, thus, ^{2}H labeled mycotoxins may show retention time shifts. Nowadays, highly sensitive mycotoxin detection methods are demanded by the food and feed safety market. To achieve low detection limits for multiple toxins, a novel rapid multi-mycotoxin sample cleanup method is being developed for LC-MS/MS. This poster presentation will demonstrate the initial results of this method. Furthermore, it will illustrate the importance of applying internal standards when performing quantitative mycotoxin analyses on an LC-MS/MS system. In this method, average recoveries determined from a spiked maize sample were >80% for total aflatoxins, >70% for ochratoxin A, and >90% for zearaleneone, deoxynivalenol, T-2 and HT-2 toxin. LODs of the in-house LC-MS/MS method applying a novel cleanup column purification together with ^{13}C labeled internal standards were well in range with European requirements for infant food mycotoxin analysis.

Characterization of starches with various levels of amylose by Mixolab

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Empirical rheological tools have been used in cereal science in order to obtain more comprehensive insight into changes in the properties of ingredients during processing—information that has relevance for predicting end-product quality. Mixolab profiles provide information about the protein and starch characteristics of a dough/flour, in terms of dough mixing properties, protein weakening, starch gelatinization, enzyme activity, and gel strength. All of these properties are associated with end-product quality. The main objective of this study was to use the Mixolab to characterize starch samples varying in their amylose-amylopectin ratios. The Mixolab testing protocol was modified with a constant dough weight (100 g) and a constant water addition level (125 ml). Mixolab profiles were generated using starches rich in amylose content: corn starch (Amylose 28%), Hylon V (Amylose 55%) and Hylon VII (Amylose 70%), and their blends. The blend samples were prepared such that the amylose content varied from 28 to 70%. Results indicated that the “first major pasting peak” decreased with increasing amylose content in the tested samples. A high

inverse correlation (-0.97) between the first major pasting peak and amylose content was obtained.

Ethanol production using varying enzyme combinations to mitigate effects of corn quality during dry grind ethanol processing

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Incoming grain quality impacts ethanol yields and quality of distillers dried grains with solubles (DDGS) in the dry grind industry. There are parameters that affect the grain quality such as test weight, percent stress cracks, unit density, moisture content, kernel weight as well as starch, protein and oil contents. Industry wide losses in ethanol yield due to grain quality are estimated to be 0.5 billion gal/yr where freshly harvested corn and year end corn results in a lower ethanol yield compared to corn processed 2 to 3 mo after harvest. The objective of this study was to understand grain quality effects on ethanol yields and DDGS quality. Ethanol yields and residual starch contents in DDGS were studied by tracking corn quality obtained from a Midwestern dry grind ethanol plant biweekly for one yr. Laboratory based conventional dry grind procedures were followed and different liquefaction and saccharification enzyme combinations were used. Two liquefaction enzymes (optimum pH – 5.8 and 5.1, respectively), a saccharification enzyme (optimum pH – 5.0) and a protease enzyme resulted in four enzyme combinations (I, II, III and IV). Liquefaction was conducted at 85°C for 2 h for all four enzyme combinations. Ethanol yields during the first month of the study were lowest ranging from 16.6% v/v (I) to 17.1% v/v (IV) compared to the yields from the following 3 mo. Residual starch contents were highest during week 1 ranging from 14.9% v/v (II) to 9.9% v/v (IV). The highest ethanol yields were observed during week 13 (fourth month) and the corresponding residual starch contents were lowest. Overall, enzyme combinations III and IV gave increased ethanol yields with lower residual starch contents in DDGS. These results are indicative that use of proper enzyme combinations can help mitigate corn quality effects on ethanol yields and residual starch contents in DDGS.

Antioxidant induction in wheat grain through insect feeding stress on the plants

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Producers of whole wheat products are interested in marketing the nutritional benefits of whole grains but before they can include them in their formulations, they need a secured wheat supply with consistent, high antioxidant levels. The levels of antioxidants in wheat are variable. In order to produce wheat with consistent, high antioxidants levels, the factors and mechanisms involved in their *in-planta* expression must be understood. Research at KSU showed that grains from wheat plants stressed by insect feeding damage (IFD) had 24% higher total phenolic content (TPC) than grains from non-stressed plants. Therefore, the plant-insect feeding system became a practical biological model to study the natural causes of antioxidant induction in wheat plants and its accumulation in the grains. Subsequent research focused in optimizing the total TPC yield of grains from stressed plants, while maintaining seed yield similar to that of non-stressed plants. Greenhouse experiments were designed and conducted to find a physiological stage at which the plant produces more antioxidants as a response to IFD. Three discrete physiological stages were studied: 5 Tiller stage (5T), early Grain-filling (EGF), and late Grain-filling (LGF). The length of IFD on plants was limited to two weeks. Additionally, some plants were stressed starting at 5T through LGF (5T-LGF), and some were not stressed at all and used as control. Results from two replicates of this experiment showed that TPC of grains from 5T-GF plants had consistently the highest antioxidants levels compared to control. Current work consists of replicating this experiment on two different wheat varieties. Findings will be presented and discussed.

Standardization and evaluation of physico-chemical characteristics of small millets incorporated breads

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Cereal Foods World 58:A66

Millets are recognized as an important substitutes for major cereal crops to cope with food shortage and to meet the demands of increasing population of developing countries. Development of low cost nutritious foods using millet will go a long way in combating the malnutrition. Millet incorporated breads were developed and standardized using millet flour *viz.*, kodo millet, little millet and foxtail millet at 10, 20, 30, 40, 50, 60 and 70% levels. The developed breads were evaluated for their sensory attributes by a panel of members using the hundred point scale. The breads were analyzed for their physico-chemical properties using standard procedures. Increase in incorporation level of millet flour increased the bread characteristics such as height, weight, specific volume, bulk density, water absorption whereas dough gassing power and extensibility decreased. The substitution of millet flour increased the whiteness index and decreased the yellowness index irrespective of the millets. The staleness of bread crumb increased on storage however the texture profiles like springiness, cohesiveness and resilience decreased. The shelf life of the bread was 7 days under ambient condition in different packaging materials. The microbial population was well within the safer limit during the storage period. The study revealed that the breads prepared with incorporation of 20% of kodo, little and foxtail millet flour were highly acceptable. Highly significant difference was noted for fibre, fat, calcium, iron and tannin content in all the treatments during storage but no significant difference between packaging materials used.

Standardization and evaluation of instant food mixes from small millets

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Small millet grains are excellent source of nutrients to the millions belonging to the economically challenged society in India. This study was aimed in eliminating the inconvenience in the preparation of millet foods and increasing its consumption through development of ready-to-cook foods. Kodo and Barnyard millets were used for preparing instant food mixes like Idli mix, Dosa mix, Paniyaram mix, Halwa mix and Appam mix. The recipes were standardized and evaluated for their sensory and nutritional properties packed in polypropylene (400 gauge-P_1), Metalized polypropylene (MPP-P_2) and aluminium foil (P_3) packaging materials during the storage period. The Organoleptic evaluation of the instant mixes was done by panel members using a nine point hedonic scale. The data revealed that the overall acceptability values of kodo millet mixes ranged between 8.2 to 9.1 in idli mix, 8.0 to 8.8 in dosai mix, 8.3 to 8.7 in paniyaram mix, 8.2 to 8.6 in appam mix and 8.6 to 9.1 in halwa mix. The barnyard millet mixes scored between 8.1 to 8.4 for idli and dosa mix, 8.0 to 8.5 for paniyaram mix, 7.9 to 8.4 for appam mix and 8.00 to 8.5 for halwa mix. The protein content of the kodo millet instant mixes ranged between 9.5 to 11.37g per 100g of the product. The fat content was found to be high in halwa mix and calcium content of appam mix was high 59.10g per 100g at the end of the storage period. The phosphorus and iron content of the barnyard instant mixes ranged from 124.00 to 277.60 and 1.83 to 2.34 respectively. The study revealed that the kodo and barnyard millet based instant mixes were highly acceptable for six months in MPP packaging materials. Highly significant difference was noted for starch, FFA, crude fibre and phosphorus content in all the treatments during storage.

Effect of packaging and storage on quality attributes of quick-frozen dumpling skin

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Cereal Foods World 58:A66

The quick-frozen dumpling is one of the most common frozen convenience foods in China. Extensive attention has been paid to investigate the variation in quality attributes of dumpling after frozen storage, but to date it is still not fully established. The objective of this research was to study the effect of different packaging materials (PVDC, PE), storage time (0-180 days), and thaw-freeze cycles (0-3 cycles) on the quality attributes of quick-frozen dumpling skin. Physicochemical properties determination, texture profile analysis (TPA), sensory evaluation, and scanning electron microscope (SEM) analysis were performed in this study. The results showed that after three thaw-freeze cycles, packaging in PVDC-plastic film significantly improved the storage stability of quick-frozen dumpling skin compared to that packaged in PE-plastic film. In addition, after storage at -18 °C for 0, 30, 60, 90, 120, 150 and 180 days, quality attributes of PVDC-packaged samples were tested. Data showed that with the increase of storage time, the quick-frozen dumpling skin displayed low gelatinization degree compared to that of fresh made samples, with declining in contents of water, amylose, glutenin, and gliadin. However, freeze-cracking rate, degree of crystallinity, and SEM scanning images of quick-frozen dumpling skin were found similar to those of fresh made samples. Also no significant changes in hardness, springiness, gumminess, chewiness, and sensory attributes were observed during the study period of 180 days. Therefore, our findings suggested that PVDC-packaging could protect the quality of quick-frozen dumpling skin and can be used instead of PE-plastic film packaging for extending the shelf-life of dumpling food.

Pasting properties and total sugars of germinated quinoa

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Germination of gluten-free cereals and pseudocereals has shown promise as a natural fortification method to increase vitamin and mineral content, and reduce anti-nutrients in food products. There is limited functional and chemical data on germinated quinoa seeds (*Chenopodium quinoa*). The effects of germination time on pasting, total sugars and moisture content were investigated. Quinoa seeds (QS) were purchased from a local supermarket, germinated for 7 days in an automatic sprouter and maintained at 10°C under fluorescent light. Prior to germination, QS were soaked for 7 h with distilled water at 9.3°C (S0). Composite samples were randomly collected on days 1, 2, 3, and 7 (S1, S2, S3, S7, respectively), rinsed at 60°C, frozen at -40°C and freeze-dried. Pasting properties, total sugars and moisture content were analyzed in triplicate. Pasting was determined using the RVA std1 pasting profile, total sugars were analyzed using the phenol-sulfuric acid colorimetric assay and moisture content using AACC method 44-15.02. Peak viscosity, an indicator of water binding capacity, trough viscosity, which represents resistance to breakdown during cooking and final viscosity, a measurement of the stability of the cooked paste decreased with germination time (S1 to S7) from 2767 cP to 1758 cP, 2753 cP to 2036 cP and 3466 cP to 2521 cP, respectively ($p<0.05$). As expected, total sugars increased with germination time from 75.6% (S1) to 87% (S5). Moisture content was highest in QS (11.4%) and decreased with germination time to 4.4% (S7). Peak and final viscosity values for quinoa samples germinated for 2 days showed the most potential for use in gluten-free food product development. Considering quinoa's growing popularity and the renewed interest in germinated seeds, understanding the effect of germination on the functional and chemical properties of quinoa is relevant.

Effect of water management treatments on rice characteristics and cooking behaviour

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Cereal Foods World 58:A67

Rice (*Oryza sativa L.*) is adapted to grow both in submerged and aerobic soils. Changes in the agro-environmental conditions and socio-cultural needs of rice farmers, as well as the reduction in the availability of irrigation water in some rice-growing areas, have led to the introduction of new cultivation practices. The different irrigation conditions, however, may influence rice composition and its cooking quality. The work aims at investigating the effect of different water management on rice milling yield, grains biometric characteristics, nitrogen and amylose content, pasting properties and cooking behaviour. Baldo, Gladio, Loto and Selenio varieties were grown in 3 different agricultural systems, characterised by a progressively more intense use of water: dry seeding and delayed flooding (A); dry seeding and rotational irrigation (B); water seeded and continuous flooding (C). The various agricultural systems did not affect the milling yield of Baldo, Gladio, and Selenio, while a significant ($P<0.05$) decrease was observed only for Loto when cultivated in system A. A significant ($P<0.05$) increase of the nitrogen content for Gladio, and a decrease for Selenio, were observed when conditions A and B were used in comparison with the conventional irrigation. As regards the amylose, practice A determined a significant ($P<0.05$) reduction for Gladio and Baldo. The three irrigation practices also slightly affected the pasting properties of the samples, but with different trends depending on the variety. Loto cultivated in condition B showed a greater resistance to gelatinization and a higher consistency than the corresponding sample cultivated in water. Considering the overall dataset, it is not possible up to now to highlight an univocal influence of the water-soil regime on rice quality, since the investigated characteristics seem to be mainly influenced by the variety.

It's a soft wheat problem: Low Falling number results in the absence of elevated alpha-amylase

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The Falling Number (FN) test was designed to indicate the presence of elevated alpha-amylase (AA) in samples of wheat. Low FNs have been periodically observed in the US Pacific Northwest (PNW) in the apparent absence of elevated AA from either pre-harvest sprouting (PHS) or late-maturity AA (LMAA). Recent observations of low FN in the apparent absence of elevated AA occurred in the 2011 PNW harvest, which had unusually low grain protein concentration (GPC). From this observation we generated a hypothesis that the baseline FN in the absence of elevated AA was affected by GPC. This does not preclude the possibilities of either PHS or LMAA. Soft white winter wheat (SWW) samples were collected from multiple sites in Oregon in 2011 and 2012. FN, GPC and, AA determinations were made. Positive correlations between FN and GPC were observed in both years: 2011 $r > 0.65$, $p \leq 0.001$: 2012 $r > 0.60$, $p \leq 0.001$). AA determinations showed in both years, but particularly the low GPC year 2011, that some samples with FN < 300 s did not have elevated AA levels. ANOVA indicated that locations with low site-average GPC had significantly ($p < 0.01$) lower mean FNs than sites with higher average GPC. This strongly suggests that low GPC increases the probability that samples will test < 300 s in the absence of elevated AA in SWW wheat grown in the PNW. Overall there appeared to be a 10 to 20 sec decline in FN for every 1% decline in GPC. Preliminary analyses suggest that there are also cultivar dependent variations in the relationship between the baseline FN and GPC.

Size reduction of starch granules for use in Pickering emulsions

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Cereal Foods World 58:A67

Using particles to stabilize two immiscible phases known as Pickering emulsions is used for its superior stability. Modified starch as particles has been successfully used to stabilize Pickering emulsions. The size of particles used is one crucial factor behind the success. A decreased particle size contributes to a decreasing emulsion droplet size. The aim of this study was to reduce the size of starch granules for use in stabilizing Pickering emulsion. Methods of size reduction were acid hydrolysis, chemical surface gelatinization and size fractionation. Starch granules were selected from quinoa, oat, waxy maize, waxy barley and potato based on size and shape differences. The starch obtained was then modified with octenyl succinic anhydride (OSA) to a degree of 1.8-3.1% to increase its hydrophobicity. Starch particles were expected to be smaller after the reaction although in some cases un-complete destruction of swollen particles and aggregation caused larger clusters. However, during emulsification with a high shear homogenizer, these clusters were broken into smaller particles which resulted in stable emulsions. The droplet sizes varied in the range of 10 to 100 µm. The size distribution and microscopy images confirmed that the droplet size decreased with the increase of starch concentration from 200 to 1000mg per ml oil. The emulsion index (EI) and relative occluded volume (ROV) increased as expected with the size reduction. The size of starch particles seemed to largely influence the droplet size. The generated shape influenced the attachment of starch to the interface and thus the stability. Reaction conditions, solvents used, botanic origin and initial morphology influenced the particle size. This study has shown high potential of using starch as stabilizing agent and that the particle size has a significant impact on the emulsifying capacity.

Investigation of the effect of barley β-glucan on the mechanical properties of Asian noodles using an ultrasonic technique

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Enrichment of food staples, such as bread and noodles, with dietary fiber is viewed as a relatively easy means of increasing consumer fiber intake. This research investigated how such a process affected the textural properties of Asian noodles. A high frequency (1.6 MHz) longitudinal ultrasonic technique was employed to investigate the capability of ultrasound to evaluate the effect of barley β-glucan (BBG) on the mechanical properties of Asian noodles. Raw noodle dough samples with three different BBG levels (0, 2.5 and 5%) were prepared. Noodle dough sheets were subject to a 20% strain using a TA.XT Plus Texture Analyser fitted with custom transducer fittings. Ultrasonic and stress relaxation measurements were carried out simultaneously over an initial 300 seconds of relaxation. Results showed that the ultrasonic velocity and attenuation increased and decreased, respectively, with an increase in noodle BBG content. Mechanical moduli including M' (longitudinal storage modulus) and M" (longitudinal loss modulus) were calculated from ultrasonic parameters and noodle dough density (measured using a water displacement method). M' and M" increased with an increase in BBG content. Loss tangent ($\tan\delta = M''/M'$), an indicator of elasticity/viscosity of the samples, decreased

significantly (P<0.05) with increasing BBG content, indicating that the greater the noodle's BBG content, the more the solid-like its behavior. With the exception SR20 which decreased significantly (P<0.05) with increasing BBG content, stress relaxation parameters increased and all samples displayed increasing solid-like behavior with an increase of BBG content. Therefore, this ultrasonic technique was confirmed to be capable of evaluating and quantifying changes in the mechanical behavior of BBG fortified Asian noodles to produce functional food products.

Ozone gas affects the physical and chemical properties of wheat (*Triticum aestivum* L.) starch

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Cereal Foods World 58:A68

Ozone can oxidize hydroxyl groups present at C2, C3, and C6 positions on the starch molecule and affect its physicochemical properties. In this experiment, bread wheat flour and isolated wheat starch were treated with ozone gas (1,500 ppm, gas flow rate 2.5 L/minutes) for 45 minutes and 30 minutes, respectively. Starch was isolated from treated flour. Ozone treated starch and starch isolated from ozone treated flour had similar chemical and physical properties. Chemical analysis of starch isolates indicated depolymerization of high molecular weight amylopectins, with a subsequent increase in low molecular weight starch polymers as a result of starch hydrolysis. Ozone oxidized starch isolates resulting in elevated levels of carboxylic groups and a decrease in total carbohydrate content in amylopectin fractions. ^{1}H NMR results indicated formation of a keto group [(1→4)-3 keto] at the H-2 terminal (proton at C-2 position) and beta-glucuronic acid at the H-1 terminal (proton at C-1 position). DSC transition temperatures and change in enthalpy were not affected by ozone treatment. Increased swelling power and RVA breakdown (peak viscosity – hot paste viscosity) were observed in starch from ozone treated samples.

Novel metabolites of alkylresorcinols as the exposure markers to reflect whole wheat consumption in human

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Cereal Foods World 58:A68

Studies have shown that increasing consumption of whole grains is associated with lower risk of chronic diseases. Many epidemiological studies, however, have failed to generate consistent results on this topic due to a lack of accurate tools to assess dietary intake and internal dosage. In order to better understand the beneficial health effects of whole grains, biomarkers for their exposure and effects are needed. The bran fraction of the whole grains contains important bioactive phytochemicals and is the major source of cereal fiber. The metabolism of these phytochemicals may reflect inter-individual differences. Alkylresorcinols (ARs) are phenolic lipids found in high concentrations exclusively in the outer parts of wheat and rye grains among commonly consumed foods. ARs and their metabolites, 3.5-dihydroxybenzoic acid (DHBA) and 3,5-dihydroxylphenylpropionoic acid (DHPPA), have been used as the exposure markers to reflect whole wheat/rye consumption. However, the metabolic profile of ARs is still unknown. In addition, DHBA and DHPPA are not unique AR metabolites and have been found as the metabolites of other type of dietary polyphenols. We recently studied the metabolic profile of ARs in mice and in humans. The beta-oxidation products, DHBA, DHPPA, and 3,5-dihydroxylphenylpentanoic acid (DHPPTA), and their glucuronidated metabolites were identified as the major metabolites of ARs in mice treated with purified ARs using LC/MS/MS. These compounds were also identified as the major metabolites of ARs in human after taking whole-wheat bread as the breakfast. Among them, DHPPTA was identified as a unique AR metabolite. In the kinetic study, we found that DHPPTA has a similar kinetic curve to those of DHBA and DHPPA indicating that DHPPTA can serve as a more accurate exposure marker than DHBA and DHPPA to reflect whole wheat/rye consumption.

WITHDRAWN

WITHDRAWN

Simultaneous screening of multiple plant-based allergens and gluten using liquid chromatography-mass spectrometry

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Plant-based allergens make up half of the FDA's list of priority allergens. Immune responses or reactions to allergenic food and gluten proteins are associated with a variety of symptoms, conditions and diseases that affect both human and animal health. Once a diagnosis of a food-related allergy or disease has been made, the food in question must be eliminated from the diet. Therefore, legislation now requires strict labeling of food and ingredients and that allergenic and gluten-related information be displayed. This necessitates the existence of analytical methodologies capable of detecting trace levels of food allergens and gluten. Mass spectrometry (MS) is now a prominent analytical technique in food safety, providing the means to identify and characterize allergenic and gluten proteins and peptides. LC-MS provides an alternative option to the current ELISA technology, for detecting and quantifying trace levels of allergens in food and consumer products. This work will describe a method which can detect and quantify peptides representing wheat, soy, sesame, mustard, peanut, nine different kinds of tree nuts, as well as wheat, barley and rye gluten in a single assay, using LC-MS. Experimental results show select target marker peptides from each analyte over a range ~0.01-100ppm. Data shown demonstrates that this method can be applied to native and processed food products, thus allowing accurate and sensitive detection of hydrolyzed, heat-sensitive plant-based allergens and immuno-reactive gluten, at concentrations into to the ppb range. Peptide concentration is shown to be related to allergen/gluten concentration by

means of a calibration method using synthetic peptide standards. Isotopically labeled synthetic peptides were used as internal standards. On average, spike recovery of the marker peptides at low levels in matrix showed accuracy >87% (+/- 13).

Development of gluten-free bread baked with banana flour
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Cereal Foods World 58:A69

Purpose of this study was to make a gluten-free bread for celiac disease patients. In this experiment we looked for a viscous material altering to gluten protein, and banana (*Musa* spp.) flour was selected. Gluten-free bread was baked with banana flour, starch, sugar (sucrose), compressed yeast, and water. Immature (green, 0 day), and matured (yellow, 5 days) banana flours did not exhibit good breadmaking properties (bread height and specific volume), however, over matured (black, 44 days) banana flour gave good breadmaking properties. The suspension of black banana flour/water was dialyzed against a large amount of water, and was separated to HMW (high-molecular-weight) and LMW (low- molecular-weight) fractions. HMW or LMW fraction alone did not give remarkable breadmaking properties, but a mixture of them gave good breadmaking properties. When the HMW/water was heated at 127°C for 100 min in autoclave, the improving effects with LMW fraction on breadmaking was lost, which suggested that enzymes would act as key materials in black banana flour. High amylase and protease activities in black banana flour could be ascertained by RVA (Rapid visco analyzer) and mixograph tests, respectively.

Effects of genotype, environment, and their interaction on the phytochemicals and antioxidant capacities of red rice (*Oryza sativa* L.)
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Cereal Foods World 58:A69

Fourteen red rice varieties were planted in summer season of Hangzhou and winter season of Hainan to study the genotype, environment and their interaction effects on the phytochemicals and antioxidant capacities of rice grain. Presence of B-type proanthocyanidin in red rice was detected by HPLC-QTOF-MS/MS, and its content was measured by vanillin assay. Analysis of variance showed that total phenolic content (TPC), total flavonoid content (TFC) and ABTS radical scavenging capacity were mainly affected by environmental factors, because the percentages of environmental variation accounted for more than 60% of the total variance. However, total proanthocyanidin content (TPAC) and DPPH radical scavenging capacity were affected by both genotype and environment, both of which accounted for almost the same percentages of variance. The genotype × environment was significant for all the traits. The pair-wise correlations among TPC, TFC, TPAC, ABTS, and DPPH were significant ($r > 0.900$, $p < 0.001$). How genes and environmental factors affect the phytochemicals and antioxidant capacities in rice grain and the implications of the results for rice breeders and food industry will be discussed.

Sorghum: An overview of the factors affecting the possible introduction into the human food supply in Australia
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Cereal Foods World 58:A69

Sorghum is a staple human food grain consumed in parts of the developing world such as Africa and Asia, but is generally confined to the role of an animal feed in the developed world, including Australia. Sorghum is particularly tolerant to heat and water stress which are characteristic of the Australian environment. It is also considered gluten free. This project aimed to investigate the feasibility of increased production of sorghum for human consumption in Australia. Specifically, literature was reviewed to examine any unique nutritional qualities and two distinct econometric models were generated to predict the impact of environmental and economic variables on Australian sorghum production. There is a paucity of literature specific to health outcomes and sorghum consumption but the antioxidant content is of specific interest. Otherwise, nutritionally, it is not dissimilar to other cereal grains such as wheat and maize. Econometric modellling determined climatic variation did not have a significant adverse effect on sorghum yields (p=0.0562). The economic model included a lagged dependent variable, input and output prices and demand variables. The area of land devoted to sorghum was not significantly affected by any of these economic explanatory variables except for the price of fuel (p=0.0015) and fertiliser (p=0.0053). Both models predict that sorghum production could withstand external shocks and therefore remain sustainable. Sorghum is of nutritional interest and stability in supply of the grain suggests that sorghum could be cultivated as a human food in the Australian context in the future.

Growing location of Lariat pinto beans and effect on lipoxygenase activity and grassy flavors
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Cereal Foods World 58:A69

Reducing grassy flavors such as hexanal and hexanol in edible beans can improve opportunities for their use as food ingredients. Growing environment can have a significant impact on lipoxygenase, total lipids and amount of unsaturated fatty acids synthesized in seeds. This will in turn affect production of grassy flavors during processing and storage. Lipoxygenase activity, total hexane extractable lipids and fatty acid profile of pinto beans (Lariat variety) grown at three different locations during the 2011 crop season in North Dakota (Hatton, Johnstown and Forest River) were investigated. To evaluate changes in hexanal and hexanol concentrations, samples were stored at 30°C for one to four weeks in an incubator. Lipoxygenase activity in beans from Hatton was significantly higher than in beans from other locations, which was likely due to exposure to higher drought conditions during growing season. The amount of peroxides produced was 245.08 μM for beans from Hatton, while beans from Johnstown had the lowest (99.30 μM). Total lipids in beans from Hatton (1.32%) were significantly lower than beans from Johnstown and Forest River (1.48%). Linolenic acid in beans from Hatton was significantly higher (51.9%) compared to beans from Johnstown and Forest River (49.3%). Hexanal concentration in beans from each location was stable during storage; however, hexanol concentration progressively decreased from week one to four. Hexanol concentration in beans from Hatton was the lowest. The amount of grassy flavors produced in edible beans will therefore likely to be more influenced by the total lipids present than its lipoxygenase activity. Reduction in hexanol concentration during storage indicates potential for reduction in grassy flavors during storage and hence need to establish a minimum storage period for bean flours before distribution.

Different polyphenols have different affinities for maltase of total human intestinal homogenate, inhibiting glucose release
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Cereal Foods World 58:A69

Some polyphenolic compounds inhibit the intestinal alpha-glucosidases. However, it is not clear how those compounds affect the maltase activity of total human intestinal homogenate. The objective of this study was to change the maltase activity of human intestinal homogenate by selected polyphenols in order to inhibit the glucose release from starch digestion. Maltase activity of human intestinal homogenate was measured by Tris Glucose-Oxidase (TGO) method. All of the compounds differed in their inhibition types (competitive, homogeneous mixed or heteregenous mixed) on maltase activity of human intestinal homogenate. (-) Epigallocatechin gallate (EGCG), followed by chlorogenic acid, had the lowest Ki (inhibition constant) or higher binding affinity for the enzyme, when compared to other compounds. In addition, both compounds demonstrated competitive inhibition and Ki values of 0.022 mM and 0.0621 mM, for EGCG and chlorogenic acid, respectively. Moreover, gallic acid showed homogeneous mixed type inhibition with Ki value of 0.2284 mM. Lastly, (+)-catechin hydrate and caffeic acid had mixed heterogeneous type inhibition with two different Ki (Ki_1 and Ki_2) values of 0.0453 and 0.2494, and 0.148 and 0.2055, respectively. These results show that maltase activity of total human intestinal homogenate can be inhibited with these polyphenols having different binding affinities and mechanisms.

Starch characteristics of bean extrudates
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Cereal Foods World 58:A69

Common beans (*Phaseolus vulgaris* L.) are one of the significant sources of food in the world. They are a rich in carbohydrates (28-35%), even though they are better known for proteins, fiber, and minerals. The objective of this study was to determine the pasting properties and digestibility of extrudates from four whole and defatted common bean flours as affected by extrusion variables. Single screw extruder with a geometrical relation of 30:1 was fed manually at constant speed (10 g/min). Three variables including feed moisture (24 and 28% moisture), die end temperature (125, 135 and 160°C) and screw speed (40, 90 rpm) were examined. Starch pasting properties were

determined with a Rapid Visco-Analyzer (RVA). Firmness of bean gel after RVA analysis was measured as force using Texture Analyzer. All extruded bean samples were analyzed for rapidly digestible starch slowly digestible starch resistant starch and total starch. Dark red kidney beans had the highest peak heat viscosity and final viscosity followed by great northern, pinto, and black bean. Great northern beans had higher peak viscosity than pinto and black beans but the final viscosities were not significantly different. Lower feed moisture resulted in lower pasting viscosity and lower resistant starch. Beans extruded at higher temperature had lower final viscosity for all beans. Faster screw speed resulted in lower paste viscosity and higher resistant starch as they had shorter residence time and greater friction. Resistant starch increased, and rapidly digestible starch decreased with extrusion. Black beans formed the hardest and great northern beans the softest gel. Whole defatted bean extrudates have potential for use as functional food ingredient. The differences among beans and extrusion conditions on pasting characteristics, and starch digestibility can be applied to advantage.

Anti-inflammatory properties of cowpea polyphenols in raw 264.7 macrophages

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Cereal Foods World 58:A70

Cowpea possess high levels of polyphenolics, which have demonstrated anti-inflammatory, immunoregulatory and antioxidant properties. This study investigated the association between flavonoid profiles of different cowpea (*Vigna unguiculata*) varieties with anti-inflammatory properties as a possible benefit against inflammatory bowel disease. Black, red, brown, light brown and white cowpea varieties were investigated for antioxidant activity (AOX), and phenolic content and composition using UV-Visible Spectroscopy and HPLC. Anti-inflammatory activity was measured via NF-κB activation in Raw 264.7 macrophages challenged with a lipo-polysaccharide (LPS). Several flavonols, mostly quercetin derivatives were identified in all cowpea varieties. In the white and light brown (IAR-48) varieties, quercetin-3-O-diglucoside was especially predominant. Flavan-3-ols were identified in all varieties except in the white phenotype. Anthocyanins were only found in the black cowpea. The cowpea extracts with higher phenolic and tannin content did not induce anti-inflammatory response at different concentrations tested (0.33, 1.67 and 3.33 µg extract/mL). Unexpectedly, extracts with the lowest phenolic and tannin content, the white and light brown (IAR-48) varieties, showed significant ($p<0.05$) anti-inflammatory properties in the LPS induced macrophages, inhibiting the activation of NF-κB at 0.33 µg/mL. The results suggest that cowpea tannins or other phenolics may interfere with anti-inflammatory response of flavonols at these concentrations; consequently, composition (and not content) of polyphenols is an important determinant of anti-inflammatory response relevant to inflammatory bowel disease.

Effect of amaranth and provitamin A-biofortified maize on the physical quality and antioxidant activity of a maize extruded snack

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Maize-based extruded products are popular among consumers world-wide. Provitamin A- biofortified maize snacks with added leafy vegetable may have a potential as nutritious and health promoting products, especially in addressing vitamin A deficiency prevalent in Sub-Saharan Africa. Thus, the physical and antioxidant properties of provitanin A-biofortified maize snacks with added Amaranth, a leafy vegetable indigenous in Southern Africa, were determined. Four varieties of provitamin A-biofortified maize varieties: PVAH 79-100, PVAH 1-26, PVAH 27-49 and PVAH 50-75 were used. Maize flours containing amaranth powder at 0, 1% and 3% (w/w) were extruded into snacks, which were then analysed for their physical and antioxidant properties. Snack from white maize (unfortified) with no amaranth added was used as a reference. The expansion ratio (ER), water absorption index (WAI), bulk density (BD) of the snacks increased when the concentration of amaranth was increased; the ER (2.06) increased by 0.92 whilst BD increased from 0.49 to 0.72 g/cm^3. However, the water solubility index (WSI) of the snacks decreased slightly by about 6 to 8% as the concentration of amaranth was increased. The snacks became dark-yellow; the Hunter L* (lightness) and a*(redness) values decreased whilst the b* (yellowness) values increased with increasing concentration of amaranth. The hardness of the snacks increased by about 3.51 N with the addition of amaranth. The phenolic content and antioxidant activity of the snacks increased to appreciable levels as amaranth was increased, 50.90 to 98.65 mg of GAE/g DB and 376.79 to 414.66 mg of Trolox equiv/g DB, respectively). Provitamin A-biofortified maize with added amaranth has a potential for use in nutritious and healthy extruded snacks.

Composition and structure of *Bauhinia* grain proteins

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Cereal Foods World 58:A70

Bauhinia grains are good sources of legume protein and oil similar to soya and peanuts. Some indigenous Southern African *Bauhinia* species are moderately to highly drought tolerant and thus may be better alternative sources of proteins compared to other legumes. To facilitate the use of *Bauhinia* protein, it is important to have knowledge of its composition, structure and functionality. The composition and secondary structure of proteins from two species of *Bauhinia*, *B. galpinii* and *B. petersiana* were determined in comparison with soya. Albumin and globulin (75%) were the major storage protein in *Bauhinia* similar to soya. But, *B. galpini* had high albumin content (28%), about twice that in soya and *B. petersiana*. Glutamic acid and Aspartic acid, which may include glutamine and asparagine, were the major amino acids in *Bauhinia* and soya storage proteins. The lysine content (6 g/100 g protein) of *Bauhinia* was similar to that of soya. By SDS-PAGE, *Bauhinia* proteins showed three major protein bands ranging from 76-17 kDa for both species. In comparison with soya, *B. petersiana* and *B. galpinii* seemed to contain one subunit (45 kDa) and two subunits (61 kDa and 41 kDa) of the vicilin (7S), respectively. The acidic glycinin (11S) subunits were absent in both species. Only one subunit (17 kDa) of the basic glycinin (11S) was present in *Bauhinia*. The proteome map of *Bauhinia* showed a simple pattern of polypeptides distribution compared to soya. This further confirms the absence of the acidic 11S subunits in *Bauhinia*. The polypeptides in *Bauhinia* appeared mainly the basic type. Fourier Transform Infrared Spectroscopy (FTIR) indicated that *Bauhinia* protein contained slightly more β-sheet structure than soya. *Bauhinia* may provide a new opportunity for protein application in foods. Possible applications are protein enrichment of cereal-based foods and production of gluten-free foods.

Starch for encapsulation and structured emulsions—Stability, structure, and functionality

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Cereal Foods World 58:A70

There is an increasing interest in use of solid particles for emulsion stabilization, so called Pickering emulsions. The functional properties of starch granules in terms of initial crystallinity, ability to swell and gelatinize, and to re-crystallize, make it superior for encapsulation in such systems and use in pharmaceutical, food and consumer product applications. Starch in granular form from different sources have been modified by octenyl succinic anhydride (OSA) or thermal treatment and subsequently used to stabilize emulsions. Depending on the starch granule size and treatment, resulting emulsions showed extremely high resistance towards coalescence and phase separation. Specifically starch from quinoa, with a granule size of 0.5-3 µm, gave highly stable emulsions even after >2 years storage. In addition, it was demonstrated that starch Pickering emulsions could tolerate freezing, thawing, and even drying processes. The starch granule stabilized system was then further used to encapsulate hydrophobic (single emulsions) as well as hydrophilic (double emulsions) components. The emulsions were also subsequently processed partially gelatinize the starch and thereby adjust the molecular and colloidal properties of the interfacial starch barrier. Partially gelatinized starch at the oil drop interface increased the barrier properties. Main methods used to characterize the properties have been particle size analysis, microscopy, rheology, measurements of emulsification index and relative occluded volume, resistance towards lipolytic activity, and release of encapsulated substances. This novel use of starch find practical use for encapsulation and controlled release in oral and topical applications, but also provide more general benefits such as storage and processing stability.

Elaboration of gluten-free nixtamalized cookies with high protein quality and low sugar

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Development of gluten-free foods is a challenge for technologists due the replacement of wheat or related cereals in order to achieve the desired

product for the consumer and impart the adequate nutritional value. Celiac disease is an inflammation effect of the small intestine due to allergic reactions to wheat, barley, rye and triticale proteins. The best approach to avoid this disease is a permanent gluten-free diet, which emphasizes the importance of the development of a wide array of these products. The aim of this research was to develop gluten-free nixtamalized cookies with soybean flour to improve protein quality. A gluten-free pregelatinized nixtamalized corn dry masa flour was used to produce a standard nixtamalized cookie (STD) that contained nixtamalized corn dry masa, brown sugar and shortening, and a high protein nixtamalized cookie (HPN) supplemented with soybean flour, inulin, waxy starch and Stevia. Moisture, crude fat, ash (AOAC methods 44-15A, 30-20 and 80-01, respectively), spread factor, color (L*a*b*, CR-310 Chroma meter Konica Minolta) and texture (penetration test, Analyzer TA XT Plus) were analyzed. HPN cookies had 41.8% more moisture, 6.4% less crude fat and 62.2% more ash. There were differences in color parameters and HPN cookies were darker (ΔL*=-0.8), redder (Δa*=+0.38) and yellower (Δb*=+1.92) compared to the STD cookies. Texture data showed that after 7 days the STD cookies hardness increased 15.2% whereas HPN only increased 10.9%. Data related to sensory analysis with an acceptability evaluation test as well as dietary fiber, protein, in vitro protein digestibility, essential amino acid determination and protein digestibility-corrected amino acid score will be presented.

WITHDRAWN

Effects of octenylsuccination on β-amylolysis of granular and pre-gelatinized starches

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Octenylsuccinated (OS) waxy starches are important emulsion stabilizers for food and non-food applications. The properties of OS waxy starches can be improved by β-amylolysis, such as to increase solubility for better emulsion stabilizer in beverages. Many studies have shown that OS groups can reduce the α-amylolysis of starch, but their effects on β-amylolysis have not been studied. The objective of this study is to understand the effects of OS groups on β-amylolysis of waxy maize and waxy sorghum starches in granular and pre-gelatinized forms. The concentration of octenylsuccinic anhydride (OSA) used for starch modification ranges from 0–24%. The profiles of β-amylolysis of granular and pre-gelatinized OS starches fit well to first-order kinetics equation, with the highest hydrolytic rates at 6% OSA modification for both granular OS starches and at lower degrees of OSA modification for pre-gelatinized OS starches (0% and 3% for waxy maize and waxy sorghum, respectively). The changes in starch molecular structure during β-amylolysis were analysed using size exclusion chromatography. The molecules at 24% OSA modification were the smallest for granular starch after 4 day hydrolysis among all levels of OSA modification, whereas they were the largest for pre-gelatinized starch after 180 min hydrolysis. The different results between the granular and pre-gelatinized OS waxy starches suggest that the OS groups might facilitate the swelling of granular starches, increasing their susceptibility to enzyme hydrolysis. However, the OS groups on pre-gelatinized starches increase the non-glucosyl branches, which can stop the hydrolytic action of β-amylase, an exo-acting enzyme.

Effects of amylose and hard wheat flour on measured phenolic content and antioxidant activity in bread substituted with Concord grape extract powder

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In developed countries, increasing numbers of health conscious consumers are reflected in the rise in food research activities focused on health-related ingredients in foods. Some of these ingredients may interact with each other in food systems and thus impair the accuracy of quantifying the ingredients. The objective of this study was to examine potential interactions between Concord grape extract powder (CGEP) and amylose in a bread system by substituting hard wheat flour (HWF) with various known levels of either CGEP or high amylose corn starch (HACS) plus CGEP. Flour blends were: A1 [93% (w/w) HWF, 7% (w/w) CGEP], A2 (83% HWF, 10% HACS, 7% CGEP), and A3 (73% HWF, 20% HACS, 7% CGEP). In control samples, HWF was substituted with HACS only (C1:0%, C2:10%, C3:20%). Breads were prepared according to AACCI Method 10-10B. Methanolic extracts of the fermented dough, crumb and crust of breads were analyzed for total phenolics (Folin Ciocalteu method), total antioxidant activity (TAA; DPPH radical scavenging method) and total anthocyanins (TAC; pH differential method). In control samples, average amounts of phenolics were significantly lower in crumb than in crust or in dough. Addition of CGEP gave about 10- to 15-fold increases in total phenolic contents, with highest-fold increase detected in the crumb. The phenolic contents throughout different parts of CGEP-added breads were not affected significantly by amylose addition. For CGEP-added breads, TAA increased 10-fold in the crust, 30-fold in the crumb, and 40-fold in the dough. HACS addition had no effect on measured TAA content in the crust, however significant changes were observed in the dough and crumb. HACS addition was associated with increased TAC content in the crumb, but had an inverse relationship with measured TAC in the crust and dough.

Absorption of sorghum polyphenolics using an *in-vitro* Caco-2 cell model

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Sorghum grains and other plant components, especially glumes and leaves, contain high levels of polyphenolic compounds. Major polyphenolics found in sorghum are flavone aglycones, their glycosides, and 3-deoxyanthocyanidins which have shown antioxidant, anti-inflammatory and chemopreventive properties *in vitro*. However, the rate of absorption of these compounds is largely unknown. This work investigates *in vitro* absorption of sorghum flavone aglycones from glume extracts (49.8 mg/g), and flavone glycosides (15.7 mg/g) and 3-deoxyanthocyanidins (0.6 mg/g) from leave extracts, using a Caco-2 cell model. Caco-2 cells were grown for 21 days to create a monolayer resembling the epithelial cells from the intestine. Integrity of cell monolayers was measured by transepithelial electrical resistance. Absorption was measure during 2 h at 30 min intervals. Absorbed flavonoids were measured by HPLC. Absorption of all flavonoids evaluated was linear during 2 hours. Absorption of flavone aglycones, luteolin and apigenin, was 30.4 and 42.3 %, respectively. On the other hand, no flavone glycosides were absorbed in the Caco-2 model. Absorption of the 3-deoxyanthocyanidins luteolinidin and apigeninidin was 1.6 and 1.4 %, respectively, while the methoxylated 3-deoxyanthocyanidin, 7-methoxyapigeninidin, had 11.3 % absorption. Flavones had higher absorption than 3-deoxyanthocyanidins which are known to have poor lipophilic properties. In general, polyphenolics with higher lipophilicity among each flavonoid type had higher absorption *in-vitro* ($p < 0.01$). These findings suggest that sorghum extracts from plant components containing high levels of flavone aglycones or methoxylated 3-deoxyanthocyanidins could be more bioavailable compared to other sorghum extracts.

Comparative analysis of starch biosynthesis in *Brachypodium distachyon* and *Hordeum vulgare*

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Brachypodium distachyon is a wild grass that was recently introduced as a plant model for temperate cereals. In order to explore pre-domesticated grain qualities and possible wild grass features of cereal grain and starch metabolism, we aimed to establish *Brachypodium* as a model for starch metabolism. We identified a comprehensive number of starch biosynthesis genes including 7 soluble starch synthases (SSs), 2 granule bound starch synthases (GBSSs), 4 starch branching enzymes (SBEs), 2 glucan- and 1 phosphoglucan- water dikinase (GWD, PWD). All sequences were clustered phylogenetically in functional groups typical for plants demonstrating highly conserved starch biosynthesis. Plastid targeting sequence motifs and putative carbohydrate-binding modules (CBMs) of the families CBM20, CBM45, CBM48 and CBM53 were identified. Grain starch micro structure, granule size, amylopectin chain length distribution, phosphate- and amylose content as well as grain starch, protein and β-glucan content from *Brachypodium* were analysed providing comparative data for *Brachypodium* with barley (*Hordeum vulgare*). Starch content was low and protein and β-glucan content were high as compared to barley grain. *Brachypodium* starch granules were relatively small, and wide-angle X-ray scattering (WAXS) and differential scanning calorimetry (DSC) revealed low crystallinity and high disorder of *Brachypodium* starch granules as compared to barley. Amylopectin chain distribution and amylose were similar in barley and *Brachypodium* but *Brachypodium* had less starch-phosphate content than barley.

Effect of sodium sulfite on pasting and textural properties of aged rice

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After storage, the texture of cooked rice becomes harder due to protein aggregation via disulfide linkages. It leads to unpalatability for some consumers who prefer softer texture. Therefore, the application of reducing agents is an alternative method to improve the texture of aged rice. The objective of this study was to investigate the treatment of sodium sulfite on physicochemical properties of proteins as well as pasting and textural properties of aged rice. The aged rice, Khaw Dawk Mali 105, which was stored at ambient temperature (27-37°C) for one year, was soaked in water containing 5, 10, 15 mM sodium sulfite (SS) or 5 mM dithiothreitol (DTT) at 37°C for 6 h. The control was soaked in the same manner. The disulfide linkage of SS-treated aged rice and the DTT-treated sample were lower than that of the control but surface hydrophobicity was not different ($p>0.05$). SDS-PAGE revealed a decrease in larger molecular weight proteins (45-57 kDa) in concomitant with an increase in smaller molecular weight proteins (subunits of glutelin) for both SS-treated samples and DTT-treated sample. The breakdown of SS-treated flour was higher while the pasting temperature, the final viscosity and the setback were lower than those of control. SS induced changes of pasting properties to lesser extent than DTT. The hardness of cooked aged rice treated with SS was decreased when compared to the control. It was suggested that SS could reduce disulfide linkages, resulting in shifting pasting and textural properties toward those of fresh rice.

Use of native functional and modified starches/flours in gluten free bakery product development

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Cereal Foods World 58:A72

Gluten is a protein which occurs naturally in wheat, barley and rye. Gluten must be avoided by people who have Celiac Disease or who have an allergy to wheat. Worldwide 1 in every 266 people has Celiac Disease. Gluten-free diet is one of the fastest growing nutritional movements with a market size of $4.2 B in 2012. Formulating gluten-free bakery products brings significant processing, formulation, texture, appearance and shelf-life challenges to manufacturers. Combinations of native flours/starches, modified cook-up and pre-gelatinized starches, gums and proteins are used in gluten-free bakery formulations. In this study, the use of native functional and modified starches/flours was evaluated in terms of moisture management, dough consistency, machinability, volume, cell structure and descriptive sensory analysis against gluten containing benchmark formulations including white pan bread, muffin and soft cookie. In addition, a resistant starch was added to some of the gluten-free formulations to enhance the nutritional profile, and formulations were evaluated in terms of dough handling and final product texture. The dough consistency, machinability and baking of developed gluten-free formulations were similar to wheat containing controls. The gluten-free formulations that were developed showed good volume, homogeneous crumb structure and crust color formation, and moist, smooth and soft texture. The addition of resistant starch in gluten-free formulations enhanced the nutritional profile while maintaining desired texture, mouthfeel and appearance. The study showed that native functional and modified starches/flours provided comparable dough handling/moisture management while providing texture, appearance and mouth feel similar to gluten containing products.

WITHDRAWN

Acceptability of whole-grain pizza crust among children in a restaurant setting

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Acceptability of whole-grain pizza crust was assessed via observation among children in a restaurant setting. Additionally, a side-by-side taste test was conducted with children in the 3rd – 5th grades. A 55% whole-grain pizza crust was designed to replace refined-grain children's pizza crust at Green Mill restaurants (a Midwest US chain). Consumption was observed by researchers (n=6) in restaurants, with high inter-rater reliability. Data were collected before (n=194) and after (n=200) the new crust was introduced. Pre- and post-intervention consumption data were compared via paired t-test. Data from five restaurant locations over six months indicate that children consumed as much of the whole-grain crust (45.3%) as the original, refined-grain crust (43.9%), based on an average adult serving size of 400g. Children at Little Canada Elementary School (Roseville School District, MN) (n=120) tasted the original, refined-grain crust alongside the whole-grain crust and rated their liking of each product on a five-point scale. Data were compared via a paired t-test, and supported the observation results. Significant differences between crusts were not found for either the consumption or the liking data ($p=0.55$ and $p=0.47$, respectively). These results show that children will eat whole-grain foods in amounts similar to refined-grain foods at restaurants, where they have more options and their parents influence food selection. This is an important outcome that could serve as the foundation for future work with large, national restaurant chains.

Accessible protein body-free sorghum kafirin show better functionality than kafirin in normal sorghum

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Cereal Foods World 58:A73

A previous study in our group showed that protein body-free highly digestible high-lysine (HDHL) sorghum-wheat composites produce better composite dough and bread compared to normal sorghum-wheat composites. This study was conducted to find whether improved HDHL lines can still provide better functionality, and to test the effects of transglutaminase enzyme (TG) to enhance dough viscoelastic properties. Wheat-sorghum dough systems were prepared using HDHL and normal sorghum flours at substitution levels of 10, 20, and 30%, with and without 0.01% TG. Rheological properties of dough were tested using a mechanical spectrometer at 0.05% strain amplitude over a 0.01- 50 rad/sec frequency range. A less elastic system was observed in normal sorghum-wheat composites at all substitution levels compared to HDHL and control samples. HDHL sorghum-wheat dough at 20% substitution level showed phase angle and elastic modulus values similar to that of the 100% wheat sample. Addition of TG to HDHL sorghum-wheat composites resulted in an increase in dough elasticity, whereas TG addition to normal sorghum-wheat composites did not significantly change dough viscoelastic properties. Bread from HDHL sorghum-wheat composites had significantly higher ($P<0.05$) loaf volume than with inclusion of normal sorghum. Bread hardness was found to increase with increasing substitution levels of either sorghum type. However, HDHL sorghum-wheat composites showed significantly lower hardness than with normal sorghum. Addition of TG into HDHL sorghum-wheat composites significantly decreased bread hardness, while TG in normal sorghum-wheat composites showed the opposite effect. These results support the view that protein-body free kafirin has the ability to improve dough viscoelastic properties and bread; and, due to protein body-free kafirin, effect of TG on HDHL sorghum-wheat composites was enhanced.

Water absorption kinetics and properties of Mexican blue corn genotypes as affected by physical and compositional characteristics

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The aim of this investigation was to evaluate the influence of physical and chemical and characteristics on water absorption properties of Mexican blue corn genotypes. A yellow commercial corn hybrid was used as control. Water absorption was measured at different points during 48 h and was expressed as g water/g sample. The vast majority of water diffusion into kernels occurred during the first hour of steeping (Initial water absorption rate=IWAR) in all genotypes evaluated; it ranged from 0.060 g/g (genotype 488) to 0.138 g/g (genotype 485). The water absorption index after a 4 h period (WAI1) varied greatly from 0.124 (genotype 491) to 0.257 g/g (genotype 485). Genotype 491 also showed the lowest water absorption index after a 24 h period (WAI2) value (0.241 g/g) while the commercial hybrid showed the highest (0.352 g/g), the latter also showing the highest value for moisture saturation point (MSP=0.430 g/g) while genotype 387 presented the lowest (0.277 g/g). Mexican blue corn genotypes showed higher water diffusion during the first 4 hours of steeping while the commercial corn hybrid had a slower diffusion at the beginning but increased during the last hours of the process (24 and 48 h). This is relevant because accelerated hydration of the kernel could result in shorted steeping times and consequently, lower processing costs. Correlation analysis demonstrated that water absorption properties were associated to different physical and chemical properties. IWAR correlated positively by the percentage of pericarp ($r=0.679$) of the kernel, and negatively by kernel density ($r=-0.671$) and test weight ($r=-0.602$). Results indicate that there is great variability in water absorption properties of Mexican blue corn genotypes and that they are influenced considerably by different quality factors of the corn grain, including physical and chemical properties.

Impact of molecular structure of amylopectin on annealing

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Starches have been classified into 4 different groups based on amylopectin internal unit chain profile. The distance between branched building blocks within clusters (IB-CL) of the groups followed the order: Group 1 < Group 2 < Group 3 < Group 4. The influence of internal structure of amylopectin on annealing of these four groups of starches was investigated. Starch samples were incubated in excess water for 3 h or 24 h at 6°C lower than onset gelatinization temperature (To) of native samples. Annealing significantly increased To and narrowed and deepened the amylopectin endotherm regardless of the starch source and incubation time. However, the extent of change in melting temperature (Tm) and enthalpy of gelatinization (ΔH) differed between groups. Starches from group 1 (oat, rye, barley and waxy barley) exhibited greatest response to annealing. Tm of group 2 starches (waxy maize, rice, waxy rice and sago) remained unchanged after 3 h annealing. Group 3 (mung bean, tapioca, arrowroot) and group 4 (canna, normal and waxy potato, yam) starches showed pronounced increase in ΔH. IB-CL positively correlated ($r=0.93$, $p<0.01$) with the increase in ΔH after 24 h annealing. The foregoing data proposed that short IB-CL enhances the amount of unpacked double helices within crystalline register. Less impact of annealing observed in group 2 starches indicates that their IB-CL and external chain length are optimal to assemble the crystalline lamellae with few structural defects. Longer IB-CL, which facilitates the parallel packing of splayed double helices, and twisting of loose ends of longer external chains, probably increased the gelatinization enthalpy in group 3 and group 4. It is concluded that annealing can be used as a probe to visualize the organization of glucan chains (alignment of double helices/degree of perfection) within the crystalline lamella.

Impact of flour heat treatment on solvent retention capacity profiles

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Wheat flour can be heat treated to modify the functional properties of its individual constituents and, hence, its performance in applications. However, the impact of heat treatment on wheat flour Solvent Retention Capacity (SRC) profiles, which predict flour performance in specific baking applications, has never been investigated. Flour was heat treated for either 2 or 5h at both 80 and 100°C. Heat treatments increased the overall water retention capacity (from 55.6% for control flour to 62.4% for flour heated 5h at 100°C) as well as sucrose SRC (from 85.0% to 113.5%), while no changes were observed in sodium carbonate SRC. The observed decrease in lactic acid SRC values (from 113.1% to 97.4%) indicated restricted swelling of the protein network after the applied heat treatments. As deduced from a decrease in the level of proteins extractable in sodium dodecyl sulfate containing medium (from 74.9% to 50.5%) and the level of free sulfhydryl groups (from 11.2 to 8.7 µmole/g dm protein) upon heat treating flour for 5h at 100°C, the restricted swelling was related to protein cross-linking within the flour particles. Such upfront polymerization prevented proper hydration and gluten network formation during mixing as observed in Mixograph analyses. Besides the drastic changes in protein functionality, starch swelling power decreased from 17.2 g/g for control flour to 15.8 g/g for flour heated 5h at 100°C. Presumably, the cross-linked protein network surrounding the starch granules stabilizes the latter against disruption and delays water uptake. The impact of the applied flour heat treatments on SRC profiles resembles that of wheat flour chlorination.

Rapid detection and identification of bacteria and yeasts by rRNA sandwich hybridization—A new technology

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This new process allows comprehensive and reliable routine control of microbial contamination for quality control in treatment plants and manufacturing processes. It is based on the detection of microbe-specific rRNA using sandwich hybridization. The signal read-out is triggered optically by an enzymatically-generated color change. The system is sensitive and specific since the method is based on molecular genetic identification, and it allows detection of a group of microorganisms as well as specific species. No PCR is required because the method is quantitative without cell counting (using standards) and uses standard laboratory equipment. The method is economical with high throughput and 96-well microplate format system. The test is performed in less than 3 hours and offers substantial time savings compared to cultivation-based assays. It is ideal for safety and quality control of water, and food & beverages (food-borne pathogens like *Salmonella*, *Campylobacter, Listeria and Cronobacter spp*., and counting of *Legionella* in water, including the most relevant species, *L. pneumophila.*

Impact of jet milling on physical properties of wheat flour doughs

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Jet milling is a process that uses highly compressed air to micronize solid materials into ultrafine powders. The objective of this research was to evaluate

the effect of jet milling on dough rheology and starch gelatinization of wheat flour (flour:water 63:37). A control wheat flour (d_{50}>100µm) preparation was milled under two different feeding rates in a jet mill resulting to two ultrafine flour streams (d_{50}: 60µm and d_{50}: 45µm). The content of total pentosans (0.98-1.47%), and the amount of damaged starch (5.21-11.60%) showed a significant increase ($p<0.05$) with a reduction of particle size. Fitting of the Burger's model to the creep-recovery curve of the doughs showed significantly lower ($p<0.05$) values of all calculated compliance parameters for the jet milled flour streams compared to those of the control flour; moreover, an increase in zero shear viscosity values (0.38-6.25 $x10^6$ Pa·s) was found with decreasing flour particle size. Texture Profile Analysis on doughs demonstrated significant differences ($p<0.05$) between the flour streams differing in particle size. Specifically, the values of hardness (3.5-13.0N), cohesiveness (20.6-84.3) and gumminess (2.6-6.4N) increased with a reduction of particle size. Similarly, stress relaxation testing showed an increase in half-relaxation time (3.8-13.7sec) of the doughs with a decrease in flour particle size. Additionally, Differential Scanning Calorimetry showed higher ($p<0.05$) starch gelatinization enthalpy values for the dough of the control flour (8.28 mJ/mg) compared to the doughs of the jet milled flours (7.53-7.91 mJ/mg). Overall, jet milling seems to largely affect the wheat flour dough physical properties.

Improving nutritional value of instant noodles using Great Northern bean

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Cereal Foods World 58:A74

Traditional instant noodles, made out of wheat flour, are generally inferior in nutritional value. The objective of this study was to improve the nutritional value of instant noodles by incorporating Great Northern bean powder. Instant noodles were prepared using a pilot-scale noodle processing machine, using hard red winter wheat flour, in combination with different levels (0, 10, 20, 25, 30, and 60% of flour replacement) of Great Northern bean powder. Noodles formulations were tested by RVA, and products were tested for color, texture, and cooking properties. Instant noodle prepared with 60% of bean flour failed to make an acceptable product. Bean flour fortification at 30% flour weight resulted in short noodle strands. Acceptable products were obtained from 10, 20, and 25% flour replacement with bean powder. Color analysis showed significant differences ($p<0.05$) among tested formulations which resulted in acceptable products. Increasing bean flour levels increased the yellow color (higher b values) and darkness (lower L values) of fried noodles. Cooking loss increased slightly with increasing levels of bean flour. Texture profile analysis on cooked (ready to serve) noodles showed an increase in springiness with increasing bean flour ($p<0.05$). No apparent trends were observed in hardness of cooked noodles. Weight gain of instant noodle, after cooking, seems to decrease with increasing bean flour proportion. Replacing a portion of wheat flour with Great Northern bean powder significantly increases protein and fiber contents in instant noodles. This study showed wheat flour could be replaced up to 25% (w/w) with Great Northern bean flour, in traditional formulations and under normal, pilot-scale processing conditions, to obtain acceptable instant noodles with improved nutritional value.

Variations in amylose fine structure of starches from different species

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Cereal Foods World 58:A74

Starch comprises two main components: amylose and amylopectin, the molecular structures of which contribute to the functional properties and final applications of starch. Although amylopectin fine structures and amylose contents of starches from different botanical origins have been extensively studied, the fine structure of amylose (i.e. the chain length distribution or CLD of amylose branches) has not been fully investigated and compared among different starches due to the limitations of previous dissolution and characterization techniques. In this study, starches were extracted from a wide range of species (rice, barley, sorghum, maize, wheat, cow pea, field pea, potato and sweet potato) following a method that allows complete dissolution with minimal degradation, followed by enzymatic debranching using isoamylase. The CLDs of amylose and amylopectin branches were characterized by size-exclusion chromatography (SEC). Amylose content was calculated from the ratio of the area under curve of amylose chains to that of the overall CLD. For amylose branches, all starches show bimodal CLDs, implying that amylose branches can be empirically divided into shorter chains (DP 100-700) and longer chains (DP 700-40000). The CLDs of both amylose and amylopectin branches, including the length and relative amount of each chain group, vary significantly depending on plant species, whereas they are similar among different varieties within the same species, suggesting the variations in starch biosynthetic pathway among different plant species. Fitting the amylopectin CLDs to a mathematical model was performed to estimate the relative activities of starch biosynthetic enzymes, showing that potato and sweet potato starches have lower ratios of the relative activities of starch branching enzymes to starch synthases than the other starches.

Properties of pea and lentil starch noodles prepared by high temperature extrusion

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Cereal Foods World 58:A74

Noodles from mung bean starch are popular staple foods in many Asian countries. Researchers have attempted to replace mung bean starch with other pulse starches in traditional starch noodle-making because mung bean starch is expensive. However, the quality, in particular the texture, of cooked noodles from those starches is inferior to that from mung bean starch. Research at our lab showed that it is feasible to prepare pea starch noodles with superior texture using high temperature extrusion technology. The objectives of this study were to prepare starch noodles from several pea (*Pisum sativum*) and lentil (*Lens culinaris*) varieties by high temperature extrusion, and to evaluate their quality. Quality characteristics of the starch noodles were evaluated according to published methods. Results indicated that pea starch noodles displayed significantly ($p<0.05$) lower expansion ratio, and were less bright in colour than lentil starch noodles. Noodles from pea starch exhibited significantly ($p<0.05$) lower cooking loss, but higher cooked weight as compared to those from lentil starch. Textural analysis showed that cooked noodles from pea starch were firmer, but less sticky than those from lentil starch. Textural differences among cooked starch noodles were correlated with the physicochemical properties of the starches. Pea and lentil starch noodles exhibited superior texture when cooked, but greater cooking loss as compared to commercial mung bean starch noodles. Starches from peas and lentils will have great potential as replacers for mung bean starch in starch noodle-making using high temperature extrusion.

WITHDRAWN

WITHDRAWN

WITHDRAWN

Analysis of octenyl succinate starches from various botanical sources using the micro-viscoamylograph

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Cereal Foods World 58:A75

Starch is an important biopolymer in food and industrial applications; and, it is often modified to provide improved functionality. Starch can be modified with substitution of octenyl succinate (OSA) to render it more lipophilic, and so increase its emulsification properties. Five starches (corn, potato, rice, tapioca and wheat) were chosen for analysis and modification. The modification was carried out by reaction with octenyl succinic anhydride. To determine the level of modification the degree of substitution was measured. The micro-viscoamylograph was used to measure the starch pasting, since starch pasting characteristics are important for the functionality of starch. OSA-potato starch had the highest degree of substitution (0.022) and OSA-wheat starch had the lowest degree of substitution (0.014). The level of damaged starch decreased in all starch samples after OSA modification. The OSA modification also caused pitting or other morphological changes to the starch granules, which could be seen by scanning electron microscopy. The peak viscosity of the starches ranged from 261.5 to 1766.0 mPa s. The peak and final viscosities of the modified starches from each botanical source were significantly ($p<0.05$) higher than their corresponding native starch. Native wheat starch had the lowest setback (86.0 mPa s) and OSA-potato starch had the highest setback (672.5 mPa s). The modified starches had significantly ($p<0.05$) higher setback than their corresponding native starches; except for tapioca starch, which had significantly ($p<0.05$) higher setback in the native starch compared to the OSA-tapioca starch. Overall, the starch modification occurred at different levels depending on the botanical source of the starch. Also, significant differences were observed in the pasting properties of OSA modified starches compared to the native starches.

Analysis of hard spring wheat flours using the micro-viscoamylograph

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Cereal Foods World 58:A75

Starch gelatinization and pasting characteristics of wheat flour are important to consider for end-use quality evaluation. One particular instrument which is available to measure starch pasting properties is the micro-viscoamylograph. The micro-viscoamylograph has been commonly used for the analysis of pure starch. This study focuses on the use of the micro-viscoamylograph for the evaluation of starch pasting in hard spring wheat flour and the correlation with other flour quality tests. The micro-viscoamylograph was run using the heating profile outlined in the standard two procedure of the AACC approved method 76-21.01. The flour quality was also determined using the rapid visco analyzer, solvent retention capacity and other traditional dough testing methods. The correlation between these flour/dough analysis methods and the micro-viscoamylograph parameters were determined. The peak viscosity determined by the micro-viscoamylograph ranged from 814.0 to 1074.5 mPa s. The breakdown for the flour samples ranged from 121.0 to 305.5 mPa s and the setback ranged from 451.5 to 653.5 mPa s. The micro-visco-amylograph peak viscosity was significantly correlated ($p<0.05$) with the gluten index ($r = 0.58$). The setback determined by the micro-viscoamylograph was significantly ($p<0.05$) correlated with the gluten index ($r = 0.59$) and had highly significant negative correlation ($p<0.02$) to the farinograph absorption ($r = -0.66$). There were also significant correlations between the micro-viscoamylograph parameters and the rapid visco analyzer parameters as well as, amylograph, falling number and extensograph. Overall, the micro-viscoamylograph is usefull for determination of flour pasting properties. Also, because of its correlation to other flour quality parameters may be useful in assessing flour quality, while using less flour than a traditional amylograph.

Determining cereal starch amylose content using a dual wavelength iodine binding 96 well plate assay

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Cereal starch amylose/amylopectin (AM/AP) ratios are critical in functional properties for food and industrial applications. Conventional determination of AM/AP of cereal starches are very time consuming and labor intensive making it very difficult to screen large sample sets. Studying these large data sets is necessary in evaluating breeding samples and studying the impact the environment has on cereal starch development. The objective of this study was to develop a scaled down version of the amylose iodine binding assay (colorimetric) in a 96 well plate single and dual wavelength (λ620nm and λ510nm respectively) assay. The standard curve for amylose content was scaled down to work in a 96-well plate format demonstrated by regression equations with R^2 values of 0.999 and 0.993 in single and dual wavelength, respectively. The plate methods were applicable over large ranges of amylose contents; high amylose maize starch at 61.7±2.3%, normal maize starch at 25.0±0.6%, and a waxy maize starch at 1.2±0.9%. The method exhibited slightly greater amylose content values than the Megazyme (K-AMYL) method for normal type starches; but is consistent to cuvette scale iodine binding assays. This method was tested on maize, wheat and sorghum starch providing excellent reproducibility.

The relationship between amylopectin molecular structure and the crystalline and crystalline-amorphous lamellae it produces

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The molecular and crystalline structures of starch are important factors that affect the properties of starch based materials, whether they are used as a food source, food additive or as an industrial input. The effect of the molecular

structures of starch on the higher order crystalline-amorphous (C-A) lamellar structures are poorly understood outside the effects of varying amounts of amylose. This paper presents new discoveries about the role of the amylopectin molecule on the properties of the C-A lamellae of native starch granules. The research uses new methods of parameterisation for the CLD, β-amylase digestion with size-exclusion chromatography to analyse the branched amylopectin structure, and small angle X-ray scattering data for the lamellar structure. The parameters produced were used to statistically analyse 11 different waxy starches. It was found that increases in the amount of long chains in the linear, negatively sloped regions, of the amylopectin CLD correlated with an increased size (average repeat distance) of the C-A lamellae. The range of the shoulder length chains of the CLD correlated with increased numbers of B-chains and both correlated with an increase in the size of the C-A lamellae. Differential scanning calorimetry and nuclear magnetic resonance studies were used to determine that the increase in the C-A lamellar size due to the number of B-chains was not related to a change in the crystalline parameters of the starches. Thus, the increase in total lamellar size was related to an increase in the size of the amorphous regions of the lamellae. The proportion of A- and B-chains, did not correlate with any other parameters that were used to examine the amylopectin CLD, thus, there was no evidence to support the commonly held belief that A-chains are necessarily smaller than B-chains.

A parameterized model of amylopectin synthesis provides key insights into the synthesis of starch

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A quantitative model of starch biosynthesis in storage tissues (e.g. cereals) is developed which considers the amylopectin chain-length distribution (CLD). The model–an evolution equation describing the rate of change of the number of chains is based on the core enzymatic mechanisms in starch biosynthesis: starch synthases (SSs) catalyse chain propagation, starch branching enzymes (SBEs) create branches, and debranching enzymes (DBEs) hydrolyse branches. It is assumed that one of each of SS, SBE and DBE form an enzyme set, and the CLD is governed by the combination of multiple enzyme sets. Quantitative agreement with experimental CLDs supports the precepts of this model; data are obtained by fluorophore-assisted capillary electrophoresis (FACE). This model is the first tool to allow the CLD to be quantitatively parameterized by a small number of mechanistically-based parameters, by nonlinear least-squares fitting of the evolution equation to experimental data. This proves useful in understanding the CLD and higher-level structures. The model gives new in-depth understanding of starch biosynthesis and structures. (1) Amylopectin synthesis is defined by the restrictions on particular ratios of enzymatic activities. (2) An independent confirmation of the conclusion, previously reached solely from genetic studies, debranching enzymes are required in amylopectin synthesis. (3) The model provides a mechanistic basis for understanding how successive arrays of crystalline lamellae are formed based on the identification of two types of long amylopectin chains, one type remain in the amorphous lamella, while the other is integral to the formation of an adjacent crystalline lamella. The model has potential in exploring new ways to alter the structure of starch to produce starches with altered functionality for food, human health or industrial applications.

Use of paramagnetic relaxation reagent in quantitative ^{13}C NMR of maltodextrin

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^{13}C NMR is a non-destructive method in studying structure of starch and its derivatives. However, long experimental time is needed for quantitative analysis. This is due to the need of a long recycle delay for fully relaxation of carbon nuclei in starch. Paramagnetic relaxation reagent such as chromium(III) acetylacetonate[$Cr(acac)_3$] can reduce relaxation time of nuclei in quantitative NMR (qNMR) measurement, but was seldom used in starch. In this research, we used maltodextrin as a model compound to demonstrate the potential of using $Cr(acac)_3$ to reduce experimental time in qNMR measurement. ^{13}C spin-lattice relaxation time (T_1) of maltodextrin was measured using Inversion-Recovery method with and without $Cr(acac)_3$ in DMSO-d_6. The longest carbon T_1 was reduced from 829 ms to 431 ms with adding 10 mM $Cr(acac)_3$. This allowed us to obtain quantitative information using Inverse-Gated ^{13}C NMR within 3 h, whereas 5.5 h was needed when $Cr(acac)_3$ was not used. Calculation of both degree of polymerization (DP) and chain length (CL) from qNMR measurement with and without using $Cr(acac)_3$ were consistent. DP and CL calculations from Non-Inverse-Gated ^{13}C NMR spectra suggested the use of Inverse-Gated sequence is necessary for suppressing Nuclear Overhauser Enhancement (NOE) and to obtain quantitative structural information of carbohydrates.

Chemical kinetics on change in breadmaking performance of bread flour during short-term storage using ESR spectra

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This study was performed to find a simple and reproducible index on change in breadmaking performance of bread flour during short-term storage. White flour milled from grain of Canadian hard wheat in a Buhler laboratory mill was used for this study. The flour was stored at room temperature for different terms. Each flour sample was measured with an electron spin resonance spectrometer (ESR), and used for bread making test. When the flour sample was measured with the ESR (resonance frequency: 9.0GHz, modulation frequency: 100kHz, g-value: 2.0040, center field: 321mT), a clear and reproducible peak was obtained in the ESR spectra. With the progress of the storage period, the peak intensity increased gradually. For the breadmaking test, loaf volume of the bread was measured. Loaf volume increased from the beginning of flour storage until about 30 days. Then, we found a correlation between ESR peak intensity of flour and loaf volume of bread. This correlation shows that an ESR signal can be applicable to an index of the quality change of the bread flour. Next, we discussed chemical kinetics to describe the time-dependent characteristics of the quality change of bread flour. We assumed that above-mentioned quality change of bread flour during short-term storage was a phenomenon that unsaturated bonds in flour were oxidized through radical intermediate compounds. Based on this assumption, the phenomenon was described by a consecutive reaction model. In actual storage of flour, there is sufficient oxygen surrounding flour, so that oxygen concentration is virtually constant during the chemical reaction. Therefore, we considered the reaction to be pseudo-first order reaction. Finally, we derived an analytical equation. Using this equation, we discussed on the results measured by means of the ESR.

Production of feruloylated arabinoxylan hydrolysates that promote sustained short chain fatty acid production during *in vitro* fecal fermentation

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High pressure hydrothermal treatment of cereal bran results in depolymerization and solubilization of cell wall hemicelluloses, releasing feruloylated arabinoxylan hydrolysates (FAH), which may be beneficial to gut health. The fermentation properties of FAH are likely different depending on parent hemicellulosic composition. The objectives of this study were to: 1) determine treatment temperatures for production of FAH from corn and wheat brans, two important cereals with widely varying hemicellulose composition; and 2) determine the potential prebiotic properties of corn bran and wheat bran FAH using *in vitro* fermentation. FAH was produced by heating bran (10% w/v) in a high pressure stirred reactor until the slurry reached 160-200 °C (in 10 °C increments). Final temperatures of 190 °C for corn bran and 200 °C for wheat bran resulted in the highest release of FAH (55% and 88% of initial insoluble arabinoxylan) and esterified ferulic acid (29% and 52% of the initial ferulic acid). Partial purification with ion-exchange and dialysis resulted in a final product containing 74% and 66% total carbohydrate and 39% and 22% FAH, respectively (other carbohydrate was largely fragmented starch). *In vitro* digestion (to remove starch) followed by fermentation was performed with corn and wheat FAH as well as fructooligosaccharides (FOS). While no further short chain fatty acid (SCFA) production was found beyond 4 h of fermentation on FOS and wheat FAH, corn FAH maintained SCFA production over 24 h with significantly higher final SCFA production compared with other substrates. Butyrate, a beneficial microbial metabolite, was also significantly higher on corn FAH compared with FOS and wheat FAH at 24 h. Our study identified a process to produce the FAH from corn and wheat brans and showed that FAH from corn may exhibit enhanced benefits compared with that of wheat.

Characterization of Tibetan hull-less barley starches for potential food applications

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Hull-less barley is a major food crop in Tibet and a significant source of nutrients for Tibetan people. Starch physicochemical properties of Tibetan

hull-less barley (THB), however, are not fully understood. Objectives of this study were to determine physicochemical properties of THB starch and to assess its potential for food and industrial applications. Six THB varieties grown at two locations, BeiQing (BQ) and KangQing (KQ), China, were investigated in this study. The THB starch showed a bimodal granule-size distribution and an A-type X-ray diffraction pattern. Amylose and total phosphorus contents of the starch ranged 24.0-26.9% and 0.045-0.050% (w/w), respectively. ^{31}P-NMR analysis showed that phosphorus in the starch was exclusively in the form of phospholipids. Amylopectin of the THB starch displayed shorter average branch-chain lengths (18.8-19.5 DP) than that of the maize starch (~23 DP), which contributed to lower percentage retrogradation of the THB starch (23.9-27.8%) than that of the maize starch (~55%) after 7-day storage at 4°C. The BQ starch showed significantly higher peak-viscosity (138.9-153.9 RVU) than the KQ starch (63.4-64.7 RVU) despite similar chemical structures. After extraction using a sodium dodecyl sulphate solution (2%, w/v) for 30min, peak-viscosity of both BQ and KQ starches increased and became similar (196.3-233.6 RVU and 191.6-214.8 RVU, respectively), while starch thermal properties remained the same. The results indicated that the difference in starch pasting properties could be attributed to surface proteins or lipids of starch granules. The THB starch showed significantly lower syneresis than maize and wheat starches after freeze-thaw cycles, which was in agreement with the low percentage retrogradation of THB starch. Its good freeze-thaw stability indicated the potential of using THB starch for frozen food products.

Stability of acetylated potato and tapioca starches during storage

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Acetylated starches are commonly used in food fields with the characters of high peak viscosity (PV) and low setback (SB), while in practice their viscosities remarkably drop after modification, especial on hot summer days. Two modified starches with their initial conductivities, 78 μs/cm in acetylated potato starch (ACPS) and 116 μs/cm in acetylated tapioca starch (ACTS), and their respective low conductivity ones, 33.5 μs/cm in ACPS-w and 72 μs/cm in ACTS-w, which were washed with distilled water 5 times after modification were stored at 25, 35, 40 and 45°C up to 2 months. The degrees of substitution (DS), conductivities, pH and pasting properties of four samples were investigated over time. DS and pH of all acetylated starches decreased with time when stored at temperatures above 35°C, while the conductivities increased with time during storage. Above 35°C, the decreases of PV and SB were observed in all acetylated starches and the rate of decreasing in viscosity increased with increasing in storage temperature. The decreases of DS, pH, conductivity and viscosity of ACPS-w and ACTS-w were more obvious than ACPS and ACTS at all storage temperatures. For acetylated potato starch, the pasting patterns on viscograms were similar with gradually decreasing in their intensities over time, while different pasting patterns on viscograms of acetylated tapioca starches were observed. The PV of ACPS-w and ACTS-w were 87 and 99% of decreases after stored at 45°C for 55 days, respectively. Under the same storage condition, the SB of ACPS-w was only 11% of its original, but the viscosity of ACTS-w stored at 45°C for 55 days was too low to calculate its SB from the viscogram. The role of washing process after modification and the storage temperature on the instability of acetylated starches should be further studied.

Why are starch granule ghosts not hydrolysed completely? Molecular and microscopic insights into amylase digestion

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Starches gelatinised in excess water have two components: solubilised polymers (mainly leached amylose and amylopectin molecules with low molecular weight) and residual granular structure (also termed granule 'ghosts'). The granule ghosts not only limit expansion and further dissolution but also contain some enzyme-resistant starch (ERS) that persists after long time amylase digestion. Two possible hypotheses for the formation of ERS can be proposed: (a) barrier effect, i.e. intact ghosts multi-micron structure; (b) starch structural features, i.e. double helix formed by amylose or long branches of amylopectin that can be augmented by proteins and lipids. The roles of multi-micron structure and protein/lipid complex were tested by breaking down the ghosts particles by high-speed vortex and extracting surface components by SDS at room temperature before ghosts were prepared, respectively. Results showed that digestion kinetics of ghosts were not significantly affected by these pre-treatments. Molecular structure evolution during amylase digestion of maize and potato granule ghosts was monitored by proton NMR and SEC, and suggested that the residues are a mixture of retrograded amylose (especially for maize granule ghosts) and α-limit dextrin (particularly for potato granule ghosts). These results provide novel insights into how ERS could be formed in cooked starchy foods.

Quality performance of an excellent Chinese soft wheat cultivar and its derivate lines

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The huge demand of soft wheat was more than six million metric tons annually in the last three years in China. High-quality soft wheat production has become the most important target in Chinese agricultural industry. Ningmai9 was the best commercial soft wheat cultivar, and an important parent in soft wheat breeding program in China, but its detailed quality report was not available. This work investigated the quality performance and stability of Ningmai9 and thirty-one derivate lines, which were bred from traditional soft wheat breeding program based on agronomy performance and kernel appearance. All of these thirty-two genotypes planted in two locations in Nanjing in two successive years (2008–2010) were milled into flour, and were evaluated for milling quality by Buhler method, flour protein content by near infrared reflectance (NIR), solvent retention capacity (SRC), alveograph parameters (NG Chopin), and cookie diameter (AACC 10-52). Genotype and environment significantly affected all of quality traits. All of genotypes characterized with higher protein content, SRC and gluten strength compared to the recommended criterions in ARS soft wheat quality laboratory. For Ningmai9, SKCS hardness value, flour protein content, water SRC, sodium carbonate SRC, latic acid SRC, sucrose SRC, alveograph P, and cookie diameter were 35.1, 10.9%, 58.7%, 74.7%, 103.7%, 112.8%, 63 mm, and 16.9 cm, respectively. Seven derivate lines showed bigger cookie diameter (17.1 cm-17.5 mm) than Ningmai9. Two derivate lines, viz. JS03 (Ningmai8//Ningmai8/Ningmai9) and JS32 (Ningmai9//Ningmai8/Ningmai9) showed outstanding quality and stability besides Ningmai9. Correlation analysis showed that cookie diameter significantly correlated with SRC (r =-0.63- -0.75, P<0.001), and alveograph tenacity(r = -0.73, P<0.001), and extensibility (r = 0.59, P<0.001). Ningmai9 was proven be an important parent with good quality performance. Decreasing SRC and gluten strength were most important targets in Chinese soft wheat breeding.

The effect of modified buckwheat flour on viscosity properties of wheat flour and sensory qualities of noodle

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Buckwheat (*Fagopyrum esculentum*) is well known by its great health benefit, such as high nutrition and abundance medical functionality. Buckwheat dry noodle is a kind of Chinese noodle production made from wheat and buckwheat flours. This noodle is widely accepted, especially by the diabetic population. Modified buckwheat flour can be produced by using extrusion puffed technology. This paper aims to study the effect of modified buckwheat flour on viscosity property of mixed flour and sensory quality of buckwheat dry noodles. Common buckwheat flour (CBF) and modified buckwheat flour (MBF) were respectively added to commercial wheat flour in the amount percentages of 5%, 10%, 15%, and 20%. Viscosity properties of mixed flour were tested by Micro visco-amylo-graph (Brabender, Germany). Viscosity curve of flours mixed with CBF and MBF decreased significantly when compared with commercial wheat flour. There was no significant change in viscosity curve due to increase in the proportion of CBF while there was a significant decrease due to the addition of MBF. Pasting temperature of mixed flours showed a curve with trend of "reduce-rise-reduce". The peak viscosity, breakdown and setback of mixed flours with MBF were significantly decreased, while there was no significant change with CBF. Buckwheat dry noodles were processed in laboratory. Sensory qualities of buckwheat dry noodles were evaluated by the professional assessment team. The MBF dry noodle qualities, such as appearance, smell, and taste, were almost the same with wheat flour noodles, while MBF dry noodle decreased significantly compared to wheat flour noodles. In conclusion, MBF could change the viscosity properties of wheat flour observably. Higher MBF in the mixed flour could significantly improve sensory qualities of buckwheat dry noodle with less processing changes and without any other food additives.

Improvement on physicochemical properties of sprouted wheat with microwave radiation

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Laboratory wheat samples with different sprout damage were treated with microwave radiation. With the increase of germination time, the falling number of wheat samples decreased; all values reflecting viscosity characteristics of paste lowered; the mixing properties of dough weakened, and stability decreased. Microwave radiation significantly improved the quality of sprouted wheat, especially for samples with short germination time: falling number and peak viscosity increased, and mixing stability enhanced. As an example, the sound sample of wheat cultivar Zhengmai 366 had falling number of 469 s, peak viscosity of 2191 B.U., and Mixolab stability of 8.7 min; after soaked at 4°C for 12 h, germinated at 20°C for 12 h, and dried at 40°C for 8 h, its falling number decreased to 232 s, peak viscosity to 551 B.U., and stability to 7.1 min; after treated with microwave radiation, the falling number, peak viscosity, and stability of the sprouted sample increased to 264 s, 1020 B.U., and 9.3 min, respectively. The results initially verified the feasibility of improvement on quality of sprouted wheat by microwave radiation. Increased alpha-amylase activity in sprouted wheat samples could explain decreased values of falling number and peak viscosity. The electrophoresis profiles of alpha-amylase showed that there were no obvious alpha-amylase isozyme bands at the early stage of germination. With the germination time extended, three low-molecular-weight (LMW) and four high- molecular-weight (HMW) alpha-amylase isozyme bands were observed. After treated with microwave, alpha-amylase activity was significantly decreased. LMW alpha-amylase isozymes were thermal sensitive while HMW alpha-amylase isozymes thermal stable. Change in alpha-amylase activity was unnecessarily the only reason that related to improvement on physicochemical properties of sprouted wheat with microwave radiation.

Improvement of AACCI 32-50.01 for the determination of dietary fiber in products containing sorbitol and/or certain soluble dietary fiber ingredients

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AACC 32-50.01 is the most inclusive dietary fiber method to date and is ideal for product types formulated with dietary fiber ingredients that are either fully, or partially, soluble in 78% aqueous ethanol. This analysis utilizes a calcium-based column to separate DP3 and greater oligosaccharides from that of non-dietary fiber disaccharides using D-Sorbitol as an internal standard. This approach works well for most product types, but it has been shown that β(2-6) fructo-triose, a component of some types of fructooligosaccharide (FOS) ingredients, is not accurately captured as dietary fiber as it coelutes with the DP2 marker. It can also be observed that other water-soluble dietary fiber ingredients, such as polydextrose, may not exhibit ideal separation of DP2 and DP3 carbohydrates, leading to potential underestimation of dietary fiber in products containing these ingredients. Underestimation of dietary fiber is also observed in products containing either naturally occurring, or added D-Sorbitol due to its use as internal standard. Alternative chromatographic conditions utilizing a potassium-based column have been developed that ensure better separation of DP3+ material for products containing polydextrose and FOS. Using these alternative conditions, D-Ribose was used as an internal standard, eliminating the need for D-Sorbitol. The increase in recovery using the modification is dependent on fiber sources, but for pure materials can range from 1% for an inulin material to 45% for a polydextrose material. For products containing sorbitol, dietary fiber content increased by approximately 400%. For products not containing sorbitol, FOS, or polydextrose, results were equivalent using traditional analysis compared to the modified procedure.

WITHDRAWN

Effects of manufacturing factors and rice flour properties on the physicochemical characteristics of pure rice pasta

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Rice is one of the most important crops served as a staple worldwide. This research aims to study the effects of whole polished rice grains on the physical properties of rice flour and the manufacturing factors of rice pasta. Generally, Indica rice cultivars with amylose content than 25% and its milled rice flour had average particle diameter from 34.82~36.03 μm for dry-milled to 15.71~20.05 μm for semi-dry-milled and damaged starch less than 18% were suited for pure rice pasta making. The rice flour and boiling water were mixed in a vacuum mixer to obtain dough with moisture content of 30-34%. The pasta extruded from rice dough of degree of gelatinization was 63.2%, which was good retention of shape and firm. The freshly rice pasta was then further dried in an air oven at 40°C for 8hr to reach a final moisture content of 11.5%. Cooking and textural quality showed that the dried pasta had higher tensile strength and gel hardness, lower cooking loss and higher water absorption than fresh pasta. Sensory evaluation showed that the satisfactory acceptance of the pure rice pasta were not significantly between fresh and dried products. Besides, both of fresh and dried pure rice pasta had obviously increased lightness (L^*) and redness (a^*) and decreased yellowness (b^*) compared to the control durum wheat pasta.