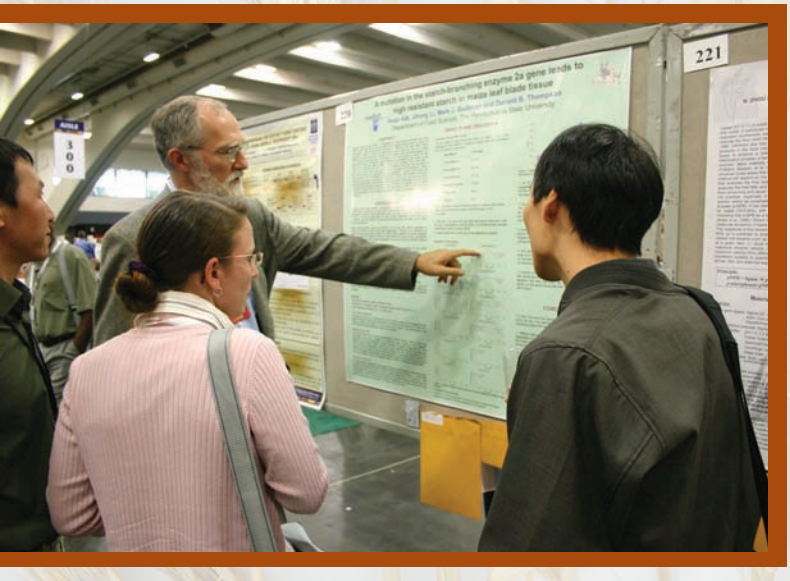
ABSTRACTS

2007 AACC International Annual Meeting

Dynamics of Grain Utilization

October 7–10
Henry B. Gonzalez Convention Center
San Antonio, Texas U.S.A.



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Rolando Flores, *University of Nebraska, Nebraska, U.S.A.*

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Emerging Issues Track
Chair: Cristina Rosell, *IATA-CSIC, Spain*
Vice-Chair: Concha Collar, *IATA-CSIC, Spain*

Industrial and Applied Science Track
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Co-Chair: Christophe Courtin, *Katholieke University Leuven, Belgium*
Vice-Chair: Peter Koehler, *Hans Dieter Belitz Institute, Germany*

2007 Annual Meeting
Abstracts of Symposia Presentations

Abstracts submitted for presentation at the 2007 annual meeting in San Antonio, Texas, October 7–10. The abstracts are listed in alphabetical order by title of symposium and time order of presentation within each symposium. Abstracts are published as submitted. They were formatted but not edited at the AACC International headquarters office.

Biofuels and Biomaterials: The Growing Demand for Carbohydrates

The emerging energy crisis and potential biofuel strategies. J. S. MCLAREN. StrathKirn, Inc. Cereal Foods World 52:A1.

Based on current data it appears that the developing energy crisis is real and is a growing threat to economic development. The magnitude of the current supply-demand issues will be quantified. Possible strategic approaches for the use of various renewable bioresources will be discussed based on current commercial contributions and projected future roles.

Why cellulosic ethanol is nearer than you think. B. DALE. Michigan State University. Cereal Foods World 52:A1.

A variety of political, social and economic factors are driving the increased use of renewable fuels, especially ethanol from abundant, inexpensive cellulosic materials. Pretreatment is necessary to make cellulosics susceptible to enzymatic conversion. The Ammonia Fiber Expansion (AFEX) process treats lignocellulosic biomass with hot concentrated ammonia. Recent improvements in AFEX and related processes have driven down the projected cost of producing ethanol from cellulosics to well under $1 per gallon. Pilot testing of promising cellulosic ethanol technologies, including AFEX, and continued research to further reduce costs are underway. The new cellulosic ethanol industry will arrive much sooner than most people think. Several myths about ethanol production will be clarified. These include the so-called negative "net energy" of ethanol, the "food vs. fuel" issue and the environmental impacts of large scale ethanol production. Finally, some opportunities for rural communities to capture economic opportunities in the biofuels revolution will be discussed.

Beyond feed, forage and food: Designing sorghum as a biofuel crop. W. L. ROONEY. Texas A&M University. Cereal Foods World 52:A1.

Sorghum possesses several attributes that make it a logical bioenergy feedstock in certain production environments. This presentation is designed to investigate the multiple types of sorghum available for use as a bioenergy feedstock, including sugar production, grain (starch) production and finally total biomass for cellulosic conversion. Information related to the development of bioenergy sorghums specifically for sugar and cellulose production will be presented. Finally, the current research activities related to the genetic dissection of compositional traits and the potential to manipulate these traits in a range of related species, including sugarcane, switchgrass and corn will be discussed.

Genetic improvement of dedicated energy crops for biomass conversion applications. S. R. THOMAS. Ceres, Inc. Cereal Foods World 52:A1.

Ceres and the Samuel Roberts Noble Foundation are collaborating to develop improved varieties of switchgrass for use as a dedicated biomass feedstock crop. A wide range of technical approaches are being deployed to meet the many and diverse needs of the "biofuels from biomass" industry. These range from the needs of the farmer, the needs of the biorefineries and the need to create an economically viable value chain in this nascent industry. Increased biomass yield remains the primary goal of our breeding program, but reduced production costs are also important. Biomass yield is important because of its impact on transport distance and delivered feedstock cost at the biorefinery. Biomass composition is another important focus because of the direct relationship to theoretical conversion yield, particularly for biochemical conversion processes. To facilitate incorporation of these chemical traits in our breeding program, we are developing rapid analytical methods for the determination of biomass composition. Our genetic improvement strategy includes implementing a marker-assisted breeding element based on over 14,000 full-length switchgrass cDNA sequences. Ceres' transgenic gene-trait pipeline in Arabidopsis has identified several hundred genes that affect one or more of a variety of agronomically important traits, such as drought tolerance, heat tolerance, cold tolerance, improved growth under limiting nitrogen conditions, etc. We use our knowledge of gene-trait associations demonstrated in Arabidopsis and rice to identify homologous sequences from switchgrass cDNA libraries. We then focus attention on these homologous genes for development of molecular markers directly associated with genes of potential agronomic importance in our breeding programs. Varieties developed using population breeding strategies are currently in performance trials around the country, and seed increase is in progress in preparation for the planned commercial release of our first improved switchgrass variety in 2009.

Development of enzyme cocktails for biomass conversion to fermentable sugars. K. A. GRAY. Diversa Corp. Cereal Foods World 52:A1.

Diversa Corp. has pioneered the discovery of novel, highly active enzymes from the environment. In addition we have developed technologies to optimize biomolecules for specific industrial purposes. Enzymatic hydrolysis of lignocellulosic biomass is challenging due to the highly crystalline nature of cellulose and the complexity of hemicellulose. In addition, the presence of non-fermentable molecules like lignin have an impact on digestibility. By utilizing our proprietary technologies to discover novel genes from diverse sources, we have discovered several hundred unique enzymes that are involved in biomass degradation. These enzymes belong to many of the glycosyl hydrolase families and have broad pH and temperature optima. Many of these enzymes have potential utility in a biorefinery process. This presentation will cover the discovery of these enzymes, the development of specialized automation technologies to evaluate enzyme activity on insoluble substrates and the performance of various enzyme cocktails on feedstock substrates.

Granular starch hydrolyzing enzymes in cereals and grain processing offers economics and co-products value benefits. J. SHETTY, K. Sanford, G. Chotani, O. J. Lantero, and D. Gang. Genencor, a Danisco Division. Cereal Foods World 52:A1.

Replacement of chemical process for hydrolyzing the insoluble starch from cereals and grain into soluble dextrins and sweeteners by enzymatic process is

a classical example of evolution of modern biotechnology. The primary liquefaction processes in the starch conversion process, utilizing high temperature – jet cooking to solubilize the granular starch to produce suitable substrate for further enzymatic hydrolysis are well established. However, further improvements with respect to reducing the unit operations, lowering the energy consumption, yield loss, processing cost and offering value added co-products would be desirable. This presentation will address the recent development of innovative technologies at Genencor on the application of granular starch hydrolyzing enzymes, GSHE in producing value added functional food ingredients, i.e., sweeteners and proteins from a variety of biomaterials.

Commercialization of new ethanol technology. G. KRISSEK. ICM, Inc. Cereal Foods World 52:A2.

The introduction portion of the presentation will emphasize the technology and market concepts that have made grain-based ethanol production facilities highly successful in recent years - including improved conversion rates, lower energy and water use, etc. Using this information as a base, the remainder of the presentation will focus on methods existing plants will consider for incorporating, frequently on an incremental basis, additional technologies for increased productivity from grain and subsequently from cellulose and biomass for both energy production and conversion of feedstock to biofuels. The information will take a "real-world" look at barriers to success from a business, technology and public policy point of view.

Building a sustainable future. R. W. MILLER. DuPont Biobased Materials. Cereal Foods World 52:A2.

This presentation will describe the driving forces behind DuPont's development and commercialization of sustainable materials and energy offerings starting over a decade ago, before higher oil prices and global warming trends were recognized concerns. The development and commercial introduction of the Bio-PDO™ and Sorona® polymer platforms will be briefly reviewed, as will progress being made to broaden the offering with value-added specialties such as Cerenol™ based on this initial platform molecule (bio-sourced 1,3 propanediol). The presentation will also briefly touch on the DuPont DOE-matching funds bio-refinery program and DuPont's partnership with BP to introduce biobutanol™ fuel for the future as well as other applications of biosciences in the surfaces and medical areas. The presentation will conclude with some suggestions on the role of academia and governments in helping businesses achieve these fundamental shifts away from petroleum dependency in our materials and fuels sectors.

Biorefining of Cereals and Other Grain Crops

The Bioeconomy—A revolution in American agriculture. L. A. JOHNSON. Center for Crops Utilization Research, Iowa State University. Cereal Foods World 52:A2.

The emerging bioeconomy wherein agriculture replaces many nonrenewable resources, especially petroleum, will have profound effects on agriculture and the entire economy. It will be a revolution, having impacts not unlike the industrial revolution. Today's biofuels industries based on grains to ethanol and biodiesel will need to transition into tomorrow's biorefineries using lignocellulose to supplement grain as feedstock and to produce industrial chemicals, bioenergy, and biobased products (adhesives, plastics, etc.,) as well as biofuels. These biorefineries may also shift from today's preferred automobile biofuel ethanol to better performing and more energy dense products, such as, butanol or plant-based hydrocarbons. Biorefineries will be able to use a variety of feedstocks to take advantage of the lowest cost inputs. Similarly biorefineries will produce a more diverse product mix and will be able to daily alter the product mix depending on what the marketplace wants to maximize returns. Both biological and thermochemical conversions will be used to produce intermediates that then can be chemically converted, this will require new integrated, systems-oriented thinking to attack problems that this new revolution will bring, especially for sustainability and minimizing environmental footprint. This presentation will address and identify issues and opportunities associated with the bioeconomy and biorefineries and set the stage for the session.

Converting a dry grind plant into a biorefinery. V. SINGH (1), D. B. Johnston (2), K. D. Rausch (1), R. L. Belyea (3), and M. E. Tumbleson (1). (1) University of Illinois at Urbana-Champaign, Urbana, IL; (2) Eastern Regional Research Center, ARS, USDA, Wyndmoor, PA; (3) University of Missouri, Columbia, MO. Cereal Foods World 52:A2.

In a conventional dry grind process, corn is processed to produce ethanol and a low valued coproduct called distillers dried grains with solubles (DDGS). Conventional DDGS is primarily used as ingredient in foodstuffs for ruminant animals. Modified dry grind corn processes can produce ethanol and multiple value added human or animal foods as well as for industrial products. Modified dry grind processes involve wet or dry corn fractionation to recover germ and pericarp fiber prior to fermentation and endosperm fiber after fermentation. Depending upon the modified process used, the amount of DDGS produced can be reduced by 70% and its protein content can be increased to 58%. Germ can be used as feedstock for producing corn oil. Corn fiber (pericarp and endosperm) can be used as feedstock for corn fiber oil or corn fiber gum production. Corn fiber oil (3% of corn fiber fraction) contains nutraceutical compounds that reduce serum cholesterol and have other unique health benefits. Corn fiber gum (40% of corn fiber fraction) has emulsifying properties and is similar to gum arabic. High protein DDGS from modified dry grind corn process can be used for ruminant or nonruminant animals. It can also be used for recovery of zein (a type of storage protein). Zein has uses in coatings for candy, nuts, other confectionary products and pharmaceutical tablets. These modified processes with multiple coproducts will convert a conventional dry grind ethanol plant into a biorefinery producing several food, fuel and industrial products.

A barley bio-refinery: Producing fuel ethanol, valuable nutraceuticals, food and feed ingredients and other products. K. HICKS (1), J. Shetty (2), M. Li (2), R. Moreau (1), A. Boateng (1), J. Nghiem (1), D. Johnston (1), and R. Flores (3). (1) Eastern Regional Research Center, ARS, USDA, Wyndmoor, PA; (2) Genencor Division, A Danisco Company, 2600 Kennedy Dr. Beloit, WI; (3) Department of Food Science and Technology, University of Nebraska, Lincoln, NE. Cereal Foods World 52:A2.

Barley is a minor crop in North America that presently has malting, feed, and some food applications. Barley acreage has dramatically fallen almost 50% in the last 10 years due primarily to lack of markets for this ancient grain. New research is showing that barley has excellent potential to be a multi-use crop in a future barley bio-refinery that would produce fuel ethanol from the grain's starchy endosperm; phytosterol- and tocotrienol-enriched edible oils from the kernel's germ; health-promoting, protein and fiber-enriched food ingredients from other kernel components; and a high-protein DDGS coproduct for animal feeds. New varieties of hull-less barley being developed are ideal for such a biorefinery as these varieties don't contain the abrasive hull that adds additional bulk but little value. Since most current barley varieties are hulled, new methods are being developed to remove those hulls and use them as feedstock to produce "cellulosic" ethanol. Alternative methods are also being developed to convert hulls by thermo-chemical pyrolysis to produce valuable bio-oil, combustible gasses, and soil amending chars. It is estimated that such bio-refineries could lead to a large increase in barley demand and acreage, producing enough barley for 1 billion gallons of fuel ethanol per year in North America. In regions of the US where barley is a winter crop, farmers can follow barley with a full crop of soybeans in the same year, allowing a two year, barley, soybean, corn rotation. This sustainable production of more grain on the same acreage is essential for avoiding future fuel versus food and feed issues.

Potential protein co-products from biofuel productions. X. S. SUN. Kansas State University. Cereal Foods World 52:A2.

Ethanol and biodiesel have been considered as alternatives for transportation fuels and will increase to billions of gallons in the next few years. Protein and cellulosic based materials as the by-products from biofuel productions will be abundant far beyond animal feed demands. On the other hand, large amount of petroleum based and synthetic adhesives and coatings are used worldwide. These adhesives and coatings contain hazardous chemicals including formaldehyde, isocyanate, vinyl acetate or acetaldehyde and polyvinyl alcohol and many other chemicals. There is a need to develop alternatives from biobased materials. Protein polymers have shown great potential for adhesive and coating applications. This seminar will use soy protein as an example to explain how to turn protein into adhesives and coating materials. Protein structure, amino acids composition, and reaction pathways are all important factors affecting adhesive and coating performance, which will also be discussed.

Effect of protease treatment on the rate of starch hydrolysis during treatment with alpha amylase of whole and decorticated sorghum. E. Perez-Carrillo and S. O. SERNA SALDIVAR. Tecnologico de Monterrey. Cereal Foods World 52:A2.

The aim was to compare dry milled maize with whole or decorticated sorghum and the treatment with protease in terms of rate of starch hydrolysis during liquefaction with thermoresistant alpha amylase. A bifactorial

experiment with a level of confidence of $P < 0.05$ was designed to study differences among grains and the effectiveness of the protease treatment prior to starch liquefaction. Sorghum was decorticated 9.4% to remove most of the pericarp and part of the germ and increase starch concentration. The decortication behavior of sorghum followed a lineal trend (r = 0.99). Starch concentration increased in decorticated kernels whereas total phenols, fiber and fat decreased. The decorticated sorghum had a significantly higher starch and protein hydrolysis compared to the whole grain. The protease treatment prior to liquefaction improved rate of starch hydrolysis especially in both sorghums. Whole and decorticated sorghum hydrolyzates treated with protease contained about 50% more reducing sugars than the untreated counterparts. Among grains, maize yielded hydrolyzates with the highest amount of free amino nitrogen (FAN) followed by decorticated and whole sorghum. The maize and both sorghum hydrolyzates treated with protease contained about 60 and 30% more FAN compared to the untreated counterparts. Both sorghum decortication and protease treatments prior to treatment with alpha amylase are recommended to increase ethanol yields, save processing time and therefore energy and to produce worts with higher FAN content which is considered as an important yeast substrate.

Advanced biorefineries: Beyond processing of commodity crops. B. R. SEBREE and K. E. Beery. Archer Daniels Midland Co. Cereal Foods World 52:A3.

We operate some of the World's largest biorefineries. Over 1,000 different products are produced from our processing facilities, including food, feed, fuels, nutraceuticals, antioxidants, and industrial chemicals. Research projects are currently underway which attempt to utilize the Advanced Biorefinery concept to fractionate lignocellulosic biomass to produce value-added products. In the talk, various conversion platforms (i.e. enzymatic hydrolysis and thermochemical conversion) will be discussed in the production of fuels, chemical/chemical intermediates, heat/power, feed, fiber, food and other products. More detail will be given to 2 projects that are ongoing in our research division: "Separation of Corn Fiber and Conversion to Fuels and Chemicals. Phase II: Pilot-scale Operation" (DOE supported) and "Biomass Research and Development for the Production of Fuels, Chemicals, and Improved Cattle Feed" (USDA supported). By utilizing a captive feedstock, corn fiber, we will address the feasibility of biochemical conversion of corn fiber to ethanol and other value-added products. The purpose of the project is to develop and demonstrate an integrated, economical process for the separation of corn fiber into its principal components to produce higher value-added chemicals, feed, and fuel. The USDA-supported project provides for several cost effective ways to facilitate the expansion of ethanol dry-grind corn biorefineries while maintaining adequate cattle feed supplies to the market. The project also outlines new approaches to efficiently process corn in dry mills by fractionation of the kernels and utilization of the fractions. The project plan to maintain cattle feed supplies includes plans to treat various lignocellulosic biomass fiber sources from captive and distributed sources to increase the digestibility for cattle thereby providing a corn replacement pellet. This project addresses the collection of decentralized sources of biomass for industrial use. The combination of the two research projects allows for a smooth transition to the direct processing of decentralized lignocellulosic biomass sources as a feedstock for an Advanced Industrial Biorefinery. The projects attempt to address the feasibility of the centralization and fractionation of lignocellulosic feedstocks; although each issue will be addressed separately.

PLA & PHA utilization. D. CARRAWAY. DaniMer Scientific, LLC. Cereal Foods World 52:A3.

Plant derived monomers can be utilized to create valuable biopolymers which have broad application in agriculture, packaging, food service articles and other important markets. Recent advances in technology have enabled manufacture of biopolymers that have excellent physical and mechanical properties and that can be produced at a price point which enables creation of value for a broad array of products. Techniques from reactive extrusion to fermentation will be discussed along with specific examples of resultant commercial application.

The future of coproducts from corn processing. K. RAUSCH (1), D. Johnston (2), V. Singh (1), R. Belyea (3), and M. E. Tumbleson (1). (1) Agricultural and Biological Engineering, University of Illinois at Urbana-Champaign, Urbana, IL; (2) Eastern Regional Research Center, ARS-USDA, Wyndmoor, PA; (3) Animal Sciences, University of Missouri, Columbia, MO. Cereal Foods World 52:A3.

Increase in demand for ethanol as a fuel additive has resulted in dramatic growth in ethanol production, and a proportional increase in coproduct production. Ethanol is produced from corn by either wet milling or dry grind processing. In wet milling, the corn kernel is fractionated into different components, resulting in several coproducts. However, wet mills are capital intensive. In dry grind processing, the corn kernel is not fractionated and only one coproduct, distillers dried grains with solubles (DDGS), is generated. Dry grind plants require less equipment and capital than wet mills. They are producer owned and add direct benefits to rural economies. Most of the increase in ethanol production during the past decade is attributed to growth in the dry grind industry. The production of ethanol could reach 11.2 billion gallons per year by the end of 2008. An overview of coproduct production will be discussed, along with issues associated with the increased production of ethanol.

Consensual Success—Is There Such a Thing?

Degree completed: How to define success now. J. HODGEN. Abingdon, IL. Cereal Foods World 52:A3.

You're getting ready to take the world by storm because you are armed with a new degree and the knowledge you have the skills to make your mark in the 'real world'. Applications for the dream positions have been sent out, interviews have been completed, and the offers are pouring in. After all the frantic pace of college activities, class work, and research, you finally see all the hard work being rewarded. Now what? You actually have to pick one of those positions. The time has come to sit down and evaluate what you want to accomplish in your life. Is the job you want in the area of the country you like the least? Is the opportunity for advancement available? Do the financial benefits of one offer outweigh the job-related satisfaction of another? Is your significant other able to find employment that fits his/her skill level in the same geographical location? You made your decision and have begun down the path where an "A" on an exam, a blue ribbon, or a diploma is not the definition of success. Now you have to decide the steps to take that will demonstrate your definition of success. Like me, will you find the path blocked by construction and have to reevaluate your definition of success so soon after graduation? Patience, but having a desire to be a productive member of society may be a key factor in reaching your success.

Journey along the personal road to success. K. SARGENT. Caravan Ingredients, Lenexa, KS. Cereal Foods World 52:A3.

After only one year in the professional world, is it possible to already be successful? Things are changing so quickly and so many decisions to be made. How can one feel successful when they are always the new kid, when everyone else has more experience and such high levels of confidence? This discussion will focus on defining personal success even at such a young stage in ones career.

My journey through applied basic research: The first ten years. A. MCPHERSON. Kraft Foods R&D. Cereal Foods World 52:A3.

Abstract not available.

Getting down the road (but not over the hill). C. F. MORRIS. USDA ARS WWQL. Cereal Foods World 52:A3.

If success = job satisfaction, then I can personally say that my career with the USDA Agricultural Research Service (ARS) has been highly successful. ARS is the official research arm of the USDA. As such the agency conducts mission oriented research in many areas of national and regional need. Research activities are organized under 22 National Programs, orchestrated under four broad topics: Nutrition, Food Safety/Quality; Animal Production & Protection; Natural Resources & Sustainable Agricultural Systems; and Crop Production & Protection. My work falls under both the 'Food' and 'Crop' topics. As cereal chemists, there are several technical career opportunities in the ARS: 1) "Category I Scientists", bench researchers, lead scientists (have their "own" lab, PhD generally required); 2) Cat. III, 'support' scientists, senior level tech's, usually MS level; 3) Cat. IV, service scientists (e.g. germplasm curators, missions with a high volume of testing and evaluation). A variety of technical support positions also exist, usually requiring a BS in a science field; work is in lab, field, greenhouse, etc. Pay scale and promotion follows the 'General Schedule' (GS). Scientists are usually GS-11 to 15; technicians GS-5 to 9; post-docs GS-11 or 12. For permanent positions, U.S. citizenship is usually required. For further details, job postings, etc. go to http://www.ars.usda.gov/careers. For Cat. I scientists, performance evaluation is linked to the "impact" of research. Impact can take many forms but is often documented with peer-reviewed publications in top-flight journals. Many ARS scientists, including myself, are located on university campuses (e.g. Washington State University). For me this is a perfect situation which provides the advantages of an academic setting with access to graduate students, libraries, etc. At WSU, ARS personnel are fully and seamlessly

integrated into university departments. However there are two notable differences that I observe between ARS and some universities. One is the level of financial support. ARS has a strong commitment to support scientists at a level where they can be productive and successful. Second is teaching. Undergraduate and graduate classroom instruction is not part of the ARS problem solving mission.

The first few steps down the road. R. CONNELLY. University of Wisconsin. Cereal Foods World 52:A4.

There are many ways to reaching the professional goals that a person has. It is also important to recognize that goals will shift and change with time. The road I have taken to reach this point in my professional development has not been particularly straight. I will share the alternatives that I explored in both the personal and professional realm before settling on my current direction for my professional goals, and the importance spending that time has had for me. As a mother of five children, as well as an assistant professor striving to achieve tenure, I have many demands on my time that I need to balance. I will share how I have managed that balance at different points in time and the criteria that I use as I constantly strive to find the best balance for achieving both my personal and professional goals.

Looking back on forty plus years of teaching cereal science, technology & common sense—At the end of the trail. L. ROONEY. Texas A&M. Cereal Foods World 52:A4.

Challenging undergraduates and graduate students to be "the best they can be" is really quite simple. It is necessary to present information based on a combination of basic fundamentals mixed with practical illustrations of those fundamentals in product quality or processing properties. One must show that cereal technology begins with the genetics of the seed and proceeds on through grain production, storage, processing, product handling, shelf life and finally consumption. The dynamics of crop quality is complex and it helps to paint a picture(s) of each and every aspect of quality from different viewpoints relative to what is realistic in the real world. The real joy of teaching a graduate class is present when one has food engineers, animal and human nutritionists along with plant breeders, food scientists and others who can be played off against each other. Learning to think broadly gives the students a new perspective on knowledge and how to use it to solve problems. The ability of scientists to communicate and respect each others' differences is critically important and must be cultivated by the professor. Examinations must be comprehensive, thought provoking and stimulate discussion among the students from different disciplines. They must develop a thick layer of scar tissue during graduate school to prepare them for the next level. Presentation of the good, bad and ugly aspects of the industry is necessary to provide a reference point for young scientists and professionals. The internet provides copious amounts of information but competent scientists are required to decipher worthwhile information.

The accidental scientist. P. WOOD. Agric & Agri-Food Canada. Cereal Foods World 52:A4.

Serendipity in science is a well recognized phenomenon. It seems to play a particularly strong role in creativity and discovery. Similarly, the course of a career might take paths governed more by serendipity, or perhaps simply accident, than by deliberation. Examples from literature, and personal experiences, will be discussed.

Current Development in Effects of Carbohydrates on Human Health

Soluble cereal carbohydrate polymers in foods and nutrition. R. G. FULCHER (1), D. Pascoe (2), and J. Slavin (2). (1) University of Manitoba, Winnipeg, MB; (2) University of Minnesota, St Paul, MN. Cereal Foods World 52:A4.

The soluble fiber components of oats, and more recently barley, have received considerable attention over the past 20 years, in part due to their impact on serum cholesterol in human subjects, and in part because of their potential impact on mammalian immune systems. We have recently completed a series of studies on human subjects in which both barley and oat beta-glucan extracts were tested for their ability to influence blood serum characteristics (e.g. cholesterol and related lipid fractions). The beta-glucans were obtained from commercial sources and ranged from ~20% to ~70% glucan polymer on a dry weight basis. In parallel studies, we have also examined the impact of highly purified cereal beta-glucans on the inflammatory responses in isolated mammalian macrophages. In particular, we have followed the synthesis and release of TNF-alpha, a commonly-measured marker of inflammatory processes in cells. The TNF-alpha system has also allowed us to test the impact of other, non-polymeric components of cereal cell walls for their ability to inhibit these inflammatory activities. Details of the interactions and experimental approaches will be provided, along with results that implicate these grain components as powerful modulators of immune responses.

Resistant starch and the prevention of colonic genetic damage due to high protein diets in rats. D. L. TOPPING (1,2), S. Toden (1), A. R. Bird (1), and M. A. Conlon (1,2). (1) Food Futures and (2) Preventative Health National Research Flagships, CSIRO Human Nutrition, Adelaide 5000, Australia. Cereal Foods World 52:A4.

Human population studies show that greater intakes of dietary protein increase risk of colo-rectal cancer (CRC) and loss of remission in patients with inflammatory bowel disease (IBD). Other population studies have linked red and processed meats to increased CRC risk while white (chicken) meat appears not to change risk. Genetic alteration is a prerequisite for carcinogenesis and we have shown in rats that higher intakes of dietary protein lead to greater DNA damage in colonocytes as measured by the comet assay. The greater damage was seen with soy, casein and red meat but not chicken. These observations are consistent with the human epidemiological data. Addition of resistant starch (RS) to the diet as high amylose maize starch opposed protein-induced DNA damage in a dose-dependent manner. Higher dietary soy, casein and red meat caused significant thinning of the colonic mucus barrier. Loss of barrier function is a feature of IBD and this finding also accords with the limited population data. Protein-induced mucus thinning was opposed by RS. Short chain fatty acids (SCFA) are produced by the fermentation of dietary carbohydrates by the large bowel microflora. Butyrate in particular has been linked to improved bowel health and the reversal of genetic damage and mucus thinning correlated most closely with increases in this SCFA in rats fed RS. Analytical data suggest that many convenience starchy foods are low in RS. There appears to be an opportunity for new product development, particularly combinations of meat and dairy products with cereal grains and ingredients which supply RS.

Carbohydrates in diabetes management: A complex situation. M. E. CAMIRE. University of Maine, Orono, ME. Cereal Foods World 52:A4.

Epidemiological studies point to obesity, rather than carbohydrate consumption, as the culprit in the global epidemic of type 2 diabetes. Dietary recommendations for prevention and management of diabetes have evolved over the past few decades. Carbohydrate-rich foods are no longer banned from diets, but the selection and amount of carbohydrates to be consumed remain controversial. Sugar (glucose, sucrose, fructose and lactose) consumption has varied effects on metabolism and diabetes risk factors. Current recommendations by the American Diabetes Association include whole grains, legumes and non-starchy vegetables along with low-fat meats and dairy products. Prevention of post-prandial blood glucose spikes is a cornerstone of these recommendations. Whole grains provide complex carbohydrates including dietary fiber, as well as phytochemicals that may slow digestion, increase insulin sensitivity, or modulate adipocyte metabolism. Opportunities exist to develop satisfying carbohydrate-rich meals that do not provoke sharp increases in serum glucose after consumption, and that may help consumers with diabetes regain normal glycemic control.

Insoluble fibers and their effects on human health. G. S. LO (1) and G. Paul (2). (1) Shenlo Associates, Inc.; (2) The Solae Company. Cereal Foods World 52:A4.

Sources of dietary fiber are divided according to their solubility characteristics in water. Soluble fiber dissolves in water to form a gel-like material and can help lower serum cholesterol and control diabetes. Soluble fiber is found in foods such as oat bran, barley and some fruits and vegetables. Insoluble fiber will not dissolve in water and increases the movement of material through the human digestive tract, promotes bowel regularity, prevents intestinal disorders and possibly also colon cancer. It is found in foods such as wheat and corn brans, flax seed, lignans and some vegetables and fruits. Unfortunately, neither the official AOAC dietary fiber analytical method nor water solubility can predict the health benefits of soluble whereas insoluble fiber. Generally, soluble fiber is rapidly fermented, and insoluble fiber is not fermentable. However, some insoluble fibers such as soy cotyledon fiber are slowly fermented and metabolized by the microflora in the lower gut to provide health benefits. Fermentable fibers supply food (prebiotics) for microflora to produce short-chain fatty acids (SCFAs) (i.e., acetate, propionate, and butyrate) and gases. These by-products of fermentation are either absorbed by

the colonic mucosa or utilized by bacteria, yielding energy and carbon for synthesis and growth of the flora. Butyrate is the primary energy substrate for the colonic mucosa in humans, but mixtures of SCFAs may better benefit small intestinal mucosal structure and function. SCFAs also stimulate sodium and water absorption in the colon that helps to control diarrhea.

Low carbohydrate diets and their effects on human health—The long and short of it. J. M. JONES. College of St. Catherine, St. Paul, MN. Cereal Foods World 52:A5.

The fad associated with low carbohydrate diets has dwindled. However, studies on the these diets continue. Overall, the studies show that if a person sticks to any diet, they lose weight. Most studies show that low-carbohydrate diets cause greater initial weight loss in short-term studies (<6 mos), but the amount of weight lost after one year is the same for all types of diets if participants stick to the diets. Low-carbohydrate and extremely low-fat diets such as the Ornish diet have higher drop out rates with diets that are more balanced. This paper will carefully assess the low carbohydrate diet studies in the aggregate. The scientific basis for claims made about the role of various types of carbohydrates including polyols, resistant starch, dietary fiber and whole grains on satiety, changes in blood lipids and other metabolic responses will be addressed. The usefulness the glycemic response as a weight loss aide for different types of dieters such as those with metabolic syndrome will be explored. The paper will conclude by looking at the variable quality of different types of low carbohydrate diets and health. It will look at effects of long-term ketosis and elevated protein.

Functional activity and stability of commercial prebiotics. R. HUTKINS. University of Nebraska, Department of Food Science and Technology. Cereal Foods World 52:A5.

Prebiotics are defined as substances that are neither digested nor absorbed in the digestive system, but that stimulate growth of specific intestinal microorganisms. However, a reliable method for assessing the extent to which a prebiotic stimulates growth of probiotic organisms and the stability of prebiotics to food processing procedures does not exist. Our objectives were to establish a prebiotic activity assay and determine prebiotic activity scores to evaluate the functional activity and stability of commercial prebiotics. Prebiotic activity scores were based on the change in cell density after growth of the test strain on prebiotics relative to that obtained for enteric strains grown under the same conditions. Prebiotic activity score were calculated for 5 lactobacilli and 5 bifidobacteria grown on either fructooligosaccharides (FOS), galactooligosaccharides, or inulin. The results revealed that prebiotic activity scores were dependent on the probiotic strains tested and the type of prebiotic utilized. In addition, different strains from the same species varied significantly with respect to their prebiotics activity scores. Next, prebiotics were subjected to low pH, heating at low pH, and Maillard reaction conditions. Stabilities were determined by comparing prebiotic activity scores before and after the treatment. In general, prebiotics were stable to low pH and Maillard browning reaction conditions. However, heating the prebiotics at low pH caused a significant reduction in prebiotic activity, with some of the FOS being the least stable to these conditions. These results provide a rational basis for evaluating and optimizing combinations of probiotics and prebiotics for applications in foods.

Embracing Emerging Technologies for Rice Quality

Applying NIR technology in assessing rice quality. J. F. MEULLENET, T. Siebenmorgen, M. Saleh, R. Bautista, and L. Roferos. University of Arkansas, Dept. of Food Science. Cereal Foods World 52:A5.

The functional characteristics of rice are important to the rice industry because they may affect both the cooking qualities and the texture of cooked rice, in addition to other end-use qualities. Because of the time and cost involved in laboratory testing for functional properties, there is a need for rapid methods to quickly test for these attributes in, for example, new breeding lines. Near-infrared spectroscopy (NIR) is an analytical technique that has been used for the past twenty years to quantify the level of various cereal grain constituents, including moisture, protein, and oil. With regard to rice, NIR has been used to predict several constituents including apparent amylose, protein, and lipids. If we assume that there is a clear relationship between the chemistry of rice and its functionality then it should be feasible to predict some rice functionality traits using NIR. NIR spectroscopy has the advantage of being rapid and non-destructive. However, most applications developed to date have involved milled rice or rice flour which rice breeders consider destructive since the ability for the kernel to germinate is annulled. In this presentation we will address several aspects of this technology. We will review the basic principles of NIR Spectroscopy and the various technologies available to date. We will also review several applications that have been developed or researched specifically for rice. These include the prediction of surface lipids, protein, amylose and cooked rice texture. We will then discuss other potential applications of this technology for functional properties such as color and pasting properties. Results of recent studies on rice color and pasting properties will be presented. Finally, we will present how we envision the use of this technology in breeding programs.

Advancements in color-sorting technology. M. STEPHENS. Sortex, Inc. Cereal Foods World 52:A5.

As customer demand for safe and clean foods continues to increase, food processors are seeking innovative and efficient ways to reach those demands without affecting the bottom-line. Buhler's advancements in SORTEX optical sorting technology are helping customers achieve these goals. We provide product options specific to their application needs in less time and at lower costs than with other solutions in the market. In our presentation we will provide an overview of the 4 basic principles of a color sorting system. We will discuss the differences in monochromatic and bichromatic color sorting. We will then focus our discussion on our latest developments in the inspection system, including color and shape recognition, and how it can be utilized for different applications. Lastly, we will discuss the options available on the bichromatic sorting machine, particularly shape recognition, and how it can be combined to simultaneously detect color defects, shape and size.

The application of Multi-Isotopic and Trace Element (MITE) analysis to determine the geographical origin of rice. S. KELLY. Institute of Food Research. Cereal Foods World 52:A5.

The globalisation of food markets and the relative ease with which food commodities are transported through and between countries and continents means that consumers are increasingly concerned about the origin of the foods they eat. A growing number of research articles have been published in the last 5 years detailing the use of natural abundance isotope variation and elemental concentrations as geographic 'tracers' to determine the provenance of food. These investigations exploit the systematic global variations of stable isotope ratios of the bio-elements in combination with elemental concentrations and other biogeochemical indicators. The combination of these techniques with multivariate statistics to determine the geographical origin of food is a growing area of research and the techniques are established in criminal forensic science, ecology and Forensic Archaeology. Specific details of research on differentiating the origin of premium long grain rice from India, Pakistan, Europe and the USA using Isotope Ratio Mass Spectrometry (IRMS) and Inductively Coupled Plasma Mass Spectrometry (ICP-MS) are presented. Nine key variables were identified by canonical discriminant analysis as providing the maximum discrimination between rice samples from these origins. High concentrations of boron were associated with rice samples from America and notably high concentrations of holmium were found in rice samples from the state of Arkansas. European rice samples generally contained relatively high concentrations of magnesium and Indian/Pakistani samples were characterised by relatively low oxygen-18 abundance. The application of MITE to the provenance determination of other cereals and foods will be briefly discussed.

RiceCAP: Development of molecular markers associated with long grain milling yield. A. MCCLUNG, E. Boza, R. Fjellstrom, Z. Guo, F. Jodari, S. Linscombe, K. Moldenhauer, J. C. Nelson, J. Oard, B. Scheffler, and X. Sun. USDA-ARS, Beaumont, TX. Cereal Foods World 52:A5.

U.S. rice breeders are focused on developing new cultivars that have high yield and high milling quality. Using traditional breeding methods, it takes approximately ten years to develop a new cultivar. Development of molecular markers that are closely linked to traits of economic value will increase the effectiveness of selection and will allow materials having limited breeding value to be quickly discarded. RiceCAP is a multi-state, multi-discipline research project funded by the USDA CSREES National Research Initiative which has the goal to develop DNA markers that are associated with long grain milling yield. Three long grain mapping populations have been developed to identify chromosomal regions using microsatellite markers that are associated with traits that influence head rice yield. As a result of this research, new techniques have been developed to accurately quantify grain characteristics known to influence milling quality. These include using an image analysis system to measure grain dimension and quantify chalk and an improved method to assess fissuring susceptibility. Results from analysis of the first mapping population, involving Cypress/RT0034, have identified

significant quantitative trait loci (QTL) associated with grain dimensions, susceptibility to grain chalk, grain fissuring, and whole grain milling yield. These markers are being validated in a second mapping population derived from Cypress/LaGrue. RiceCAP is facilitating the integration of molecular technology into each of the public U.S, breeding programs so that new discoveries in genomic research can be used by the rice breeding community for the development of new cultivars that have high value and which will help the US rice industry remain competitive in the global market.

Using genetic engineering to improve nutritional quality of rice. M. A. GRUSAK. USDA-ARS, Children's Nutrition Research Center. Cereal Foods World 52:A6.

Rice is a good source of readily digestible starch and protein, which are important to humans for energy or as a source of amino acids. Rice's concentration of vitamins, minerals, and health-promoting phytochemicals, however, is quite low, especially when one assesses the polished grain. These nutrient limitations are not a major concern for consumers in developed countries, where rice is eaten in a mixed diet; however, it is a major concern in developing countries where rice is a staple food, and might contribute 50–70% of daily caloric intake in some populations. To enhance the nutritional value of rice, researchers have designed several genetic engineering strategies to manipulate the expression of diverse biosynthetic pathways in the developing rice grain. Sufficient molecular information is now available to alter carotenoids (especially pro-vitamin A), tocopherols and tocotrienols (vitamin E), folate, and even amino acid or protein levels. Similarly, there are strategies available to enhance the mineral composition of rice through alterations at the grain and/or whole-plant levels. In this presentation, we will focus our discussion on Golden Rice, the transgenic product that produces beta-carotene in the grains, as an example for other genetic engineering strategies. We will discuss how efforts are already underway to combine more nutritional traits onto a Golden Rice platform. We will provide an overview of the range of nutritional strategies that are possible for rice, the impact these changes might have on the farmer, and the challenges/benefits these might pose to the processor. Lastly, we will discuss the dietary impact of these nutritional changes for the consumer and the potential opportunities for those who market rice products.

Using associative genetics to better understand rice end-use quality. C. BERGMAN, R. Fjellstrom, and M.-H. Chen. University of Nevada, Las Vegas, NV. Cereal Foods World 52:A6.

Most crop end-use quality characteristics are complex traits under multi-gene control. Improvement of such traits is challenging due to the reliance on time consuming phenotyping methods and data that is confounded by environmental effects. Marker assisted methods lessen the challenges of breeding by providing data for selection purposes that are not influenced by the environment. Historically, genetic markers have been identified by first creating a progeny population segregating for the trait of interest. The population is phenotyped, scored for genetic markers placed throughout the genome, and associations between the two identified by mapping the proportions of phenotypic variation explained by the markers. The power of this method, known as quantitative trait loci analysis, is limited due to the multiple years required for population development and the restricted number of genetic recombinations that are typically present in mapping populations. Association genetic analyses can overcome these constraints by using germplasm that is unrelated and contains a high degree of phenotypic variation, and which normally has more genetic recombinations between markers and traits compared to mapping populations. Thus, lengthy population development is avoided. A mapping type approach can be performed by genotyping markers across the genome for each accession and then identifying associations between markers and the trait of interest. Also, mutations in candidate genes can be identified, genotyping of the accessions performed and associations between the mutations and phenotypes evaluated. Both approaches have been used to a limited degree to identify genetic markers associated with end-use quality traits of cereal grains. This presentation will focus on the use of the candidate gene approach to association genetics as related to several rice starch traits.

Chalk—A perennial problem of rice. A. Resurreccion and M. FITZGERALD. Grain Quality, Nutrition and Postharvest Centre, International Rice Research Institute, DAPO 7777 Metro Manila, The Philippines. Cereal Foods World 52:A6.

Chalk, an opaque area in the rice grain, is one of the criteria used to grade rice in domestic and international markets. Chalk decreases the value of rice resulting in less profit for farmers and traders. Chalkiness can cause grains to break during de-hulling and milling, thus reducing the yield of whole milled rice. High temperatures generally induce chalk, and is a world that is becoming warmer, the effect of high temperatures on forming chalk will become, and is becoming, a significant issue. The objective of this work is to determine the effect of high temperature on the physical processes of grain-filling that lead to chalk. IR8, which has a large panicle with many secondary branches and IR60, which has a small panicle with few secondary branches, were grown at either high or low temperatures in the phyotron. Plants were reduced to a single culm. At either, 6, 10, 15, 18, 22, 25, or 28 days post anthesis (dpa) 4 plants were pulsed with ^{15}N to determine source-sink dynamics of delivery to the panicle at that stage. ^{15}N was supplied for 2 days and was followed with incubation in water for 2 days. The plants were harvested immediately after the water chase and ^{15}N content of panicles was determined. High temperature significantly affected the delivery of sugars to the grain, and this significantly affected the ability of grains on secondary branches to develop fully. Further, we found that the starch granules in the dorsal slices are much larger and contain more starch than the starch granules in ventral slices. This suggests that the pattern of grain development causes the ventral side of grains to develop later. The effect of sugar supply and growth of starch granules on chalk will be discussed.

Emerging Technologies Applied from Cereal Grains to Process and Product Analysis

Innovation in milling technology to exploit the nutritional potential of wheat grain. J. ABECASSIS, C. Barron, M. Chaurand, Y. Hemery, X. Rouau, and V. Lullien-Pellerin. UMR1208 Agropolymer Engineering and Emerging Technologies INRA, SupAgro, UM2, CIRAD. Cereal Foods World 52:A6.

Conventional milling aims at recovering pure endosperm in form of white flour. However, wheat grains are considered as a potential source of bioactive compounds (fibres, micronutrients, phytochemicals) but mostly eliminated during the milling process with the bran. The recovering of these bioactive compounds is hampered as they are partly co-localized with some other detrimental compounds (mycotoxins, heavy metals,...). New knowledge and new technologies are needed in order to prepare safe and nutritionally enriched cereal ingredients and foods. Research on wheat grain fractionation are being developed with the aim to fully exploit the potential of the grains, in including positive compounds and increasing their bioaccessibility and in excluding negative compounds. To help the development, optimization and control of new processes as well as to deliver a more precise composition of the generated fractions, a system of reliable markers of the different grain tissues and sub-structures was developed. Combinations of conventional (milling, grinding, sieving) and advanced technologies (pre-treatments, debranning, abrasion, attrition, jet-milling, air-classification) demonstrated the possibility to produce flours containing selected peripheral compounds or to prepare different fractions of contrasted composition from brans.

Innovative tracks in bake off technology. A. LE-BAIL. ENITIAA-GEPEA. Cereal Foods World 52:A6.

This paper presents an overview of the technologies used at the industrial level for the production of bread and of viennoiseries using refrigerated dough or baked products. Refrigeration plays a major role in these technologies also called "Bake Off Technologies". Some examples will be given on frozen part baked bread, prefermented frozen dough. Challenges in term of quality and tracks in term of innovation will be outlined.

Reduction of energy consumption during industrial baking: A newly designed pilot oven is used to assess key parameters and elaborate appropriate strategies. M. MARCOTTE. Agriculture and Agri-Food Canada, Food Research and Development Centre, St. Hyacinthe, QC, Canada. Cereal Foods World 52:A6.

Baking industry is one of the major energy consuming food industry. Baking cycles are usually established using a trial and error approach to obtain good quality products. Very little consideration is given to the energy consumption. Baking is a very complex process where many physicochemical changes (e.g. textural, color, volume expansion etc.) take place. Quality parameters (e.g. shape and volume, color, texture, moisture content and mouthfeel) must always be taken into account and coupled with energy saving actions as they may be conflicting. Similarities can be found with drying operations but major differences are observed (e.g. volume expansion instead of shrinkage, high temperature being applied, low air velocity, high air humidity, and low moisture evaporation). This paper provides an oriented review of the energy aspects during industrial baking. To allow a thorough understanding of the industrial baking, a new prototype pilot oven was developed and com-

missioned reproducing industrial baking conditions at laboratory scale. Special features of this oven will be presented. The characterization of the baking process will be discussed as well as the method developed to link industrial conditions to laboratory baking. Based on some similarities between baking and drying, two practical methods of energy savings for the bakery industry will be presented.

Generation of pores in food materials by dehydration with radiant energy under vacuum (REV). T. DURANCE, P. Yaghmaee, J. Sundaram, and M. Ressing. The University of British Columbia, Vancouver, BC, Canada. Cereal Foods World 52:A7.

Dehydration by application of radiant microwave energy under vacuum has been shown to maintain porous structure in dried plant and animal tissues, resulting in microstructure appearance similar to that of freeze-dried tissues. During REV processing steam bubbles are generated by the absorption of microwave energy which raises the temperature of intracellular water above the boiling point. Viscoelastic structures initially trap steam to create pores and subsequent dehydration may stabilize the pores. Wheat flour dough and starch, pectin, alginate and gelatin gels were employed to investigate the impact of rheology, dielectric properties, and microwave power on expansion and porosity of the dried materials. Resonance chamber and traveling-wave designs of vacuum microwave equipment are discussed with respect to generation of porosity. A finite element model was employed to test theories of expansion. Video monitoring of the REV process suggests that expansion of entrapped non-condensable gases was also a factor that contributed to total porosity. Apparently total porosity of REV dried materials increases up to a critical Young's modulus, then declines as E increases further, with the critical E value varying substantially for different materials. Dry REV materials exhibit total porosity of up to 88% and pore throat diameters from 1 to 500 microns.

High pressure calorimetry and scanning transitiometry in situ studies on the impact of pressure on the starch gelatinization. S. L. RANDZIO, M. Orlowska, and A. Le-Bail. Polish Academy of Science. Cereal Foods World 52:A7.

Starch is one of the most important natural macromolecules. Its importance comes basically from the fact that the starch granule is an almost universal form for packaging and storing carbohydrate in green plants, including many cereals. Starch is a natural renewable raw material important for food, pharmaceutical and chemical industries. Elaboration and production of biodegradable copolymers with starch becomes an important challenge in the preservation of natural environment. Fundamental understanding of the influence of starch processing on end products requires studies to elucidate how the physical properties of end products vary as a function of conditions encountered in processing. Temperature and pressure parameters are the most important variables relevant to processing, especially in extruxion. The impact of temperature and water content have already been extensively used as variables in physicochemical investigations of starch. However, the impact of pressure has not been studied that much, especially as it is concerned with in situ studies. We present here investigations on pressure influence on the phase transitions encountered during thermal gelatinization of wheat starch aqueous suspensions. The in situ investigations have been performed with the use of high pressure calorimetry and scanning transitiometry over the temperature range from 285 K to 415 K under pressures up to 100 MPa. The reported results are concerned with detailed data on the dT/dp slopes of the transitions encountered during gelatinization and their enthalpy and volume variations. On the basis of the obtained results it is now possible to predict the physical state of a given aqueous suspension of wheat starch over very wide pressure and temperature intervals, what is of importance in planning any processing with the use of wheat starch as a raw material and to understand the complicated phase diagram of starch.

High hydrostatic pressure processing applied to dough and bakery wheat products. J. Á. GUERRERO-BELTRAN. Universidad de las Américas-Puebla-Mexico. Cereal Foods World 52:A7.

High hydrostatic pressure is one of the novel technologies applied to treat food products to accomplish a number of objectives. The inactivation of microbial load and/or enzymes is one of the main targets when applying high pressure to foods. However, there are other results that can be obtained when using pressure in foods. Composition of cereal products can be affected by high pressure, mainly when water is present. Pressure can induces denaturation (coagulation and/or gelatinization) of biomaterials such as starch and proteins. Starch and proteins (gliadins and globulins) are the main components in flour to prepare cereal processed products. Since high pressure can affect the intermolecular interactions in the polypeptide chain and in the starch chain some "special" polymeric structures can be obtained from proteins and starch that can give different rheological properties to cereal doughs. Rheological characteristics of high hydrostatic pressure treated dough are different to non-pressurized dough. New textural characteristics can be obtained from pressurized doughs. As a result, new varieties of baked food products can be offered to consumers.

Ultrasound technology to develop the baking process. J. SALAZAR. Polytechnic University of Catalonia (UPC), Barcelona, Spain. Cereal Foods World 52:A7.

Sensors and instruments based on non-contact methods are especially attractive to the food industry to be employed in quality assurance, process control and non-destructive inspection, for being both hygienic and easy to maintain. Within the baking industry, the control of dough and batter properties is required to achieve final product quality and consistency. While traditional methods are slow and off-line, ultrasound provides a non-destructive, rapid and low cost technique for the measurement of physical food characteristics. The ultrasonic wave parameters generally measured are the velocity of propagation, the attenuation of the acoustical wave travelling through the material and the acoustical impedance. These parameters can be related to several physical properties of the material such as hardness, density, elastic modulus, grain structure and others. In this work, the rheological properties of dough were investigated using ultrasonic techniques. The measurements were correlated with dough quality tests. Extensive tests have been carried out on many different types of dough for bread, pastry products, biscuits and cookies and flours. Experimental results on different flour quality, water content and dough processing are presented indicating that ultrasound measurements are able to separate flour types with specific properties of velocity and attenuation. The relationship between measured ultrasonic parameters and final product quality is discussed since ultrasound seems to be affected by the physical properties of dough that could affect final bread quality attributes. Ultrasound has provided discriminatory results and can therefore be used for the creation of control charts that could be used to monitor the production and control of process, which would lead to improve product quality and reduce dough waste.

Empowering Rheology with Modern Techniques for Meeting the Challenges of Consistent and Quality End-Products

New instrumentation in dough rheology. J. DREISOERNER and S. Iaquez. C.W. Brabender Instruments Inc. Cereal Foods World 52:A7.

Wheat is a unique food grain due to its ability to form an elastic gluten structure. The physical properties of gluten have a major influence on the baking performance of various wheat-related goods. Protein in the flour (gluten) combines with water to produce an elastic and porous web capable of trapping gas bubbles released by the action of a leavening agent. Therefore, to establish a test method that measures the forming ability of gluten network structures in an easy, quick, and reliable procedure is of great importance to the Baking Industry. The Gluten Peak Tester (GPT) is a new instrument specifically designed to measure gluten properties. A sample of water/flour or water/gluten-starch mix is produced under high speed mixing using a specific geometric paddle -- during the test, the gluten is separated. Then the ability of the gluten in regards to its building capacity and strength structure is measured. Evaluation is done by the provided software. In the internal study, different wheat samples and different vital gluten samples have been used to develop a new, easy, and efficient test method utilizing the GPT. The entire test procedure is completed within 5–10 minutes (depending on the strength of the gluten).

New information on dough rheology from low-intensity ultrasonic techniques. M. G. SCANLON, J. H. Page, V. Leroy, G. G. Bellido, Y. Fan, and K. L. Mehta. University of Manitoba. Cereal Foods World 52:A7.

The appearance and texture of many cereal products is critically dependent on the gas cell structure created during processing. Low-intensity ultrasound measurements are particularly useful in monitoring gas cell development because of their sensitivity to the presence of bubbles in viscoelastic materials. Measurements of ultrasonic velocity and attenuation over a wide range of frequencies have allowed us to gain new insights into the structure, properties and dynamics of cereal dough systems. We have examined the effect of surface-active bakery ingredients on ultrasonic propagation in dough, and how such ingredients alter dough matrix properties as well as alter bubble entrainment capacity. We have observed Ostwald ripening of bubbles within

breadmaking doughs made without yeast, a novel observation dependent on ultrasound's ability to probe bubble sizes inside opaque food systems, and confirmed this phenomenon using transmission and reflection techniques. A model for ultrasound propagation in bubbly materials is currently being applied to estimate mean bubble radius from measurements of the frequency dependence of ultrasonic velocity and attenuation. Ultrasonic velocity and attenuation were also used to study time-dependent changes in dough with higher volume fractions of gas brought about by various chemical leavening agents. Using effective medium models, we have determined the contribution of matrix and bubbles to the overall properties of the system. Ultrasound is an emergent technique for the cereals processing industry with the potential to provide new information on dough properties that will allow better prediction of the cellular structure of the resulting loaf of bread.

An overview of U.S. wheat marketing system and the role of rheology. R. CHINNASWAMY. USDA. Cereal Foods World 52:A8.

Six major U.S. wheat classes are meant to describe the end-use qualities of wheat such as bread. Five U.S. numerical grades mainly describe physical properties of the grain such as bulk density and damage. There are about 275 popular wheat cultivars grown across the U.S. Most of these cultivars are blended or mixed or grouped and classified into six classes based on the U.S. Grain Standards. Once harvested, the wheat begins its journey towards the end-users in a variety of ways. The wheat flows into and mixes within combines, trucks, grain-bins, silos, rail cars, barges, ships; next, it continues flowing and mixing in the form of flour in mills, and finally as a dough towards an end product in food production plants. In other words, the wheat flows and mixes continually in the grain marketing chain in one form or another. This action of flowing and mixing of large quantities of wheat cultivars, flours, or dough continually changes its rheological temperament. Therefore, the role of rheology is important to FGIS in assessing wheat functional qualities throughout the wheat marketing chain in order to improve both consistency and marketing terms. The end-use and the end-user functional quality assessments of wheat are expected to vary worldwide. A market survey conducted by the U.S. Wheat Associates showed that there are over one dozen tests used worldwide to assess wheat end-use qualities. Although the end-use quality criteria varied from country to country, almost all wheat quality testing involved rheological examination of dough. The popular rheological methods used for examining dough properties are Farinograph, Alveograph, and Mixograph. These methods are cumbersome, time consuming, highly variable, and unsuitable for testing wheat in the field. Since 2003, FGIS has been working with the wheat industry to standardize existing rheological methods as well as looking for quick tests to assess rheological characteristics of wheat—viscous and elastic properties of gluten. The wheat industry needs a rapid rheological test or a rapid NIR test that can predict the rheological properties of wheat for blending, segregating, and marketing of wheat based on its rheological behavior from the farm gate to the end-user.

Ensuring precise processing and foaming of molten starch with rheological tools. M. MACKLEY and N. Nowjee. University of Cambridge. Cereal Foods World 52:A8.

This talk will provide an overview on the way a Cambridge Multipass Rheometer (MPR) has been used to probe the rheology, processing and foaming behaviour of molten starch. The MPR provides unique pressure, temperature and flow control and has been used to measure both the shear viscosity and viscoelastic properties of molten starch containing low water content. The data can be linked to the extrusion processing behaviour of different starch formulations being processed under different conditions. By using optical windows and the fast pressure release facility of the MPR, foaming kinetics for certain starch formulations have been followed and modelled. The experimental results show that pressure release rate is one of a number of factors that affect the final bubble size of the foam caused by water coming out of solution during the foaming process. Water diffusion within the molten starch matrix also has a significant effect on the foaming kinetics.

Application of near infrared diffused reflectance for determining bread dough development. R. DEMPSTER, M. Olewnik, and V. W. Smail. American Institute of Baking International. Cereal Foods World 52:A8.

Current techniques for predicting proper development of dough during mixing include physical measurements based on mixing torque or power consumption. Initial research using Mid Infrared (MIR) and Near Infrared (NIR) spectra has demonstrated the possibilities of monitoring the development of dough during mixing and predicting the end point. In this study, a method was devised to monitor the development of "Straight Dough" and "Sponge and Dough" formulas in a laboratory mixer fitted with a water-jacketed McDuffee mixing bowl with a double helical agitator, and instrumented using a diode array Near Infrared spectrometer. By calculating a ratio of starch to protein in the presence of water during mixing, an optimum point occurs that correlates to peak dough development. Further application of the algorithm has demonstrated its effectiveness to determine peak dough development in a 300 lb. pilot scale horizontal mixer. Additionally, NIR calibrations have been implemented through a bench top NIR instrument that determine optimum water absorption and prediction of certain finished product quality attributes when the flour is scanned prior to entry into the mixer. These two methods can be combined into the mixing calculation in order to provide a system for objectively identifying these variables prior to and during the initial mixing process. Combining these two NIR approaches into one system, leads to effective control of the dough consistency, and hence the finished quality characteristics of dough/bread, for any given bread flour quality.

Dynamic rheology methods with applications in extrusion and baking. J. KOKINI and N. Sozer. Rutgers University. Cereal Foods World 52:A8.

This paper will focus on using dynamic rheological methods to understand the performance of cereal materials during baking, extrusion and other unit processes as well as the link between fundamental rheology and the baked and extruded product performance as a function of process history. Sound rheological measurements are obtained through well defined geometries and in relatively small deformations. Food process operations on the other hand are conducted in ill defined geometries and at large deformations. Bridging high quality rheological measurements with process needs has remained a challenge. This presentation will focus on transformation of small deformation rheological measurements into large deformation behavior. The math is often complicated but the outcome is useful. A lot of slow and painful but moderately successful results are beginning to emerge utilizing rigorous rheological methods to link fundamental rheology with processing performance and quality needs. This talk will review some of the recent progress and offer some thoughts on how to gear up useful research to bridge the large gaps that still exist.

Enzymes in Cereal Processing: A Focus on Breadmaking

Enzymes in breadmaking: Economic relevance, markets, future perspectives. L. POPPER and L. H. Kutschinski. Muehlenchemie GmbH & Co. KG, Kurt-Fischer-Strasse 55, D-22926 Ahrensburg, Germany. Cereal Foods World 52:A8.

According to recent studies, the market for baking enzymes (added at the flour mill, via bread improvers or as they are at the bakery) will continue to grow. The annual growth rate is estimated to be 7.2%, with the volume rising from 32.1 million € in 2003 to 52.3 million € in 2010 (Frost and Sullivan, 2005). In developed markets like the U.S. or the EU the growth is mostly generated in rather new segments such as frozen dough and pre-baked bread, or by new enzymes such as lipases. In emerging markets the demand is primarily for "classic baking enzymes", i.e. amylases and xylanases. Enzymes are defined as processing aids, but they do not just improve the processing. In particular xylanases, lipases and amylases can improve the volume yield, the crumb structure and the appearance of baked goods. When combined with specific amylases they can prolong the shelf-life of bread, reducing the cost of returned bread. The flour yield can be increased because enzymes are able to compensate for some of the volume loss caused by increased amounts of aleuron layer in the flour. Other enzymes lighten the color of the crumb, improving the acceptance of bread made from darker flour. Certain oxidases and pentosanases improve water absorption and thus the bread yield. The wheat quality can be upgraded by enzymes, reducing raw material costs and flour quality fluctuations. Additives such as potassium bromate or emulsifiers can be omitted or reduced. In certain applications such as crispbread, enzymes significantly reduce the energy costs. Asparaginase has recently attracted the attention of bakers because the enzyme can help to reduce the formation of acryl amide in baking. Sulfhydryl oxidase for stabilization and feruloyl esterase for rheologicial fine-tuning just have achieved market maturity.

The role of cross-links and cross-linking enzymes in breadmaking. P. E. DEGN. Danisco A/S, Genencor Division, Brabrand, Denmark. Cereal Foods World 52:A8.

Intermolecular cross-links between cereal proteins play an important role in the functional properties of both dough and bread. This recognition has boosted research regarding chemical and enzymatic means to enhance and control the formation of such cross-links. Within the last two decades several

enzyme solutions have been proposed and investigated with the aim to substitute the chemicals traditionally added to modulate cross-link formation. Some solutions such as hydrogen peroxide generating carbohydrate oxidases and the isopeptide forming transglutaminase, have already been commercialised, others are still being investigated. Common for all the solutions is that they are set to work in an extremely complex matrix, comprising a multitude of chemically functional groups situated on all the major flour constituents (proteins, carbohydrates, and lipids). As many of the enzyme-induced cross-links can be regarded as product of secondary reactions initiated by a functionalisation of certain chemical groups, the cross-link formation is also inherently complex. However, equipment and analysis techniques are becoming more sophisticated, which makes it possible to identify and evaluate the significance of an increasing number of cross-links. This talk will give a short review of the enzymatic routes to cross-link formation in the dough matrix, the chemistry behind, and the functional properties obtained. Results from the recently concluded EU-project "Crossenz", which focused on cross-link formation by laccases and tyrosinases, will be included.

On glycoside hydrolase family 13 amylases and transferases and their use in breadmaking. M. J. E. C. VAN DER MAAREL. Business Unit Food and Biotechnology Innovations, TNO Quality of Life, Groningen, The Netherlands. Cereal Foods World 52:A9.

Starch is a mixture of amylose, containing essentially only alpha-1,4 linked glucose residues, and amylopectin, which is composed of an alpha-1,4 linked glucose polymer branched with alpha-1,6 linkages. It is an important energy reserve of plants such as rice, maize, wheat, and potato. The amylose and amylopectin are is stored in compact spherical granules and that are insoluble in water at ambient temperatures. Upon heating, the granules swell and the amylose and amylopectin chains become hydrated. Complete solubilization of starch, i.e. disrupting of the granular form and release of the amylose and amylopectin in solution, is reached at higher temperatures. Subsequent cooling leads to retrogradation, an irreversible process in which the amylose chains interact by hydrogen bonding resulting in the formation of a gel. During baking, the starch granules also swell but this does not lead to a complete release of the amylose/amylopectin. Some of the amylose leaks out of the granule, while a fraction of the granules become damaged, resulting in the release of amylose and amylopectin. Enzymes of the glycoside hydrolase (GH) family 13 hydrolyse the *O*-glycosidic linkage and degrade the amylose/amylopectin to short chain maltooligosaccharides, maltose and glucose. To improve the properties and quality of the bread regular amylases (e. g. Fungamyl), maltogenic amylase (e.g. Novamyl) and maltotetraose forming amylase (e.g. Grindamyl) are added. The transferase enzymes of the GH family 13 such as cyclodextrin glucanotransferase and branching enzyme do not hydrolyse but modify the amylose/amylopectin. They initially break the *O*-glycosidic linkage and use another oligosaccharide as acceptor substrate to form a new *O*-glycosidic linkage. The (possible) use of these different members of the glycoside hydrolase family 13 enzymes in dough preparation and baking will be discussed.

Enzymatic degradation of celiac-toxic proteins and peptides. P. KOEHLER, G. Hartmann, and H. Wieser. German Research Center for Food Chemistry, Lichtenbergstrasse 4, 85748 Garching, Germany. Cereal Foods World 52:A9.

Celiac disease (CD) is an inflammatory disease of the upper small intestine in genetically susceptible individuals caused by glutamine- and proline-rich peptides from cereal storage proteins (gluten) with a minimal length of nine amino acids. Such peptides are insufficiently degraded by gastrointestinal enzymes; they permeate into the lymphatic tissue, are bound to celiac-specific, antigen-presenting cells and stimulate intestinal T cells. The typical clinical pattern is a flat small intestinal mucosa and malabsorption. The only therapy is a strict lifelong gluten-free diet. Different authors have shown that celiac-toxic peptides can be degraded by bacterial and fungal prolyl endopeptidases as well as by lactobacilli. Accordingly, preparations containing these enzymes have been suggested for the 'detoxification' of gluten-containing raw materials and for an oral therapy. Another approach to hydrolyze celiac-active peptides are endogenous cereal petidases, which are known to degrade storage proteins during the germination of the seed. Therefore, they were tested for their capability to detoxify gluten peptides by extensive fragmentation. Kernels of wheat, rye, barley, and corn were germinated up to seven days, freeze-dried and milled into flour and bran. Generally, the proteolytic activity was significantly higher in the bran compared with flour; wheat, rye, and corn brans were more active than barley bran. A highly active peptidase fraction was extracted from rye bran and incubated with celiac-toxic peptides; their degradation was followed by RP-HPLC and mass spectrometry. The results demonstrated that the peptides were cleaved into non-toxic small peptides and amino acids very quickly. The protease fraction consisted of endo- and exopeptidases; they were active within a pH-range from 3.0 to 9.0 with optima at 4.5 and 6.5, and at temperatures up to 60°C. Proteases can easily be enriched by ammonium sulfate precipitation. In comparison with bacterial and fungal proteases described in literature, petidases of germinated cereals appear to have distinct advantages.

Lipases—Unlocking the dough strengthening potential of flour. H. LUNDQVIST, L. Erlandsen, P. B. Arskog, C. Jørgensen, J. Vind, L. De Maria, and T. Fatum. Novozymes A/S, Krogshøjvej 36, DK-2880 Bagsvaerd, Denmark. Cereal Foods World 52:A9.

The use of triglyceride modifying lipases for bread making has been known for many years. They are applied to give bread volume, crumb structure and crumb softness. Recently, the use of lipases in the baking industry has escalated with the introduction of lipases with activity towards polar lipids. Besides the benefits mentioned above, these lipases provide a dough stabilizing effect and they are used as cost efficient alternatives to emulsifiers in many bread processes. The popularity of these new lipases has also resulted in renewed interest in the role of flour lipids as stabilizers of the foamy dough structure. Particularly, the importance of the liquid lamellae or the dough liquor in relation to dough stability has attracted major attention. This paper will review the current knowledge and development in this area. The effect of lipases on surface properties of dough liquor has been investigated by the pendant drop technique. It was found that lipases with activity towards polar lipids are more efficient in promoting changes to the surface properties than lipases only active on triglycerides.

Concepts for understanding and optimising xylanase functionality in cereal processing. C. M. COURTIN and J. A. Delcour. Laboratory of Food Chemistry and Biochemistry, K.U. Leuven, Leuven, Belgium. Cereal Foods World 52:A9.

Although arabinoxylans are minor constituents in cereals, these cell wall non-starch polysaccharides can have a large impact on process parameters and/or final product quality in biotechnological processes where cereals are used. This becomes especially evident through the use of xylanases. These enzymes hydroyse the arabinoxylan xylan backbone in a random manner and, by doing so, catalyze the conversion of water-unextractable arabinoxylan to solubilised arabinoxylan on the one hand and the degradation of water-extractable and solubilised arabinoxylans to lower molecular weight compounds on the other hand. In order to understand functionality of exogenously added xylanase in processes such as bread making, gluten-starch separation and pasta making and in animal feed it has become increasingly clear that insight in the preference of an endoxylanase for the hydrolysis of water-unextractable versus water-extractable arabinoxylan is of major importance. In addition, xylanase functionality is not only dependent on the enzyme itself, but also on xylanase inhibitors that are endogenously present in a number of cereals and interfere with enzyme activity. This presentation aims to provide a clear, up-to-date view on the impact of the trio xylanase, arabinoxylan and xylanase inhibitor in cereal processing, with an emphasis on breadmaking.

Oxidoreductases and related enzymes in breadmaking. J. NICOLAS. Conservatoire National des Arts et Métiers - UMR SCALE 1211 (ENSIA-CNAM-INRA). Cereal Foods World 52:A9.

Abstract not available.

New Applications of Ancient Cereals

Teff and other millets: Small grains with a big future. J. TAYLOR. University of Pretoria. Cereal Foods World 52:A9.

Millets are simply cereals with very small grains. At least 12 different species are cultivated. They are tropical grasses of two different tribes, the Eragrostideae to which teff and finger millet belong and the Paniceae to which the others belong, including the most common species: pearl millet, proso millet and foxtail millet. Despite the fact that collectively millets are the sixth most important cereal, our knowledge of their food chemistry is very limited and the technologies to process them into foods are mostly still at the household level. This situation is beginning to change as people seek more variety in their foods, in order to promote long-term good health. In this respect, each of the millets has particular unique characteristics that make them attractive as specialty foods. For example, teff is preferred for making the Ethiopian leavened flatbread injera. This good breadmaking property of teff flour seems to be related to the fact that it has compound starch granules.

Some finger varieties contain condensed tannins, like sorghum, which have strong antioxidant properties. Millets are very versatile food ingredients. Traditional and modern products include: flatbreads, instant porridge, extruded snacks, couscous, fermented non-alcoholic and alcoholic beverages.

Spelt: Primitive wheat and new prospect. E. ABDELAAL. Agriculture and Agri-Food Canada. Cereal Foods World 52:A10.

Spelt (*Titicum aestivum* ssp spelta) was the predominant bread wheat from the fifth century until the beginning of the twentieth century but currently is grown only on a limited scale mostly for organic and specialty foods. It is the ancestor of modern common wheat exhibiting similar genetic makeup of three pairs of genomes designated as AABBDD. Nowadays spelt is considered the wheat of choice for organic agriculture (i.e., no use of synthetic fertilizers, pesticides or genetically modified materials) due to its ability to better utilize nutrients in a low-input system, to perform well in suboptimal growing conditions and to fight a number of pathogens. A diverse range of organic and non-organic foods have been developed from spelt and commercially produced. These include conventional and specialty foods such as pan bread, pita bread, pasta, breakfast cereal, cookie, biscuit and muffin. The quality of these products could be enhanced by choosing the appropriate spelt cultivar and/or by manipulating processing conditions. Studies on protein, starch and fiber in spelt and common wheat products have shown some differences in their nutritional properties and digestibility. Some spelt cultivars contain high levels of resistant starch and relatively have different soluble dietary fiber compositions compared to common wheat. In addition, consumers claim a sense of well-being when they consume spelt products. They believe spelt products are more tolerable and healthier than normal wheat products but the facts to support such claim remain unclear. More research on health-enhancing constituents and phytonutrients in pure spelt products may help substantiate this claim. On the other hand, spelt proteins and amino acid sequences were found to be similar to that of common wheat indicating potential gluten toxicity in celiac disease. The compositional aspects and recent developments in spelt use will be discussed.

Innovative food products from amaranth and quinoa. G. LINSBERGER, R. Schoenlechner, and E. Berghofer. University of Natural Resources and Applied Life Sciences, Vienna. Cereal Foods World 52:A10.

Amaranth (Amaranthus spp.) and quinoa (*Chenopodium quinoa*) are representatives of pseudocereals – plants that form starch-rich seeds. Amaranth and quinoa have excellent nutritional properties like high protein quality, good fatty acid pattern and high content of minerals. Contrary to cereals, the starch granules in amaranth and quinoa are stored in the so-called perisperm and pseudocereals do not contain the network forming gluten. The lack of gluten requires special adaptations in food processing but makes them suitable for persons suffering from coeliac disease. Due to these nutritional and physical unique properties amaranth and quinoa are a very valuable and interesting alternative for incorporation into our diets and qualify them for the production of new innovative high quality food products with new taste and flavour characteristics. Investigations on a range of products from pseudocereals have been carried out. Gluten free products from pure amaranth or quinoa or from mixtures thereof like non-dairy beverages, extruded or popped products, noodles and biscuits were produced and characterised. Mixtures of amaranth or quinoa with wheat flour or legume flour were used for the production of cookies, noodles and bread. Our investigations showed that after adaptation of processing parameters and recipes tasteful functional food products with amaranth and quinoa can be produced.

Progress in utilization of sorghum for healthy foods & phytochemicals. L. ROONEY. Texas A&M University. Cereal Foods World 52:A10.

Sorghums with high levels of anthocyanins and condensed tannins have unique properties compared to other cereals. The condensed tannins located in the pigmented testa are high molecular weight and have strong antioxidant activity. They can be concentrated in the bran to produce high levels of antioxidants, dietary fiber, luteolinidins and apigeninidins which are relatively rare in nature. In addition, other sorghum types have significant quantities of flavones. Breeders have developed specific sorghums with unique combinations of these components. These and white sorghums have been formulated into a wide array of food products including deep purple tortillas, chips, natural colored high fiber baked products and whole grain cooked like rice. Sorghum is used in gluten free products for Celiacs, including baked and extruded products, beer, and many other items. Special sorghums have anti-breast and colon cancer activity, reduced digestion of carbohydrates relative to type II diabetes, and high dietary fiber levels. Internationally, sorghum is used in lager beer, alcohol production and a wide variety of non-alcoholic beverages and foods. Special USA white sorghums are used in an array of snacks and related products in Japan.

Novel application of buckwheat. F. DAL BELLO. University College Cork, Ireland. Cereal Foods World 52:A10.

Buckwheat (*Fagopyrum esculentum*) is a pseudocereal from the Polygonaceae family. Traditionally the plant has been grown in South-East Asia and Central and Eastern Europe, and today's main producers are China, Russia and the Ukraine. Interest in buckwheat has grown during the last decade due to its favourable nutritional properties. Besides starch as the main component, the buckwheat kernel contains high quality protein and polyunsaturated fatty acids. Buckwheat is rich in antioxidants and minerals and is therefore recommended as an ingredient for functional food products. Furthermore buckwheat is gluten-free and therefore acceptable for the diet of Coeliac Disease sufferers, who cannot consume products containing proteins from wheat, barley and rye. The objective of this presentation is to give an overview on buckwheat as a cereal, as well as reviewing its novel application in a wide range of products. One of the new applications of buckwheat has been its use for the production of gluten-free malt and beer. The impact of changing malting conditions will be reviewed and the results presented. It was possible to optimise the malting conditions to produce a raw material for the production of beer as well as novel functional drinks. Fundamental studies have also been carried out on the ultra-structural changes taking place during the malting of buckwheat. These were compared to the traditional beer-making grain, namely barley. Additionally, the use of buckwheat as a raw-material for gluten-free bread was investigated. Comparitative studies with other gluten-free cereals revealed that buckwheat is an excellent candidate for the production of gluten-free products of good quality, nutritional value and flavour. The resulting products were analyzed with a wide range of tests, from fundamental rheological evaluations to pilot scale baking tests and ultra-structural analysis. One of the main problems associated with gluten-free breads is the lack of structure. In University College Cork we have investigated the impact of network forming enzyme such as transglutaminase on the quality of gluten-free bread based on buckwheat. The rheological, baking as well as ultra-structural analysis revealed that transglutaminase is an excellent tool to achieve structurally sound gluten-free bread. The use of cereal proteomics allowed elucidation of the enzymatic reaction mechanism. In conclusion it can be said that buckwheat is a pseudocereal with high nutritional value which has a wide range of applications not yet fully exploited.

Structural and Chemical Imaging Techniques in Cereal Science: Beyond Conventional Microscopy

Digital image analysis in cereals. J. D. WILSON. USDA-ARS. Cereal Foods World 52:A10.

Image analysis is the extraction of meaningful information from images, mainly digital images by means of digital processing techniques. The field was established in the 1950s and coincides with the advent of computer technology, as image analysis is profoundly reliant on computer processing. As the computer sciences has expanded with respect to data storage and processing speed, the applications of digital image analysis has also expanded into all areas of science and industry. The cereal sciences industry has also expanded the use of image analysis to include: classification and morphological identification of cereal grains, phytopathological identification of diseases, milling yield and quality of various cereals, starch size distribution as related to quality, bread volume and crumb grain scores, noodle quality as well as numerous other aspects of cereal processing and research. This presentation will review some of the more recent developments and applications of image analysis in cereal research. Some of our own research concerning wheat starch size distribution as it relates to quality will also be discussed. Starch constitutes the greatest weight portion of the wheat endosperm (65–75%) and contributes its own unique functional qualities such as texture, volume, consistency, aesthetics, moisture and shelf stability to various baked products. Particle size, distribution and shape have long been recognized as an important variable in the efficiency of a range of processes including predicting rheology and flow behavior. Digital image analysis coupled to light microscopy offers the ability to have physical parameters recorded for each individual particle and be able to distinguish among individual granules, agglomerated granules, and non-starch particles.

Atomic force and integrated microscopies. P. COOKE. USDA-ARS. Cereal Foods World 52:A10.

Conventional microscopy and traditional microtechniques have contributed substantially to the enormous database from which we have developed our general understanding of the biology, chemistry and materials science of

agricultural commodities. These conventional and traditional approaches continue to help resolve important basic questions and add new information despite obvious drawbacks. Modern microscopy using digital imaging hardware allows one to probe structural features through contrast enhancements of the intrinsic properties of objects and/or processes of interest. Atomic Force Microscopy (AFM) is one example of scanning probe microscopy that has provided unique information about the nanoscale organization of extracted cell wall polysaccharides formulated into soft gels. Similarly, recent developments of variable pressure and environmental scanning electron microscopy (VP-ESEM) for example, obviate some drawbacks in sample preparation for study of uncoated, non-conductive surfaces. In one example, micro-porosity and gradual charring of native barley hulls as a potential bio-fuel feedstock was studied. Both AFM and VP-ESEM have been used in many laboratories to address a variety of questions concerning fundamental and applied properties of cereal grain starches and proteins with some success. Efforts to resolve structures and characterize processes draw benefits from comparative measurements made over several orders of magnitude. Integrative microscopy, where the same sample is examined in different specialized microscopes (imaging in series) or preparations (imaging in parallel), offers an array of advantages over conventional microscopy for understanding the connectivity between levels of organization and performance.

Application of microspectroscopy techniques to cereal chemistry in situ. L. N. PIETRZAK and S. S. Miller. Agriculture & AgriFood Canada. Cereal Foods World 52:A11.

Microspectroscopy is a technique which combines the microscope with the spectroscope. During the last 15 years, the use and capabilities of Fourier Transform Infrared (FTIR) microspectroscopy in biology and materials sciences have increased, including applications to plant and cereal science. Mid-infrared spectroscopy covers the range of the electromagnetic spectrum from 400–4000 cm-1 (2,500–25,000 nm), and is associated with the rotational-vibrational structure of molecules. Using synchrotron powered FTIR microspectroscopy, we have mapped/localized in situ some of the major chemical components (proteins, lipids and carbohydrates) in different tissues of cereal grains and mature soybean seeds. Improvements in FTIR microscopy have increased the spatial resolution, such that a single cell can be mapped, or even a cell wall, in certain cases. The protein secondary structure of soluble and storage proteins and their distribution within tissues will be discussed. FTIR microspectroscopy has also been applied to gluten formation during dough mixing and correlated with farinograph data. Combination of NMR microimaging and FTIR microspectroscopy data allows us to explain the pattern of water movement during imbibition processes in soybean seeds.

Spectroscopic imaging of grains: MIR and Raman. D. S. HIMMELSBACH. USDA-ARS. Cereal Foods World 52:A11.

Spectral imaging techniques, based on vibrational spectroscopy, have developed to the degree that they have formed a field known as chemical microscopy. When applied to cereal grains, these techniques can provide detailed information on the location and chemistry of multiple sample components such as starch, protein and lipids. In some cases, additional components can be identified and located. The two most definitive vibrational imaging techniques are mid-infrared (MIR) and Raman imaging. They provide complementary information. Infrared absorbance responds to vibrations that arise from dipole changes and Raman scattering to changes in polarizability. Fourier-transform infrared (FT-IR) imaging is most rapidly done using a focal plane array (FPA) but point mapping is still occasionally done. Raman imaging is mostly done in a dispersive mode that provides the highest spatial resolution (1 micron). FT-Raman with near-infrared (NIR) excitation is employed when fluorescence is a problem. Examples of four versions of these techniques as applied to corn, wheat and rice samples will be presented. These techniques are complementary to histological staining but often provide more definitive information.

Magnetic resonance imaging of foods. P. CHEN and R. Ruan. University of Minnesota, Dept. of Bioproducts and Biosystems Engineering. Cereal Foods World 52:A11.

Laboratory analysis of chemical and physical properties of foods and bioproducts often involves extensive preparation procedures, during which samples are severely disturbed by size reducing, deforming, or diluting steps. This is much in contrast to the way that consumers evaluate the quality of these products. For example, foods are consumed while their integrity is generally intact. One may ask: are the current chemical and physical methods for quality measurement reliable? Naturally, it would be desirable to be able to analyze chemical and physical properties in a completely nondestructive and noninvasive way. Nuclear magnetic resonance imaging or more frequently termed magnetic resonance imaging (MRI) can be used to nondestructively and noninvasively study the chemical and physical properties and phenomena, anatomical structure, and dynamic processes of raw materials and products. In this presentation, the basic principles of MRI techniques will be introduced and the relationship between NMR relaxation properties and quantity and states of water and solids and temperature will be discussed. Some typical examples of studies involving MRI such as state transition and heat and mass transfer, which are important to staling, hardening, storage, tempering, soaking, drying, heating of cereal foods, will be presented.

Confocal microscopy to study the effect of processing on the structure of gluten networks at different length scales. E. H. A. DE HOOG, H. J. Klok, S. H. Peighambardoust, C. Primo Martin, T. van Herpen, and R. H. Hamer. Wageningen Centre for Food Sciences. Cereal Foods World 52:A11.

The interactions between the bulk ingredients of food - proteins, polysaccharides and fats - determine the macroscopic physical properties of food. Confocal Scanning Laser Microscopy (CSLM) is uniquely suited to image the 1 micron to 1 mm sized structures that are typically present in food and are relevant from a processing and sensory point of view. CSLM needs fluorescent labelling of the ingredient to be imaged. By labelling different ingredients by different labels, they are imaged in different colours. In this way, the effect of combining specific ingredients on the microscopic structure can be learned. For example, the spreading of the gluten network by kneading bread dough (gluten and starch in different colours) has been studied with this method. Because confocal microscopy does not need the transmission of light across the sample, there is no necessity for very thin samples. As a consequence, structure well away from the surface of food stuff can be seen. An inverted configuration, in which the sample is observed from below, is convenient for combining microscopy with large equipment, such as heaters, rheometers and texture analysers. Such a combination allows the study of the response of food systems to mechanical and heat treatment in situ. Conditions can be chosen to mimic those of industrial and oral processing. In this presentation the state-of-the-art of Confocal Microscopy applied on food will be described. Standard and more advanced labelling techniques will be treated. Applications of CSLM in the study of the microstructure formation and large-deformation fracture properties of processed dough will be discussed.

X-ray microtomography: A powerful tool for nondestructive microstructural characterization. H. DOGAN. Kansas State University. Cereal Foods World 52:A11.

Most agricultural and food materials are complex mixtures that are physically and chemically heterogeneous. The spatial distribution of these properties has an impact on the final product characteristics. Structural probing of foods is of critical importance as their microstructure has significant effect on the processing, functionality, storage, stability, and end use of these products. This presentation aims to point out high-resolution X-ray microtomography (XMT) as a powerful tool for accurate microstructural characterization. XMT is a non-destructive technique that has been used successfully for structural investigation of a wide range of materials such as foods, rock, bone, ceramic, metals and pharmaceuticals. It is an emerging technique which operates on the same basic principles as medical CT scanners, but has a spatial resolution that is typically 5–20 μm. Its principle is based on contrast in the X-ray images being generated by differences in X-ray attenuation (absorption and scattering) arising principally from differences in density within the specimen. X-rays are passed through an object yielding an image which displays differences in density in a 2D slice through the specimen. Many contiguous slices, each of a certain finite thickness, are generated in this way and stacked to construct a 3D distribution of material density within the object. The scanning process is controlled by a software package via a computer, which also allows microtomographical reconstruction using a filtered back-projection algorithm. The features in the stacks of 2D images can be then quantified using image analysis software.

Whole Grains—Are We Hitting the Mark?

Whole Grains – Wholly unappreciated to wholly cow! J. M. JONES. College of St. Catherine, St. Paul, MN. Cereal Foods World 52:A11.

Over the past decade, research on the effects of whole grains on health has moved the agenda for these foods from the equivalent of a boring backwater hardly worth mentioning to being a metropolis with numerous avenues to study and mechanisms of action. New intervention and epidemiological data on the role of whole grains in diabetes, heart disease, hypertension, certain

cancers, weight control provide strong supporting evidence that whole grains are foods in the diet when omitted lead to long-term adverse health consequences. Whole grains tidy package of nutrients and phytochemicals offers numerous vitamins, minerals and phytochemicals as well as dietary fiber that are critical to health. This overview will concentrate on the most recent research on whole grains and their constituents and show how these data support previous findings, add new avenues in the body of knowledge and further the nutritional importance of these foods. Some potential mechanisms of action will be reviewed.

Progress towards increasing whole grains in the diet. L. MARQUART. University of Minnesota, St. Paul, MN. Cereal Foods World 52:A12.

Over the past 150 years the popularity and dietary intake of whole grains have moved full circle. The roller mill revolutionized the grain industry by setting the stage for many refined grain product introductions in the late 1800's, which many remain as today's market leaders. More recently, the scientific evidence, policy / regulatory statements and consumer understanding about whole grain foods have slowly evolved. However, a dramatic paradigm shift occurred in the grain industry with the release of the 2005 Dietary Guidelines as whole grains moved front and center. Industry leaders were challenged to decipher optimal approaches to deliver whole grain products to consumers despite numerous barriers, opportunities and incentives throughout the grain supply chain. The market leaders of tomorrow will deliver whole grain products that are less caloric dense (higher fiber, lower fat and sugar), meet consumer cost requirements, and have taste appeal.

Success of current whole grain products and future trends. C. HARRIMAN. Oldways, Portsmouth, NH. Cereal Foods World 52:A12.

1554 new whole grain products were introduced in 2006, a ten-fold increase over those launched in the year 2000. From a baseline of cereals and breads, offerings have expanded to include cookies, crackers, waffles, pizza crust, and even drinks. At the same time, manufacturers have finally learned how to make whole grain foods both delicious and nutritious, creating choices that are worlds away from the hard and chewy prototypes of the Birkenstock era. Which products turn out to be the most successful with consumers and why? How does this help us plan future products that will increase consumption of whole grains, for better health? This presentation will provide a close-up look at the world of whole grain products, and will report on successes in educating consumers and changing the perception of whole grains.

Germ: Nutritional benefits and unique applications. J. SMITH. Quaker Oats, Barrington, IL. Cereal Foods World 52:A12.

Whole grain products have traditionally been associated with high nutritional value and have received considerable attention in the nutrition community. Consumers are also becoming aware of the importance of getting more whole grains in their diets while many food manufactures are responding with an ever increasing number of whole grain offerings. An emerging challenge faced by the food industry is how to improve the nutrition of whole grains and create product differentiation. Wheat germ is an ingredient that has been available for many years but has received limited attention as a vehicle to provide enhanced nutrition in a wide range of food products. Containing high levels of protein, oil, sugar, minerals and vitamins compared to wheat endosperm, wheat germ offers considerable potential to naturally enhance the nutritional content of whole grain foods. This presentation outlines the nutritional value of wheat germ and provides some examples for incorporating wheat germ into grain-based products.

Concentrated aleurone: Nutritional benefits and unique applications. J. WELLNITZ. Cargill Incorporated, Minnetonka, MN. Cereal Foods World 52:A12.

Growing awareness of the importance of whole wheat raises the question "What makes whole wheat good for me?" Some consumers are aware that wheat consists of three very important parts; bran, endosperm, and germ. The aleurone layer, genetically part of the endosperm, but typically removed with the bran in the milling process, is unfamiliar to the general population. Aleurone are the life cells of the wheat kernel, containing the highest concentration of vitamins and minerals found in whole wheat. New milling technology enables the aleurone layer to be concentrated and used as a source of natural enrichment in various products. This presentation will discuss the advantages of utilizing concentrated aleurone in various applications and the importance of public awareness of the components of whole grains.

Underutilized grains: Nutritional benefits and unique applications. E. ARNDT. ConAgra Foods, Inc. Cereal Foods World 52:A12.

In conjunction with the Dietary Guidelines for Americans 2005 report recommending increased whole grain consumption, there has been tremendous interest in whole and multigrain-based products. These include the more common, but less utilized grains, barley, rye and wild rice, as well as exotic ancient grains such as, amaranth, millet, quinoa, sorghum and teff. These grains range in seed color, size and shape, flavor profile, texture and nutritional attributes. The exotic grains do not contain gluten which can provide a challenge in formulating baked goods that traditionally rely on gluten for structure. Product development aspects in a range of grain-based foods will be discussed, including inclusion levels, flavor, functionality, cost and special nutritional attributes. Increased availability of tasty, convenient and clearly-labeled foods made with a variety of whole grains will provide consumers more opportunities to better their health through whole grains.

What do we really need: The whole or the parts? B. ATWELL. Cargill, Inc. Cereal Foods World 52:A12.

The story of the introduction of white flour into the diet, the concomitant rise of deficiency diseases such as pellagra, and the subsequent government mandated enrichment program is well known. Clearly whole grains provide a great deal to the consumer that white flour does not. Where are these important constituents found and what are they? Does enrichment restore white flour to whole grain goodness? Does the nutrition of whole grain equal the sum of the parts? There are lots of questions to be answered on this topic. This presentation may confound these issues more, but will at a minimum attempt to address them all.

World Grain and Food Trade Issues: Adventitious Presence, Traceability, and Regulatory Issues

Useful traceability: Ensuring ID and safety information. F. BELLATIF. Eurofins Formation Conseil. Cereal Foods World 52:A12.

Abstract not available.

MONIQA—A new EU-project towards the harmonisation of analytical methods for monitoring food quality and safety in the food supply chain. R. POMS. International Association for Cereal Science and Technology. Cereal Foods World 52:A12.

MoniQA is an EU funded Network of Excellence, which works towards harmonization of analytical methods for monitoring quality and safety in the food supply chain. The MoniQA Network of Excellence (NoE) is coordinated by ICC. MoniQA seeks to establish durable integration of leading research institutions, industrial partners and SMEs working in complementary fields of food quality and safety. MoniQA aims at overcoming European and worldwide fragmentation in analytical methods for monitoring food quality and safety by integrating key organisations across the food supply chain. Main objectives of MoniQA will be 1) to develop harmonisation guidelines for risk assessment and standardisation of analytical methods and technologies in food safety and quality (in particular emerging and rapid test methods). 2) to assess implications of advanced processing and monitoring technologies implemented in modern HACCP systems. Identify and prioritise gaps and needs for future food quality and safety research. 3) to develop a database of food quality and safety issues and corresponding analytical tools for food production and supply chain including information on the validation level and a thesaurus of terms and definitions used in standardisation/validation of analytical methods. 4) to analyse new EU food quality and safety regulations with respect to industry, control and regulatory bodies and regarding their socio-economic impacts in terms of efficiency, effectiveness and consistency, their administrative costs and their impact on international trade. Furthermore the consortium will investigate mechanisms for coordinating and finally merging research activities, personnel and infrastructure to achieve synergetic affects. As a result, harmonised methods, databases and training will be made available beyond the network via associated partners and involved stakeholders. Ultimately, industry and SMEs and international trade will benefit through application of harmonised analytical methods and technologies, in particular emerging and rapid methods, as will the consumers of high quality and safe food.

The TRACE EU project. H. BROLL. Federal Institute for Risk Assessment. Cereal Foods World 52:A12.

Abstract not available.

Stewarding new product launches. G. AUSTIN. Monsanto Company. Cereal Foods World 52:A13.

Abstract not available.

Maintaining international markets in light of conflicting biotechnology regulatory systems. K. BRENNER. DTB Associates, LLP. Cereal Foods World 52:A13.

Over nine hundred million tons of the main crops modified through biotechnology (maize, soy and cotton) were produced in the 2005/2006 crop year. About two hundred twenty million tons of this production moved in world trade, and U.S. exports of these crops and their products was over ninety million tons – nearly 10% of world production and nearly 45% of world trade. However, eleven years after the introduction of the first crops improved using modern biotechnology, the legal and regulatory framework for international trade remains a patchwork of conflicting requirements that must be met by traders who operate in the international arena. Agricultural biotechnology is regulated under environmental, food safety and feed safety rules at the international, national and bi-lateral level. At the international level, traders need to comply with provisions of the Cartegena Protocol on Biosafety (BSP) governing transboundary movement of "living modified organisms". Compliance with the BSP is complicated by the fact that most importing nations have ratified the treaty, but most major world exporters have not. The Codex Alimentarius Commission has published guidelines for food safety assessment of foods derived from modern biotechnology, and is currently working on food safety guidelines for food derived from transgenic animals and guidelines for food safety assessment for crops which have been approved for release in the country of export but not in the country of import. In addition, traders need to be aware of a variety of bi-lateral agreements between countries setting conditions on trade in biotechnology crops and products. Finally, while it does not issue regulation, the World Trade Organization exercises some oversight to ensure that biotechnology regulation complies with the provisions of the WTO Sanitary and Phytosanitary Agreement. At the national level, governments have established widely differing regulations governing planting and food and feed approval, import approval, labeling and co-existence with organic crops. And, even where safety assessment policies are similar, wide differences in the time taken by different countries to complete safety assessments and approvals challenge the trade. These differences between national legislation and policy have led to a number of serious trade disruptions over the past decade, and without further efforts at international harmonization will continue to be a major issues for the world commodity trade.

Impacts of product tracing. N. KALAITZANDONAKES. University of Missouri-Columbia. Cereal Foods World 52:A13.

Abstract not available.

Allergen detectives - Tracing the origin of immune system challenging proteins. B. PÖPPING. Eurofins Scientific Group. Cereal Foods World 52:A13.

Allergen assays have never been used as much as in recent days. This is predominantly due to new legislation having come into force in the USA and Europe. While both, USA and Europe have the 'big eight' allergens, i.e. egg, milk, fish, shellfish, tree nuts, peanuts wheat and soya, Europe in addition requires mustard, celery, sulphite and sesame to be labelled – and – very shortly – lupine and molluscs. Currently, allergens are routinely detected by either PCR or ELISA assays, with ELISA being the more established test method. However, many assays are not well characterised and validation is a 'must' for these assays. There are several validation programs for these assays at various levels. Recently, several kit producers have applied for 'PTM' approval of their assay and submitted data which have been reviewed by the chairs of the Presidential Taskforce for Foodallergens and the General Referee for Allergens. While these studies in general were very sound, it became obvious that some discrepancies need to be resolved. In addition to already performed and evaluated studies, this presentation will give an outlook on planned studies on egg and milk and the impact the result have on cleaning procedures in factories.

2007 Annual Meeting
Abstracts of Oral Presentations

Abstracts submitted for oral presentations at the 2007 annual meeting in San Antonio, Texas, October 7–10. 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.

Comparison of the hydration and antioxidant properties of different varieties of peas grown in different years

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Cereal Foods World 52:A14

To improve the processing of whole pea products and assess nutritional concerns, we investigated hydration and antioxidant properties of different varieties of peas grown in 2005 and 2006. Hydration capacity, water uptake rates and percent stone seeds were determined for four varieties for each type of pea (marrowfat, yellow and green) grown in 2005; and for ten of these varieties which were grown in 2006. Hydration capacity was calculated as the percent increase in weight of seeds after soaking for 16 hours. The hydration rate was monitored by determining the change in weight of the seeds every 30 minutes while soaking in excess water for a total of 16 hours. We also determined the antioxidant properties using DPPH and ABTS methods. Low hydration capacities were seen for samples with a high level of stone seeds. Low hydration capacity was also associated with a delay in the onset of water uptake. Peas grown in 2005 tended to have higher hydration capacities and antioxidant properties than those grown in 2006. Yellow and Marrowfat peas have higher antioxidant properties than green peas in both years. Based on these results, varieties for which water can consistently be absorbed to an acceptable level and possess high antioxidant levels have been identified for whole seed processing.

Addition of germinated wheat to bread improves blood glucose homeostasis in healthy volunteers

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Cereal Foods World 52:A14

Former studies have shown that the amount of dietary fibre in wheat can be increased by germination. The aim of the present project was to investigate whether the intake of bread fortified with wheat seedlings (30% dry weight) has a positive impact on selected parameters of glucose metabolism in healthy volunteers. At the beginning of this longitudinal study, a 75 g-OGTT (oral glucose tolerance test) was performed. Subsequently, the subjects received 300 g of a control wheat bread or a bread containing wheat seedlings daily for 9 days. After the experimental diets, again a 75 g-OGTT was performed. Venous blood samples were collected at the time points of 0, 30, 60, 120 and 180 min and selected parameters of glucose homeostasis in the plasma (glucose, insulin, C-peptide, free fatty acids, gastric inhibitory polypeptide) were analyzed. The intake of 300 g of the control bread per day for 9 days led to a significant decrease of fasting plasma insulin levels. Also, the insulin levels after intake of the glucose solution were decreased. Insulin sensitivity was markedly increased as determined by the HOMA-index. The intake of the control bread did not show any effect on plasma glucose levels, neither in the fasting state nor after the uptake of the glucose solution. In contrast to this, the daily intake of 300 g bread containing wheat seedlings for 9 days resulted in a significant decrease of fasting plasma glucose levels, although no difference in the dietary fibre content had been present. In addition, peak plasma glucose levels were reduced after the uptake of 75 g glucose. All other markers of glucose homeostasis analyzed remained unchanged, compared to the results obtained after administration of the control bread. Notwithstanding, insulin sensitivity was improved after the intake of bread containing wheat seedlings.

Effect of incorporation of bean (*Phaseolus vulgaris* L.) flour on some physical and nutritional properties of wheat flour tortillas

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Cereal Foods World 52:A14

Composite flours containing varied levels (15, 25, and 35%) of bean (navy, black, pinto, and red) and wheat flours were made into tortillas. Farinograph results showed increased water absorption and increased mixing tolerance index as bean concentration increased. Firmness and cohesiveness were evaluated using a Texture Analyzer (TA-XT2). Significant changes in texture were observed in tortillas containing different levels of bean flour, however, the effect of bean variety was insignificant. Similarly, diameter, thickness and rollability indicated acceptable bean tortillas at 25% substitution. Except for navy bean tortillas, bean addition had a significant impact on color. Nutritionally, all bean tortillas had significantly higher levels of crude protein, total phenolics and antioxidant activity. Protein content of formulations containing beans ranged from 12.29 to 14.38%, demonstrating that even at the lowest concentration, bean tortillas were 13.6% richer in protein than the control (10.98%). Phenolics ranged from 62.67 to 157.75 mg of ferrulic acid eq/100g of sample, with the highest levels found in tortillas substituted with 35% of red and pinto bean flours. This parameter was positively correlated with antioxidant activity ($r = 0.90$), confirming the importance of colored beans in the prevention of oxidative stress. Based on the overall analyses, flour tortillas containing 25% bean flour have good sensory properties, thus representing a new opportunity for the functional foods market and adding value to bean crops.

Mixing characteristics of dough as determined by the Newport Scientific Micro doughLAB

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Cereal Foods World 52:A14

Small-scale devices for testing flour and dough, which emulate traditional testing equipment and technological processes, can benefit researchers and breeders who work with limited amounts of sample. The Newport Scientific Micro doughLAB is a prototype small-scale sigma-arm dough mixer that tests 4 g of flour, and measures water absorption (WA) and dough mixing parameters. Flours with varying mixing characteristics were tested on both the regular doughLAB and Micro doughLAB, using AACC Method 54-21 (63 rpm, 30°C). There was good agreement ($R^2 > 0.7$) between the two instruments for mixing characteristics (WA, dough development time, stability, and softening). A hard flour was heated (up to 80°C) and cooled

(30°C) on the regular doughLAB, to assess pasting properties of the dough. The high solids concentration of the dough and the shearing action of the mixing blades caused the dough mass to tear, indicating that accurate viscometric data cannot be obtained from hot dough due to its thick consistency. Similar tests were performed on the Micro doughLAB, but the instrument was allowed to dead-stop while still measuring the residual torque as the dough relaxed (creep tests). Through high-speed data acquisition, the torque applied by the dough was observed to decay over time. The decay data of the dough may give an indication of its elasticity, allowing evaluation of both the viscous and elastic properties of dough throughout a single mixing test. This information appears promising as a means of measuring the true viscoelastic behaviour of a heated dough.

Rice individual kernel breaking force and hardness index distributions and the relationship to milling quality

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Cereal Foods World 52:A15

The objective of this study was to investigate rice individual kernel breaking force and hardness index distributions and their correlations to milling quality. Specifically, the goal was to correlate the percentage of strong kernels (kernel with breaking force greater than 20 N) and kernel hardness index to head rice yield as a possible indicator of milling quality. To accomplish this goal, rice varieties/hybrids Bengal, Cheniere, Cocodrie, Francis, Wells, and XP723 were harvested at various harvest moisture contents from Arkansas, Mississippi, and Missouri in 2004 and 2005. Samples were cleaned and gently dried at 20°C and 56% RH to approximately 12% MC, then analyzed for kernel breaking force, hardness index, and HRY. For breaking force measurements, 200 rough rice kernels were randomly selected from each sample lot and manually-dehulled to produce brown rice. Individual kernel breaking force of brown rice kernels was measured using a texture analyzer (TA.XT2i, Texture Technologies Corp., Scarsdale, NY) with a flat-faced loading head, having a thickness of 1.48 mm and a width of 9.9 mm, and a loading rate of 0.5 mm/s. For kernel hardness index, 300 rough rice kernels were randomly selected from each sample lot. Individual kernel hardness index of rough rice was measured using a single kernel classification system (SKCS 4100, Perten Instruments, Springfield, IL). Individual kernel breaking force and hardness index distribution trends among varieties/hybrid were discussed. Results indicated a generally good correlation (R = 0.81) between HRY and percentage of strong kernels across varieties/hybrids tested. Average kernel breaking force and kernel hardness index showed weak correlations with HRY across varieties/hybrid; however, a linear trend existed between the average breaking force/hardness index and head rice yield.

Estimating the cooking time of rice

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Cereal Foods World 52:A15

The time required to cook a sample of rice may seem a simple problem but it is dependent on several factors such as grain size, shape and degree of milling. In the literature the methods used are often vague or omitted but accurate knowledge of the degree of cooking influences and later analysis of cooked grain texture, an important quality parameter in rice. In the literature methods commonly used involve direct measurements on rice grains removed at timed intervals from grains cooked in excess cooking water and then rapidly cooled. Grains are then squashed between thumb and forefinger and the non-gelatinised core estimated by touch or the grain is squashed between two glass plates and the core estimated visually. Various definitions state cooking time to be when a proportion, often 90 percent, contain no core. Such methods are inherently operator dependent and hard to reproduce and as a consequence cooking time is often not quoted (or done?). Data will be presented that shows that control over the squashing process, by using a known force for a set time or by squashing to a predetermined thickness, can improve the reproducibility of cooking time determinations. Parallel studies on the alpha amylase available starch, expressed as a proportion of the total starch, show that the point where all the grains starch is gelatinised could be used as a definition for completely cooked grain. Such analysis could be used as a check on the degree of cooking where textural analysis is being done.

The effect of screw element on the SME and viscosity property of material during high moisture extrusion of defatted soy flour

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Cereal Foods World 52:A15

The purpose of this research was to understand the main function of different screw elements and to optimize the screw configuration during high moisture extrusion of defatted soy flour. The different screw elements included 1 transfer element (TE1), 1 reverse element (TE2), 3 kneading block (KB) with different stagger angle, such as KB1 with 45°, KB2 with 90°, and KB3 with –45°, and 1 tooth block (TB1). The influence of the 6 pieces of different screw elements on the specific mechanical energy (SME), and the viscosity property of material during high moisture extrusion of defatted soy flour with a Brabender twin-screw extruder (DSE-25) equipped with a slit viscometer was investigated. The effect of screw elements on the SME was significant. The sequence of screw elements with decreasing SME was TE2, KB3, TB1, KB2, KB1, and TE1. The effect of screw elements on the material viscosity and shear stress in slit viscometer was significant, but on the shear rate in slit viscometer was insignificant. The sequence of screw elements with decreasing material viscosity was TE2, TB1, KB1, TE1, KB3, and KB2. There was significant relationship between the SME and the material viscosity in slit viscometer. There were no relationship between the shear rate in slit viscometer and the SME, the shear stress and material viscosity in slit viscometer.

Effect of nitrogen application and crop rotation on the accumulation of silica in the rice kernel

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Cereal Foods World 52:A15

Silica is needed for high production and healthy growth of rice. However, little is known about the effect of nitrogen (N) application and crop rotation on the accumulation of silica in the rice kernel. Therefore, the objective of this study was to grow the rice cultivars 'Wells' and 'Cybonnet' in three rotation systems: 1) continuous rice (S1), 2) rice-soybeans rotation (S2), and 3) rice-corn rotation (S3) using 112 and 168 kg per hectare of N and analyze the silica content of each. There was a significant decrease in silica accumulation in the hull of 'Cybonnet' with the use of high N in all three systems. For 'Wells', system S1 showed a significant decrease in hull silica under high N application and no significant effect was seen in system S2 and S3. The accumulation of silica was highest in S3 for both cultivars under both treatments with 'Cybonnet' using low N being the highest. 'Wells' grown in S1 using high N had the lowest accumulation of silica. 'Cybonnet' accumulated more silica in its hull than did 'Wells'. The experiment showed no effect on the accumulation of silica in the rice grain. This study shows that N application and crop rotation can have a significant effect on the accumulation of silica in the rice hulls with some varieties being affected more than others. As expected the protein content increased with increase N application for all systems. However, there were cultivar and system differences.

A flowable paste from high amylose corn starch

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Cereal Foods World 52:A15

The flow and structural properties of pastes prepared from high amylose corn starch were examined. The starch was cooked in an excess-steam jet cooker in the presence of a fatty acid. The cooked product was rapidly cooled and then freeze dried or drum dried. Amylose is removed from solution by forming helical inclusion complexes with the fatty acid, and the inclusion complexes form small aggregates upon cooling. A paste can be formed from the dried solids that exhibits gel-like properties in small-amplitude oscillatory shear flow, but that flows readily when shear is applied. The effects of fatty acid concentration, solids concentration in the reconstituted paste, and the method of sample drying and reconstitution on the flow properties are examined. The pasting properties of the dried solids are also shown. The results are also compared to commercial shortenings and spreads.

End product quality effects of novel *Ha* loci from *Triticum tauschii* L. on soft wheat (*Triticum aestivum* L.)

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Cereal Foods World 52:A15

Wheat (*Triticum aestivum* L.) grain hardness affects many end product quality traits and is controlled primarily by the *Hardness* (*Ha*) locus that contains the *Puroindoline a* and *b* genes (*Pina* and *Pinb*, respectively). All soft hexaploid wheats carry the same wild-type alleles *Pina-D1a* and *Pinb-D1a* and hard wheats carry a mutation in *Pina* or *Pinb*. One possible route to increased *Ha* functionality was via novel *Pin* alleles present in synthetic hexaploid wheat (*Triticum tauschii*). Previous research has indicated that seeds of synthetic hexaploid lines containing the PINAc or PINBh proteins are significantly softer than those carrying other alleles. Here we show F2 derived lines containing the PINAc / PINBh or the PINAa / PINBj *Ha* locus exhibited significant increases in grain hardness, flour ash, flour particle size, starch damage, and protein content as well as decreased kernel weight relative to F2 genotypes carrying the PINAa/PINBa *Ha* locus. The resultant phenotypes revealed a potentially useful intermediate hardness with improved product

quality properties. Increasing the range of grain hardness possible via increased *Ha* locus dosage or via the incorporation of novel *Ha* loci may lead to increased soft wheat quality and marketability.

Interrelation between cellular size, a_w, and crispness perception for toasted rusk rolls

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Cereal Foods World 52:A16

Crispness was evaluated of two different types of toasted rusk rolls. The first set was a commercial version, which had the standard cellular (pore) size. The second one was specially prepared for these tests, and had a larger cellular size. Both types of rusk rolls were tested by instrumental as well as sensorial procedures to evaluate crispness. Instrumentally measured characteristics were fracture and acoustics parameters; while structure was evaluated by microscopy and image analysis. Sensorial evaluated characteristics were, among others, crispness, hardness, sound, crumbliness, and toughness. Both samples were tested fresh (a_w = 0.3) and at an a_w that was increased by storage at higher relative humidity, giving samples with an a_w of 0.4, 0.5, 0.55, 0.6, 0.65, 0.7, and 0.8 respectively. Results of instrumental and sensorial tests agree regarding their results. Crispness was instrumentally tested and sensorically perceived as higher for the rusk rolls with the larger cellular size. When the a_w of the samples was higher that 0.5 crispness was scored lower as expected for toasted rusk rolls.

Flow effects on structure development in bread dough mixes

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Cereal Foods World 52:A16

A bread dough is considered to have reached an optimal state of development when the mixer power requirement reaches a maximum during mixing of flour and water. The optimal state of development is also considered to represent the stage at which dough has the greatest gas holding capabilities and thus would provide the best results in terms of baked product qualities. Flow visualization experiments monitoring the flow of dough in a 6-pin mixer tell a different story and imply that dough mixes can be more functional when "undermixed" and that the finished product qualities depend more on the manipulations performed on dough than the state of mixing achieved during mixing. Measurements of rheological properties plus bake results support the implications of the flow visualization experiments. Results will be provided.

Plant sterols in pearled wheat

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Cereal Foods World 52:A16

The main objective of our study was to evaluate pearling as a potential technique to obtain fractions with higher levels of wheat phytosterols. Plant sterols are structurally similar to cholesterol. These compounds have the capacity to lower plasma cholesterol and LDL cholesterol. Naturally occurring plant-sterols in the diet are thus of some significance. The outer layers of wheat kernel are known to be rich in minerals and phytosterols (like sitosterol and campesterol). In this study, wheat kernels were pearled and scarified to obtain fractions rich in phytosterols. Pearling is a technique to gradually remove the hull, pericarp, and other outer layers of the kernel. Some investigators have used scarification as a fractionation technique. Scarification is a technique to obtain fractions by moving grain over an abrasive surface. We have determined that pearling employing a carborundum wheel yields predictable fractions when controlled by time of instrument operation (in seconds). Furthermore, no sifting is required. A laboratory scale pearler was used to produce pearling fractions and pearled grain. Total sterols were measured by gas chromatography and flame ionization detection. Non polar lipids were analyzed by using normal phase HPLC with UV detection and ELSD. Wheat fractions obtained in this manner may be used in fortification of foods.

Processed mixture analyzed for ingredient identity, concentration and distribution by spectroscopic chemical imaging

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Cereal Foods World 52:A16

When the processing of raw ingredient material and their blending into a product results in mixture of guaranteed specification the identity, quality, and distribution of each ingredient must be determined. Modern chemical imaging with a near-IR focal plane array spectrum has the potential for providing information regarding all these concerns. Each pixel (x, y location) in the image has a size determined by elements in the focal plane array detector system and its associated lens used to collect radiation from the specimen. When the granulation of the product is similar to or larger than the image pixel size then each pixel, when chemically identified, can be enumerated in a particular column for that ingredient. From these data the relative amount of each ingredient is determined. The image reveals the heterogeneity or homogeneity of the blend and the absence of a wrong ingredient or foreign material is assured. To illustrate the analytical scheme for use of chemical imaging a series of feed ingredients stocked in the KSU pilot feed mill were characterized by collecting 82,000 spectra in the 1100–2500 nm range of the indium antimonid focal plane array. A multiwavelength statistical characterization was established for each. When mixtures were produced then images were obtained and using the database prepared, each pixel was identified and counted. As blending of a mixture takes place the distribution of the ingredients can be monitored.

Measurement of acetic acid

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Cereal Foods World 52:A16

The most commonly used method for the quantification of this acid is by enzymatic bio-analysis, using an assay format using acetyl-CoA synthetase. However, this method is not based on a "true" end-point reading, instead relying on an indicator reaction catalysed by L-malate dehydrogenase. The test is relatively laborious to conduct in terms of both performance of the assays and subsequent calculations. In the current research, four advanced methods for acetic acid were evaluated. This paper describes the characteristics and applicability of each of these methods. The focus of the presentation will be on a rapid method employing "true" end-point biochemistry, employing acetate kinase and phosphotransacetylase.

The CarboStar Method: Enabling native starch to function like dietary fiber

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Cereal Foods World 52:A16

Almost every person in America is touched by a condition that is directly affected by food. These conditions include obesity, diabetes, and heart disease. The food industry is under increasing pressure to offer consumers "healthier" options to help combat these illnesses. However, consumers are unwilling to give-up taste and enjoyment of their favorite foods. At the same time, food manufacturers continue to face pressure on product margins. Saatwic Foods' CarboStar Method can enable food manufacturers to quickly and easily revamp popular products to be aligned with today's focus on health and wellness by increasing nutritional value while maintaining the familiar tastes and textures consumers enjoy today. This technology also reduces overall ingredient costs, which significantly increases product margins. The CarboStar Method strengthens the starch cell wall using a proprietary blend of GRAS-classified plant extracts. The treated starch is digested at a reduced rate, thus providing energy and satiety for a longer period of time. Any product made from corn, wheat, potato, or rice can utilize the CarboStar Method. In vitro studies showed a 50% reduction of calories from carbohydrates in CarboStar product compared to Control. NLEA analysis showed CarboStar product contained 56% more fiber than Control. Glycemic index testing confirmed CarboStar product was low in glycemic index (GI) and glycemic load (GL), thus allowing consumers to manage obesity and diabetes with CarboStar foods. A trained hedonic panel preferred the taste and texture of the CarboStar product over Control prepared under a variety of conditions, including extended warming table exposure and retort packed. These results were further validated with instrumental evaluation. The CarboStar Method provides direct material cost savings of >20% through elimination of egg whites and other proteins, increased product yield, and reduced waste.

Rice *Waxy* gene SNPs: Associations with amylose content and structure, and pasting properties

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Cereal Foods World 52:A16

Apparent amylose content (AAC) strongly impacts rice end-use quality, and thus is used as a predictor of end-use quality traits during varietal development. Pasting properties are an additional tool used for predicting

certain quality traits that AAC cannot discriminate. Both AAC and pasting properties have been mapped to the *Waxy* gene on rice chromosome 6. Several DNA sequence variations in this gene have been associated with these traits. We investigated these sequence variations and their associations with AAC and pasting properties using 171 rice accessions originating from 43 countries. In addition, amylose structure was determined using size-exclusion chromatography coupled with multiple angle laser light scattering and differential refractive index detection. Three single nucleotide polymorphic sites (SNP) in the *Waxy* gene, In1G/T (in intron 1), Ex6A/C (in exon 6), and Ex10C/T (in exon 10) were genotyped. Together, a total of four haplotypes or alleles were identified in this germplasm. These four haplotypes were: In1T_Ex6A_Ex10C, In1G_Ex6C_Ex10C, In1G_Ex6A_Ex10C, and In1G_Ex6A_Ex10T, and were associated with low, intermediate, high AAC-types, and high AAC/strong pasting-property-type, respectively. For the rice accessions with the Ex10C allele, the AAC was negatively correlated with the RVA of peak, hot paste, and breakdown (r = –0.85, –0.75 and –0.79, respectively), and was positively correlated with the setback viscosity (r = 0.76). Three different hydrodynamic-volume mass fractions of amylose were observed, and the ratios of each mass fraction to total AAC differed among haplotypes. In conclusion, the *Waxy* haplotypes studied appear to be useful markers for selecting the AAC and strong pasting-property of breeding lines developed from the world's rice germplasm. The AAC associated with several pasting parameters of the rice accessions with *Waxy* Ex10C allele.

Encapsulation of fish oil in starch matrices utilizing extrusion processing

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Cereal Foods World 52:A17

The objectives of this study were to encapsulate fish oil in starch or modified starch matrices utilizing extrusion processing, and to evaluate the oxidation of fish oil entrapped in the matrices at different storage times. Pharmaceutical grade fish oil was encapsulated into starch/ modified starch matrices using lab-scale twin-screw extrusion at low temperature and low shear conditions (20% wet basis in-barrel moisture content). Extrudates were freeze-dried, milled to powder, and frozen before putting into a controlled environment chamber, set at a temperature of 50°C and relative humidity of 50%, for storage studies. Samples were taken out of the chamber every week during a one month period. Fish oil extracted from the extrudate samples and oil stored at the same conditions were analyzed using Gas Chromatography (GC)-Mass Spectrometry (MS) for oxidation using standard AOAC methods. Initial results indicated that the relative levels of arachidonic acid (AA, 20:4), eicosapentaenoic acid (EPA, 20:5), and docosahexaenoic acid (DHA, 22:6) were not significantly different in the control oil compared to encapsulated oil at zero storage time, and the relative levels of these polyunsaturated fatty acids were 80% lower in the oil and 90% lower in encapsulated oil after three weeks of storage. Ongoing research is focused on enhancing the effect of encapsulation in retarding fish oil oxidation by use of micro-porous starch matrices.

Oat phenolics: Structure, synthesis and bioactivity of selected avenanthramides from oat kernels

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Cereal Foods World 52:A17

Recent interest in the role of bioactive phenolic constituents in oats has necessitated an in-depth evaluation of both their structure *in planta* and their physicochemical properties. Avenanthramides represent a unique component of the readily bioavailable phenolic components of oats with antiatherogenic activity. However, the lack of readily synthesized gram quantities pure standards for use as standards for quantitative analysis, *in vitro* and *in vivo* bio-assessment has hampered further progress in the elucidation of the potential role these unique antioxidant alkaloids may play in human health and nutrition. Accordingly, mild, efficient methods were developed for the synthesis and purification of several of the major and minor avenanthramides. The principal synthetic route involves the condensation of a suitably-substituted acetylanthranil with a suitably-substituted benzaldehyde or cinnamaldehyde followed by aqueous alkaline hydrolysis of the resulting 2-aryl-4(H)-3,1-benzoxazolin-4-ones. Purification of the products was carried out by liquid chromatography and crystallization to give pure avenanthramides. These compounds were evaluated *in vitro* in conjunction with ongoing adenovirus-mediated chemotherapy of human bladder cancer and shown to enhance the efficacy of current treatment regimes. Using transformed human bladder cancer cells, Avenanthramide B alone at 100 micromolar was shown to be as effective as the Phase II clinical trial lead compound in a dose-dependent manner. In combination with the lead chemotherapeutic, Avenanthramide B was more than 60-times more effective. This is the first report of the potential effects of naturally-occurring oat constituents on the progression of this disease. The consequences of these findings from the standpoint of preventative nutrition involving dietary oat products and ingredients will be presented.

Effect of soy protein concentrate and extruder screw speed on physico-chemical, textural and cellular properties of corn starch-based expanded snacks

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Cereal Foods World 52:A17

Soy protein is gaining importance as a food ingredient in snacks and breakfast cereal due to its functionality, nutritional value and relatively low cost. The effects of varying levels of soy protein concentrate or SPC (0, 5, 10, 15 and 20%) and extruder speed (230 and 330 rpm) on the physico-chemical, textural and cellular properties of corn starch-based expanded snacks were studied. Mean expansion ratio (ER) at 330 rpm (11.23 ± 0.32) was significantly (P < 0.05) higher than that at 230 rpm (9.71 ± 0.32). For both extruder speeds, ER decreased with increasing SPC (17.74 to 6.47 at 230 rpm and 18.48 to 8.80 at 330 rpm). Mean piece density was lower at 330 rpm than at 230 rpm. At 230 rpm, piece density increased from 35 to 69 kg/m3 between 0 to 15% SPC, and decreased by 3% at 20% SPC. At 330 rpm, the effect of SPC on piece density followed a similar trend as that at 230 rpm, except for a 9% drop at 10% SPC and a bigger 16% drop at 20% SPC. Void fraction (VF), as measured by X-ray microtomography, followed an inverse trend as piece density. VF was higher for 330 rpm as compared to 230 rpm, and decreased from 0.76 at 0% SPC to 0.34 at 15% SPC, and subsequently increased to 0.53 as SPC increased to 20%. Crispness work (CW), as measured by texture analyzer, increased linearly from 16 to 323 N-mm from 0 to 10% SPC at 230 rpm. At 330 rpm, however, CW showed a variable response to increasing levels of SPC, but was 17 to 24 times higher for 5–20% SPC as compared to 0% SPC. Gel permeation chromatography and pasting properties were used to understand the molecular changes in starch-SPC blends during extrusion. Correlations amongst the parameters were significant (P < 0.05). ER was markedly correlated to piece density (r = –0.79) and CW (r = –0.73), and strongly correlated to VF (r = 0.87). Piece density was moderately correlated to CW (r = 0.58) and markedly correlated to VF (r = –0.67).

Computer tools for product development: Beyond the spreadsheet…

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Software for the Food Technologist and Research Nutritionist has evolved from the Mini-computer, to a variety of DOS programs. Since the advent of Windows, several hard programmed lab software products have evolved as part of ERP batch process manufacturing programs, but except for internally developed programs in larger food and additive firms, data gathering LIMS programs and individuals' use of spreadsheets, little new logic has been provided the Food Technologist to take advantage of the full power of the Windows platform for formulation creation, Project Management and documentation of the new and revised recipe. This talk reviews the development of lab-book formulation software to provide the Food Technologist a range of user controlled tools to develop data bases of ingredients, develop recipes & formulations with control of properties, explosions of intermediates, nutritional and property calculations as developed by the user, while meeting regulatory requirements and QC documentation. The presentation also discusses export and import of data within networks and the availability of data exchange tools between researchers and between the laboratory and manufacturing process. It reviews how to insure security of data, both from outside the system and with full data logging.

Enhancements in color-based detection of mold-damaged wheat kernels

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One of the most common molds that infect the seeds of small cereals, such as wheat, throughout the world is Fusarium Head Blight (FHB). A metabolite, known as deoxynivalenol (DON or vomitoxin), often occurs with the FHB and is cause for concern because of a moderate toxicity to humans and non-ruminant livestock. Government regulatory bodies of most countries impose limits on the allowable levels of DON in raw and finished food/feed products, which adds burden onto grain exporting countries, such as the United States, that must ensure that grain sent overseas is safe and meets the recipient country's specifications. Over the years, the Beltsville USDA laboratory has explored the use of visible and near-infrared spectroscopy as a basis for identification and removal of kernels infected with FHB. Whereas laboratory tests have demonstrated a >95% rate at detecting mold-damaged kernels, this accuracy drops off precipitously as kernels are processed at speeds

approaching those of commercial optical sorters. Current work is underway at Beltsville that utilizes alternate methods of lighting at high frequencies (> 1 kHz) that allow for multiple measurements of reflected broadband light such that, when processed with measurements from other bands, category assignment (normal vs. mold-damaged) improves. For example, multispectral information is collected and processed on single kernels in freefall at the sub-millisecond level. Aspects of the selection of wavelength bands, lighting, timing, and decision algorithms are addressed.

What is the fate of the glutenin particles when mixing under an alternative atmosphere?

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Cereal Foods World 52:A18

Mixing is the key step in developing dough. As mixing proceeds, the amount of SDS insoluble Glutenin Macro Polymer decreases. This phenomenon has been demonstrated by various authors for both UPP and GMP. That is, when the dough mixing experiment is done in air. However, when an alternative atmosphere is used, e.g. nitrogen, then the relation between mixing and decrease of GMP is less clear. Oxygen plays an important role in the breakdown of glutenin polymers during mixing, but what happens with: i) the glutenin particles and GMP-composition? ii) what is the rheological significance of an altered GMP breakdown pattern? We set out to study the rheological properties of: the GMP-fraction, glutenin particle suspensions and respective dough sample. Dough was prepared from 100g of flour, 2% NaCl in a GRL mixer at a speed of 66 revs/min. under pure nitrogen or oxygen containing atmosphere. After the appropriate mixing time, dough was divided into two parts: one was directly freeze dried, the other dough piece of 3g was placed in the plate-plate geometry (gap 3mm) of a Bohlin rheometer for a flow-relaxation test. From the freeze dried samples GMP-gel proteins were isolated by suspending the powdered sample in 1.5% SDS followed by centrifugation. The GMP-gel stiffness was determined with a strain sweep on a Bohlin rheometer. The reference experiment showed 100% GMP breakdown within 10 minutes, mixing under nitrogen resulted in a slower (>15 min.) and 10–20% GMP breakdown. Under nitrogen the GMP-gel stiffness (G') and glutenin particle voluminosity decreased significantly (>30%), hence indicating physico-mechanical breakdown of the glutenin particles. Contrary to the reference dough, mixing under nitrogen with addition of 40 ppm cystein had a negligible effect on glutenin particle breakdown. The optimal flow relaxation half-time of dough mixed under nitrogen was 16s, for the reference dough this was 28s, revealing that the reference dough is more visco-elastic. SDS-PAGE of GMP-fractions indicates a balanced effect of GMP breakdown by covalent thiol-disulphide reactions and physico-mechanical disruption of glutenin particles. The physico-chemical mechanisms underlying observed results will be discussed.

The prevention or retarding of staling during the baking process of bakery products by adding an intermediate thermostable or thermostable protease

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Cereal Foods World 52:A18

Bread staling is a complex phenomenon. The hardening of the crumb is not only due to a loss of water during storage, but it is the result of a number of physico-chemical processes. Proteases have a long history of use in the baking sector. They are mostly used to reduce mechanical dough development requirements of strong or tough gluten. Proteases also have major disadvantages. The action of the proteases is not limited in time, it continues after mixing and weakens the dough structure in time. Several intermediate thermostable and thermostable proteases have been tested on crumb softness and on retarding the staling of baked products. Keratinase from *Bacillus licheniformis* LMG 7561 and Taq protease from *Thermus aquaticus* LMG 8924 have been studied more in detail. The thermostable proteases are characterised by having a positive effect as anti-staling agents. This effect is especially noticeable in combination with other anti-staling enzymes (thermostable amylases and thermostable maltogenic amylases). Their effect is also additive to the anti-staling effect of mono- and diglycerides, stearoyllactylates and other emulsifiers used in baking. The advantage of using intermediate thermostable and thermostable serine proteases is, that there is no adverse effect on the crumb elasticity or no increase of the crumb stickiness as compared to a control. This will be shown by baking tests and softness measurements in different applications.

Effect of processing parameters on protein enriched snack made out of defatted soyflour-rice blend

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Cereal Foods World 52:A18

Extruded snacks foods have become an integral post of the eating habits of the majority of the world's population and extrusion technology bas become one of the pioneer processes of producing varieties of foods. Snacks contribute an important part of many consumers in daily nutrient and calories intake (Tetlweiler, 1991). The defatted soybean meals are the by product of solvent extraction plant and its edible use is numberless. Rice brokens are the by product of rice milling industry and rice flour prepared out of rice brokens can be used as important ingredient for many ready-to-eat breakfast cereals and snacks. Experiments were conducted following Response Surface Methodology (RSM) (Myres, 1976). In the present study, Central Composite Rotatable Desigh (CCRD) of five independent variables with five levels of each was used. In this study the effect of processing parameters of feed i.e. moisture content of feed (12,15,18,21 and 24%), blend ratio i.e. soy flour-rice blend (10:90, 14:86, 18:82, 22:78 and 26:74), operational parameters of extruder i.e. barrel temperature (100,110,120,130 and140°C), die head temperature (160, 170, 180, 190 and 200°C) and screw speed (100, 110, 120, 130 and 140 rpm) were optimized for physical properties. The minimum value of longitudinal expansion index lies near 185°C die head temperature and about 120 rpm. The minimum value of bulk density observed in between 18 to 20% blend ratio and 115°C barrel temperature.

Novel seed storage proteins of *Aegilops longissima* have potential for end product quality improvement in wheat

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Wild species of wheat are useful source of genetic variation for crop improvement. They have been utilized for improving the tolerance of wheat to different biotic and abiotic stresses. However, their potential for wheat quality improvement has not been much investigated. One hundred and seventy seven alien chromosome addition lines from the Tottori Alien Chromosome Bank of Wheat (TACBOW), Japan were therefore studied for High Molecular Weight (HMW) glutenin subunit profile to determine the presence/location of HMW glutenin locus on individual chromosome of wild species. This was followed by study of protein profiles of LMW glutenin subunits and gliadins. Selected lines were studied for dough strength. Among these addition lines, *Aegilops longissima* addition line was found to have significant positive effect on quality. Its HMW glutenin profile showed two additional bands, one slow moving above 1Dx2 and another near 1By8. LMW glutenin profile also showed addition bands in this line. Gliadin profile revealed several additional gliadins not observed in any other addition line of any wild species available. It appears that *Ae. longissima* has more number of novel seed storage protein genes than any other cultivated or wild species of wheat and these can be utilized for improvement of end product quality of wheat. We are now studying this addition line in detail. Work on cloning of HMW glutenin genes from *Ae. longissima* and its addition line is also in progress.

Low levels of waxy wheat flour in bread and their effects on volume and texture

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Cereal Foods World 52:A18

Volume and texture of bread baked at different baking times with partial replacement of flour with hard waxy wheat flour were investigated. Two hard waxy wheat flours, 2114 and 2489, which varied significantly in quality, were used to partially replace Karl '92 hard wheat flour. Mixograms showed that sample 2114 had 65% absorption with a peak height (59.5%) and short peak time (3.45 min), whereas sample 2489 had 62% absorption with a peak height (47.4%) and longer peak time (4.71min). Replacement was made at 5, 10, 20 and 30%. Loaves containing higher levels of waxy wheat flour exhibited excessive shrink after baking and a 'keyhole' shape. Extending the baking time by 20% minimized shrinkage and resulted in a higher loaf volume. One hour after baking, the volumes of loaves containing 10% or 20% waxy wheat flour 2489 were 863 cc and 920 cc respectively, which were significantly ($P < 0.05$) higher than the control (810 cc). C-cell™ analysis was used to measure slice brightness. With an extended bake time, there were no significant ($P > 0.05$) differences in slice brightness between the control and the bread made with 10 and 20% waxy wheat flour. However, with a short bake time slice brightness decreased as the level of replacement increased. This study indicates that pan bread made with partial waxy wheat flour replacement had an increased bread volume, when a longer baking time is used to fully set the structure. In addition, bread made with 10–20% waxy wheat flour could potentially have reduced firmness and increased shelf life.

Nutrient composition of retail samples of amaranth, Kamut, quinoa, spelt, and teff

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Cereal Foods World 52:A19

The *2005 Dietary Guidelines for Americans* recommends eating at least three servings of whole grain products per day. In the Food and Drug Administration's guidance for Whole Grain Label Statements, amaranth, quinoa and teff are listed as examples of cereal grains. In order to provide up-to-date nutrient data for these less common whole grains in the USDA National Nutrient Database for Standard Reference (SR), amaranth, quinoa and teff along with spelt and Kamut brand wheat were analyzed. Three different brands of each type of grain were purchased from retail outlets. Samples were prepared at the Food Analysis Laboratory Control Center at Virginia Polytechnic Institute and State University and shipped by overnight delivery to analytical laboratories with appropriate control and reference materials. Samples were analyzed for proximate components, vitamins, minerals, fatty acids and amino acids. These laboratories had previously been qualified to perform analyses of these nutrients through the National Food and Nutrient Analysis Program. All of the grains were high in protein, ranging in content from 13.3% for teff to 14.7% for Kamut. Amaranth and quinoa contained over 6% fat compared to about 2% fat in the other three grains. Total dietary fiber content ranged from about 7% in amaranth and quinoa to over 10% in spelt. The vitamin and mineral content of these five grains is usually at least as high, and in many cases higher, than in regular wheat. As people are trying to incorporate more whole grains into their diet, having data for these grains in SR provides an easily accessible source of nutrient information.

Looking into the cereal processing through TD-NMR

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Cereal Foods World 52:A19

Cereal grains go through different unit operations during the manufacturing processes. These unit operations induce several physicochemical changes in the cereal-based products, which lead to the desirable attributes in the final product. Hence the understanding of the dynamics of the physicochemical changes during the manufacturing and distribution steps helps us in optimization of the process parameters and associated equipment designs. Once the process is optimized and implemented for regular industrial production, constant monitoring of the physicochemical properties of the cereal-based materials during processing, storage, and distribution gives better process control and helps produce consistent desirable products while minimizing the cost. An ideal method for this process monitoring and quality control has to be fast, repeatable, and non-invasive. The low-field TD-NMR (time domain nuclear magnetic resonance) method is a suitable candidate for the same. Small bench-top TD-NMR instruments obtain signal from all the hydrogen atoms in the molecules present in the samples, irrespective of their color, surface characteristics, or opacity. Mathematical analysis of the acquired data gives concentration of constituents like oil, water, protein, etc. The signal can also be analyzed to look directly into the molecular mobility and quantify them. During this presentation, the fundamentals of TD-NMR measurement will be discussed and various examples of process monitoring and quality control in cereal processing industry utilizing this powerful TD-NMR technique will be shown.

Strengths and limitation of the Institute of Medicine definition for dietary fiber

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Cereal Foods World 52:A19

Dietary fiber (DF) is a term recognized by everyone, but no official definition exists in the U.S. or accepted by the FDA. The U.S. Institute of Medicine (IOM) has proposed a definition for DF. Dietary Fiber: consists of nondigestible carbohydrates and lignin that are intrinsic and intact in plants. Functional Fiber: consists of isolated, nondigestible carbohydrates that have beneficial physiological effects in humans. Total Fiber: is the sum of Dietary Fiber and Functional Fiber. The purpose of this presentation is to discuss the rationale for this IOM definition, but more directly, explain the difficulties in having this definition accepted even by FDA. Dietary fiber was declared a nutrient by an act of Congress, the Nutrition Labeling and Education Act (NLEA) of 1991. This occurred because of the great interest in the purported health benefits of DF during discussions of the NLEA, and to have the term DF on the food label and associated nutrient content and health claims. To measure the content of any nutrient in a food, including DF, an approved AOAC INTERNATIONAL method must be available. FDA specifies that the DF content of a food shall be determined by AOAC method 985.29 (56 Fed Reg 60366 at 60388; November 27, 1991). While the FDA specifies a method to measure DF, use of this method does not define DF. Some of the major issues in the FDA possibly not accepting the IOM definition are: 1) lack of any evidence that the human body differentiates between dietary fiber and functional fiber; 2) disparity in the volume of reliable scientific evidence as to the benefits of functional fiber compared to dietary fiber and; 3) lack of cost effective and standardized clinical protocols to demonstrate beneficial physiological effects in humans. A further justification for this presentation is the pending "Notice of Proposed Rulemaking" by the FDA to find a definition for DF.

Using NMR to characterize amylose in rice starch

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Cereal Foods World 52:A19

Measurement of amylose content is employed throughout the world as the measurement of cooking quality of rice. Many world laboratories have developed a high level of precision in the measurement of amylose/amylopectin, yet the accuracy of the measurement remains questionable. A selection of rice samples with similar amylose content has been shown to have very different cooking qualities. The presence of lipid starch complexes and long chain amylopectin has been shown to give erroneous results. Alternative or complimentary techniques are needed to fully characterize the fine structure of rice which in turn can be used to predict the cooking quality of rice. Chain branching ratios, average chain length, and end terminal ratios of degraded starch have been measured by nuclear magnetic resonance (NMR). We have used NMR to measure the branching ratios of total starch (amylose and amylopectin) in a variety of rice samples. Branching ratios of total starch ranged from 20 to 50 glucose residues linked in alpha (1-4) for each alphaa (1-6) linkage. Rice varieties with branching ratios in the low twenties would indicate starch consisting primarily of amylopectin or waxy rice cultivars. A high ratio would indicate rice with a high amylose concentration or the presences of long chain amylopectin.

Morphology changes in waxy wheat, normal wheat and waxy maize starch granules in relation to their pasting properties

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Cereal Foods World 52:A19

Waxy wheat contains starch that lacks amylose and consists only of amylopectin. To realize the full potential of waxy wheat, we are investigating the wet-milling of waxy wheat flour to produce gluten and waxy wheat starch, and determining how the structure and properties of waxy wheat starch compare with those of normal wheat and waxy maize starches. The specific objectives of this study were to compare the morphological changes of waxy wheat granules heated in water with those of normal wheat and waxy maize starches and to relate that information to their pasting properties. Waxy wheat and normal wheat starches were suspended in water (1%, w/w) and heated at 5°C/min and 25°C/min on a hot-stage microscope. Changes in morphology of waxy and normal wheat starch granules were recorded *continuously* during heating. The video recorded images revealed the detailed changes of the starches in the heated slurry. Normal wheat starch granules started increasing in size at 57°C, continued to swell above that temperature, and retained a rounded shape even at 90°C. In contrast, waxy wheat starch granules swelled greatly at 60–70°C but then disintegrated into many small fragments between 70–80°C depending on heating rate. At the low heating rate, more swelling was observed before granule disintegrated than at the high heating rate. The pasting curves obtained by RapidVisco Analyser (RVA) at 7% solids showed that waxy wheat starch had a low initial pasting temperature, high peak viscosity, great breakdown and low set-back profile compared to normal wheat starch. The easy fragmentation of waxy wheat granules explains the cohesive texture of cooked waxy wheat starch and provides basic information for future work on the chemical modifications of waxy wheat and waxy corn starches and a comparison of their properties.

Structural basis for target protein recognition by thioredoxin and quantitative cereal disulfide proteomics

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Cereal Foods World 52:A19

Thioredoxin (Trx) is a ubiquitous redox protein involved in key life processes. Trx reduces disulfide bonds in target proteins, thereby providing reducing equivalents or modulating enzymatic activities. Trx has been extensively studied during the past 30 years but the target protein recognition mechanism

is still poorly understood. We study the molecular mechanisms of two barley h-type Trx isoforms (HvTrxh1 and HvTrxh2) identified in barley seeds. A range of target proteins of HvTrxh1 and 2 have been identified using proteomics techniques. We have recently established a quantitative proteome analysis of the extent of Trx (or other "reagents") disulfide reduction and apply this to identify the status for individual protein disulfides in cereal seeds. Specific Trx target disulfide bonds are identified, e.g. the C144-C148-disulfide in barley alpha-amylase/subtilisin inhibitor (BASI). We determined the first three-dimensional structure of a Trx-target protein complex (HvTrxh2-BASI) as a disulfide bonded covalent reaction intermediate. The crystal structure reveals interactions between a conserved hydrophobic motif in Trx and a sequence of residues from BASI through backbone-backbone hydrogen bonds and van der Waals' contacts. This mode of binding suggests that recognition of features around protein disulfides plays an important role in the target specificity of Trx. We shall validate the quantitative disulfide bond proteome analysis in the light of structural motifs. The new information will have specific impact on cereal food technology.

The development and application of a new procedure for analysis of folic acid in cereal foods by capillary electrophoresis

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Cereal Foods World 52:A20

Folic acid is increasingly of interest as the form of folate used in food fortification. Currently HPLC and microbiological methods are widely used for analysis, however there is a need for a rapid, reliable and inexpensive alternative for the quantification of folic acid in foods. A novel method has been developed using capillary electrophoresis (CE), with a phosphate-borate buffer and spectrophotometric detection at 214nm. Using response surface methodology the operating conditions have been optimized and involve a running buffer of 8 mM phosphate and 12 mM tetraborate, pH 9.5, operated at +28 kV and 30°C. For quantification purposes, nicotinic acid is used as an internal standard, calibration curves are linear and the limit of detection corresponds to 8.13 parts of folic acid per million. The method has been validated and recoveries for spiked samples of cereal foods have been in the range 100–109%. Reproducible results have been obtained for instant Asian noodle samples that have been fortified with folic acid as well as for preparations of microencapsulated folic acid. When compared with HPLC, analysis results were accurate, precise and can be obtained more rapidly. When applied in a fortification study of instant noodles, the CE procedure confirms that folic acid losses occur particularly during the deep frying stage of processing.

Determing the gluten functionality requirements for flour tortillas using glutenin and gliadin near-isogenic deletion lines

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Cereal Foods World 52:A20

The synthesis of high molecular weight (HMW), low molecular weight gluten (LMW) and gliadin proteins are controlled by nine major loci present in wheat chromosomes. The loci Glu A1, Glu B1, Glu D1 and Gli A1, Gli B1, Gli D1 and Gli 2 and their allelic variants play important roles in determining the functional properties of wheat flour. Our study has focused on understanding the functionality of these protein subunits with respect to tortilla quality and development of identity preserved wheat cultivars with ideal tortilla baking quality. Near-isogenic wheat lines in which one or more of these loci are absent or deleted have been used in the study. The analysis has revealed that elimination of certain HMW-GS or gliadin loci provide outstanding gain of function both for tortilla diameters and overall tortilla quality.

Comparative study of egg white protein and egg alternatives used in an angel food cake system

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The egg alternatives can be used to replace egg as a functional ingredient in angle cake productions. These alternatives can deliver functionality at a lower cost and can be incorporated to produce a suitable angle cake especially whey protein isolate. Comparison of the physical and sensory properties of several commercially egg alternatives in angel food cake formulation was studied. Fourteen samples were investigated for foaming properties at 10 and 20 min. whipping time. Collagen, Cryogel-Gelatin (CG), Solugel collagen hydroysets (SCH), Gelatin, Whey protein concentrate (WPC), Fish protein (FP), Whey protein isolate (95% WPI, 90%WPI), Hydrolyzed whey protein isolate (HWPI), Pea protein (PP), Rice protein concentrate (RPC), Soy protein (SP), Corn Zein (CZ) and casein. However, only eight showed potential and were moved forward for further evaluation. Only WPI alternative was able to maintain a meringue during baking. All other foams collapsed during the baking process. The angel food cake formulated with WPI exhibited a significantly firmer crust and crumb compared to the egg white control. The L value, height and volume of control cake were also significantly higher than the egg alternative. The control significantly out performed the angel food cake formulated with the egg alternative in all sensory categories evaluated.

High diastatic milled barley malt—Its critical role in the care of weanling infants and the severely malnourished

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Cereal Foods World 52:A20

High diastaic milled barley malt has been used in the baking and confectionary industries for many decades. The package of enzymes contained in high diastatic milled barley malt; diastase, proteases, and phytases; can be used to predigest the complex carbohydrate based staple foods of the developing world. This has important and critical implications in the care of weanling infants and the care of severely malnourished people in the developing areas of the world. This paper is based on an extensive literature review and documents the efficacy for the use of high diastatic milled barley malt in the care of these individuals.

Explaining why flavor release is better from soups thickened with starches than other hydrocolloids and which starches are best

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Cereal Foods World 52:A20

The perceived reduction in flavor of thickened foods is a well known problem, but starches are normally perceived as being better than other hydrocolloids. When the amount of volatile release is measured by direct in-nose assessment (as a food is consumed) it is not affected by viscosity or type of thickener. Therefore the perceived lack of flavor could be due to low levels of the non volatile component of flavor, e.g. salt, sugar, acid, etc. Most hydrocolloids can be generalized for their effect on flavor perception by knowing their viscosity at a shear rate appropriate to the mouth (50 sec-1). However, starches consistently produce better flavor scores, at equivalent viscosity, compared to other hydrocolloids. In-mouth amylase activity for panelists was measured. The correlations ($P < 0.05$) indicated that flavor release was actually perceived as better when amylase levels were low, ie, the starches were degraded less and retained their viscosity. The explanation for starches' better flavor release seems to lie in the manner in which they mix with other materials. This type of behavior is easy to observe, but the rheological characteristics by which it occurs are less well defined and studied. Diffusion of the sapid materials from foods is not quick enough for them to move from the food bolus through saliva and onto the taste receptors. Hence rapid mixing of the food within the mouth needs to occur for flavor perception. Thickened systems containing markers (sodium chloride or colored compounds) were mixed with water. The rate and amount of marker release were measured. The best mixing occurs when the starch retains its granular structure and the viscosity of the polymer phase is low. Emerging work demonstrates the mixing abilities, after different treatments, for a wide range of starches including wheat, waxy maize, maize, crosslinked maize, cassava and rice.

Flour performance data extraction from rheology profiles

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There is a great deal of information in a rheology curve of a dough sample that is taken through temperature gradients. There is information about the gluten strength, extent of starch gelatinization, and amylase activity in such a plot. However, it is very difficult to set specifications on a rheology plot and numerical information is more useful, if it can be extracted. The Mixolab from Chopin was used to collect rheology plots of a number of different flours and flour with additives. This instrument creates a very reproducible mixing curve for flours. This reproducibility allows one to analyze the data using statistical techniques and modeling approaches. Each sample was mixed and taken from 30°C to 90°C and then to 50°C. A multivariate analysis was then accomplished on this viscosity data to determine relative strengths of gluten, starch gelatinization strength, and amylase activity. Purified gluten, wheat starch and wheat malt (amylase) were added and analyzed to vary each of these characteristics independently from the others. To date this research has shown that the full information content of a rheology curve is not completely captured by the current common measurements of peak heights, slopes and times. Pretreatment of the data to make them consistent and then analysis of the shapes via Principal Component analysis has been used to describe the natural variables or independent axes of a rheological curve. The goal of this research

is to be able to rotate the scores and loadings deduced from the rheology curves in such a way to better characterize flour performance. The results of the analysis data pretreatments and PCA model development will be presented. These results include the loadings plots which indicate where and which shapes in the rheological curves contain independent information consistent with dough modifiers and which are redundant.

Procyanidins and other phytochemicals in purple wheat

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Cereal Foods World 52:A21

Proanthocyanidins (condensed tannins) exist in a variety of foods including cereal grains. They range from monomers, dimers, oligomers through large polymers. *In vitro* and *in vivo* studies have been shown that dietary proanthocyanidins in colored cereal grains have beneficial health effects including: the reduction of tumor growth, the lowering type 1 and type 2 diabetes and the lowering of serum cholesterol levels. Such health benefits are at least partially attributed to the antioxidant activity of proanthocyanidin compounds. This study aimed to measure the proanthocyanidin composition of normal purple wheat versus heat-damaged purple wheat. HPLC in combination with LC/MS were applied to isolate and to identify the major proanthocyanidin compounds in normal and heat-damaged purple wheat. Acetone:water:acetic acid (70:29:1) extracts of purple wheat samples contained simple monomeric, dimeric, oligomeric flavanols in addition to higher molecular weight polymers. (+)-Catechin, (-)-epicatechin, procyanidin B1 and B2 were readily separated by HPLC. Adsorption chromatography permitted group separation and measurement of oligomers and polymers. Proanthocyanidin profile of normal purple wheat was significantly higher (1130.69 mg/100g) than the heat-damaged purple wheat (890.27 mg/100g). The total monomer, dimer, oligomer and polymer contents of normal wheat were determined to be 160.03, 243.97, 305.70 and 420.98, respectively. The corresponding values for the heat damaged purple wheat were 89.68, 130.67, 225.48 and 444.43, respectively. This study suggested that heat was the major factor that affected the proanthocyanidin contents of the heat-damaged purple wheat sample and, thus its nutraceutical and functional values. In summary, the order of proanthocyanidin contents of both normal and heat damaged purple wheat was: polymer > oligomer > dimer> monomer. However, these values with exception of polymers were significantly ($P < 0.05$) higher for normal purple wheat than the damaged purple wheat sample. Results on anthocyanin and lignan contents are also presented.

Phenolic acids and policosanols in bran from near-isogenic waxy wheat lines

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Modern wheat breeding programs give priority to selecting lines with favorable qualities for intended end-use. Waxy wheat contains lower lipid content than regular wheats. Starch related characteristics of waxy wheats have been extensively studied while information on phytochemicals of bran is meager. Wheat bran represents a good source of dietary fiber along with presence of other health beneficial phytochemicals such as phenolic acids and policosanols. Phenolic acids are known to inhibit LDL oxidation and thus eventually reduce the risk of cardio vascular diseases. Policosanol is a mixture of primary long chain aliphatic alcohols that lower the cholesterol levels by several mechanisms one of which is blocking the formation of cholesterol in the liver. The objective of the study was to examine the phenolic acid and policosanol composition of bran from near-isogenic lines of waxy wheat. Two different sets of waxy wheat lines from the varieties N11 and Svevo that has partial and completely waxy have been studied. Findings of this study may prove beneficial to plant breeders and food industry, which may incorporate the elevated levels of these phytochemicals in functional foods. Bran samples were extracted by the soxhlet method. Compounds in bran oil were determined based on alkali hydrolysis and analysis of trimethylsilyl derivatives by gas chromatography/mass spectrometry. Ferulic acid was the most abundant phenolic acid found in wheat bran. Tetra, hexa and octacosanols were the major policosanols found. Concentrations of these components found in these bran samples were differed significantly.

Factors influencing the quality of extruded sinking aquatic feed pellets

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Aquatic feed production is an important application of extrusion processing. This study focused on the effect of formulation particle size and processing parameters on physical and stability characteristics of extruded sinking shrimp feed. The parameters studied were ration particle size (0.8 mm and 1.2 mm), single screw extrusion die profile (land length of 2.5 and 5.0 mm; die output area percentage of 4.5 and 6.7%), and drying conditions (cooling only and drying followed by cooling). The single screw extruder die L/D ratio was 30: 1, with outlet diameter of 2.5 mm. The same formulation was also pelleted by a ring die pellet mill with die L/D ratio of 13.3: 1 and diameter of 2.38 mm, followed by only cooling of pellets. The quality of feed obtained by extrusion and pellet mill was evaluated. The optimum parameters for sinking feed production by extrusion were - formulation particle size of 0.8 mm, die profile with 5.0 mm land length and 6.7% die output area percentage, and drying for 10.5 min at 210°C followed by cooling for 5.5 min. The process and pellet quality data for these parameters were 213.2 kg/h production rate, 68.4 kJ/kg specific mechanical energy (SME), 529.4 kg/m^3 pellet bulk density, 6.7% final moisture content, 99.8% pellet durability, 100% pellet sinking percentage after immersion for 21–24 h, and water stability of 100% after 30 min, 90% between 30–60 min and 80% between 1–24 h. The corresponding pellet mill results were 444.1 kg/h production rate, 23.9 kJ/kg SME, 658.3 kg/m^3 bulk density, 98.4% durability, 100% sinking percentage after 45 min, and water stability of 40% after 15 min, 10% after 30 min and 0.0% after 1 h. Results indicated that SME was the most important factor affecting pellet quality, and better quality sinking aquatic feed could be produced using single screw extrusion processing as compared to pellet mill processing.

Comprehensive analysis of insoluble, soluble and nondigestible oligosaccharides in foods: Extension of AOAC method 2001.03

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Any defintion for dietary fiber (DF) must be accompanied by a method(s) of analysis. The most commonly used methods to measure DF in foods are AOAC INTERNATIONAL (AOAC) methods 985.29 and 991.43. However, these methods do not recover nondigestible oligosaccharides (NDO) in the approximate Degree of Polymerization range of 10-3. The solution to this short-coming of AOAC Methods 985.29 and 991.43 was the development and acceptance of AOAC methods for common sources of nondigestible oligosaccharides (NDO) added to foods: (H) inulin-oligofructans (997.08; 999.03); Polydextrose (2000.11), galactooligosaccharides (2001.02) and resistant maltodextrin (2001.03). Results reported here are extensions of AOAC Method 2001.03, using existing HPLC procedures, which allow for the measurement of insoluble, soluble and NDO DF components to include resistant starch. Nine nondigestible food-based carbohydrates (NDF-BC) including:(A) cellulose; (B) wheat bran; (C) gum Arabic; (D) resistant maltodextrin; (E) Polydextrose; (F) fructooligosaccharide; (G) galacto-oligosaccharides; (H) inulin; and (I) resistant starch were incorporated in various combinations into 11 test-breads. Calculated versus determined values using this comprehensive analysis scheme for the total NDF-BC in bread samples were: Bread 1 (A,B,C,D,I = 4.96 vs 5.66); Bread 2 (A,B,C,E,I = 5.04 vs 5.04); Bread 3 (A,B,C,F,I = 4.92 vs 5.00); Bread 4 (A,B,C,G,I = 4.82 vs 5.15); Bread 5 (A,B,C,D,E,F,G,I = 5.88 vs 6.07); Bread 6 (A,C,D = 4.77 vs 4.69); Bread 7 (A,C,E = 4.84 vs 4.82); Bread 8 (A,C,F = 4.73 vs 4.81); Bread 9 (A,C,G = 4.62 vs 4.37) Bread 10 (A,C,D,E,F,G = 5.71 vs 5.62); Bread 11 (H = 3.42 vs 3.11) and; Bread 12 (Control no NDF-BC = 3.01 vs 3.22). These data provide preliminary evidence as to the utility of AOAC Method 2001.03 for the comprehensive measurement of all insoluble, soluble and NDO DF components in foods.

Effect of partial baking and frozen storage on shelf life extension of *Tandoori roti* - Indian traditional flat bread

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Tandoori roti, a very popular product in India and abroad is prepared from the dough made by kneading whole-wheat flour, water, and salt and then baked in a conventional earthen *tandoor* oven. The present study was undertaken to extend the shelf life of tandoori roties. Tandoori roties were partially baked on hot plate at 110°C for 10 sec and then frozen at –18°C. The samples were analyzed at specified intervals for their various physico-chemical and textural properties and electrophoretic patterns. The frozen storage had significant effect on the above properties. Moisture content showed a decreasing path from 34.3% to 25.8% with the increase in storage period. The loss of moisture resulted in decrease in extensibilities and increase in peak load force of tandoori roties as measured by texture analyzer. The 60th day sample showed the greatest force (10.397 N) needed to rupture the roties. The electrophoresis revealed that protein bands were also affected with the storage period. HMW bands of 94 and 67 KDa gradually increased upto 7 days and then decreased whereas the bands of LMW region of 30 and 20 KDa significantly increased.

The pasting (RVA) characteristics were significantly changed during frozen storage and the viscosity increased during storage.

Comparison of modified and conventional dry grind processes for different corn hybrids

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The increasing demand for ethanol has resulted in an increase in the number of dry grind ethanol plants. Increase in conventional dry grind ethanol production will result in a proportionate increase in distillers dried grains with solubles (DDGS). Wet (E-Mill) and dry (3D) fractionation techniques have been developed to remove the germ and the pericarp fiber before fermentation, resulting in a reduction in the amount of DDGS. Enzymatic dry grind (E-Mill) process, dry degerm defiber (3D) process and conventional dry grind processes were performed on four corn hybrids. Hybrids selected were high oil, high extractable starch, waxy and high fermentable. Each hybrid was obtained from two growing locations. Hybrids were tested in duplicate for germ and pericarp recovery using the wet (E-Mill) and dry (3D) fractionation technologies. The remaining endosperm fraction was fermented. Fermentation rates, ethanol profiles and coproduct yields were determined for the three processes. Germ oil content was measured for 3D and E-Mill processes. DDGS protein was measured for all three processes. Differences were observed in ethanol profiles and DDGS protein contents among all processes.

FT-IR microspectroscopy of wheat scutellum chemistry before and after germination

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Lack of dormancy in wheat kernels may cause preharvest sprouting under moist conditions in the field that results in economical loss and degradation of the functional quality of wheat. In response to the need to identify HWW breeding lines that are relatively resistant to premature sprouting in the field under moist conditions we previously developed nondestructive Near-IR focal plane array imaging method. Subsurface penetration of the short waves produced contrast that revealed the developing embryo at early stages before detection by conventional means. This study was undertaken to learn about the chemical changes within the kernel that are the result of the germination process. FT-IR microspectroscopy was used on frozen sections to seek better chemical definition from fundamental vibrational bands and improved localization from high spatial resolution. Wheat kernels to be sectioned were germinated on moist blotter paper in a petri dish for 36 hrs at ambient temperature. Frozen sections, 4–6 μm thick, from sprouted and unsprouted kernels that included the embryonic axis, the scutellum and a portion of the endosperm were mounted on BaF_2 for examination in a transmission mode. During germination, seed reserves of kernel are mobilized, and starch and storage proteins are degraded into simple sugars and peptides by the enzymes. As new life initiated from the embryonic axis develops, it is nourished by scutellum which surrounds the embryonic axis. Scutellum is composed primarily of lipid and it absorbs the simple sugars and peptides to nourish the growing embryo further. As the miniature biochemical factory is working it produces products and consumes raw materials. Change in the store house of raw materials in the vicinity of the embryonic axis and elsewhere in the kernel provides the opportunity to study the mechanism and rate of the germination in chemical terms. The lipid to protein ratio and lipid to carbohydrate ratio were of interest in the scutellum part of the germ. The experiment was carried out in Microbeam Spectroscopy Lab. at KSU with a FTIR Focal Plane Array microspectrometer. Spectra and images reveal the ratios of the materials of each part of the wheat kernel after germination in comparison to before, as well as the more subtle changes that can be detected at earlier or intermediate stages of the sprouting process.

New ways to characterize the hierarchical structure of starch

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

Effects of milling yield, extent of chlorination, and flour particle size on cake baking functionality explored by RVA and baking

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Chlorination is an essential flour treatment for production of high-ratio cakes. Also, a post-milling treatment is often used to reduce flour particle size. Starch pasting and egg white setting during baking are the major events linked to cake baking performance. Effects of milling yield, extent of chlorination, and flour particle size on cake baking functionality were explored by RVA and baking. The effects of milling yield and extent of chlorination were dramatic, but additional milling to reduce particle size was a less significant factor. RVA showed that chlorination was a dominant factor in starch pasting, and the effects were exaggerated in high sugar concentrations relevant to cake baking, such as 50% sucrose, compared to the effects in water. With increasing extent of chlorination, starch pasting occurred earlier, and both peak and set-back viscosities were increased. Caking baking showed that starch pasting and egg white setting occurred too early for cakes made with excessively chlorinated flour ($\leq$pH 4.0), but too late for cakes made with unchlorinated or insufficiently chlorinated flour ($\geq$pH 4.9), compared to the ideal performance with appropriately chlorinated flours (below pH 4.9 and above pH 4.0). The effects of extent of chlorination showed the impact of starch pasting on collapse. The use of timelapse photography and interpretation of the expansion profiles of cakes during baking led to a breakthrough in understanding about cake baking functionality, which will make it possible to relate RVA behavior in 50% sucrose solution to cake baking potential of cake flours.

Corroborative study on maize quality, dry-milling and wet-milling properties of selected maize hybrids

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The corroborative study was conducted on maize quality and dry- and wet-milling quality properties by the participation of six laboratories to compare their measurements and provide the variance structure within and between laboratories and hybrids. Eleven blind-duplicated samples were sent to collaborators with suggested laboratory procedures for evaluating end-use properties. Partial correlation coefficient among maize quality properties varied between laboratories, of which one or two deviant laboratories significantly contributed to the coefficients of maize quality properties averaged across laboratories. The repeatability and reproducibility precision values of the properties were computed on the basis of the result of analysis of variance with and without outliers detected by Cochran and Grubb tests. The precision values were acceptably low for the physical quality tests except for tangential abrasive dehulling device and Stenvert Hardness Tester time to grind measurement. The yields of dry- and wet-milled products and their correlation with maize quality properties were dependent on the collaborating laboratory. This paper highlights the importance of laboratory variation when

considering which maize hybrids are best suited for wet milling, dry milling, and alkaline processing.

A rapid fluorescence measurement of deoxynivalenol in wheat
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Deoxynivalenol (DON) also known as vomitoxin is produced by a number of species of Fusarium and some other fungi. DON is one of the common mycotoxins contaminating cereals such as wheat, barley and corn. To detect DON in cereals, VICAM has developed a rapid, simple, accurate and quantitative method for measuring DON in wheat. Wheat samples are simply extracted in water, toxin isolation is done by immunoaffinity column, then DON is derivatized by developer A & B and quantitated by fluorometer. The results show that VICAM DONtest FL+ has a very high degree of linearity (r^2 = 0.996) with a detection range of 0.25 to 5ppm. Comparative study indicates that the results generated from this correlate very well with the results of HPLC. The limit of quantitation is 0.25 ppm. The time required for test is about 15min.

Physical, structural, textural and sensory evaluation of wheat flour cookies and tortillas with Moringa leaf
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Leaves of Moringa tree (*Moringa oleifera*) are edible and commonly cooked and eaten in many Asian, African, and Latin American countries. They are an exceptionally good source of vitamin A, vitamin B, vitamin C, minerals, and the sulphur-containing amino acids - methionine and cystine. Our objective is to produce high nutritional wheat cookies and tortillas with Moringa leaf. Cold and hot water swelling and pasting properties, rheological properties and sensory tests of wheat flour with Moringa leaf were characterized and compared at different levels of Moringa leaf content. Functional and rheological properties of wheat flour were studied in the bakery production of tortillas using RVA and PTA. Peak viscosity increased as the content of Moringa leaf in the wheat flour decreased. Quality parameters for the tortillas were measured at 1, 4, 8, 12 and 16 days of storage, respectively. The Moringa leaf had a negative effect on the viscosity of wheat flour. The more the Moringa leaf was added, the lower the viscosity was (80-310RVU). Also, the results showed the softening temperature (T_s) and flowing temperature (T_g) of wheat flour increased with more Moringa leaves being added. Weight of cookies was different with varied content of the Moringa leaf, and the width reduced as the Moringa leaf level went up. Thickness was vice versa to width. Weight (36.5 ± 0.3), diameter (13.8 ± 0.7), and height (1.8 ± 0.6) of the tortillas were not affected by the addition of Moringa leaf. Water activity of Moringa leaf wheat Tortillas was greater than 0.86. Rollability of the tortillas decreased with storage time. The sensory test showed that there was no significant difference in hedonics among different levels of Moringa leaf content. This new bakery product represents a new use of Moringa leaf in human food, and has the potential of delivering high levels of nutrition.

Effect of degree of polish on milling characteristics of barnyard millet
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Barnyard millet (*Echinochloa frumentacea*) is commonly grown millet in Uttarakhand state of India. In hilly areas of Uttarakhand, it is popular as *Banti*, *Madira* and *Jhangora* and in Tarai belt, it is familiar by the name of *Sanwa*. Barnyard millet is small sized grains, containing large proportion of husk and bran, require processing prior to consumption. Processing of barnyard millet involves de-husking, de-branning/decortication and milling. Milling properties of barnyard millet have direct and great influence on its commercial value. Experiments were conducted to study the milling characteristics of barnyard millet (VL-172) at four moisture levels (8, 10, 12 and 14%, db). The milling quality is judged by high head millet yield and minimum brokens. The milling yield of barnyard millet decreased linearly, whereas, the head yield was found to decrease exponentially with an increase in degree of polish for all experimental moisture levels. For the entire range of extended milling (0–6 min of milling), at 10% moisture content, there was higher head yield (52.97%) compared to that of other moisture levels. The broken millet recovery of milled barnyard millet increased with increase in degree of polish for all experimental moisture levels and power model was found to be the best fit.

Interactions of corn lutein and retinal pigment epithelial cell in the presence of lipofuscin
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Age-related macular degeneration (ARMD) is a common cause of visual loss in the elderly and people with diabetes. There are no effective standard treatments for ARMD. Lipofuscin such as the pyridinium bis-retinoid pigment A2E that accumulates in retinal pigment epithelial (RPE) cells may contribute to the onset and progression of the disease. Most current drugs against ARMD may also cause side effects on normal tissues. Epidemiological studies have indicated tha lutein may prevent or delay the onset of ARMD but the mechanisms of lutein action are not fully understood. We have studied the interactions of lutein and RPE cells in the presence or absence of A2E for 7 days. Results indicated that A2E decreased gap junctional communication, stimulated the increase in levels of pro-angiogenic factor vascular endothelial growth factor (VEGF) and depleted pigment epithelium derived factor (PEDF). A2E also affected the morphology of RPE and reduced cell viability over time. Lutein at 100 micromolar incubated with RPE cells before addition of A2E was more protective of RPE against cell damage and the increase in VEGF and decrease in PEDF than lutein addition to RPE previously incubated with A2E. However, lutein when added after treatment of RPE cells with A2E helped the damaged cells recover over within 7 days. These studies suggest that functional foods such as lutein may be helpful to prevent the onset or progression of ARMD. This presentation will discuss the potentials of lutein against ARMD.

A technological approach to reducing salt in bread
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High sodium intake may raise blood pressure, increasing the risk of heart attack and/or stroke. The average salt (NaCl) consumption in the western diet is 11 g person/day, 75% of which is obtained from processed foods with bread products contributing to at least a quarter of dietary sodium intake. In this study, doughs and breads containing levels of salt from 0% to 1.2% (the latter representing the average salt level found in Irish bread) were investigated. Intermediate values were chosen to include those which may carry the nutritional claims associated with low sodium diets. Standard baking tests, i.e. bake-loss (BL), specific volume (SV), moisture loss, texture analysis, and digital image analysis (DIA), were performed. Salt caused a linear increase in the resistance to extension (RE) of the dough as measured by Extensiograph and Kieffer cell. The gaseous retention coefficient significantly decreased at low NaCl levels. Rheological evaluation showed that lower salt doughs have higher viscoelastic moduli and complex viscosity. The reduction in salt resulted in a slight decrease in BL and SV of the baked breads. Five-day staling trials revealed that bread with 0% NaCl had excessively high hardness values when compared to all other samples. Loaf volume increased with lower salt addition. DIA, combined with Scanning Electron Microscopy (SEM), showed that the presence of salt induces a larger number of smaller air cells. In conclusion, the results of this study show that breads produced at low salt levels are not physically different when compared to “standard” breads, even though the doughs display different behaviours. The 0.3% is a salt level that produces larger volume bread that is structurally optimum according to DIA and SEM, and deems that optimisation of this formula will allow the production of low salt bread that is suitable to industrial processing.

Effect of weathering on color and pigment content of pasta
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Damp conditions after kernel desiccation often result in roughening of the seed coat which gives the grain a weathered appearance. Pasta made from weathered grain has been observed to have reduced yellow appearance. Research was conducted to determine the effects of cultivar and kernel weathering on the color and pigment content of pasta. Ten durum cultivars were grown near Prosper, ND. The experimental design was a randomized complete block with four replicates. After harvest, grain samples were cleaned and subdivided. One subsample was used as a control and the other subsample was artificially weathered by tempering to 35% moisture for six days. The weathered sample was air dried at room temperature. All samples were tempered to 17.5% moisture and milled on a Bühler experimental mill fitted with two Miag laboratory-scale purifiers. Semolina was hydrated to 32% mb, extruded under vacuum and dried using a low temperature (40°C) drying profile. Pasta color score was determined using a color map. Pigment content was determined using AACCI Method 14-50. Weathering reduced kernel vitreousness and resulted in increased number of specks in semolina, reduced semolina extraction, and increased the amount of flour produced during

milling. Pasta color score was negatively correlated with semolina speck count (r = –0.76) and positively correlated with kernel vitreousness (r = 0.70), semolina protein (r = 0.72), semolina pigment content (r = 0.35) and pasta pigment content (r = 0.49). Durum cultivars varied in pigment content, which ranged from 6.0 to 8.2 ppm. Removing bran and germ during milling reduced the pigment content an average of 30%. Similarly, pasta extrusion followed by low temperature drying reduced pigment content an average of 24%. Artificially weathered durum wheat reduced pigment content but did not seem to enhance pigment decline during milling or pasta processing.

Determination of cultivar effect on the functional and nutritional properties of wheat and pea flour tortillas

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Dry field peas have an excellent nutritional profile and are currently underused in the North American food market. To increase human consumption of this crop, new food products containing pea flour are being developed. Besides increasing the nutritional value of foods the use of pea flour in foods will allow for product differentiation of products and increase the value of dry field pea crops for producers. Currently harvested dry peas are mixed together and not separated by their cultivar. Different peas may contribute different functional and nutritional properties when used as an ingredient in foods. The aim of this research was to determine if there was a difference of physical and nutritional properties of tortillas when different cultivars of pea flour were used in production. Four varieties of yellow peas were used for the research including; Alfetta, Midas, Mozart and Eclipse. These were incorporated in tortillas as 15, 25 and 35% of the flour. Three batches of tortillas were made in duplicate of each pea flour concentration using a DoughPro tortilla press. These tortillas were evaluated for their compression characteristics, firmness and cohesiveness, as well as their color characteristics, diameter, thickness and rollability scores. Nutritional factors such as antioxidants and total phenols were characterized for each tortilla formulation. From the study it was found that there was no significant difference ($P > 0.05$) in the firmness and cohesiveness values for the genotypes. This indicated that of the pea varieties studied, none were better suited for tortilla production in terms of textural characteristics. This research will lead to the development of food products which may be formulated to include pea flour.

The impact of inhibition on the efficacy of xylanase as a flour improver

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Cereal Foods World 52:A24

Microbial xylanase preparations are routinely used as processing aids to improve characteristics such as baked loaf volume. We describe the development of a simple assay, based on commercially available components and modified from literature sources, which could be used to optimise xylanase addition. Under the specific conditions of the assay simultaneous measurements of xylanase activity/relative inhibition using 4 commercially available xylanase preparations added to each of 15 UK wheat cultivars, grown in multiple locations, was conducted. The pattern of activity/relative inhibition varied according to the microbial source of the enzyme and the wheat cultivator assayed. Differences in xylanase activity as high as 25% were observed. Inhibitor type and enzyme susceptibility to inhibition thus compromises the efficacy of added xylanase. Separation and isolation of the inhibitors present was used to support the observed variation in relative inhibition of xylanase activity between wheat cultivars. Quantification of the inhibitors present by the construction of dose-response curves for the isolated inhibitors supports the observations from the relative inhibition assay. The effect of xylanase addition on dough rheology was investigated. A reduction in viscosity resulted from microbial xylanase addition from a *B. subtilis* source, when applied to selected breadmaking wheat cultivars. The difference in viscosity between baseline readings and samples dosed with known amounts of xylanase varied according to the wheat cultivar under test. Thus, matching specific xylanase preparations and wheat cultivars provides a potential means of optimisation.

Sodium chloride's influence on the quality of breakfast cereals

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Cereal Foods World 52:A24

Decreasing the amount of salt in processed cereal products, including breakfast cereals, without the perceived decrease in quality is a major goal. Flavor, volatile, color and acrylamide formation are all influenced by levels of sodium chloride. To start elucidating the salt action mechanisms, a model for breakfast cereal products has been developed. This model, composed of native maize starch, glucose and a mixture of 4 amino-acids (glucose/total amino-acid molar ratio = 1/1, initial moisture 20% w/w), generates similar color and volatiles (MW = 44, 58, 68, 72, 86, 102 and 172 g/mol) after heating compared to commercial breakfast cereals. A designed experiment used this model to study the influence of salt concentration (0 to 4.33% w/w), heating time (0 to 25 min) and heating temperature (180 to 230°C). Salt concentration as well as heating time and temperature had a significant influence on the lightness (L* value) of the model systems ($P < 0.05$). The higher the salt concentration (heating time and temperature), the darker the products. However, salt did not have a significant influence on volatile type and level. These findings confirmed some observations on 3 types of commercial breakfast cereals. There has been evidence that acrylamide is reduced in the presence of sodium chloride. The originally developed model was changed to include asparagine so that the levels of acrylamide generated could be determined. A mechanism that might be influencing the generation of melanoidins in the presence of salt could be due to water content as the products dry. The isotherm shows a significant increase of 1.5% moisture (w/w) in the model systems in the presence of 5% salt at 75%RH, decreasing Tg by 27°C. Other plasticisers, eg glycerol, potassium chloride, etc have been used to achieve this Tg and color levels are then equivalent to models containing salt.

Comparison of alternative mechanisms for the synthesis of high amylose starches in cereals

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Increasing the amylose content of starches in cereals is of interest in developing cereals with potential utility in food and non-food applications. In particular, the development of starches with increased amylose content is a major mechanism for increasing the availability of "resistant starch" in foods and for reducing glycaemic response, outcomes that are important for improving bowel health and reducing the incidence and impact of type II diabetes respectively. In this report, we discuss two mechanisms for increasing the amylose content of cereal starches, decreasing starch synthase and branching enzyme respectively. A barley mutant, Himalaya292a, has been identified that contains a mutation abolishing the activity of starch synthase IIa. Himalaya292 has an amylose content of 70–75% and studies in rat, pig and human systems have demonstrated the presence of resistant starch in products produced from Himalay292, and demonstrate that such products have a reduce glycemic index. The roles of starch branching enzyme (SBE) IIa and SBEIIb in controlling amylose content in barley and wheat endosperm were examined by down regulation using an RNA-mediated gene interference strategy. Essentially complete suppression of SBEIIb was achieved without any impact on SBEIIa expression. SBEIIa activity was accompanied by a concomitant suppression of SBEIIb, despite their being limited homology between the regions used for gene suppression. In lines where SBEIIa and SBEIIb expression were reduced by >95%, a high amylose (amylose content >70%) phenotype was observed, along with major changes in starch fine structure. Comparison of the starch structures generated using each mechanism for increasing amylose content will be presented. The potential utility of these novel wheat and barley starches in food processing and nutrition will be discussed.

Effect of gluten addition, mixing procedure, and fermentation on the viscosity of barley beta-glucan incorporated into bread dough

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Beta-glucan (BG), a soluble fibre, has a cholesterol lowering effect important today due to the causal relationship between high blood cholesterol and heart disease. Successful incorporation of BG into bread holds great potential as bread is a staple in the diet. However, BG's cholesterol lowering effect is related to its viscosity, which may be decreased by certain processing conditions. The effects various bread dough production techniques have on BG's viscosity when added at levels deemed physiologically effective, as well as the dough mixing characteristics, were studied. Dough was formulated with barley BG concentrate at 0g, 0.75g (low), 1g (med), and 1.5g (high) per serving, with or without added gluten (4g gluten/1g BG). Dough was subjected to pre or post mixing of dry ingredients and evaluated before or after fermentation. Farinograph measurements indicated that water addition, dough development time, stability, and breakdown time of the experimental doughs were greater ($P < 0.05$) than those of the control. BG doughs with gluten had higher ($P < 0.05$) values than those without. Decreasing BG, adding gluten, premixing, and fermentation all decreased ($P < 0.05$) the BG viscosity, which was extracted under physiological conditions. An interaction

($P < 0.05$) was seen between dough blend and premixing, as well as between blend and fermentation. High BG dough, without gluten and fermentation, produced the most viscous extracts ($P < 0.05$). BG incorporation into the dough system affected mixing and BG viscosity, which may have detrimental effects on its cholesterol lowering ability. This highlights the need to more thoroughly understand the processing induced changes in beta-glucan and their physiological implications to produce effective products that will offer a convenient and non-pharmacological means of lowering blood cholesterol.

Size reduction for dry grind ethanol: Comminution law coefficients and new insights

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While developing a size reduction model for a fuel ethanol plant, a literature review for the coefficients for corn and grain sorghum for the three most popular comminution laws yielded no results. Hence, the coefficients for Bond's, Rittinger's, and Kick's laws of comminution for hammer mill size reduction of these cereal grains for dry grind fuel ethanol production were determined. By measuring the power consumption during grinding and the change in particle size from whole kernel to ground product, the coefficient for each law was calculated. Combinations of hammer mill shaft rotational speed settings of 30, 45, and 60 (2330, 3503, and 4674 RPM respectively) and vibratory feeder voltage settings of 60, 90, and 120 V (1.2, 2.6, and 4.0 kg/min respectively) were used to determine the variance of the comminution law coefficients. The Bond's Law coefficients for feeder settings of 90 and 120 V were 10.1 and 13.2 kJ•mm1/2/kg with standard deviations of 3.6 and 7.0 kJ•mm1/2/kg, respectively. The coefficients for Rittinger's law for feeder settings of 90 and 120 Vwere 13.2 and 17.4 kJ•mm/kg with standard deviations of 5.5 and 10.7 kJ•mm1/2/kg, respectively. The coefficients for Kick's law for feeder settings of 90 and 120 V were 7.1 and 9.1 kJ/kg with standard deviations of 2.2 and 4.3 kJ/kg, respectively. Kick's law showed the least amount of variance across the different shaft rotational speed settings, followed by Bond's and then Rittinger's. Shaft rotational speed settings of 45 and 60 yielded far less variance in the comminution coefficients. The Bond's law coefficient standard deviations for feeder settings of 90 and 120 V without the data from shaft rotational speed setting of 30 were 0.9 and 0.4 kJ•mm1/2/kg, respectively as compared to the 3.6 and 7.0 stated above. The trend of less variance in coefficients at higher shaft rotational speed settings was observed for all three laws. This implies use of greater rotational speeds is desirable for practical prediction of grinding energy. Further study is needed to completely understand moisture loss and particle size distribution effects on the comminution coefficients.

Physical and chemical characteristic of extruded red kidney beans (*Phaseolus vulgaris* L.)

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In the developing world, dry beans are an important source of protein and calories for middle and low-income families because animal protein is very expensive. The most common method of cooking beans in developing countries is an open wood fire that is not fuel-efficient because the rate of burning cannot be controlled and much of the heat is dissipated into the surrounding atmosphere. Large quantities of wood and charcoal used to cook beans leads to deforestation and erosion, as well as air pollution from the burning wood. Existing extrusion equipment used in developed countries is not suited to the context of developing countries as it requires large financial investment. In the present study, a low-cost Chinese extruder model JS30A was used. The screws were 30 mm in diameter and the barrel has a L/D of 14. Raw ground bean flour was extruded at screw speeds of 118, 184, or 253 r.p.m; feed rate was 80 or 120g/min and extrusion barrel temperatures were 105 or 130°C (die end); moisture content was 25% or 36% wet basis. Physical characteristics measured included water absorption index, water solubility index, expansion ratio, bulk density, residence time distribution, degree of fill, and specific mechanical energy. Chemical analysis was to determine starch gelatinization, and phytohemagglutinin activity. The objective of the present study the effect of a low-cost extruder on the physical and chemical characteristics of extruded red kidney beans. Under the conditions studied, starch was completely gelatinized, and phytohemagglutinin reduction was over 90%. The cost of using an extruder was 43% lower than using charcoal. Extruded bean products can be used to produce nutritious and low-cost instant flours that could offer a long-term solution to malnutrition among children in developing countries.

Controlled release properties of starch phosphates prepared by reactive extrusion

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Reactive extrusion has been shown to be a commercially viable process to produce starch phosphates due to its low cost, absence of waste, and short reaction time. The aim of this study was to evaluate extruded phosphorylated starch as an excipient in controlled release of drugs. Starches of different origins, amylose contents, and modification conditions were compared to better understand how these factors affect the controlled release properties of the resultant modified starches. Five commercial starches, waxy corn, potato, common corn, Hylon V, and Hylon VII, were used to prepare the phosphorylated starch at pH 9.0 or 11.0 using a mixture of sodium tripolyphosphate and sodium trimetaphosphate. A lab-scale twin-screw extruder with counter-rotating screws was used in the extrusion process and metoprolol tartrate (MPT) was used as the model drug. Waxy corn starch (~100% amylopectin) exhibited better controlled release of MPT, followed by potato starch (~80% amylopectin) and then common corn starch (~73% amylopectin). Hylon V (~50% amylopectin) and Hylon VII (~30% amylose) rapidly disintegrated and displayed poor drug release. Their rapid disintegration was attributed to their limited swelling, presumably from insufficient phosphorylation. In general, extruded and phosphorylated starches at pH 9 exhibited slower drug release than those at pH 11, presumably because of the improved gel layer formation from increased substitution at pH 9. Commercial pregelatinized waxy starch exhibited better controlled release properties over its extruded and phosphorylated counterparts. However, pregelatinization enhanced the interaction between amylose and lubricant in native potato starch, thus resulting in its poor drug release. Extruded starches showed better or comparable powder flow properties relative to pregelatinized starches Amylopectin content was found to dominate hydrogel formation and mediate drug release for extruded and phosphorylated starches.

High-pressure-induced gelatinisation of normal and waxy rice starches in skim milk

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Various aqueous starch suspensions have been found to gelatinise when subjected to high hydrostatic pressure (Stute et al., 1996). In this study, high-pressure-induced gelatinisation of normal and waxy rice starches in skim milk suspensions were studied and compared to those in water suspensions. The effects of milk components on starch gelatinisation were also examined. Starch suspensions were treated at various pressures (from 300 to 700MPa at 20°C, 30 min treatment time). After pressure treatment, samples were examined for pasting behaviour, initial viscosity, degree of swelling and birefringence changes. The extent of starch gelatinisation in skim milk suspensions as indicated by the initial apparent viscosity and the characteristics of pasting curves were dependent on the treatment pressure and the type of starch, which were similar trends to those observed in starch-in-water suspensions (Oh et al., 2007). However, there were subtle differences in gelatinisation characteristics between the skim milk and water suspensions. Various milk components were found to affect the pressure-induced gelatinisation of starch, and these components may account for these observed differences.

Type 4 resistant starch in extruded cereals

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Products rich in dietary fibre are known to be an important part of a well balanced diet. Fibre fortification of breakfast cereals without negatively influencing the organoleptic and physical properties remains a challenge for the industry. The aim of this study was to test the influence of RS 4 type starch on the product quality (nutritional and sensory properties) of extruded cereals. Corn based cereals containing different amounts of resistant starch were produced on a Clextral BC45 twin-screw extruder. Extrusion parameters such as barrel temperature, die pressure, specific mechanical energy, moisture content, and feed rate were continuously monitored. Total dietary fibre (AOAC 991.43) recoveries were correlated to extrusion parameters. The RS 4 products exhibited good extrudability and Compared to RS 3 type resistant starches high processing tolerance. Fibre yields were negatively correlated with specific mechanical energy in that fibre yields decreased with an increase

in mechanical energy. The resulting cereals were tested for bowl life, texture, expansion, and moisture sorption and compared to reference products not containing RS4. Typically, cereals containing RS 4 were harder, had longer bowl life, and lower water sorption. Compared to other types of fibres typically used for fibre fortification (e.g. bran), RS4 resistant starch can be incorporated at higher levels before negatively impacting organoleptic acceptability, expansion, and physical properties of the cereals. RS4 starches in extruded products can provide very acceptable cereal products high in dietary fibre with good textural attributes.

Influence of degree of polishing on physical and milling properties of rice
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Cereal Foods World 52:A26

Investigation were conducted on commercial variety of paddy/cultiver (Pant Dhan – 4) commonly grown in Northern India. Physical, gravimetric and milling properties were analysed in the laboratory at different degree of polish ranging from 0 per cent to 11.31 per cent. It was observed that the length, width, thickness and 1000 kernel weight ranged from 6.53 mm to 6.13 mm; 2.36 mm to 2.20 mm; 1.84 to 1.76 mm and 27.01 g to 20.00 g respectively for 0 per cent and 11.35 per cent degree of polish. Milling, head broken yield were significantly affected by degree of polish. The various mathematical models had been developed for expressing the interaction between physical, gravimetric and milling properties with degree of polish were computed.

Flavor interactions during hydrothermal treatment of starch based matrix application to sponge cake
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The use of exogenous aroma is more and more used in the industry to adjust and reinforce the aroma profile of a product. Different interactions occur during cooking between aroma compounds and the ingredients of the matrix such as starch, eggs proteins, fat, …. The flavoring molecules that are added to the recipe are expensive and also address some health concerns when used in excess. It is thus important to optimise the way they are used. To understand the disponibility or the accessibility of the flavoring molecules, it's necessary to study the affinity of the ligand with the matrix. Indeed during the sponge cake making, the flour starch is undergoing several transformations. The macromolecules which constitute the starch granule are released by hydrothermic treatment, giving the possibility to the flavoring molecules to interact with them. The localization and the quantification of the trapped molecules allow to explain retention phenomena. Amylose is known to trap a lot of molecules as iodine, alcohols, lipids and flavoring molecules. To initiate this study, the trapping of flavoring molecules by a very simple matrix (amylose) has been considered. Wide angle X-ray diffraction was also used to monitor changes in structure during washing or extractions of complexed molecules. A method using FT-IR spectroscopy and principal component analysis was developed to estimate the amount of each molecule which can be complexed into the amylose. Obtained values are in agreement with those of existing literature. In order to measure the quantity of molecules in crystalline layer only, mild acid hydrolysis experiments were conducted and permitted to assess a stoichiometry for these amylose-ligand complexes.

Effect of vacuum cooling on the crispness of the bread crust
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Cereal Foods World 52:A26

Crispness of bread crust is an essential characteristic of several European types of bread as, for example, French baguettes, Italian Chiabatta and German Kaiserbrötchen. Crispness is characterized by multiple fracture events accompanied by acoustic emission and low work of mastication on eating. The main problem of crispy breads is the rapid deterioration of the crispness of the crust resulting from the increase of water in the crust upon storage. Water migrates from the crumb to the crust or becomes absorbed from the air, causing hydration of crust components and loss of crispness. Here, we studied the effect of vacuum cooling after baking on initial crispiness and crispiness retention. Vacuum cooling is a technique that allows fast evaporative cooling of products with high moisture content. Fracture-mechanics, moisture content and sensory perception of the bread crust were clearly affected by the type of cooling used. The crust of vacuum cooled bread exhibited a larger number of force and sound events on fracture compared with the control (breads cooled at atmospheric conditions), which is indicative for a more crispy behaviour. If breads are stored for 4 h at 22°C and 50% RH, crispiness is lost as is clear from the absence of sound events upon fracture. However, if vacuum was employed to cool the breads prior to storage, crispiness was retained. We observed that vacuum cooling both gave an improvement of the crispness directly after baking and during storage. A possible explanation for this observation will be discussed.

High pressure calorimetry and scanning transitiometry in situ studies on the impact of pressure on the starch gelatinization
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Starch is one of the most important natural macromolecules. Its importance comes basically from the fact that the starch granule is an almost universal form for packaging and storing carbohydrate in green plants, including many cereals. Starch is a natural renewable raw material important for food, pharmaceutical and chemical industries. Elaboration and production of biodegradable copolymers with starch becomes an important challenge in the preservation of natural environment. Fundamental understanding of the influence of starch processing on end products requires studies to elucidate how the physical properties of end products vary as a function of conditions encountered in processing. Temperature and pressure are the most important variables relevant to processing, especially in extruxion. Temperature and water content have already been extensively used as variables in physicochemical investigations of starch. However, pressure has been used very seldom, especially as it is concerned with in situ studies. We present here investigations on pressure influence on the phase transitions encountered during thermal gelatinization of wheat starch aqueous suspensions. The in situ investigations have been performed with the use of high pressure calorimetry and scanning transitiometry over the temperature range from 285 K to 415 K under pressures up to 100 MPa. The reported results are concerned with detailed data on the dT/dp slopes of the transitions encountered during gelatinization and their enthalpy and volume variations. On the basis of the obtained results it is now possible to predict the physical state of a given aqueous suspension of wheat starch over very wide pressure and temperature intervals, what is of importance in planning any processing with the use of wheat starch as a raw material and to understand the complicated phase diagram of starch.

Effect of the microwave heating on the physico-chemical properties of maize kernel and its relation to masa and tortilla quality
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Four types of maize (popcorn; flint; dent and soft) were evaluated in order to measure the effect of microwave heating (MH) on the physico-chemical properties and to overcome poor masa and tortilla yield and quality of flint maize with traditional nixtamalization process (TNP) (Patent pending). The MH treatments (trt) were every 5 seconds until 50 s on 200 g of kernel of maize. The microestructural changes in the kernel were monitoring using Ultrasonic velocity (V), hardness (H), elastic modulus (EM) and density. V showed two well defined regions. The region 1 (R1) from 0 to about 25 s of MH, were V increased from 626 to 722 m/s in trt of 25 s, was characterized with a decreasing in H (156 N) in control until 83 N in trt of 30 s. The region 2 (R2) from 30 to 50 s, showed that V decreases from 722 (30 s) to 475 m/s in the 50 s trt and the kernel H increased until 101 N. The kernel density remained constant (1.30 g/cc) at R1, then decreased to 1.03 g/cc in the R2. The EM indicates that in R1 during heating (0-20 s), the kernel become more elastic (from 487 to 639 MPa) then the elasticity decreases sharply to 325 MPa in the R2. Those changes affected swelling and the starch gelatinization where RVU increased from 3135 cP (control) to 3641 cP (trt 25 s) in R1 and decreased until 1995 (trt 50 s). The treatments of R1 increased masa and tortilla yield as well as quality and in R2 the yield and quality was poor. SEM analysis showed that starch granule diameter increased from 14.5 µm in control to 14.9 µm in TNP and 16.7 µm in the TNP with MH maize. Studies of protein solubility using UV-vis at 280 nm, IR and X-rays diffraction indicates that at about (12%) moisture content the MH destroy mainly the protein that is located around the starch granule, releasing it from protein matrix and allow to swell freely during gelatinization.

Incorporation of by-products of the brewing industry into extruded products
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Extrusion cooking is a versatile and rapid method of cooking utilized by many segments of the food industry. This process is particularly useful for obtaining

a uniformly processed product with attractive texture and shape in a continuous operation with variable thermal and mechanical energy inputs. Extruded foods and feeds are made from a diverse range of raw materials, starch the most popular. The food industry is, however, interested in developing novel products with healthy attributes by incorporating different parts of the cereals in the extrudates, providing a source of protein and fiber in the final product. Increased interest in the ethanol and brewing industries, and in their by-products, has prompted equivalent interest in incorporating cheap and suitable sources of fiber into extruded products. Brewer's Spent Grain (BSG), the main by-product from the brewing industry, is usually viewed as a problematic waste by the industry. The aim of this work is to incorporate spent grain into extruded products. A laboratory scale co-rotating twin-screw extruder was used for the research. The feed rate was kept constant for all feeding material. Concentration of BSG, barrel temperature, and screw speed were the process variables. Samples were evaluated for expansion, texture, color, water absorption and solubility indexes. The results demonstrated that BSG is a suitable source of fiber to be incorporated into extruded snack products and our findings demonstrated the optimum conditions of screw speed and temperatures for achieving the best expansion. The hardness of the extrudates decreased as BSG concentration increased. This project demonstrates new feasible ways of introducing healthy products and at the same time be environmentally friendly.

Effect of gums and nontraditional ingredients on pasta quality

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Nontraditional ingredients can be incorporated into pasta to improve nutritional and healthful properties of pasta products. Effect of gums (Arabic, guar, locust bean and xanthan) and nontraditional ingredients (flaxseed flour, oat flour and soy flour) on pasta quality was studied. Semolina was fortified with gums (2% w/w) and nontraditional ingredients (15% w/w) alone and together. Semolina mixtures were hydrated, extruded under vacuum and dried using a high temperature (70°C) drying profile. Spaghetti containing gums had a dull appearance. Spaghetti containing nontraditional ingredients had a rough surface and was darker than traditional spaghetti. Gums and nontraditional ingredients altered the extrusion and cooking properties of spaghetti. Gum Arabic reduced extrusion pressure and extrusion rate when extruded with semolina or semolina containing nontraditional ingredients. Xanthan gum increased extrusion pressure but did not affect extrusion rate when extruded with semolina or semolina containing nontraditional ingredients. Gum Arabic increased cooking loss and decreased cooked firmness, while xanthan gum increased cooked firmness but did not affect cooking loss. Compared to traditional spaghetti, cooked firmness was reduced by oat flour and flaxseed flour but was not affected by soy flour. Conversely, cooking loss was increased by soy flour but was not affected by oat flour or flaxseed flour. These results indicate that the type of gum and nontraditional ingredient affects pasta quality.

Glass transitions of waxy maize starch in water

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A mixture of waxy maize starch and water (1:2, w/w) was heated in a differential scanning calorimeter (DSC) pan to different final temperatures to obtain different degrees of gelatinization. Each pan was then quenched to –30°C, rescanned, and its sub-zero glass transition (T_g') determined. A three-phase model of a starch granule: a mobile amorphous phase, a rigid amorphous phase, and a crystalline phase, was used to interpret the results and explain the glass transitions in starch. Waxy maize starch has an onset gelatinization temperature (T_o) of 61°C, peak temperature (T_p) of 71°C, and end temperature (T_c) of 81°C. No clear T_g' was observed when a mixture of waxy maize starch and water was heated up to T_o (61°C) and immediately cooled to –30°C. However, if the starch and water mixture was heated to T_o (61°C) and held at 61°C for 2 h, a T_g' was detected. T_g' was also observed after the starch and water mixture was heated to T_p and T_c. In addition, when the starch was annealed at 55°C, which was 6°C below the T_o, for 2 h, a small T_g' began to appear and was barely observable. This study supports the proposed concept that the glass transition of the mobile amorphous phase in granular starch extends over a broad range of temperature before gelatinization and is not easily pinpointed by conventional DSC. When temperature is high enough to melt the crystals in granular starch, the rigid amorphous phase begins to become mobile, and a T_g of the mobile amorphous phase is observed below zero in excess water.

Is glutenin protein quality for breadmaking a function of wheat protein content? Evidence from a G x E study

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Gluten protein composition and breadmaking quality data were collected and compared for six adapted hard spring wheat genotypes grown in western Canada in seven locations over two years. Diverse weather and soil types contributed to a wide range in flour protein (FP) (8–18%). Gluten protein was fractionated in different ways. Composition was quantified by methods including SE-HPLC of sonicated and unsonicated protein fractions and RP-HPLC of reduced glutenin subunits (GS). Insoluble glutenin (IG) measured by spectrophotometry and by SE-HPLC of unextractable polymeric protein (UPP) were closely related to each other and with FP. For individual GS, there was wide variation in relationships to FP depending on how the data was quantified. The amount of individual HMW-GS on a genotype-by-genotype basis was strongly correlated to FP ($R > 0.90$). However, the proportions of HMW-GS responded very differently. For example, By9 was distinctly correlated to FP ($R = 0.85$), but for Dx5 and Bx7 there was no correlation ($R < 0.16$). Further, the ratio of HMW- to LMW-GS varied closely with FP, IG and UPP depending on genotype ($R = 0.76$ to 0.93). These results suggest that the molecular size distribution of glutenin was remarkably sensitive to variation in protein content caused by normal variation in wheat growing conditions. Interestingly, only %UPP (UPP as a percentage of total polymeric protein) was totally independent of FP and consequently was generally uncorrelated to all technological quality parameters except, surprisingly, mixograph work input. Clearly, there is much to learn about how environmental variation and FP affect the proportions of different glutenin subunits and measures of polymeric glutenin in order to better understand and predict breadmaking quality.

Novel wheat bran and extracts with improved sensory characteristics, improved dough properties and enhanced antioxidant activity

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The increasing popularity of whole wheat bread and other products containing whole grain reflects the gaining importance with consumers of foods with positive health attributes. Still, many consumers dislike the sensory properties of foods containing significant amounts of bran due to the latter's strong and different aroma and flavor. Whole wheat products are also challenging to manage from a processing perspective. In this paper, we describe results of a new patented (University of Manitoba) treatment that adds considerable value to wheat bran by changing its physicochemical and sensory properties and radically enhancing the antioxidant activity (AOA) of extracts. Control (untreated) and treated bran of different wheat types and derived extracts were compared on the basis of numerous tests and analytical measurements. Altered sensory properties of treated bran and extracts were the most obvious qualities initially observed; the strong "organic" aroma of control bran and bitter flavor of extracts were transformed by the treatment to "cooked" and savory descriptors, respectively. Sensory and electronic-nose results were correlated and indicated a significant shift in aroma of whole wheat bread (treated red wheat bran) towards "white bread" character. Dough mixing tolerance was significantly improved using treated bran at 15% replacement levels. AOA and related properties of extracts of treated bran were remarkable; there was a major shift of AOA from insoluble bound phenolics to the free phenolic fraction and substantial enhancement of AOA as a result. Those extracts at very low concentrations exhibited strong growth inhibition of cultured hepatoma cells in preliminary experiments. Results taken together were very compelling, and point to the development of novel wheat bran and extracts with considerable potential for whole grain food and nutraceutical applications.

Effect of dry heating of wheat flour on Kasutera (Japanese specific cake) cake batter and its volume

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Cereal Foods World 52:A27

A soft wheat flour "Tokutakaragasa" (protein 9.69%) was dry heated at 120 degree centigrade for 10, 20, 30, 60, 120 minutes and Kasutera cake baking was performed. It was found that the volume of Kasutera cake increased with increasing duration of dry heating. It was also found that the stability of air bubbles in Kasutera cake batter increased with increasing dry heating time of wheat flour. Mixograph profiles showed strong hydrophobicity of the dry heated wheat flour. The dry heated wheat flour was fractionated to water solubles, gluten, prime starch and tailings fractions by an acetic acid (pH 3.5)

fractionation technique, and a gradual increase of interaction between prime starch and tailings fractions could be observed from inclusion of prime starch to tailings fraction in wheat flour with increasing heating time. It was found that the increase of volume of the Kasutera cake was highly correlated to the interaction between prime starch and tailings fractions in dry heated wheat flour, due to the hydrophobicity of the prime starch fraction. It was thus suggested that hydrophobicity of the dry heated wheat flour could stabilize the air bubbles in Kasutera cake batter resulting in an increase of Kasutera cake volume.

Influence of protein content and gluten composition on the starch and gluten separation of selected wheat cultivars

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The aim of the work is a better understanding for the parameters, which are important for a technical starch separation from wheat flours. In a three year field trial (2003 to 2005) six German wheat cultivars (A quality: Applaus, Batis; B quality: Flair, Maltop; C quality: Contra, Hybnos) were cultivated at three different nitrogen fertilization levels on one location. The harvest quantity was enough (approximately 200 kg) for the investigation of the grain quality, the milling and starch separation behavior not only in the laboratory, but also in a small technical scale. The extreme differences in climatic conditions within the studied years during the vegetation periods until harvest (2003: dry; 2004: wet; 2005: moderate), produced grain with likewise deviating results in yield and quality with focus on protein content. The lowest yield and highest grain protein level (over all 15.3%) was produced in the dry vegetation period of 2003, while in 2004 the highest yield and an inferior over all protein level of 9.6% was observed. By technical scale milling flours were gained having protein contents between 6 and 17% (following in general the grain protein content by a 1% reduction). Using a protein content of about 12% as limiting factor for wheat flour in terms of starch production, some samples could be regarded as critical. But with regard to the starch separation and gluten recovery also some samples with higher protein content were not processable. The first investigations of the composition of the gluten proteins by Osborne-extraction and RP-HPLC indicates a critical value of the HMW:LMW ratio of 0.3, below which a technical processing and gluten recovery was not possible.

Effect of enzyme treatments and amylose: Amylopectin ratios on dry grind processes

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Cereal Foods World 52:A28

Enzymatic hydrolysis of starch may be affected by amylose:amylopectin ratios because amylose and amylopectin have different physical and chemical properties. Enzymatic starch hydrolysis and fermentation in conventional dry grind processes are performed in two steps: 1) 90°C liquefaction with alpha-amylase (pH 5.5 to 6.0) and 2) 30°C simultaneous saccharification and fermentation (pH 4.0) with glucoamylase and yeast. Conventionally high temperature (90 to 105°C) and high pH (5.5 to 6) liquefaction enzymes have been used but novel enzymes that operate at low temperature (30 to 48°C) and low pH (4 to 4.5) have been developed. Amylose and amylopectin may react in different ways with enzymes working at different temperatures and pH conditions during liquefaction and result in different hydrolytic conversions. Starch and corn with varying amylose:amylopectin ratio were dry grind corn processed with enzymes at different liquefaction treatment (temperatures and pH conditions). Four enzymes working at different liquefaction treatments, enzyme 1 (48°C and pH 4.2), enzyme 2 (liquefaction at 90°C and pH 5.5), enzyme 3 (liquefaction at 60°C, pH 5.5) and enzyme 4 (liquefaction at 90°C and pH 4.5) were used for this study. Differences were observed in the ethanol yield among treatments. For starch samples, final ethanol concentrations were 2.2 to 9.1 (% v/v) with enzyme 1; 6.7 to 9.3 (% v/v) with enzyme 2; 2.7 to 8.4 (%v/v) with enzyme 3 and 7.2 to 9.3 (% v/v) with enzyme 4. Higher ethanol concentrations were observed for 100% amylopectin starch for all enzyme treatments. For corn samples, ethanol concentrations were higher for waxy corn for all enzyme treatments and maximum yield was achieved for enzyme 4 (10.33% v/v). Lowest ethanol concentrations were observed for high amylose corn samples for all enzyme treatments and lowest was for enzyme 3 (4.4% v/v).

Experimental study on saccharification and fermentation process of mash for extrusion cooked rice beer adjunct

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It is difficult to be saccharified and filtrated of mash for extrusion cooked beer adjunct. This problem is paid more attention all along by domestic and foreign scholars. The results of the author's previous experimental research indicated that above problem had been solved. This invention patent technology has been authorized in 2003 in China. Meanwhile the recoverable ratio of wort extract for extrusion cooked rice beer adjunct was 1.3%~3% more than that for traditional non-extrusion cooked rice adjunct. As compared with presently widely used dual mash saccharification method (including saccharification method with additive-enzyme) for brewing beer, this patent technology makes the malt grist and the grist of extrusion cooked beer adjunct put together into water in the brew kettle and saccharified. This is that the saccharification method for extrusion cooking beer adjunct is single saccharification method. In this paper the feasibility of single mash saccharification method for extrusion cooking rice beer adjunct was studied by experiments in which the extrusion cooking and traditional non-extrusion cooking rice beer adjuncts were used for brewing beer of 600L and 900L respectively. Meanwhile the change regularity of main index of wort and fermentation liquor for extrusion cooking and traditional non-extrusion cooking rice beer adjuncts was researched. The test results indicate that the saccharification and filtration of mash for extrusion cooking rice beer adjunct could be carried on successfully. The recoverable ratio of wort extract for extrusion cooking and non-extrusion cooking rice beer adjunct is 63.88% and 57.10% respectively. The alcohol degree, actual concentration, concentration of original wort, fermentation degree, bitter, diacetyl, total acid of wort for extrusion cooking rice beer adjunct are 5.75%, 3.44%, 12.19%, 71.8%, 9%, 0.04% and 1.43% respectively. The above indexes of wort for traditional non-extrusion cooking rice beer adjunct are 4.935%, 3.47%, 11.07%, 68.7%, 10%, 0.03%, 1.47% respectively.

Vacuum fermentation for *in situ* removal of ethanol during simultaneous liquefaction, saccharification, and fermentation

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Vacuum fermentation is among several methods being developed for the *in situ* removal of ethanol from fermentation broths. Removal of impurities such as ethanol reduces osmotic stress and product inhibition, thus improving ethanol productivity. Also, an enzyme has been developed that converts starch granules directly to dextrins at $\leq$48°C, circumventing the energy intensive cooking process in the dry grind process, while simultaneously reducing mash viscosity. We combined the vacuum and enzyme technologies in a bench scale process, which we call vacuum simultaneous liquefaction, saccharification and fermentation. Results demonstrated a two fold increase in ethanol productivity compared to conventional dry grind. The vacuum distillate had a higher ethanol concentration compared to beer from the conventional dry grind process. Using a higher concentration of ethanol can reduce downstream processing. Due to the reduction in viscosity and improvement in productivity, the initial solids concentration can be higher than 32% (w/w).

Optimal harvest moisture contents for maximizing milling quality of long- and medium-grain rice cultivars

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The objective of this study was to determine the harvest moisture contents (HMCs) at which rice milling quality peaked for various rice lots. Multiple samples per field of cultivars Bengal, Cypress, and Drew were harvested at northeast and southeast Arkansas, USA locations in 1999 and 2000. Additional field sample sets of multiple cultivars were collected in 2004, 2005, and 2006 at various locations in Arkansas, Mississippi, and Missouri, USA. Head rice yields (HRYs) were described by a quadratic equation with HMC as the independent variable. Peak HRYs varied from 63.8 to 70.6%. Optimal HMCs, determined as the MC at which HRY peaked, varied from 18.7 to 23.5% for long-grain cultivars and 21.5 to 24.0% for medium-grain Bengal. The general range of optimal HMCs was 19 to 22% for long-grains and 22 to 24% for medium-grain Bengal. For rice lots with HMCs less than the optimal HMC, the amount of HRY reduction from peak values was strongly correlated to the percentage of fissured kernels at harvest; fissured kernel percentage accounted for 77% of the variation in HRY reduction from peak HRYs.

Deposition of carotenoid pigments in durum wheat

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The yellow color of pasta can be attributed to the carotenoids present in durum wheat grain. Carotenoid pigment content in durum wheat varies with cultivar. Research was conducted to determine the content and composition of

carotenoid pigments deposited in the endosperm during grain filling. The five durum cultivars were grown in field plots located near Prosper, ND. The experimental design was a randomized complete block. Cultivars were blocked into four replicates. Spikes from each cultivar were harvested every 5 days until harvest beginning 7 days after anthesis. All cultivars showed a similar pattern of pigment deposition. RP-HPLC analysis showed that lutein, zeaxanthin and beta-cryptoxanthin content per kernel increased during initial grain filling. After 20 days of grain filling, there was a decline in lutein and beta-cryptoxanthin contents whereas zeaxanthin content remained constant. At maturity, lutein was the predominant pigment. Total yellow pigments and zeaxanthin were more concentrated in the bran/germ layer than the endosperm. Lutein content was greater in the endosperm than in the germ/bran layer. Lutein was uniformly distributed in the endosperm. Research has shown that beta-carotene can be detected early in grain development but is absent in the fully developed grain.

Emission characteristics of methyl ester of rice bran oil as fuel in compression ignition engine

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The emission characteristics of methyl ester of refined rice bran oil – diesel blend mixed in the proportion of 10:90, 20:80, 30:70, 50:50 and 10:0 (v/v) were studied. The emission of carbon monoxide, unburnt hydrocarbons, nitric oxide and nitrogen di oxide by different fuels at various load on 3.73 kW C.I. engine were compared with respect to diesel. The emission of carbon monoxide from the engine was found to be lower on all the blends of methyl ester of rice bran oil-diesel compared to diesel at rated load. The emission of unburnt hydrocarbon from the engine at higher loads was found to be more on all the fuel blend as compared to diesel. The emission of No_x from the engine found to be higher on the all fuel blend as compared to diesel.

Effect of processing parameters on shape and functional properties of chickpea extrudates

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Chickpeas are an excellent source of high quality protein, dietary fibre, vitamins and minerals and offer great potential for production of healthy extruded snacks of different shapes and sizes using twin extrusion technology. The objective of this study was to develop chickpea based extruded snack and study influence of processing parameters on characteristics and functional properties of extruded products. The study was conducted in two phases. In phase I we determined the level of incorporation of i) texture-modifier, ii) dietary fibers, iii) modified starches and iv) emulsifiers to improve the textural and sensorial attributes of value added extruded products from chickpeas. Based on both physical characteristics and sensory evaluation using BIB multi sample ranking test, the best formulation was finalized. Phase II focused on, the effect of cutter speed on the shape and functional properties of the products from best was evaluated. The shape of the product greatly varied with the cutter speed. Disks having sphericity of 0.74 was obtained at the highest rpm of 2315 whereas nice small balls with sphericity of 0.89 and rods were obtained at 700 rpm and 140 rpm respectively. All sensory attributes evaluated by hedonic scale for uncoated extrudates indicated no significant difference due to change in cutter speed or change in shape of the product. However the functional properties such as sectional expansion indexes, water absorption index, water solubility index, water activity and bulk density of these products were significantly different due to change in cutter speed. We observed a significant reduction in moisture content and water activity as we increased cutter speed. For example, moisture content and water activity for rods were 8.52% wb and 0.423 respectively for rods but reduced to 3.58% wb and water activity 0.144 for disk. Finalized formula included 65% chickpea flour and 5% of additional dietary fiber.

Avenanthramide content in oats as affected by germination

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Avenanthramides are amides of anthranilic and cinnamic acid derivatives and are found exclusively in oats among the cereals. They have antioxidant activity *in vitro* and *in vivo* and have potential anti-inflammatory and antiatherogenic properties. A goal with studies on the avenanthramides is to find processing methods that will sustain or increase the levels of endogenous avenanthramides in oat based food products. In this presentation effects of steeping and germination will be discussed. Samples from different North American oat (*Avena sativa* L.) cultivars were steeped and germinated in a pilot plant malting system. The content of avenanthramides and the activity of the avenanthramide-synthesising enzyme hydroxycinnamoyl-CoA:hydroxyanthranilate *N*-hydroxycinnamoyl transferase (HHT) were measured at different stages during the germination process. An increase in avenanthramide content and HHT activity of germinated seeds, as compared to raw grains, was observed. Various unknown compounds also increased significantly during the germination, especially at late germination stages. This study indicates that a highly controlled steeping and germination process can be a valuable tool to increase the content of endogenous avenanthramides in oats.

Viscoelastic behavior of rice pasta dough supplemented with proteins and gums

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Viscoelasticity of rice pasta dough was studied by creep-recovery tests for various formulations containing guar gum (0.5%), casein (1%), egg white (1%) mixtures. Non-gelatinized rice semolina (RS) was also mixed with gelatinized RS with various ratios (0, 25, 50, 75 and 100%) for each formulation. The effects of gelatinization, gum and proteins on pasta dough rheology were determined by a control stress rheometer (Haake Rheostress 1). The creep-compliance and creep-recovery of samples varied between samples, but overall pattern of responses were similar. Addition of guar gum and its mixture by casein and egg white decreased creep compliance values. This decrease in creep-compliance was more severe for the formulation with guar gum and protein mixture for the samples which contain 50, 75 and 100% gelatinized rice semolina. After analysis of these curves with Burgers model the two-term model gave the best fit ($R^2 > 0.99$). For all the dough samples the instantaneous compliance value ranged from $3.44*10^{-6}$ to $6.77*10^{-6}$ Pa^{-1}. Loss modulus G" values were 5 times lower than the storage modulus G' values for samples containing 25% gelatinized RS and 10 times lower for samples prepared from 100% gelatinized RS. As frequency increased this factor was lower showing the system is acting more elastically. In fact G' values of dough samples without any supplementary material was higher than the other samples; it was the opposite for samples as the samples were cooked.

Pericarp fiber separation from corn meal flour using sieving and air classification

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Cereal Foods World 52:A29

In the dry grind process, starch in ground corn (flour) is converted to ethanol and the remaining corn components (protein, fat, fiber and ash) form the coproduct, distillers dried grains with solubles (DDGS). Fiber is not fermented in dry grind corn process and its separation prior to fermentation would increase ethanol productivity in the fermenter and produce an additional coproduct. Recently, we showed that Elusieve process, the combination of sieving and elutriation (air flow), was effective in fiber separation from DDGS. In this study, we evaluated Elusieve process for separating pericarp fiber from corn meal flour. Corn flour remaining after fiber separation was termed "enhanced corn flour". Of the total weight of corn flour, 3.8% was obtained as fiber and 96.2% was obtained as enhanced corn flour. Neutral detergent fiber (NDF) of corn flour, fiber and enhanced corn flour (dry basis) were 9.0, 61.5 and 5.7%, respectively. Starch content of corn flour, fiber and enhanced corn flour (dry basis) were 68.8, 23.5 and 71.3%, respectively. Final ethanol concentration from enhanced corn flour (14.12% v/v) was higher than corn flour (13.72% v/v). No difference in ethanol yields from corn flour and enhanced corn flour was observed. The combination of sieving and air classification can be used to separate pericarp fiber from corn meal flour.

Strain hardening: A balance between strength and extensibility of wheat flour proteins

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The primary gluten film (apart from secondary liquid lamellae) around gas cells, determines the extent to which gas cells can expand biaxially during fermentation and baking without undergoing coalescence, thus affecting bread volume. Rheology of the gluten film is important to determine gas cell stability. The gluten film must be sufficiently extensible to respond to gas pressure but also have sufficient strength to resist collapse. Strain hardening has been shown to be a necessary rheological property preventing disproportionation and delaying coalescence of gas cells. Study was conducted to understand gluten protein molecular structure-function relation-

ship required to stabilize expanding gas cells. Rheological properties of doughs were varied by addition of protein fractions prepared by pH fractionation. Fractions were characterized by SE-HPLC and MALLS. The molecular weight distribution (MWD) of fractions progressively shifted to higher values as the pH of fractionations decreased. Mixograph peak development time paralleled the MWD. However, the strain hardening index and the test-bake loaf volume increased with increasing MWD up to a point (optimum), after which they declined. The phenomenon of strain hardening appears to depend on the proportion and molecular weight distribution of the polymeric fraction. There appears to be a critical molecular weight of this fraction at which maximum strain hardening is achieved. This shift in balance between strength and extensibility affects bread making potential of the flour.

Effects of plasticizers and extrusion processing conditions on the structure and properties of starch-clay nanocomposite films

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Global concerns due to the over use of petroleum-based packaging material are being actively addressed by exploring the application of renewable biopolymers such as starch. Starch-clay nanocomposites have a great potential for use in biodegradable packaging due to their superior properties. In the current study, starch-clay nanocomposites were prepared using a melt extrusion process with different types and amount of plasticizers, and varying process conditions. The structure and morphology of the nanocomposites were characterized by X-ray diffraction and transmission electron microscopy, and film properties such as water vapor permeability, tensile strength and elongation at break were also measured. As the glycerol content decreased from 20 to 5%, the degree of clay exfoliation increased. Films with 5% glycerol exhibited the lowest water vapor permeability ($0.41 g \cdot mm/kPa \cdot h \cdot m^2$) and highest tensile strength (35MPa), but low elongation at break (2.15%). Urea, formamide and their combination were tested as alternative plasticizers for the starch-clay nanocomposites. Results indicated that the starch-clay nanocomposite films plasticized by urea and formamide had less water vapor permeability (decrease of 6.4–39.9%) and higher tensile strength (increase of 13.9–43.2%), but lower elongation at break (decrease of 49.3–69.1%) than conventional starch-clay nanocomposites plasticized by glycerol. Different extrusion conditions (in-barrel moisture content, screw profile, screw speed and temperature profile) were also used for the preparation of starch-clay nanocomposites. The results indicated that the processing conditions also substantially affected the formation of nanostructure, and the barrier and mechanical properties of the films.

Use of in vitro extractions of beta-glucan to predict glycemic response

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Mixed linkage beta-glucan, a soluble fibre found in cereals, has been shown to attenuate blood glucose levels and lower serum cholesterol in humans. The development of viscosity in the gut appears to play a major role in the former but equivalent evidence for the latter is less developed. Conducting clinical trials to determine efficacy of beta-glucan containing foods is time consuming and expensive. Therefore, an *in vitro* method that can estimate bioactivity is needed. Oat bran muffins were prepared to test the effect of beta-glucan dose, molecular weight (MW) and solubility on glycemic response. There was a decrease in peak blood glucose rise (PBGR) between 4g and 8g beta-glucan/serving but no further decrease when 12g beta-glucan was consumed. There was a sequential increase in PBGR by up to 57% as the MW was decreased from its native size (~2 million) to 130,000 using beta-glucanase. Also, there was an increase by up to 40% in PBGR as the solubility of beta-glucan was reduced by freeze/thaw cycling. Soluble fibre was extracted from these muffins under conditions similar to those found in the upper gastro-intestinal tract, including addition of enzymes and pH changes. Correlations were found between the PBGR and the viscosity of the extract. As viscosity of beta-glucan solutions is dependent on the concentration (C) and MW of the beta-glucan, a powerlaw relationship was expected between the viscosity and C x MW. For fresh muffins, this was true. But, for frozen muffins, the values for C x MW were lower than expected. This method has the potential to estimate glycaemic response of oat and barley foods and could be used to prescreen samples for clinical trials and show whether changes in formulation or processing are likely to affect bioactivity.

Value-added chemicals from grain sorghum: Isoamyl acetate and succinic acid biosynthesis *via* fermentation and engineered *Escherichia coli*

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Production of value-added chemicals using renewable resources, such as cereal grains, is a welcome trend to initiate a biobased economy. Isoamyl acetate, produced *via* fermentation, is a natural flavor chemical with applications in food and other allied industries. A novel and cost-effective fermentation process was developed to produce isoamyl acetate using grain sorghum derived-glucose as feedstock. Two alcohol acetyltransferases (AAT) from Saccharomyces cerevisiae (ATF1 and ATF2) were cloned from and expressed in an appropriate *ack-pta* mutant strain of *Escherichia coli*. Operational parameters have been optimized and low-cost media components, such as fusel oil, sorghum glucose and corn steep liquor was identified for high yield of isoamyl acetate. Using engineered *E. coli* to produce natural ester is the first of its kind and an encouraging yield of 0.1 g isoamyl acetate/g of glucose was obtained with the low-cost fermentation medium. Similarly, a novel and cost-effective fermentation process has been developed to produce succinic acid, a platform chemical that can be used to make several industrial chemicals including non-toxic solvents, adhesives, paint-additives, and non-corrosive road deicers. Shake flask experiments for succinic acid biosynthesis using grain sorghum-derived sugar and metabolically engineered *E. coli* SBS550MG resulted in a yield of 1.1 g succinic acid/g glucose with minimum by-product formation, similar to the control experiment that used synthetic sugar as feedstock. Fermentor experiments were performed and consistently high succinate yields have been obtained with 2% initial glucose concentration.

Interrelations between sensorial crispness and molecular mobility of bread crust components

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Crust crispness is an important driver of consumer appreciation for baked goods. Loss of crispness is related to an increase in A_w and with that to molecular mobility of certain crust components. However, it is not clear if it is the changes in the starch or the protein phase that onset the loss of crispness. Here we studied the effect of water on the glass transition of model bread crusts in detail using two complimentary techniques: phase transition analysis (PTA) and temperature modulated differential scanning calorimetry (TMDSC). In the PTA a piston applies pressure to material in a closed chamber and the displacement of the piston is measured at constant pressure when increasing the temperature. Gluten, starch and different flours were tested. PTA and TMDSC experiments were compared to results of a sensorial test and low field Nuclear Magnetic Resonance (NMR) experiments. The sensory panel indicated that crusts started to lose crispness at A_w 0.55. At A_w above 0.70 crispiness is completely lost. DSC and PTA gave a transition A_w of 0.70–0.75. This supports the hypothesis that loss of crispness starts as a result of processes at a molecular level, before the macroscopic glass transition. NMR gave a transition point in the mobility of the protons of water at A_w 0.55. This suggests that non-bound water causes the loss of crispness at low A_w. At higher Aw increased mobility of the macromolecules will start to play a role. Additionally, samples were tested that were brought at the same A_w, but different water contents by making use of the hysteresis effect in water sorption. The water content (instead of A_w) was found to be decisive for the transition point as measured by PTA. The sensory transition takes place at lower water content than the glass rubber transition as measured by PTA is likely to be due to the non-bound water causing a loss of crispness at low A_w.

Sonication enhanced granular starch hydrolysis in the dry grind corn process

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Granular starch hydrolysis (GSH) is an important step in the fermentation of corn to ethanol without the need for cooking. The high amounts of enzyme and time required to accomplish this step contribute to the total cost of dry grind corn ethanol production. Recently, sonication has been demonstrated to facilitate starch extraction from corn. We evaluated the effect of sonication on starch hydrolysis of dry grind corn by a commercial GSH enzyme. The starch hydrolytic yield (expressed as dextrose equivalence of the produced reducing sugars) increased with sonication intensity up to a maximum of 40 to 50% intensity, after which enzyme deactivation became a dominant effect. The

increased hydrolysis with sonication was observed at different enzyme concentrations and reaction temperatures. Moreover, it was shown to be synergistic as sequential application of sonication followed by enzyme digestion did not produce the same effect. Fermentation of starch hydrolysates obtained with and without sonication both gave comparable results; therefore, enzymatic starch hydrolysis with sonication may be employed in a liquefaction / presaccharification step without adversely affecting subsequent fermentation performance.

Use of proteases and a granule starch hydrolyzing (GSH) enzyme usages in dry grind corn process

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Granule starch hydrolysis (GSH) is a solid phase digestion process that is different from soluble phase digestion process used in conventional dry grind. Generally, solid starch hydrolysis requires a larger amount of enzyme compared to soluble starch hydrolysis. GSH enzymes are more expensive compared to conventional enzymes. The amount of GSH enzyme used is an important factor affecting dry grind process economics. Starch granules in corn are embedded in the protein matrix. Protease can weaken the protein matrix, help in starch release and reduce RSH use. Protease can hydrolyze protein into free amino nitrogen (FAN) which can be used as yeast nutrient during fermentation. Use of protease might reduce the need for urea which is used as nitrogen source in the dry grind corn process. Two types of proteases, an exoprotease and an endoprotease, were selected to evaluate the effect of proteases in the GSH process. Final ethanol concentrations and fermentation rates were analyzed at three levels of GSH enzyme and four levels of each protease. Both proteases increased fermentation rates and resulted in higher final ethanol concentrations (5 to 12%) compared to control sample (no protease addition). Proteases reduced GSH enzyme use in the dry grind corn process.

Effect of debranning on the distribution and composition of pentosans of different hard spring wheats

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Pentosans, despite their low content in refined wheat flour, are important in determining breadmaking properties as related to water absorption and gluten formation. In whole wheat and bran in particular, pentosans represent a major source of dietary fiber as well as antioxidant activity whose nature is associated with ferulic acid, a phenolic constituent. We investigated the effects of debranning on the distribution and composition of pentosans to determine the optimum degree of processing to maximize both pentosan content and antioxidant activity. Four cultivar samples were debranned incrementally to obtain fractions, each equivalent to 5% of initial sample weight up to 60%. Total pentosans (TP), water-extractable pentosans (WEP), total phenolic content and antioxidant activity were determined. TP and WEP ranged from 3 to 33% and 0.90 to 1.20% (dm), respectively; there were significant differences among genotypes in response to degree of debranning. WEP was maximized for the 10% fraction which likely had the highest content of aleurone tissue. TP content followed a curvilinear trend with maximum content (31% on average) for the initial 5% fraction. The 10% fraction was substantially lower in TP content (20% on average) and progressively declined in later fractions containing increasing amounts of endosperm. Relationships between TP and WEP and antioxidant activity also followed different trends in response to degree of debranning, but there was little difference in antioxidant activity between the 5 and 10% fractions. TP content was highly correlated (R = 0.94) to antioxidant activity for fractions between 10 to 60% debranning. Debranning wheat to recover fractions between 5 and 10% of original sample weight is an effective strategy to produce bran fractions, for food or nutraceutical purposes, enriched in both dietary fiber and antioxidant activity.

Chemical imaging of botanical parts in heterogeneous processing intermediates

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Chemical imaging of coarse heterogeneous mixtures with a near infrared focal plane array spectrophotometer allows identification of each pixel in the image by its botanical origin within the grain kernel. Dry milling of cereal grains physically separates different botanical parts of the kernel into various intermediate products. Each of these output mixtures has a concentration of a desired fraction from the input stock of material. The residue is transferred into a separate intermediate product. Determining the distribution of each part of the kernel between the two fractions provides the opportunity to assess the efficiency of a single processing step. Statistically based image processing does this objectively. A multidimensional spectroscopic characterization of each part of the kernel is used to establish a database for single pixel recognition. Data are presented to illustrate the pixel definition and its utility as a way to evaluate the separation efficiency during dry milling.

Densification of corn distiller dried grains using response surface methodology

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The supply of distillers dried grains with solubles (DDGS), co-products of the ethanol fermentation process, is increasing rapidly with increasing fuel ethanol production. Large amounts of DDGS are needed to be transported to domestic or to export markets via ship and rail. The low bulk density of DDGS results in high transportation cost and low handling efficiency. Therefore, a technique to convert loose DDGS into a densified form is needed. In our experiments, a laboratory-scale closed cylinder piston-and-die was loaded axially with an Instron Universal Testing Machine. The effects of the independent variables of raw material moisture content, pressure, holding time, and temperature on density, durability and stability of densified DDGS were determined using response surface methodology. Cubes with smooth surfaces and good shapes were prepared when the moisture content, pressure, holding time and temperature were in the ranges of 25–35% (dry basis), 12.5-37.5 MPa, 5-15 s, and 100–120°C, respectively. Raw material moisture content and temperature significantly affected ($P < 0.05$) the quality of the densified DDGS cubes, while the influences of pressure and holding time were less significant. The optimum level for each variable was identified as determined to be 30.5% of moisture content, 20 MPa of pressure, 10 s of holding time, and 105°C to obtain maximum durability and stability, and appropriate density.

Functional and sensory properties of extruded breakfast cereals made from oat lines with various amounts of beta-glucan

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Cereal Foods World 52:A31

Directly expanded extruded breakfast cereals (EBC), made from two experimental, N979 and IA95111, and two traditional, 'Paul' and 'Jim', oat lines (*Avena sativa* L.) grown in two replicate fields, were analyzed for physical and sensory characteristics. To judge the physiological impact for potential reduction of serum cholesterol, *in vitro* bile acid binding (BAB) of EBC slurries at 3% dry solids (DS) was measured. Oat flours had 8.6, 7.6, 5.9, and 5.7% beta-glucan, and the finished EBC had 4.7, 4.5, 3.5, and 3.2% beta-glucan, respectively. All experiments were evaluated at a significance level of $P < 0.05$. Field replicates had no effect on proximate composition of the EBC. N979 and IA95111 EBC had greater beta-glucan, protein and less starch concentrations than the EBC processed from Paul and Jim. Paul EBC had the greatest percentage of insoluble beta-glucan among all EBC. N979 EBC had the greatest BAB (38.7 μmol/g DS), whereas Jim had the lowest BAB (24.4 μmol/g DS). However, BAB of the EBC made from two field replicates differed. Paul EBC generally had the greatest expansion ratio (ER), followed by IA95 EBC. Jim EBC had the least ER, greatest density, least water absorption (WA) of intact EBC, and least water solubility index (WSI) of ground EBC. BAB capacity of EBC was highly correlated with total, but not insoluble, beta-glucan concentration. Protein or starch, but not % beta-glucan, affected WA and WSI. Jim EBC had the lowest value for brown color, cereal aroma and flavor, but the greatest value for tooth packing when tasted without milk by a trained sensory panel. Paul and N979 EBC, although different from each other in color, grittiness, and tooth packing with milk, had similar likenesses as judged from a consumer test, suggesting that oats with elevated beta-glucan concentrations can be successfully incorporated into EBC with minimal processing alterations.

Genetic and physico-enzymatic modifications of maize starch

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Genetic and physico-enzymatic modifications to manipulate starch structure may have potentials in terms of functional diversity and regulatory advan-

tages. In the presentation, we will introduce our works with maize starch generated from *ae* and *su1* gene dosage combinations, and discuss a newly developed procedure to conduct enzymatic starch modifications. While the two approaches will be discussed individually, our long-term goal is to integrate both for enhanced starch functions. For genetic modifications, 16 maize endosperm genotypes containing 0, 1, 2, or 3 doses of *ae* and *su1* genes were constructed by reciprocal crosses among *normal*, *ae*, *su1*, and *ae su1* at W64A background. SEM observation and HPLC analysis indicated that the kernel starch from these genotypes showed a broad diversity of granule morphology (e.g. granule size and surface pores), amylose content, and amylopectin branching. Both morphology and branch structure are associated with *ae* and *su1* genes and their doses. For physico-enzymatic starch modifications, the objective was to effectively modify starch structure and meanwhile to maintain the low swelling of starch granules. High-solid gelatinization (HSG) of maize starch was conducted followed by beta-amylase hydrolysis (beta-amylolysis). It was found that extensive heating at 95°C with moisture content from 29% to 40% could substantially reduce the swelling factor (SF) to <4.5, and that certain HSG treatments led to an equivalent degree of beta-amylolysis as that of fully cooked starch (SF>20) in excess water. Due to low SF of treated starch, sugars produced by beta-amylolysis can be effectively separated by a repetitive suspension-centrifugation process. The physico-enzymatically modified starch thus obtained has potentials of improved processing and storage stabilities.

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Abstracts of Poster Presentations

Abstracts submitted for poster presentations at the 2007 annual meeting in San Antonio, Texas, October 7–10. 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.

A comparison of the effect of selected oils and fats on the final volume and physical properties of bread and puffed pastries

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Fats play an important role in many aspects of baked products. The growing preference for non-hydrogenated fats stimulated this study examining the potential of vegetable oils and their fractions in the manufacture of baked products. Breads and flaked pastries were made without additional lipid or with butter, soybean oil, palm oil and fractions of palm oil. The samples produced with butter had the highest expansions. There were no significant differences for the volumes between the samples prepared with palm oil, mid fraction, stearine and the soybean oil. These oils were all significantly better, in terms of volume of product, than palm olein, which in turn was only 3% better than the non-oil control. The expansion was therefore not correlated with the solid/fat ratios. Investigation of the bubble formation showed the greatest number of bubble cells per unit area to occur in the palm stearine loaves and the smallest number in the soybean sample. The palm mid faction had the largest cell diameter and palm oil the smallest. Bread staling was investigated by change in texture and calorimetry, where the results showed changes after one day and continuing retrogradation throughout the next four days of storage (at ambient temperature and in sealed containers). The recrystallisation endotherms showed little dependence on the oil type. However, though the hardnesses of the samples were not significantly different after baking, significant differences were apparent after four days of storage. The butter and palm oil samples were softer than the other breads. The hardest stored samples were those containing no oil or the palm olein. As it was hard to obtain the plasticity necessary to layer the solid fats for making flaked pastries, the palm oil was tempered at ambient for 24 hours. The layered pastries then expanded by a similar amount to those made with butter.

Handling properties of cereal materials in the presence of moisture and oil

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The final quality of baked materials can depend on their initial mixing and handling behaviour. The particle size and shape, as well as water content and ingredients will govern material flow. A powder flow analyzer attached to a Texture Analyser (Stable Micro Systems, UK) was used to compare the flow behaviour of four cereals systems: maize and wheat (in both starch and flour forms), as functions of particle size and distribution, water content and the addition of different types of oil. It was expected that the smaller the particle size the higher the tendency to stick (because of less free volume between the particles), but that was not the case. The results showed that wheat starch, with a bigger particle size than maize starch, had higher cohesion properties and as water content increases the cohesion increases by the same magnitude. Caking strength for both starches was influenced by the water content; in particular at 30% water content (w/w), neither cohesion nor caking indices could be measured for wheat starch because of the high stickiness of the particles. Although the two flours had particles of very similar sizes, with differences in the distributions only, maize showed higher cohesion indexes compared to wheat flour, these values decreased with increasing water content. The caking property for maize was not significantly affected by water content with values of approximately 100 ± 5. The caking strength increased for wheat flour from 8 to 500 as moisture increased from 12.5 to 30%. Generally cohesivity and cake forming ability were affected by the physical state of the oil i.e. by solid/liquid ratios. Wheat starch showed the greatest packing and cohesive behaviour, with and without the oil. Maize flour exhibited the weakest packing and cohesive properties.

Starch biosynthesis enzymes in pigmented maizes

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Pigmented maizes have a great importance due to the nutraceutical effects associated with the anthocyanins present in the grain. Tortillas elaborated with pigmented maizes are consumed in the sub-urban and rural areas of México, and they are softer and with different aroma than tortilla prepared with white or yellow maizes. Starch is the principal component of maize and is perhaps the most important in the functionality of the maize products such as tortilla. The aim of this study was to identified the enzymes involved in starch biosynthesis of pigmented maizes. Pigmented (blue and black), and white (as a control) maizes were used. Starch was isolated using a wet-milling process; protein was separated and purified in different steps using diverse buffers. Two-dimension electrophoresis was used in order to determine the molecular weight of proteins associated to starch granule. Protein bands at molecular weight of 92, 80 and 60 KDa were observed in the three samples analyzed. Those molecular weights correspond to branching enzyme, starch synthase soluble (SSS) and granule-bound starch synthase (GBSS), respectively. The GBSS was the band with higher resolution indicating that this enzyme is the predominant in maize starch granules. Gels of white and blue maizes showed a band close to 97 KDa. pH range for white maize was 5.3–5.7 whilst for blue maize between 5.1–5.5. Black maize starch did not present that band. The difference in the patterns of enzymes involved in starch biosynthesis might affect the chain length distribution of amylopectin. Bands for branching enzyme were not found in 2DE-PAGE, but they were observed in one-dimension electrophoresis. These findings provide useful information regarding starch biosynthesis that might be used for further studies focused on modification and improvement of the starch structure in order to obtain maize with specific functional properties.

Retrogradation of starch in tortillas: A multi-technique study

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Tortilla is the principal staple of Mexican people, however, nowadays its comsumption has extended to people living in the United States, Europe and

Asian. Starch is the principal component of corn tortilla that is gelatinized during cooking and retrograded during storage with an increase of rigidity which affects palatability. The objective was to test the retrogradation of corn tortilla using diverse methodologies. Tortilla was prepared from nixtamalized corn flour and the retrogradation phenomenon was studied using wide angle X-ray scattering (WAXS), Fourier transform infrared (FTIR) spectroscopy and differential scanning calorimetry. WAXS showed that the sample stored for 12 h and more, at 4°C had peaks at different 2θ degrees. The type of diffraction pattern of stored tortilla was a mixture of the A- and B-types. The sample stored at 4°C and the lowest water content (30%) presented higher crystallinity index than those stored at 25 and 40°C and higher water content. The short-range order measurement with FTIR spectroscopy showed that the ratio increased with increasing storage times, reaching a plateau after ~24 h. The samples with 50% of water content showed a significantly effect over the temperature on the retrogradation phenomenon. The melting enthalpy was used to obtain the retrogradation level of tortilla. After 16 h of storage the melting enthalpy showed that a plateau was reached in the sample stored at 4°C and different water content. Pattern that agrees with those results obtained with FTIR and X-ray diffraction. The techniques used in this work can be complementary for measurement of starch retrogradation in starchy products.

Dough physical properties and bread making performance of flours from four Mexican wheat varieties

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Flours from four Mexican wheat varieties grown during the 2005–2006 cycle, at the INIFAP-Yaqui Valley Experimental Station located in Ciudad Obregon, Sonora, were analyzed for moisture, protein and ash content. Dough physical measurements with the National Mixograph, Chopin Alveograph, and Texture Analyzer TA-XT2 were performed. Bake test was also carried out for each variety. Among varieties, Rayon presented the shortest mixograph development time (4.2 min), statistically different ($P < 0.05$) from Kronstad and Tacupeto varieties. According to the Alveograph test, Tarachi and Rayon were significantly less extensible and presented the lowest G and W values than Tacupeto and Kronstad. There was no difference ($P > 0.05$) on tenacity among the varieties; however, differences in P/L and P/G ratios were observed, indicating that Tarachi had the most unbalanced gluten. Dough maximum resistance (Rmax) and extensibility measured with TA-XT2 varied from 29.8 to 61.1 g-cm, and 4.5 to 7.4 cm, respectively. Rayon showed the highest Rmax and almost doubled the Rmax value of the other varieties. The highest bread volume (235.7 cm^3) and specific bread volume (5 cm^3/g) was obtained from Kronstad flour, being only significantly different from Tarachi flour. Flours from Kronstad and Rayon showed a better bread-making gluten.

Effects of protein-modifying enzymes on the structure and shelf-stability of flour tortillas

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Effects of protease and transglutaminase (TG) on dough and tortilla structures, and on shelf-stability were determined to infer the role of gluten in tortilla production and storage. Confocal microscopy was used to study the effects of the enzymes on dough and tortilla microstructure. Control and treated tortillas were prepared using standard procedures in a pilot-plant scale hot-press and gas oven, and evaluated for texture properties and shelf-stability after 0.04, 1, 3, 7, 14 and 21 days. Micrographs of control dough had thin protein strands forming a continuous, web-like matrix. Protease-treated dough had pieces of proteins in place of the continuous matrix, while TG-treated dough had thicker protein strands that were heterogeneously distributed. Control tortillas had a well-developed and well-distributed continuous protein structure. Protease-treated tortillas had a continuous structure despite being composed of hydrolyzed proteins in the dough, while the TG-treated tortilla retained clumps of proteins. Protease-treated tortillas required the least force, distance and work to rupture. Tortillas prepared with protease and TG broke on the third and seventh days of storage, respectively, while the control broke after two weeks using the subjective rollability evaluation. Both protease (hydrolyzing enzyme) and TG (cross-linking enzyme) weakened dough and tortilla structures. Thus, it appears that at least a moderate gluten network is necessary to impact a longer retention of tortilla flexibility during storage.

Effect of starch molecular structures on the glucogenesis with recombinant human small intestinal maltase-glucoamylase

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The digestion of starch in the human body requires activities provided by six mammalian enzymes: salivary and pancreatic alpha-amylases, and the two enzyme complexes maltase-glucoamylase (MGAM) and sucrase-isomaltase (SI). Starches are the major source of dietary glucose. However, small intestine glucogenesis from starch digestion is poorly understood due to substrate structural complexity and the multiplicity of participating enzymes. In the study, solubilized starches from different botanical sources were incubated with human pancreatic alpha-amylase and recombinant maltase-glucoamylase (rhMGAM). The results showed that glucose production increased with the extent of alpha-amylase hydrolysis. Alpha-amylase strongly amplified the glucogenic activities of rhMGAM by pre-processing of starch to malto-oligomer substrates. The results also demonstrated that starch structures with a greater proportion of long branch-chains and less alpha-1,6 linkages were more easily attacked by alpha-amylase and rhMGAM. The study is important to gain a better understanding of the wide differences in digestion among starchy foods. Use of human enzymes gives the promise of finding starches that have special structures with slow digestion or resistant properties for health benefit.

Physicochemical, rheological, thermal and structural characteristics of triticale (*Tritticosecale Wittmack*) starch, extracted by wet and dry milling

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Triticale (*Tritticosecale Wittmack*) is a cereal used to feed animals because of its high nutritional quality. Nevertheless, its human and industrial usage is not well known. Triticale as other cereals, such as wheat and maize, has high content of starch (74-78% (w/w)). Little is known about the starch properties from triticale, therefore their uses are very limited. In this work, triticale grains of a new variety produced in México were studied, and the starch properties were evaluated. The starch granules were extracted by two methods, wet and dry milling, and their characteristics were determined. Starch from commercial wheat flour, extracted by wet method, was used as a reference. Both types of starch, triticale and wheat, were characterized by their physical, physicochemical, rheological, thermal and structural properties. The results were analyzed by standard deviation and Duncan's means multiple comparisons test. The triticale starch did not show significant differences in the most evaluated variables, comparing the two tested extraction methods. However, the triticale starch showed high significant differences in most properties compared with wheat starch. The triticale starch granules showed oval and semispherical shapes, and two ranges of particle size, (4–8 μm and 15–35 μm). The x-ray diffractgrams of triticale and wheat starch showed the characteristic pattern from cereal starches. The water absorption and solubility index of triticale starch, extracted by wet and dry methods, were lower (1.86 and 2.1 mL/g, and 0.030 and 0.031), than for wheat starch. The triticale starch extracted by the two methods showed the follow mean values for thermal and rheological properties: onset, peak and endset gelatinization temperatures, 57, 60 and 65°C for starch extracted by both methods; peak and retrogradation viscosities, 3885 and 2815cp, and 2113 and 1397cp, to starch extracted by wet and dry milling, respectively. In general, the triticale starch did not show significant differences for both types of extraction methods used, and the triticale starch properties were significantly different to wheat starch properties.

Evaluation of alternative heat sources to cook maize tortilla

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A main step in the elaboration of maize tortilla is the baking. Since its beginning, the mud "comal", heated with direct fire, was used to cook the nixtamalized maize masa. The mud comal was changed by the metal comal later. The baking stage of maize tortillas elaboration process has not had important changes. Today, tortillas machines, which consume gas L.P. are used. In this work, tortillas elaborated by the traditional method and cooked in an infrared furnace (IR) with different times and cooking temperatures, and in a microwaves (MW) stove with times of 50, 55 and 60s, were tested and compared with cooked tortillas on comal heated with L.P. gas. Puffing degree,

color parameters (L, a, b), tensile strength and cutting force tests were determined. The moisture content of tortillas elaborated with MW was very low (32%, w/w), and the appearance and rheological properties were poor quality. Tortillas elaborated with traditional and lR methods were similar and their quality characteristics (color, texture and puffing degree) were very good. Base on results we concluded that the IR method is one of the best alternatives for the maize tortilla elaboration.

Detecting chalk in rice with a reflected light image analyser

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Cereal Foods World 52:A35

Rice, unlike wheat, is typically consumed as intact kernels. This makes the visual appearance of the grain a critical quality parameter. Chalk, a white patch in the endosperm, is the principle defect affecting otherwise sound kernels. Most grain standards specify that a kernel that is at least 50% white is regarded as chalky. Manually assessing rice samples for grains that are estimated to be more than 50% chalky is subjective and tedious. Digital image analysis can provide a rapid and objective alternative assessment. As existing chalk standards are based on human vision, the CIE L*a*b* was selected as the most appropriate colour space to test for chalk defect correlations. American, Australian, Indian and Thai rice samples were examined with SeedCount DIA systems. Both brown (cargo) and white (polished) data is presented. Examination of affected kernels indicated that kernels lying in edge-on indents could often hide the chalk, so only kernels in the shallower wide-on indents were used. Calibrations were developed that demonstrated that most of the chalk areas were confined to a small region of the three-dimensional colour space. A complex whole kernel approach based on an inverted version of the SeedCount tests used for blackpoint in wheat produced high correlations with manual chalk assessments. The SeedCount system can also evaluate other grain parameters such as kernel weight, discolourations and dimensional characteristics.

Thin stillage fractionation using ultrafiltration

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In the dry grind corn processing industry, production of thin stillage requires evaporation of large amounts of water and maintenance of evaporators. Evaporator operation and maintenance requires excess evaporator capacity at the facility, increasing capital expenses, requiring plant slow downs or shut downs and resulting in revenue losses. In our study of fractionation of thin stillage, we used ultrafiltration to evaluate membranes as an alternative to evaporation. To obtain thin stillage, corn was fermented using laboratory methods. Ultrafiltration experiments were conducted in batch mode under constant temperature and flow rate conditions. Two regenerated cellulose membranes with molecular weight cut off of 10,000 and 100,000 kDa were evaluated. Filtration studies were carried out with the objective of retaining solids as well as maximizing permeate flux. Operating pressures were evaluated for maximum permeate flux. Optimum pressures for 10,000 and 100,000 kDa membranes were 207 and 69 kPa, respectively. Long term flux profiles for both membranes differed. For the two membranes types, total solids in permeate and retentate streams were 2.10 to 2.30% and 22 to 27%, respectively. Total solids in retentate streams were found similar to those from commercial evaporators used in industry (25 to 35% total solids).

The effects of Condensed Tannins (CTs) and grain hardness on starch digestibility and Estimated Glycemic Index (EGI) of sorghum porridges

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Cereal Foods World 52:A35

The effects of CTs and endosperm structure on starch digestibility of porridges of 5 Sorghum [*Sorghum bicolor* (L.) Moench] varieties with different levels of CTs and grain hardness were evaluated. Grain hardness was evaluated by Single Kernel Hardness Test (SKHT). White sorghum (hardness of 57.73), black sorghum (hardness of 55.64), high tannin sorghum (hardness of 50.66), black with tannin (hardness of 42.31), and sumac sorghum (hardness of 37.87) varieties were used. Total starch (TS), resistant starch (RS), and digested total starch (DTS) were measured using enzymatic hydrolysis. The *in-vitro* rate of starch digestion was used to estimate the GI of the porridges. Also, total phenols and condensed tannins were measured. Significant negative correlations ($r = –0.612$, $P = 0.007$) were observed between grain hardness and CTs content, respectively. CTs content was also highly correlated ($r = 0.96$, $P = 0.00$) with RS. Harder endosperm sorghum varieties with CTs had significantly lower DTS (62.06%) and EGI (85.7) than soft endosperm sorghum varieties with CTs, which are DTS (72.9%), and EGI (95.15). This information can be useful for selecting sorghum varieties with relatively lower starch digestibilities for sorghum products.

Stability of sorghum 3-deoxyanthocyanin pigments exposed to light in acidic environments

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The rare 3-deoxyanthocyanins found in sorghum are reportedly more stable than anthocyanin colorants; however these pigments have not been tested in systems that are typically encountered in food processing or display. We compared the stability of six 3-deoxyanthocyanidin (3-dx) standards (methoxylated and non-methoxylated) with those of natural sorghum pigment extract and five commercial natural food colorants at pH 3.0 and 5.0 in aqueous buffers, exposed to laboratory fluorescent light for 100 days at 30°C. Samples absorbance at maximum wavelengths were monitored by UV-Vis spectroscopy. Among standards at pH 3, the dimethoxylated 3-dx were most stable at pH 3 (88–92% color retention), compared to the mono- (40–61% retention) and non-methoxylated 3-dx (20–26% retention); indicating methoxylation improved stability at this pH. At pH 5, luteolinidin and its derivatives were more stable (81–83% color retention) compared to apigeninidin derivatives (26–47% color retention). This was probably due to the presence of a catechol unit on the B-ring of luteolinidin 3-dx family which is lacking in the apigeninidin family. Among natural pigments, sorghum extract outperformed the commercial colorants at pH 5 (94% color retention for sorghum vs 20–27% retention for commercial colorants); while at pH 3, sorghum performed as well as the most stable commercial sample (50% color retention). Half-life for sorghum extract was over 100 days at pH 5, and 68 days at pH 3; compared to 19–37 days and 45–95 days for commercial colorants at pH 5 and pH 3, respectively). Unlike the common anthocyanins, sorghum pigments were more stable at pH 5 than pH 3. This indicates these pigments have a strong potential as natural food colorants.

Glucose and lipidemic responses in rats fed quinoa (*Ch. quinoa*), amaranth (*A. caudatus*) and cañihua (*Ch. pallidicaule*) brans

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Dietary fiber consumption helps to maintain a healthy gastrointestinal tract, influences the postprandial glycemic response and may help to prevent cardiovascular diseases. Quinoa, amaranth and cañihua are pseudocereals grown in the Andes of South America. Besides good protein content and quality, these grains also contain dietary fiber. We determined the effect of diets supplemented with bran fractions of quinoa, amaranth and cañihua on the serum glucose and lipid levels in rats. Quinoa grains were washed and dried before milling. Bran and flour fractions were obtained by roller-milling and sieving. Soluble dietary fiber was 9.6, 3.8 and 8.2% and insoluble fiber was 15.4, 13.7 and 24.3% in quinoa, amaranth and cañihua brans, respectively. Bran soluble fiber (pentosans and beta-glucans) and insoluble fiber (cellulose, lignin and resistant starch) composition were also determined. Glucose (0.5g glucose/kg) or glucose and bran (15%) preparations were intragastrically administrated to groups of six rats. Glucose levels were measured every 30 min for 2 hr with a commercial blood glucose monitoring system. Rats fed glucose and quinoa bran produced a lower glucose response than those rats fed only glucose, but this difference was not significant. Under a high lipidic diet, triglyceride and cholesterol levels in rats fed 15% bran-diets were lower on the 15th day compared to the control diet. On the 30th and 45th day, the triglyceride and cholesterol levels were relatively the same as those reached on the 15th day. No significant effect of the bran supplement diets was observed on serum HLD levels.

Reaction of octenyl succinic anhydride with waxy maize starch and the structure of the modified starch

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Octenyl succinic anhydride (OSA) modified starch products are widely used in emulsion and encapsulation applications. However, the reaction conditions and the structure of the OSA modified starches are not well understood. The

objectives of this work were to determine how OSA concentration affected the degree of substitution, and to examine the structures of the OSA modified waxy maize starches by nuclear magnetic resonance (NMR) spectroscopy. The information would be useful in understanding the emulsification properties of OSA starches and finding potential uses of OSA starches with high degrees of substitution. OSA modified waxy maize starches were prepared in aqueous slurry where the pH of the suspension was controlled at 7.5 with a pH meter while adding 3% NaOH. After NaOH uptake ceased, the slurry was stirred another 30 min. The product was isolated and its degree of substitution (DS) determined by saponification and titration. Treatment with OSA at 3, 6, 9, 12, 15, 25 and 50% based on the weight of starch resulted in starch esters with DS 0.017, 0.036, 0.053, 0.060, 0.070, 0.106 and 0.129, respectively, with reaction efficiency decreasing as OSA concentration increased. The OSA modified starches were digested by alpha-amylase and then examined by 1H- and 13C-NMR. Compared with the 1H-NMR spectrum of enzyme-degraded waxy maize starch, extra peaks at 0.800.89, 1.2–1.4, 2.0-3.0, and ~ 5.57 ppm were observed in OSA-modified starches. Moreover, an extra ill-resolved signal was observed to the high-field side of the peak at 5.40 ppm. The majority of the modifying groups were substituted on the O-6 position when the reaction was conducted at pH 7.5. The effects of the rate of OSA addition, reaction time, and reaction pH on the esterified positions were studied and related to possible impacts on emulsification properties.

FT-IR microspectroscopy of octenyl succinic anhydride modified starches

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Spatial resolution of FT-IR microspectroscopy enables assessment of the uniformity of octenyl succinic functional groups within the starch matrix in granular form. Waxy maize starch was reacted with 3, 6, 9, 12, 15, and 25% octenyl succinic anhydride (OSA). These OSA modified starches and unmodified waxy maize starch were examined by FT-IR microspectroscopy. OSA modified starch was identified by the carbonyl functional group and the stretching vibration of the O-C portion of the resulting ester. In addition, the CH stretching vibrational region was enhanced and a peak due to the CH3 stretching was found in OSA modified starches. The ratio of the carbonyl peak height at 1724 cm-1 and the complex carbohydrate peak height was used to measure the bound OSA content. Targeted areas of 20 µm by 20 µm were used in the microscopic field of view. The uniformity of the OSA in modified starch granules was assessed. Moreover, smaller spot sizes were also examined and the potential of single granule analysis was explored. Data is presented to illustrate the utility of FT-IR microspectroscopy for determination of the reaction uniformity among starch granules.

Classification of growing locations based on their probability for production of wheat with required protein content

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Increasingly competitive wheat markets demand wheat of improved end-use quality. Production and supply of wheat with desired protein content have become essential for the continuous prosperity of the wheat industry. Large fluctuations in climatic conditions among years and locations as well as the large number of wheat cultivars pose a great challenge to growers in production of wheat with consistently desirable protein content. We explored and established procedures for identifying growing locations suitable for the production of wheat with required protein content. Protein content of 6–12 varieties of hard red spring (HRS), hard white spring (HWS), soft white spring (SWS), soft white winter (SWW) and winter club (WC) wheat, which were grown in 17 to 19 locations of varying climatic conditions for 5–6 years, was collected and analyzed for variances. In all five classes of wheat, location and crop year contributed 69–86% of the variation for protein content, while the contribution of variety was 4–17%. In each location, crop year was responsible for >80% of the variation in protein content with exception of 2–5 locations, where overall variation was relatively small. Average protein content over crop years and varieties, and probability for production of wheat with required protein content (>14% for HRS, >12.5% for HWS, <12% for SWS, and <11% for SWW and WC) for each location varied widely among locations and identified those locations suitable for growing each class pf wheat. The probability for production of wheat with required protein content was more accurate in describing protein content potential for a location than the average protein content. Negative relationships between protein content and cumulative precipitation during crop year were observed in spring wheat (HRS, HWS and SWS), but not in winter wheat (SWW and WC).

A comparison between Brazilian upland and lowland rice varieties

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Brazilian rice samples were examined by gas chromatography/mass spectrometry using solid phase microextraction. Volatiles analysis identified over 35 compounds using the a mass spectral data base. There was little variation in the relative amounts of lipid oxidation products such as hexanal and nonanal, indicating that post harvest handling and storage of the rice was consistent for all samples. Straight chain hydrocarbons as well as branched chain hydrocarbons were more prevalent in the upland set relative to the lowland set.

Genetic characterization kernel polyphenol oxidases in wheat (*Triticum* spp.) and its cultivated and wild relatives

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Polyphenol oxidase (PPO, EC 1.10.31) is a major cause of discoloring in raw dough containing wheat flour. PPO is a ubiquitous enzyme that occurs in many tissues of the wheat plant, including the outer layers of wheat kernels. High levels of flour PPO have been associated with diminished end-product color and brightness in a variety of Asian noodle products. This is because PPO catalyzes the oxidation of a number of endogenous phenolic substrates in flour, producing the dark pigmented products that diminish product quality. However, breadwheat is composed of the genomes of three grass species, and the genetic source(s) of PPO activity are not well understood. The aim of this study was to characterize the PPO genes and activity in wheat's diploid and tetraploid relatives. The L-DOPA colorimeteric assay was used to determine PPO activity levels in whole kernels. Northern and Western blot analysis was used to estimate PPO mRNA and protein levels in whole kernels respectively. Southern blot was used to estimate gene copy number in genomic DNA. PCR and DNA sequencing was used to confirm the presence of unique PPO sequences in each genotype. We also determined that each diploid wheat relative has active PPO enzyme expressed in the kernel. Analysis of genomic DNA indicates that the diploid wheat relatives have as few as two (A. speltoides and A. tauchii) to as many as four (T. urartu) PPO genes that are expressed in developing kernels. However, we have also observed a substantial degree of variability in PPO protein and enzymatic activity levels between individual lines of the species A. speltoides and A. tauchii, indicating that a large amount of genetic variation exists to be exploited in reducing the PPO levels in breadwheat.

Textural studies of stored corn tortillas adding xanthan gum

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The tortilla market has expanded. Today, with the aim being to produce products with longer textural shelf life, tortillas are produced from nixtamalized corn flour mixed with hydrocolloids. The tortilla cooking process produces starch gelatinization, and when the tortillas are stored, the starch components undergo retrogradation, which yields a rigid tortilla structure. Hydrocolloids retard starch retrogradation in a variety of products, including bakery products and tortillas. The objective of this study was to determine the effects of xanthan gum addition and storage time on the textural characteristics of corn tortillas. During tortilla preparation, nixtamalized corn flour was mixed with xanthan gum at different concentrations. Rollability, puncture, and extensibility tests using a texture analyzer machine measured the effect of xanthan gum on staling. These tests were simple, fast, and repeatable. The rollability parameters showed that the addition of xanthan gum produced more flexible tortillas with a decreased likelihood of staling. The addition of hydrocolloids diminished the force required to penetrate the tortilla, but a slight increase in this parameter was found when storage time increased. The parameters determined in the extensibility test showed textural differences, since fresh tortillas had higher distance of extensibility and this parameter decreased when storage time increased. Untreated stored tortillas produced higher deformation, work, and rupture force values; however, the addition of xanthan gum decreased these values. The addition of hydrocolloids to tortillas decreased the hardness and increased the flexibility and rubbery characteristics of the tortillas.

Tortillas added with amaranth flour: Chemical composition and in vitro starch digestibility

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Corn is defficient in certain essential amino acids. The actual tendency is to improve the nutritional balance of this grain using blends with other seeds or isolated ingredients. Amaranth is an ancient crop with outstanding agronomic traits and good nutritional properties, whose seeds contain a waxy type starch with low retrogradation tendency. The objective of this work was to determine the enzymatic starch availability in cold-stored tortillas, made from nixtamalized corn flour (NCF) alone or added with 20% (w/w) amaranth flour (AF). Tortillas were stored for different periods at 4°C. They were analyzed regarding chemical composition and *in vitro* starch digestibility. NCF-AF tortilla had lower available starch (AS) content than NCF tortilla, a parameter that decreased upon cold-storage. Such a change was larger in NCF tortilla, which might be due to formation of retrograded resistant starch (RRS), suggesting slower starch retrogradation in NCF-AF tortilla. Total resistant starch (RS) values in 96h-stored NCF tortilla were higher than in NCF-AF tortilla; however no differences were detected thereafter, indicating that starch retrogradation was similar in both samples after prolonged storage. Retrograded resistant starch contents (RRS) indicated that only part of total RS in tortilla is due to the retrogradation phenomenon, a result that agrees with the tendency recorded for AS and RS in both types of tortillas. No differences were detected in the alpha-amylolysis rate between NCF-AF and NCF tortillas, although some decrease was observed with storage. The predicted glycemic index was higher in NCF-AF tortilla than NCF tortilla, a pattern that might be due to the waxy type starch present in amaranth, which exhibits high amylolysis rates. NCF-AF tortilla might be suggested as a high protein product with greater potential glycemic index than conventional NCF tortilla.

Biological evaluation of reduction of Fumonisin B1 toxicity in corn grits by extrusion processing

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Extrusion processing appears to reduce the concentrations of fumonisins in the final product, but little is known about toxicity of degradation products that may be formed. The goal of this research was to determine the identity and toxicity of degradation products obtained by extrusion of fumonisin-contaminated corn grits in the presence and absence of glucose. Uncontaminated clean grits, grits spiked with 30 µg/g FB1, and grits fermented with *F. verticillioides* M-2552 (40–50 µg/g FB_1) were subjected to extrusion in the presence and absence of glucose (10%) using a single screw extruder (temperature: 160°C and screw speed: 60 RPM). The fumonisins and degradation products were analyzed by HPLC, ELISA and LC-MS. Toxicities of the extruded and non extruded materials were evaluated in a bioassay where young male Sprague-Dawley rats were fed samples for 3 weeks with the kidney used as a biosensor. LC-MS showed that most of the fumonisin recovered from the extruded samples in the absence of glucose was still the FB_1 form, while the main degradation product obtained by extrusion of contaminated grits in the presence of glucose was N-(1-deoxy-D-fructo-1-syl) FB_1. Bioassay results showed significant differences in kidney weight for the different groups of rats. Those fed with non-extruded spiked and fermented grits, as well as those fed with spiked and fermented grits extruded in absence of glucose showed significantly lower weights. Results obtained with rats fed grits that were fermented and extruded with glucose, were mixed, with one batch no different than the control, while the other gave lower organ weights. Histopathologic examinations of kidney tissues showed that lesions were least severe in rats given grits extruded with glucose, suggesting that the N-(1-deoxy-D-fructo-1-syl) FB_1 was less toxic than FB_1.

Serological response of IgA from celiac patients to prolamins of wheat and gluten-free breads treated with microbial transglutaminase

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Celiac disease is an enteropathy triggered by dietary gluten, which pathogenesis is mediated by IgA antibodies to gliadins, deaminated gliadins and tisular transglutaminase (tTG). As tTG has activity and homology similar to these of microbial transglutaminase (mTG), it could be a risk for celiac patients to elicit or increase their immune response to proteins of tTG treated foods. The aim of this study was to evaluate the serological response of celiac IgA to prolamins of wheat and gluten-free breads treated with mTG. Prolamins were extracted from wheat and gluten-free (maize and rice flours) breads conventionally made or mTG-treated. Extracts were used for serological tests by ELISA and immunodetection on blotted membranes, using sera of celiac patients of recent diagnosis, and different characteristics of age and disease chronicity. IgA of all sera presented high titers against prolamins of conventional wheat bread and 2 of them (long-time symptomatics, 8 and 18 y old) had a higher response to mTG treated bread. IgA of 3 sera (the former 2 plus other 29 y old with actual onset and no previous symptoms) recognized prolamins of gluten-free bread and such response was increased after mTG treatment in one of them and other 3 y old celiac patient. There was only one case (the 18 y old long-time symptomatic) in which the titer for mTG treated gluten-free was higher than it of mTG wheat bread prolamins. The celiac IgA response was increased to mTG treated breads due to formation of new m.w. subunits. Risk of immunological responses to mTG treatment of cereals apparently is related to chronicity of the celiac disease; anyway, it is needed to re-evaluate using of mTG for cereal food's technology because celiac disease.

Swelling properties of waxy corn mutant starches

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Swelling of starch is very complex because various contributing factors are involved and their respective roles are still not well elucidated. The objective of this research was to investigate the specific influence of amylopectin structure on starch swelling as measured by dynamic rheometry, Rapid ViscoAnalyser, and swelling power. Four experimental corn mutant lines (HSyn99^{6}w *wxwx*, HSyn99 *wxwx*, HSyn99 *duwx*, and HSyn73 *duwx*), were studied, and their structures were characterized by high-performance anion exchange chromatography. *duwx* mutant had a decreased proportion of long B-chains and an increased proportion of short B-chains. Both *duwx* mutants had larger M_w but smaller R_z, indicating the more branched structure of *duwx*. Waxy corn starches had different swelling power and some also exhibited different pasting properties. The peak viscosities of HSyn99^6 *wxwx* and HSyn99 *wxwx* were similar and much higher than those of the two *duwx* mutants. However, the final viscosity of HSyn99^{6}w *wxwx* is lower than that of HSyn99 *wxwx* but similar to those of the *duwx* mutants. Both *wxwx* mutants display slightly higher onset gelatinization temperatures as measured by differential scanning calorimetry and significantly greater swelling power, i.e. water holding capacity, than the *duwx* mutants. At a small deformation, both *duwx* mutants displayed much higher G' and G" than the *wxwx* mutants. When HSyn99 *duwx* and *wxwx* were subjected to a large deformation, their G_{max}' and G_{max}" decreased, and their difference were narrowed. During cooling, *duwx* also showed greater G' than *wxwx*. The results suggest that all amylopectin B chains (B1, B2, B3+) work collectively in controlling waxy starch swelling. When the shear force is minimal, the more the B1 chains, the higher the overall viscosity. When the shear force is large as in most applications, a larger proportion of B3+ chains increase the overall viscosity.

Engineering design parameters for recirculation and flow of ozone through grain storage structures

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Previous trials of ozone treatment for post-harvest food grains have proved ozonation as a potential non-chemical, non-residual and environmentally sustainable alternative for treatment of stored food grains and end-products. Properly designed ozonated air recirculation-flow system is important for the effective drawdown and distribution of ozone through the grain mass in a storage structure. This study was based on data collected in scale-up demonstration trials of ozonation that were conducted at the Purdue University Post-Harvest Education & Research Center with conventional maize, at a popcorn facility located in Indiana and a wheat farm located in Kansas. The primary objective of this study was to determine the basic engineering design parameters to properly perform and monitor ozonation trials in grain storage structures. The basic setup for ozonation in grain storage structures consisted of generating ozone at a constant rate with commercially available generators, introduction in the headspace, drawdown to the plenum with a suction or exhausting fan with a minimum air velocity of 0.03 m/s, re-circulation of ozone back into the headspace or exhausting the ozone from the plenum into another bin. A monitoring system for ozonation was designed to quantify and control the ozone concentration throughout the grain mass in any

storage structure with a computer-based monitoring and analysis system that consisted of multiple monitoring lines distributed throughout the grain mass and controlled by a computer interface to take samples on a continuous basis and quantify ozone concentration with an ozone analyzer. The relationship between the concentration-time product in the grain mass exposed to ozone was validated. The determination of engineering design parameters will help to improve the efficacy of ozonation as a treatment for stored food grains and end-products.

Concentration and temperature stability of anthocyanins in black sorghum

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The anthocyanins present in sorghum are the unique 3-deoxyanthocyanins that are more stable to pH changes compared to common anthocyanins from fruits, which render them as potential natural colorants. Concentration and temperature stability of anthocyanins in black sorghum bran were evaluated. Extracts at different concentrations were reconstituted in aqueous ethanol, and the pH was adjusted to 3 using 0.1N HCl. Color change was evaluated for each sample over a four-week period as L*, a*, and b* (CIELAB) color space coordinates. Hue and chroma were also calculated. Thermal stability was also evaluated using aqueous ethanol extracts (pH 3) at –4°C, 4°C, 25°C, and 100°C over 0 h, 2 h, 1 day, and 1 to 4 weeks, and compared with standard red colorants FD&C Red #3 and FD&C Red #40. At different concentrations, the color ranged from orange to dark red; changes in L*, a*, and b* values occurred over time. There were also changes in the L*, a*, and b* values when the aqueous ethanol extracts were exposed at different temperatures over time. Sorghum bran shows potential use as a natural food colorant.

Rheological and textural properties of noodles with rice flours

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The rheological properties of raw noodles, and cooking loss and textural properties of cooked noodles, made from patent flour (patent flour noodle) and patent flour composed with various ratios of different rice flours (composite noodles) were compared for elucidating the effects of ratio and variety of rice flour on noodle quality. Results showed that the storage modulus (G') of raw composite noodles were higher than that of patent flour noodle, while the tan δ of raw patent flour noodle was higher than those of composite noodles. The cooking losses of composite noodles (6.3 to 8.4%) were slightly higher than that of patent flour noodle (5.3%). The tensile strength of cooked composite noodles were lower than that of patent flour noodle, except for composite noodle made of indica rice flour with the ratio lower than 20%. The tensile strength of composite noodles decreased with increasing ratio of rice flour, especially for composite noodle made of waxy rice flour. The hardness of cooked composite noodles made of japonica and waxy rice flours were also lower than that of patent flour noodle, and decreased with increasing ratio of rice flour. However, no obvious difference was found on the hardness between patent flour noodle and composite noodles made of indica rice flour. Results suggest that more elastic raw noodle can be prepared by composing patent flour with rice flour; however, slightly higher cooking loss will occur. Moreover, composite noodle with textural quality similar to that of patent flour noodle can be prepared from patent flour incorporating with indica rice flour up to 20% composite ratio.

Extraction of ginsenosides from blends of wheat flour and ginseng

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Interactions of proteins and starch with relatively small molecules, such as saponins and flavor compounds, have been studied. Ginsenosides (G; ginseng saponins) are major active components in ginseng root and are a complex mixture with a triterpenoid aglycon and various sugars. It is necessary to quantify G in a cereal product if ginseng is to be used as one of the ingredients, and to be able to do so despite any interactions among the ingredients. This study is to explore optimum extraction of G (Rb1, Rc, and Rd) from blends of wheat flour (WF) and ginseng powder (GP). Samples of WF, GP, and blend of WF-GP (10% GP, w/w) were heated at temperatures from 25 to 90°C. Samples were ultrasonically extracted for 30 min for G. Individual G (Rb1, Rc, and Rd) were fractionated and identified by HPLC. No significant differences in HPLC profiles between GP and WF-GP were found throughout the temperature range. Quantities of G extracted from GP were constant at all the temperatures studied, while the amounts of G extracted from the WF-GP blends decreased with increasing heating temperature. Results suggested that interactions between WF components and G (Rb1, Rc, and Rd) did occur, and that the interactions increased with increasing temperature. To disrupt the interactions, ultrasonication extraction (UE) time was increased to 60, 90 and 120 min for each sample. The quantities of G extracted from GP were not affected by increasing UE time. However, the amounts of G extracted from the WF-GP blends increased with increasing UE and similar quantities of ginsenosides Rb1, Rc, and Rd (0.88, 0.54, and 0.26 mg per 100 mg of GP, respectively) were obtained after 90 min of UE as were extracted from pure GP at 30 min. Thus, the interactions between WF components and ginsenosides could be disrupted by increasing UE up to 90 min for a complete extraction.

Objective image analysis for bread quality characteristics using C-Cell instrument

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Bread volume, crumb grain, crumb texture, and crumb color are the most important quality factors evaluated in wheat-based bread products. Each of these factors can be estimated by using separate instruments or by experienced baking experts. The objective of this study was to investigate the potential of C-Cell instrument in evaluating all these bread factors concurrently. Based on C-Cell image data collected from pup loaves of a set of 53 Hard Red Winter Wheat breeding lines, correlation coefficient of loaf volume obtained by rapeseed displacement with data obtained by C-Cell images was 0.90. After all data from C-Cell images and crumb grain scores were categorized into 7 levels based on number of cells, the average data of each category were then correlated with the average sample crumb grain score. Correlation coefficient of the average crumb grain scores (0–6 scales) subjectively determined by an expert baker with the average cell number, the average cell wall thickness, the average coarse/fine cluster, and the average crumb fineness (number of cells/mm^2) was 0.97, –0.93, 0.89, and 0.91, respectively. The results indicated that the C-Cell instrument had the capability potential to determine all of the important bread attributes simultaneously.

Volatile compounds from ozone treated flour

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Ozonation of soft wheat flour was studied as an alternative to chlorination. Soft wheat flour after treatment with ozone had unique odor. Identification of volatile compounds that contribute to the odor of ozone treated flour was conducted. Volatile compounds of chlorinated wheat flour, soft wheat and defatted soft wheat flour treated with ozone were analyzed using a purge and trap instrument interfaced to a gas chromatograph equipped with mass spectrometric detectors. Soft wheat flour was treated with ozone at the rate of 0.06 L/min for 10 to 40 minutes. Different types of volatile compounds were detected in flour samples. Aldehydes, alcohols, ketones, benzenes, furans and terpenes were mostly found in soft wheat control flour and chlorinated flour while the volatile compounds present in ozone treated flours were mainly aldehydes and ketones including hexanal, nonanal, decanal, heptanal, octanal, E-2-nonenal, E-2 octenal, and 2-propanone. Increasing time of ozonation tended to increase the level of those volatile compounds. Rapid decrease of volatile compounds was detected when ozone treated flours were kept in the fume hood. Ozonation of defatted soft wheat flour produced less volatile aldehydes than ozone treated whole flour.

Effect of edible film coating on lipid oxidation inhibition, moisture retention and hardness improvement of Korean traditional cookie (*Yackwa*)

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Effect of edible film coating on lipid oxidation inhibition, moisture retention and hardness improvement of *Yackwa* (Korean traditional cookie) manufactured by deep fat frying was investigated. The *Yackwas* were prepared by conventional method in Korea and coated with corn zein (CZ), soy protein isolate (SPI), hydroxypropyl methyl cellulose (HPMC) or methylcellulose (MC), respectively. Uncoated samples were used as control. All of the samples were stored at 60°C for 2 weeks. and moisture content, acid values, peroxide values and hardness of samples were measured at intervals of

2 days. The moisture contents in *Yackwas* coated with various edible films were higher than those of control during storage. Also acid and peroxide values of coated samples were lower than those of control. No significant differences in hardness of coated samples and control were observed. CZ and SPI coatings were more effectiveness in reducing moisture loss and acid value and peroxide value of *Yackwa* than HPMC and MC ones during storage at 60°C for 2 weeks. These results showed that protein–based edible coating is useful as means for moisture retention and reduction of lipid oxidation of *Yackwa* during storage.

In vitro digestibility and physicochemical properties of starch from Canadian grown pulses

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Resistant starch and slowly digestible starch have been introduced to human nutrition and the food industry as increasingly important functional food ingredients. In this study, starches were isolated from different varieties of pea, lentil, chickpea and bean grown in Canada. The in vitro digestibility and physicochemical properties of pulse starches were characterized, and the correlations between physicochemical properties and starch digestibility were determined. Pulse starch granules were irregularly shaped, ranging from oval to round. The surface of all starches appeared smooth and showed no evidence of fissures. There was considerable variation in amylose content, swelling factor and amylose leaching, gelatinization, retrogradation, and pasting characteristics among these pulse starches. The extent of enzyme hydrolysis of starch by pancreatic alpha-amylase was nearly the same. However, they differed with respect to the rate of hydrolysis, slowly digestible starch (SDS), resistant starch (RS) content and expected glycemic index (EGI). Among the starches, lentil exhibited the lowest RDS content, the highest SDS content, the lowest hydrolysis rate, and the lowest EGI. Bean starch exhibited the highest RS content. Chickpea starch had different protein content, swelling factor, amylose leaching, digestibility, pasting property, and gelatinization enthalpy among chickpea varieties. Results showed a significant correlation ($P < 0.05$) between peak temperature of the gelatinization endotherm and digestibility of pulse starches.

Genetic and biochemical characterization of vromindolines, the major oat tryptophanins

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Oats (Avena sativa) is an important grain crop used in animal feeding and the human diet. Among the cereal crops, oats has an extremely soft endosperm phenotype, attributed to the presence of genes coding for avenoindolines a and b, two homologs of wheat puroindolines a and b, respectively. Two-dimensional A-PAGE x SDS-PAGE fractionation of proteins accumulated on endosperm starch granules in oat cvs Donata and Primula revealed equal amounts of two groups (V1 and V2) of polypeptides named vromindolines (oat = vromi in Greek), approximately 13 KDa in size, each group containing three (x, y and z) major components. Antisera specific for proteins encoded by oat cDNA clones 3B3 and 3B3T known with the generic name of tryptophanins, reacted strongly with V2y and V2z, whereas an antiserum specific for avenoindoline a gave no reaction with any protein associated with starch granules. Using PCR, cvs Donata and Primula were found to contain three genes coding for V2y, three genes for V2z and two genes for V2x. Two genes coding for avenoindoline a and two genes coding for avenoindoline b were found as well. As early as 7 days post-anthesis (dpa), vromindoline transcripts were detectable in developing seeds of cv Donata, accumulation of mRNA reaching a peak between 14 and 21 dpa. On the contrary, very low amounts of avenoindoline a mRNAs and no traces of avenoindoline b mRNAs were detectable at all developmental stages. A-PAGE fractionation of cv Donata revealed that vromindolines started to deposit on starch granules between 7 and 14 dpa, and reach a peak at 35 dpa. Purified vromindolines were found to possess strong foaming properties and permeabilizing effects on membranes of human Caco-2 cells grown in vitro. Results strongly suggest that vromindolines are responsible for the extremely soft phenotype of oat kernels.

Jatropha curcas L. flour addition to wheat flour doughs and their effects rheological properties

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The purpose of this investigation was to study the effects of added *Jatropha curcas L.* flour into wheat flour to prepare fortificated dough on protein content and dough rheology. Total protein content according AOAC (1995); dough extensibility, adhesiveness and texture profile analysis test were conducted using a texture analyzer (TA-HDi). Wheat-*J. curcas* mixture dough making were prepared with wheat flours (WF) fortifying with various levels (*Jc:* 5.0, 10.0, 15.0 and 20.0%). The protein content for *J. curcas* was 63.3%, the extensographs showed that, increasing the *J. curcas* flour percentage from 0% to 20%, the dough were less extensible as indicated by higher ratios of R50/Ex, while the area under the curve (i.e. the energy required to break the strength of dough) increased substantially by adding up to 5% Jatropha flour. This indicates that the dough of the blends are still strong and elastic. However, when the amount of Jatropha flour was increased up to 100%, the dough became very weak and the stability and development time decreased as well as the extensibility and the resistance. The adhesiveness decreased particularly in samples prepared with 20 and 100% of Jatropha flour. The presence proteins produced a decrease in the firmness and consistency of the dough and an increase its cohesiveness, which favours the production of a high-quality product.

Use of DNA markers for assessment of wheat PPO activity

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High polyphenol oxidase (PPO) activity in wheat flour results in time-dependent discoloration of cereal products such as Asian noodles. PPO expression and activity are affected by both genotype and environment. Most of the current PPO assays, with the exception of the oxygen electrode method, are only crude indicators of the total amount of total enzyme present in a sample and as such can be misleading. DNA markers that distinguish low PPO genotypes from medium/high PPO genotypes have been reported. The <PPO18> and <PPO33> sequence tagged site (STS) markers have been found to be suitable for polymerase chain reaction (PCR) identification of wheat genotypes with low PPO activity. The DNA markers were used to evaluate selected wheat cultivars from Australia, Canada and the USA for PPO activity. Genotypes identified as having low PPO activity (oxygen electrode method) revealed the low PPO DNA markers. Only a limited number of the Canadian wheat cultivars surveyed showed the low PPO DNA markers. The DNA markers are useful for screening of breeder lines with low PPO activity.

Effects of hull-less barley roller mill flute orientation and roll differential on the yield, composition and properties of milled products

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In December, 2005 the Food and Drug Administration allowed whole-grain barley and barley-containing products to carry a claim of reduced risk of coronary heart disease, increasing interest in using whole-grain barley and barley fractions as functional food ingredients. High beta-glucan barley genotypes are challenging to roller mill. Endosperm cell walls are difficult to break down, resulting in high power consumption during grinding and low flour yields. Low flour yield is offset by a higher yield of a fiber-rich fraction (FRF), comprising remnants of endosperm cell walls rich in beta-glucan. FRF is potentially more valuable as a food ingredient that barley flour. We have developed a short simple roller mill flow that maximizes FRF yield. In this study we examine the impact of roll flute orientation (dull-to-dull or sharp-to sharp) and roll differential (1.5:1 up to 4:1) on the yield and composition of mill products for two hull-less barley genotypes. Regardless of differential, power consumption during grinding was about 20% less when roll flute orientation was sharp-to-sharp. Power consumption increased linearly as differential increased regardless of flute orientation. Sharp-to-sharp grinding gave lower flour yield and higher FRF yield, although the effects were slight. Beta-glucan content of FRF produced by sharp-to-sharp grinding was slightly lower. As differential increased, flour brightness decreased and flour yield increased linearly, concomitant with a linear decrease in FRF yield. The drop in FRF yield as differential increased was partly offset by an increase in beta-glucan concentration. These results indicate that sharp-to-sharp grinding may

be preferable to dull-to-dull grinding because of lower power consumption, and roll differential should be kept low to maximize FRF yield.

Starch to ethanol fermentations using *S. cerevisiae* and *S. fibuligera*
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The cost of ethanol production is one factor that limits ethanol's ability to compete with fossil fuels. Enzyme, energy, water costs, and a long fermentation time all negatively impact production efficiencies. The use of an enzyme producing yeast has the potential to reduce processing costs. A laboratory method for yeast fermentations was developed. Regular corn starch was fermented, along with 0.3% (w/v) yeast extract at 30°C for 55h. This fermentation method produced 0.37g ethanol/g glucose (73% of theoretical maximum). Two yeast strains, *Saccharomyces cerevisiae* and *Saccharomycopsis fibuligera*, an enzyme producing yeast, were analyzed for their effectiveness in ethanol production in comparison to the previous method. Ethanol content was determined using a YSI 2700 Select Biochemistry Analyzer. Four different enzyme treatments were used: no added enzymes, addition of alpha-amylase [E.C. 3.2.1.1], addition of glucoamylase [E.C. 3.2.1.3], and addition of both enzymes. *S. fibuligera* did not produce as much ethanol as *S. cerevisiae*. Data using individually optimized fermentation systems for each yeast is also presented.

Separating waxy from wild-type kernels using an automated NIR sorting system
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Waxy (amylose-free) wheat is gaining interest because it converts to ethanol faster than other wheat, is a possible low-fat replacement for vegetable shortening, is used to produce modified food starches, and has unique absorption and pasting characteristics. Several breeding programs are developing waxy lines in an attempt to take advantage of these potential new markets. After crosses between waxy and non-waxy breeding lines, the frequency of waxy progeny may be as low as 1/64. The ability to segregate waxy seed from segregating populations can provide breeding materials enriched in the number of individuals with this desired trait. We have shown that near-infrared spectroscopy can separate the waxy kernels (all null alleles) from partial waxy kernels (at least one null allele and one functional allele) or wild-type kernels (all functional alleles). Our automated system can separate waxy from non-waxy kernels at a rate of about 1 kernel/2 s, which is a rate sufficient to select waxy kernels from breeding lines or to purify contaminated samples. Testing on hundreds of samples over several years shows that waxy kernels can be selected from segregating lines with about 100% accuracy. We have applied this technology to sorting hard red winter, hard red spring, and durum wheat, in addition to sorting waxy proso millet. Prior to our research, the only ways to distinguish between full and partial waxy were iodine staining and the use of molecular markers. These techniques are too slow and tedious for purifying large seed samples, thus our technology offers significant advantages to breeding programs working on the waxy characteristic.

Phenol profile and antioxidant activity levels of black sorghums grown in different environmental conditions
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Pigmented sorghums, especially those with a black pericarp, have high levels of 3-deoxyanthocyanins. However, information on phenol profile and antioxidant activity levels of black sorghum genotypes grown in different environmental conditions is lacking. A wide variety of black sorghum lines and hybrids with or without a pigmented testa were grown in different environments and were analyzed for total phenols, condensed tannins, and antioxidant activity using the Folin-Ciocalteu, vanillin/HCl, ABTS, and DPPH assays. Phenolic profiles of the black sorghums were determined using HPLC-PDA. Total phenols, condensed tannins, and antioxidant activity levels varied among the genotypes. The 3-deoxyanthocyanins were the main flavonoids detected in black sorghums with the hybrids having the lowest levels. Small amounts of flavones, such as apigenin and luteolin, were also detected. The main phenolic acids detected were small amounts of caffeic and ferulic acids. The phenol levels and profiles of black sorghums differed significantly when the grain was grown in various environments. This study shows that the major flavonoids in black sorghums are the 3-deoxyanthocyanins and the phenol type and concentration depend on environmental conditions.

Application of hydrophilic starch-based coatings to polyethylene surfaces
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Methods for imparting hydrophilic surface properties to hydrophobic plastics are of interest because of their ability to retard the build-up of static electricity, to alter friction and adhesion properties between surfaces, to allow surfaces to be printed with water-based dyes and inks, and to improve the compatibility of surfaces with biological fluids. This study describes the application by spraying of formulations prepared from an aqueous dispersion of jet cooked cornstarch (JCC), a water-born epoxy resin (ER), a wax emulsion (WE), a fluorinated surfactant (FS), and a melamine/formaldehyde resin that was added in some experiments as a crosslinking agent (CA) for starch. The starch component of air-dried sprayed films containing JCC, ER, WE, and FS readily washed off with water within 1 minute. Heating the dry films at 80°C for 24 hours increased the starch adhesion such that gently rubbing the wet film was required to remove the starch. If the CA was added to the spray formulation and the film was heated for 24 hours at 80°C, most of the starch remained bonded to the wet coating, even after gentle rubbing. The interactions of the formulation components were investigated by microscopy and FTIR spectroscopy. By optimizing the specific ingredients as well as the spraying technique and subsequent heat treatment, starch-based film properties could be modified for various commercial applications.

Quality and deoxynivalenol concentration of hard white wheat infected with fusarium head blight
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Quality characteristics of fusarium head blight (FHB)-infected wheat of the Canada Western Hard White Spring class, variety Snowbird, were studied. Effects of milling and noodle-making on deoxynivalenol (DON) concentration and the distribution of DON among mill streams were investigated. DON concentrations were determined in FHB-infected grain samples from western Canada using an enzyme immunoassay. Samples were bulked into three groups with high, medium and low DON concentrations, which were then milled into eight flour streams using a Buhler experimental mill. Low DON concentrations were found in streams 2 and 3 of the reduction flour for all samples. High DON concentrations were found in all the shorts and bran fractions of the low and medium DON concentration samples, and in the reduction flour stream 1 of the high DON sample. The average amount of DON retained in the straight-grade flours after milling was 61% of the grain DON concentration. The DON concentration remaining in kansui noodles averaged 31% and 27% of the flour and seed DON levels, respectively. Test weight was negatively correlated with DON levels in grain and flour. For straight-grade flour, DON level was negatively related to dough strength as indicated by reduced farinograph stability and time to breakdown, and mixograph development time, energy to peak and band width energy.

Corn tortilla quality baked using an ecological infrared continuous oven
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Corn tortilla is the basic food of daily consumption in Mexico. Currently, tortilla production in Mexico is over 14 billion metric tons each year, of which 90% is made with tortilla machines. In spite of the advances that the former inventions had represented, still a lot of problems to be tackled in the tortilla production. Among them, there is a lack of new technology incorporated in the 60,000 tortilla machines that require the Mexican market. Tortillas are baked in a continuous oven on a metallic gas heated conveyor belt where more than 50% of the heat used to bake the tortilla is lost by dissipation to the air. The combustion gases are an important contamination problem to solve. In gas heated oven the temperature ranges from 190 to 250°C. The method involves turing over the product 3 times each 15 s, in order to inflate the tortilla and also determines the quality of the baking process. At the end of the baking time, moisture levels of the tortilla should above 40% to maintain the quality. Although this method is satifactory in producing the capping layers of

the tortilla, some drawbacks are: the fire produces some pollution gases, poor thermal energy transfer between the hot plate of the conveyor and the product, the process is slow and inefficient. The infrared (IR) oven (Patents US 5,567,459; Mex 185,953) overcomes those problems and can produce satisfactory quality tortillas in approximately 10% of the traditional time. Some additional advantages of IR ovens are: compact ovens, more efficient, ecological oven, tortilla quality similar to the gas heated oven. The present work shows some data regarding to corn tortilla baked using IR continuous ovens as well as the application of control systems, heating efficiency, and heat transfer analysis, as well as the tortilla quality.

Sensory evaluation in corn tortillas (*Zea mays L.*) added with different fiber sources

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The mortality incidence has changed over the past century from acute to chronic disease. The dietary fiber intake has been associated with the prevention of human chronic diseases. Corn tortillas added with different fiber sources (wheat bran, soybean husk or oat husk) were made by the traditional nixtamalization process. Tortillas were evaluated for 30 non-training judges in color, flavor, texture and overall quality parameters. Sensory evaluation showed that there were no significant differences in tortillas added with 5% and 10% of oat husk in overall quality, color, texture, and flavor, when compared with the tortillas control. Other products with good scores in all parameters evaluated were tortillas added with 15% oat husk, 5 and 10% of soybean husk and 5% of wheat bran.

Effect of acid-methanol treatment on the physicochemical and structural characteristics of cassava and corn starches

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Cereal Foods World 52:A41

Acid hydrolysis has been used to modify starch granule structure and produce soluble starch. Yield and solubility of acid starch depend of acid concentration, hydrolysis time and starch source. Acid-alcohol modification has been proposed to maximize conversion of raw starch into soluble starch with minimal production of low molecular weight dextrins. In this work, cassava and corn starch suspensions were treated with 0.36% HCl in anhydrous methanol at 54°C for 1–8 h, and their physicochemical and structural characteristics studied. The average yield was about 97 % for both starches. Solubility of the starches increased and after 3 h of treatment reached 93% for corn and 97% for cassava at 95°C. The average size of the starch granules decreased from 11.7 to 9.9 μm for cassava and from 11.8 to 11.2 μm for corn, after 8 h of treatment. Granules observed by scanning electron microscopy showed rough and exfoliated surfaces after treatment, suggesting exocorrosion that was more evident for cassava starch. Cristallinity of starches increased with the reaction time. Amylose content decreased from 21.41 to 18.81% and from 26.27 to 23.01% and intrinsic viscosity reduced from 2.36 to 0.21 and from 1.85 to 0.04 for cassava and corn starches, respectively after 8 h of reaction. Gelatinization temperatures and enthalpy, as well as gelatinization temperature range increased with treatment time for both starches. The pasting viscosities of modified starches were lower than those in native starches as the reaction time increased, especially for cassava starch, confirming the high solubility of these starches. These results suggested the acid-methanol action on the starch granules, more effective for cassava starch in the first hours of reaction, occurred preferentially in the amorphous areas located in granule periphery and composed mainly of amylose molecules.

Effect of acid and acid-methanol modifications on the physicochemical properties of corn starch

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Acid hydrolysis has been used to modify starch granule structure and produce soluble starch. Acid-alcohol treatments have been proposed to maximize the conversion of raw starch into soluble starch. In this work, corn starch suspensions (25% w/v) were treated with 0.36% HCl in water or anhydrous methanol at 54°C for 1–8 h, and their physicochemical properties compared. The recovery yields of starches modified with acid and with acid-alcohol were about 91 and 97%, respectively, independent of the reaction time. The presence of the methanol increased the solubility of the starches reaching high values such as 86.11% after 1 h of treatment, while the starch treated just with acid showed solubility of 46.77% at 95°C, after the same time of reaction. The degradation of amylose was faster as methanol was used instead of water. After 8 h of treatment, there was a reduction of 7.12% and 12.41% in the amylose content of the starches treated with acid and acid-alcohol, respectively. The intrinsic viscosity also decreased faster for the starches treated with acid-alcohol than for those treated with acid. From X-ray diffraction, it was observed, for both treatments, that the crystallinity index of starches kept constant in the first 3 h of reaction and then increased. The onset gelatinization temperatures (to) also increased after 3 h of reaction. However, there were no differences in the gelatinization temperatures and crystallinity index of starches between the treatments. The decrease of peak viscosity was more intense for the starches treated with acid-methanol confirming the higher solubility of these modified starches. These results suggested that the corn starch is more susceptible to acid-alcohol degradation than to acid degradation.

Pre-cooked fiber-enriched wheat flour obtained by extrusion: Functional, nutritional and baked product sensory properties

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Foods with high fiber can reduce calorie uptake and provide health benefits linked to obesity, and chronic ailments like diabetes and cardiovascular disease. However, inclusion of fiber diminishes the final product quality and consumer acceptability of cereal products. The overall objective of this project was to produce fiber-enriched (0, 10, 20 and 30% wheat bran) pre-cooked wheat flours using extrusion processing (at mild and high shear and temperatures) in order to enhance their nutritional value, while maintaining functional and sensory properties in baked products such as cookies and tortillas. For all flours, as % bran increased, RVA peak viscosity (RVA-PV) and Mixograph peak height (M-PH) decreased by up to 46% and 38%, respectively, with the exception of mildly processed flour with 20% bran that had higher RVA-PV and M-PH as compared to 0% bran. At all bran levels, RVA-PV and M-PH were significantly lower for pre-cooked flours as compared to uncooked flours. The quality of cookies (weight and spread factor) and tortillas (specific volume, rollability and extensibility) from both pre-cooked and uncooked flours deteriorated progressively as % bran increased, with a greater negative effect of pre-cooked flours as compared to uncooked flours. Soluble dietary fiber increased by 20–45% and insoluble dietary fiber decreased by 25–35% in pre-cooked flours as compared to uncooked flours at corresponding bran levels. Consumer acceptability results showed that pre-cooked flour products were comparable in overall liking to uncooked flour products. Extrusion pre-cooking did not lead to enhancement in functional properties of fiber-enriched flour or quality of cookies and tortillas. However, pre-cooked flours had higher soluble dietary fiber level as compared to uncooked flours, and also resulted in cookies and tortillas of comparable consumer acceptability.

Plasticizers effects on mechanical properties of oat starch films

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Oat starch films were prepared by casting using glycerol, sorbitol, glycerol: sorbitol (1:1) mixture, urea and sucrose as plasticizers. The effects of these plasticizers were investigated on mechanical properties of films stored at different (11, 57, 76 and 90%) relative humidities (RH). The plasticizers did not affect significantly ($P \leq 0.05$) the equilibrium moisture content of oat starch films, except at 90% RH, at which condition films without plasticizer adsorbed less water. In general, a decrease in stress at break and Young's modulus and an increase in strain at break were evidenced when RH increased in all film formulations. Films without plasticizer, in all RH values, showed higher stress at break values than plasticized ones and presented strain at break stable at different RH conditions. Sucrose plasticized films were more fragile than others at low RH conditions probably because the bulky-ring of its structure difficult the interaction with starch chain molecules compared to straight chains of the other plasticizers.

Understanding and measuring starch "degree-of-cook" in dilute starch systems as a function of thermal and mechanical energy inputs

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Starch-based foods are often produced using processes involving heating and shearing. The purpose of this study was to develop a reliable and meaningful

method to measure "degree of cook," as defined by changes in starch imparted by thermal and mechanical energy. A response surface central composite design was employed to study the effect of temperature (60–85°C), cook time (5–60 min), and shear rate (10-160 W) on degree of cook as measured by viscosity parameters, gelatinization enthalpy, and other responses. Slurries of raw, native regular corn starch (4.5 g of starch and 55 g of water) were treated at a specified temperature and time for each experimental unit using a Rapid Visco Analyzer (RVA). Following RVA treatment, shearing was applied using a sonicator in a water bath maintained at the treatment temperature for 10 minutes, after which the samples were frozen using liquid nitrogen and freeze-dried. Reduced quadratic response surface models were significant ($P <$ 0.05, insignificant lack of fit, and high R^2) for cold paste, peak, final, and setback viscosities, and gelatinization enthalpy. Response surface graphs suggest that both cook temperature and shear dictate the starch degree of cook, with cook time having a secondary, but significant effect.

Physicochemical changes in quality protein maize starch during the extrusion process to prepare nixtamalized flour and tortillas

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The extrusion process is an alternative one to produce nixtamalized corn flours, due to that does not produce pollution effluents. Using the extrusion process in combination with quality protein maize (QPM) is possible to produce tortillas with high nutritional value. On the other hand, starch is the main chemical component of corn and during nixtamalization is suffering some physicochemical changes that affect the tortilla texture. The objective of this study was to investigate physicochemical changes in starch of QPM during the extrusion process to make extruded nixtamalized corn flours (ENCF) and in the tortilla making process. QPM (V-537C) was ground, then added 0.3% (w/w) lime, conditioned to 27% moisture content and rested for 12 h at 25°C. Then it was processed in a single screw extruder with a 1:1 nominal compression ratio, a screw speed of 112 rpm, a final zone temperature of 135°C and a 3mm diameter die. To obtain ENCF the extruded was dried at 40°C and ground. Masa and tortillas were prepared with the ENCF and compared with a commercial nixtamalized corn flour (CNCF). Samples of ground corn, ENCF, and tortillas were taken and analyzed for starch content, apparent amilose, water absorption index and viscosity with the rapid viscoamylograph. The starch structural studies were performed by x-ray diffraction and optical and scanning electron microscopy. The starch thermal characterization was measured with a differential scanning calorimeter. During extrusion cooking, some starch granules did not suffer damage, some granules were fragmented, some swollen granules came together (aggregate) and some granules were completely fused. The viscosity and gelatinization enthalpy of ENCF were lower than the commercial flour. The major starch changes were during baking and tortilla. In conclusion, the starch of ENCF suffered more severe changes than the CNCF.

Buckwheat in wheat flour tortillas

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Buckwheat (Fagopyrum esculentum) is a pseudo-cereal grown in Eastern Europe and Asia. Its proteins have good distribution of essential amino acids, such as lysine and tryptophan. These proteins have high solubility and nutritional value. Buckwheat contains dietary fiber, vitamins (B1, B2, B3) and minerals (P, Ca, Fe), resistant starch, rutin and D-chiro-inositol. Rutin is an antioxidant in buckwheat with desirable properties for treatment of chronic heart disease and varicose veins. D-chiro-inositol occurs in relatively high levels in buckwheat. It might reduce levels of sugar in the blood and have applications in diets of people with type II diabetes. Whole buckwheat was ground into buckwheat flour that was blended with wheat flour to produce press type flour tortillas containing 5, 10 and 20% buckwheat. Tortillas containing buckwheat flour were darker; the 10% blend had an attractive color with a pleasant aroma, and taste. Rollability of the fresh tortillas decreased slightly from 5 to 4.5 for the tortillas containing 0 and 20% buckwheat flour respectively. Distance to rupture and force to rupture were 14, 8 and 7.5 for the control and 17.1 and 7.5 for the tortillas containing 20% buckwheat flour. In 4 days force to rupture did not significantly change. Rupture distance decreased to 12.6 mm for the control and to 12.2 for the tortillas containing 20% buckwheat flour. After 4 days, the rollability decreased slightly to 3.5, 3.5, 2.4 and 3.0 for the control, 5, 10 and 20% buckwheat tortillas, respectively. The modifications in composition and in vitro starch hydrolysis and estimated glycemic index will be measured.

Tortilla quality and antioxidant properties of flour tortillas with tannin sorghum bran and brown flaxseed

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The flour tortilla market continues to grow and become popular in the U.S. Consumption of whole grains or products containing healthy ingredients are increasing. Two ingredients that contribute natural sources of dietary fiber, antioxidants and color include tannin sorghum and brown flaxseed. Inclusion of bran into baked products increases a healthy perception, but often changes the texture of products. Therefore, the goal of this study was to analyze the effect of the addition of tannin sorghum bran with stabilized and ground whole brown flaxseed on antioxidant properties and texture properties during storage in flour tortillas. Antioxidant activity, phenol content, subjective tortilla rollability and objective texture measurements using the 3D extensibility method were evaluated in flour tortillas with different levels of tannin sorghum bran (0%, 5%, 10%) combined with 5% whole ground flaxseed. Color (CIE L*a*b* scale) was measured 24 hours after baking. Texture was evaluated using the TA.XT2i Texture Analyzer (Texture Technologies Corp., Scarsdale, NY/Stable Micro Systems, Godalming, Surrey, UK) using a 3D extensibility method. The addition of flaxseed and bran significantly darkened the tortillas in each successive treatment. After day 1 there was no significant difference in rupture force and modulus values between treatments. Control tortillas retained flexibility longer than the other treatments; tortillas with 10% bran had cracks after eight days of storage, while the control lasted 16 days without cracking. Treatments containing 10% and 5% sorghum bran with 5% flaxseed had higher values for phenols and antioxidant activity and the lowest L values. Tannin sorghum bran and brown flaxseed provided natural color with higher antioxidant capabilities than control treatment.

Wet-milling of starch from waxy wheat flours

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Flours of six waxy hard wheats and two normal hard wheats (Karl '92 and Trego) were fractioned by the dough-washing method. Among the six waxy wheat flours, five wheat flours gave about 80% starch recovery, which was higher than the starch recovery (73.3%) from Karl flour but lower than from Trego flour (90.6%). Waxy flour dough was stickier during the early stages of dough-washing, and glutomatic tests showed that waxy wheat flour had a lower Gluten Index than normal wheat flour. At the optimal water level (47.6%, w/w) in the mixograph, one waxy wheat flour (sample 2489) displayed a narrower peak width than both normal wheat flours, indicating a weaker dough. A commercial hemicellulase was added to degrade the arabinoxylans in the waxy wheat dough at 48.5% water content. A mixogram showed that the peak width of the waxy flour dough increased with the addition of the enzyme, indicating that the dough became stronger. During the washing step, the dough became less sticky when the hemicellulase was used.

Structure and properties of barley starches of normal, waxy, and *ae* waxy varieties

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The objective of this study was to determine the physicochemical properties of *ae* waxy barley starches and compare them with the normal and waxy counterparts. Normal (McGwire), two waxy (Alamo and Candle), and two *ae* waxy (Fibar and Rattan) starches were provided by Crop Development Centre-Saskatoon, Canada. Molecular size distributions of normal barley starch, determined by gel permeation chromatography, showed a substantial peak corresponding to the amylose content. Other starches, waxy and *ae* waxy, showed little or no amylose present, depending on the sample. The pasting temperature of the starch was correlated to the amylose content of the starch. The highest pasting temperature displayed McGwire, followed by Candle and Rattan. The highest peak viscosity was observed for the *ae* waxy varieties, followed by the waxy, and the lowest was for the normal starch. Little setback was observed for waxy and *ae* waxy starches. Significant setback viscosity was observed for normal starch. Gelatinization properties of starches were measured by differential scanning calorimetry and onset gelatinization temperatures ranged from 54.5 to 61°C. McGwire showed the

lowest gelatinization temperature, whereas Candle the highest. All barley starches displayed the A-type X-ray diffraction pattern. On contrary to *ae* waxy maize starch, *ae* waxy barley starches showed the A-type crystalline pattern. This correlated to the much shorter branch chains of *ae* waxy barley starches compared with their maize counterpart. Furthermore, ae waxy starches did not show any significant elongation of amylopectin chains when compared to normal and waxy barley starch. That might explain no significant difference in physicochemical properties of *ae* waxy barley starches when compared to waxy and normal barley starch.

Influence of enzymatic treatment with trypsin from sierra *Scomberomorus sierra* on durum wheat bread quality

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The partial hydrolysis of the durum wheat proteins by trypsin-like enzyme from gut of marine species apparently improves some functional properties in dough; however the effect of the trypsin on the bread has not been well defined. The aim of this study is to investigate the influence of enzymatic treatment on bread making quality parameters. Two enzyme doses (0.14 and 0.28 U) from sierra *Scomberomorus sierra* guts (ST) and porcine pancreas (PT, commercial) were used. Control bread was prepared without enzyme with 100% durum wheat flour. The temperature changes as a result of the trypsin reactions were measured inside the dough during proofing time. Specific volume and texture (firmness) of breads were determinate. The crumb grain was observed of digital image field of view relative to a complete loaf bread slice. Results were analyzed by ANOVA and the Tukey test. Dough temperature had an oscillatory behavior during the first 30 min of proofing time. Only the dough with 0.28 U ST had a higher temperature increase than the rest (4.43°C, compared to the control with 3.91°C). Volume not changes significantly. The highest value was 2.96 mL/g (control and bread with 0.28 U ST) and the lowest value was 2.73 mL/g (bread with 0.14 U ST). With respect to firmness, breads with 0.28 U (ST and PT) presented values that ranged 0.605 to 0.614 kgf, breads with 0.14 U ranged from 0.476 to 0.478 kgf and the control was 0.350 kgf. An improved crumb grain was observed in breads with 0.14 U ST and PT. The significance of these results is that trypsin from gut of marine species can be applied to durum wheat flour, but future work is required for the production of desirable bread making products.

Fractionation of anti-carcinogenic phytochemicals from type III sorghum bran using fast centrifugal partition chromatography

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During the last years sorghum (*Sorghum bicolor*) has been recognized as an important source of phytochemicals with both antioxidant and potential anti-carcinogenic activity. The use of fast centrifugal partition chromatography allows the separation of compounds with different polarity with the advantage of a full recovery of the injected sample. In the present work, raw extracts form type III sorghum bran were separated in normal and reverse phase modes. Extracts were obtained with 80% methanol at room temperature or using a Soxhlet extractor. Both extracts were vacuum evaporated and then lyophilized before resuspending in a mixture of water-butanol-ethyl acetate that was used as the biphasic system for separation in a 1 L column. Collection of fractions was based on time and 254 nm absorbance was recorded during the experimental tests. Fractions were dried and resuspended in methanol and then diluted 1:100 with DMEM-F12. For anti-carcinogenic activity, 100 µl of the fractions were transferred to 96 well plates that were previously prepared with hormone-dependent mammary (MCF-7), liver (HepG2), and colon (Caco-2) cancer cells. After 48 hours, cell viability was determined. The most bioactive compounds were obtained after Soxhlet extraction at room temperature. It was observed that some of the most active fractions contained flavonoids. Fractions with high tannin concentration reduce cell viability but were not the most actives. Additionally, some active fractions were effective against certain kinds of cancer cell lines. In general, the less polar compounds were not as active in colon cancer as in the other cell lines tested.

RIDASCREEN® Gliadin competitive - New approach to gluten analysis in hydrolyzed food samples

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Cereal Foods World 52:A43

Some foods contain highly processed cereal proteins, e.g. beer, starches or syrups. Hydrolyzed proteins do not allow the use of classical sandwich ELISA methods for determination of gliadins. R-Biopharm developed a competitive enzyme immunoassay for the detection of gliadin from those samples, the RIDASCREEN® Gliadin competitive. A 33 amino acid peptide from gliadin with the sequence LQLQPFPQPQLPYPQPQLPYPQPQLPYPQPQPF which is resistant to gastric and pancreatic hydrolysis acts as a strong stimulator to intestinal T cells is discussed to be the toxic sequence. This peptide, respectively sub-sequences of it were used to check for their reactivity with the R5 antibody. This antibody is internationally recognized as the most fitting for determination of the gliadin content in foodstuffs. A small peptide – QQPFP – was selected for the development of the competitive gliadin ELISA. In house studies using hydrolyzed starches, syrups and beer showed in many cases notably higher "gliadin concentrations", compared to analysis using the classical sandwich ELISA. The ELISA detects the intact molecule as well as fragments down to one epitope.

RIDASCREEN® Gliadin AOAC Research Institute Performance Tested Method SM 120601

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One of the key points in gluten analysis is the availability of an efficient method for the detection of gluten from both unprocessed and heat-processed food samples including an all purpose extraction procedure. RIDASCREEN® Gliadin is a sandwich enzyme immunoassay, based on the monoclonal antibody R5 from Prof. Dr. Enrique Méndez/Spain (1), launched in 2002. The test kit is sufficient for 96 determinations including standards and contains all reagents ready-to-use. This new generation of ELISA for gluten analysis detects prolamines from wheat (gliadin), barley (hordein) and rye (secalin) equally down to a level of 2.5 ppm from liquid and soft samples as well as from meat products and sausages. For preparation of all types of matrices, the so-called "cocktail" extraction-solution (2), containing reducing and disaggregating reagents (patent WO 02/092633 A1), is recommended. In order to show its functional capability the RIDASCREEN® Gliadin was tested in an international ring trial organized by the Working Group on Prolamin Analysis and Toxicity in 2002. In 2006 the Codex Alimentarius set up the method as "Type 1 Method". The test kit shows excellent stability, provides acceptable accuracy and precision data. It has been granted AOAC Research Institute *Performance Tested MethodsSM* status and assigned certification number 120601 in December 2006. The test is valid to determine gliadin contamination around a 10 ppm cut off with sufficient accuracy. Thus the RIDASCREEN® Gliadin kit fulfilled the criteria of the gliadin ring trial and guarantees the sensitivity of a new limit for gluten-free food.

Vitamin determination with VitaFast® in infant food and enteral clinical nutrition

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Cereal Foods World 52:A43

Infant food and food for special medical purpose (FSMP) are highly complex food matrices. Vitamins are added as premixes to increase the nutritional value in order to fulfil nutritional requirements and regulations. The natural vitamin content of the raw materials has to be taken into account since the total vitamin content, native and added, must be labelled. The innovative microbiological assays VitaFast® in microtiter plate format are able to measure the content of all water soluble B-vitamins in different types of vitamin enriched foods. For the determination of added vitamins, a hot water extraction is usually sufficient. For measuring the total vitamin content, including the native vitamins, the vitamins are extracted by specific enzymatic treatment. In cooperation with the Central Laboratories Friedrichsdorf GmbH, Germany, four VitaFast® parameters, biotin, pantothenic acid, folic acid and vitamin B12, were validated for infant milk formula (IMF), milk cereals and enteral clinical nutrition (ECN).

Physical characterization of the modified rice starch resulting from the ultra-fine pulverization

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The ultra-fine dry pulverization of the rice starch was attempted in order to graft a physical modification technique that is technologically sound for food use. The freeze-dried rice starch, an extract from short grain rice kernels was ground to a nano-size fineness using a micro pulverizer. The iodine value of the pulverized rice starch (PRS) that corresponds to amylose contents were

very comparable with that from the untreated rice starch (RS) at around 24.7% levels although the average chain lengths (CL's), included with inner chain length (ICL) and outer chain length (OCL), became shorter (21.6 →19.6 glucose units) throughout the treatment. The beta-amylolysis limit(%) of the PRS increased up to 58.1% from 48~58% of RS's, indicating the cleavages of alpha-1,6 bonds, as well as alpha-1,4 bonds. The reduction in the molecular weight of the starch from 6.1×10^6 g/mol (PRS) to 2.8×10^6 g/mol (RS) was confirmed at the major peak of the gel permeation chromatogram. The particle size analyzer result showed the formation of an unified curve at PRS that extended from 0.2 to 30.0 μm ranges of the diameter with a peak at 6.5 μm. The pulverization of the RS caused the 20% reduction in the average diameter of the starch while the specific surface area increased by 24.5% from 19,470 to 24,233 cm^2/g. The results indicated the anticipated increases in physicochemical- and biological reactivity of PRS with other unit materials.

Characterization of chemically modified waxy, partially waxy, and wild type tetraploid wheat starch

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Durum wheats (*Triticum turgidum* L. var. *durum*) contain two Granule Bound Starch Synthase (GBSS) genes (*wx-A1* and *wx-B1*) controlling amylose synthesis; the other major starch polymer in durum wheat is amylopectin. Starches with little or no amylose are "waxy." A GBSS null (non-producing) gene results in a starch granule with reduced amylose content, or a "partial waxy" character. Sets of wild type, partial waxy (*wx-A1* null or *wx-B1* null), and waxy (*wx-A1* and *wx-B1* double null) durum wheat lines were developed in several genetic backgrounds. Seed from the individual genotypes, wild type to full waxy, were composited across genetic backgrounds with the intent of removing confounding genetic background effects. The starches from each genotype from two crop years were isolated using dough ball washing followed by flow table separation. Protein (0.1% to 0.4% dwb), lipid (0.0% to 0.3% dwb), and amylose (0% to 30% dwb dependent upon genotype) contents in the isolated starches were determined. These isolated starches had mostly large granules with a size distribution profile similar to commercially prepared waxy or wild type starches. Hydroxypropylation using propylene oxide was performed three times on each sample, resulting in an average molar substitution of 0.040 (± 0.010). Rapid-Visco Analyses (RVA) were performed and profile changes, defined as the average of the mathematical difference of substituted minus native results in cp of the pasting curves for waxy (peak viscosity, 176; breakdown, 329; final viscosity, -206; setback, -53.5; and pasting time, -0.8) and wild type (peak viscosity, 510; breakdown, 677; final viscosity, 646; setback, 813; and pasting time, -2.2) were observed. Substituted fully waxy starches had increased peak viscosities, breakdowns, reduced final viscosities, setbacks, and pasting times. Regular (full wild type) substituted starches had increased peak viscosities, breakdowns, final viscosities, setbacks, and decreased pasting times. RVA results for the partial waxy genotypes and a phosphorus di-ester cross-linking reaction will also be presented. Modified starches are used as thickeners in foods such as pie fillings, sauces, gravies, and salad dressings. These results indicate that partial waxy wheat starches, starch blends, and/or chemical modifications of these starches would provide a range of functional attributes allowing for the focused selection of starches for specific applications.

Digestibility and physicochemical properties of *opague-2* maize and quality protein maize

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The objective of this research was to study the digestibility and the physicochemical properties of *opague-2* (*o2*) maize and quality protein maize (QPM) and starches isolated from these lines. *Opaque-2* maize has lower zein and higher globulin and albumin contents than the normal maize counterparts. Thus, *o2* maize flour was more dispersible in an aqueous solution than the normal maize counterparts. To investigate the enzyme digestibility of *o2* maize and QPM, two wild-type lines (B46wt and M14wt), two *o2* lines (B46o2 and M14o2), and one QPM line were used for the study. B46o2 and M14o2 display severe and minor *o2* phenotypes, respectively. B46wt, B46o2, and M14wt flours had ~13% protein and M14o2 flour had 9.6% protein. Enzymatic hydrolysis results showed that wild-type flours were more susceptible to porcine pancreatic alpha-amylase (PPA) hydrolysis than the *o2* and QPM flours. Isolated B46o2 starch, however, was the most susceptible to PPA hydrolysis among all the starches studied. B46o2 starch had less apparent amylose content (29.6%) than B46wt starch (34.0%). M14wt and M14o2 starches had similar amylose content (~32.5%), and QPM starch had the least (26.0%). There were more pinholes observed on the surface of the *o2* starch granules than on that of wild-type. The *o2* and QPM starches showed more voids inside of the granules than the wild-type starches when viewed under a confocal laser-light scanning microscope. When B46o2 was encapsulated with egg albumin prior to PPA digestion, the enzyme hydrolysis rate decreased. These results suggested that greater enzyme digestibility of B46o2 starch was due to the loosely packed structure and voids present inside of the granules and less apparent amylose content. The enzyme digestibility of the *o2* maize flours could be attributed to physical barrier resulting from swollen albumin and globulin surrounding starch granules.

Impact of genotype and environment on oxidative enzymes in Canadian wheat: Relevancy to Asian noodles

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Consumer purchases of yellow alkaline noodles are initially based upon their subjective perception of quality based upon the noodles appearance. Brightness, yellowness and the absence of discolored specks are key to their decision process. The enzymes polyphenol oxidase and peroxidase are thought to be responsible for the darkening of the raw noodle sheets. These enzymes are primarily located in the outer layers of the wheat kernel and PPO levels have been highly correlated with ash content. This study investigated these enzymes in 6 Canadian wheat varieties representing the Canada Western Red Spring, Canada Western Hard White Spring and Canada Prairie White Spring classes over three years (2003–2005) at sites within Western Canada. None of the varieties investigated displayed the low PPO gene marker. Peroxidase enzyme levels were found to be significantly lower in the varieties AC Elsa (CWRS) and AC Vista (CPSW) although PPO levels in AC Vista tended to be higher than those observed in the other varieties. No meaningful correlation was observed between the two enzyme levels. While a linear relationship was observed between PPO and ash content an inverse relationship was detected for peroxidase. The lowest noodle speckiness, detected by image analysis, was observed for the two white wheat classes and was not found to have a meaningful correlation with either PPO or peroxidase.

In vitro digestibility of starch-based films

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The bioavailability of starch in foods is variable and depends on the rate and extent of its digestion in the intestine. Corn, potato, banana and sagu starches were used to prepare edible films, by boiling in the presence and absence of glycerol as plasticizer, and their in vitro digestibility features were evaluated. Although available starch (AS) contents did not differ between native starches and glycerol-free films (86.80–95.27%), those containing glycerol exhibited significantly lower values (56.22–60.69%) due to starch dilution by the plasticizer. Compared to native starches, total resistant starch (RS) decreased in films from starches with B-type X-ray diffraction pattern (banana, potato and sagu); observed changes went from 34.47–45.56% (native samples) to 7.35–16.49% (films). However, this indigestible component increased in the corn starch-based film (A-type), rising from 0.44% to 16.35%. Retrograded resistant starch contents (RSR) were slightly higher in the films without glycerol (2.99–3.48%) that in the films with glycerol (1.63–2.05%). Thus, overall concentration of enzyme-resistant fractions in edible films may vary depending on the starch source. Alpha-amylolysis rates were higher in films than in corresponding native starches, and were further augmented by additional heating. This suggests that film production does not promote complete starch gelatinization. The presence of plasticizer diminished the digestion rate of starch films. In conclusion, the preparation of starch films may represent a way to alter starch bioavailability with potential applicability in the development of reduced calorie and diabetic foods.

Incorporation of pseudocereal bran fractions into sugar snap cookies

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Chemical and dietary fiber composition in three commercial varieties of quinoa (*Cheponodium quinoa*), amaranth (*Amaranthus caudatus*) and cañihua (*Chenopodium pallidicaule*) were determined. Total dietary fiber (TDF) content in quinoa, amaranth and cañihua was 9.3–10.4%, 9.8–10.3% and 17.3–20.0%, respectively. Soluble fiber content relative to TDF was higher in quinoa (31–46%) than in amaranth (17–22%) or cañihua (12–19%) grains.

beta-glucan content in grains was <0.1% in quinoa and cañihua and 0.6–0.9% in amaranth, while pentosans content was 1.6–1.8% in quinoa, 0.7–1.0% in amaranth and 0.2–1.0% in cañihua. Klason lignin content was 2.4–3.8% in quinoa, 3.0–3.9% in amaranth and 5.6–8.8% in cañihua grains. Pseudocereal grains were roller-milled and sieved to obtain bran and flour fractions. Bran yield was 42–47% for quinoa and amaranth and 34–37% for cañihua. Based on bran yield and TDF fiber content, one variety of each crop was selected for cookie production. Water and oil retention capacities were higher in cañihua Cupi cv. bran fraction than in quinoa Salcedo cv. or amaranth Moroco cv. bran fractions. Wheat flour was replaced at 10, 20, 30 and 40% for bran fractions. Cookie water activity, CIE Lab color and hardness were determined. Cookies at different flour levels of substitution were ranked according to appearance, taste, aroma, and texture. Cookies made from flour blends containing 30% of quinoa or amaranth brans and 40% of cañihua bran were ranked highest. The results indicate that fiber enriched fractions of pseudocereals could be incorporated into cookie production.

Product acceptance and purchase intent of corn tortilla as affected by consumer education/profession

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In this study we evaluated effects of education/profession on acceptance and purchase intent of corn tortilla. Ten tortilla samples (home-made, commercial, and experimental) were evaluated by two groups of 150 consumers each: (A) faculty/graduate students, and (B) field labor personnel. Consumers rated acceptability of overall appearance, color, thickness, rollability, resistance to tearing, aroma, chewiness, taste, aftertaste, and overall liking using a 9-point hedonic scale. Acceptance and purchase intent were rated using a binomial scale. Data analysis was done using ANOVA, multivariate ANOVA, Descriptive Discriminant Analysis (DDA), principal component analysis (PCA), and logistic regression (LRA) at alpha = 0.05. For given samples, education/profession did not affect color, thickness, and taste acceptability. Consumers used rollability, resistance to tearing, and chewiness to differentiate among samples, but group B consumers paid more attention to these attributes according to higher canonical correlation values (0.53, 0.31,0.40 vs. 0.81, 0.57, 0.66, respectively). Product acceptance was influenced by overall liking for group A and B (odds ratio (OR) = 2.20 and 1.85 respectively); chewiness (OR = 1.34) and taste (OR = 1.28) were also significant for group B. Purchase intent for group A and B was influenced by overall liking (OR = 2.27 and 1.97) and taste (OR = 1.42 and 1.54); in addition color (OR = 1.31), for group A, and overall appearance (OR = 1.30) and chewiness (OR = 1.31) for group B were also critical. Results from both DDA and LRA clearly indicated that group B consumers had higher expectations towards corn tortillas as indicated by lower acceptability ratings. This study demonstrated that the education and profession of groups A and B did affect consumer acceptance and purchase intent of tortillas. This information can be used for product guidance and design for specific consumer segments.

High solid physico-enzymatic modification of starch

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Cereal Foods World 52:A45

As food ingredient, starch should exhibit desirable properties regarding its ability to swell and absorb water, retain its granule structure and exhibit processing and storage stability. One aim of this research is to produce starch materials with modified swelling factor, retrogradation, and rheology. To achieve this goal, a high solid thermal treatment of starch coupled with enzymatic modification was investigated. Normal corn starch samples were prepared at moisture contents ranging from 29% to 40%. These samples were subjected to different thermal treatment, including one or two 60-95 C thermal cycling or 60-95 C cycling followed by 121 C autoclave. The swelling factor (SF) was determined at room temperature and ranged from proximate 3.3 to 4.5, depending on the moisture content and thermal history applied. For comparison, the SF of uncooked and fully cooked starch were 1.8 and >20, respectively. Partial Beta-amylolysis was conducted for individual samples and the maltose yields ranged from proximate 17.6 to 48.0% depending on moisture content and thermal history as well. For comparison, the maltose yield was 0.29% and 46.3% for uncooked and fully cooked starch, respectively. Evidently, compared with fully cooked starch, sufficient Beta-amylolysis was achieved using starch substrates with substantially reduced swelling. Based on this finding, a further investigation was performed with starch of 35% and 40% moisture. A single cycle of 60-95 C was conducted and followed by partial Beta-amylolysis. Maltose yields were 32.0% and 36.3% for 35% and 40% moisture, respectively. Polarized light microscope was used to compare residual granule crystallinity. The results indicated that the birefringence was reduced by thermal treatments, although still observable for both 35% and 40% moisture samples. In addition, partial Beta-amylolysis did not remove residual birefringence.

Baking characteristics and resistant starch contents of cookies and muffins prepared with pea starch

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Cereal Foods World 52:A45

White cake muffins and sugar cookies containing air-classified and/or purified pea starch were analyzed for their baking characteristics, consumer acceptance and content of resistant starch. The addition of air-classified pea starch increased the perception of moistness in both white cake muffins and sugar cookies, which may be of benefit in muffins that tend to be dry. Some panelists preferred the muffins containing air-classified pea starch. The resistant starch contents of muffins and cookies containing pea starch were significantly higher than those of the wheat flour control. Substituting purified pea starch for 20% of the wheat flour increased the resistant starch content of muffins from 0.18 to 0.42% (w/w) and that of cookies from 0.21 to 0.58% (w/w). Substituting air-classified pea starch for 20% of the wheat flour increased the resistant starch content of cookies from 0.21 to 0.56% (w/w). Therefore, consumption of baked products containing pea starch would increase the intake of resistant starch. Resistant starch may be beneficial in the treatment of Celiac disease due to the anti-carcinogenic and anti-inflammatory properties of short chain fatty acids produced from fermentation of resistant starch in the colon. Additionally, gluten-free chocolate chip cookies were prepared with purified pea starch substituting for 15% of the control gluten-free flour (which contained rice flour, potato flour and tapioca flour). Sensory panelists were unable to distinguish between cookies containing purified pea starch and those prepared with gluten-free flour only.

Anthocyanins and lignans in normal and heat-damaged purple wheat

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Cereal Foods World 52:A45

This study aimed to measure the major anthocyanin composition of normal purple wheat versus the heat damaged purple wheat using HPLC and LC/MS. The lignan, secoisolariresinol diglucoside (SDG) content of these two samples was also measured. Total anthocyanin profile of heat damaged purple wheat was significantly ($P < 0.05$) higher (525 mg/Kg) than the new purple wheat (500 mg/Kg). Six major anthocyanins were isolated from these samples including: cyanidin-3-glucoside (cy-3-glc), cyanidin-3-galactoside (cy-3-gal), malvinidin-3-glucoside (mv-3-glc), petunidin-3-glucoside (pn-3-glc), cyanidin chloride (cy-cl) and petunidin-3-glucoside (pn-3-rut). Cyanidin-3-glucoside was the predominant anthocyanin in both samples. The anthocyanin contents (mg/Kg) of new purple wheat was cy-3-glc (103.95), cy-3-gal (77.77), mv-3-glc (53.78), 31.40 (pn-3-glc), cy-cl (7.94), pn-3-rut (3.40), respectively. The corresponding values for the heat damaged purple wheat were 110.80, 71.34, 90.36, 32.19, 9.16 and 6.00, respectively. The SDG content of new and heat damaged purple wheat was 7.7 and 5.2 mg/100g. In summary, the order of anthocyanin contents of both normal and heat damaged purple wheat was: cy-3-glc > cy-3-gal > mv-3-glc > pn-3-glc > cy-cl > pn-3-rut. Higher contents of total anthocyanins and SDG were present in heat-damaged purple wheat. This is the first report on the presence of lignan SDG in cereal grains. This study suggests that presence of such bioactive compounds in cereal grains may help to prevent depression and age-related diseases and improve the quality of life.

Effects of drying conditions on the puffing quality of waxy rice

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The effects of soaking time (1–3 h), drying conditions (temperature (60–80°C) and relative humidity (30–50%)) on the pasting properties of dried cooked-waxy rice (pellet) and specific expansion volume (SEV) of puffed waxy rice were analyzed by performing the tests based on the response surface methodology. All the pellets were dried to reach the moisture content of 7–8% for the purpose of storage in practice. The drying time needed was ranged in 2–4.5 h and significantly affected by the moisture content of cooked waxy rice which ranged from 32–44% and drying temperature. It is found that all the pellets were fully gelatinized when analyzed by using the differential scanning calorimetry (DSC), except the sample with the shortest soaking time (0.32 hr). While, the pasting properties analyzed by using rapid-visco-analyzer (RVA) were different among samples and the peak viscosity (PV) and breakdown (BkD) of pellets were negatively correlated to the SEV. The pellets with high initial viscosity but low PV and BkD had good puffing properties. The glassy

temperature (Tg) of pellets determined by DSC indicated that the lower Tg of pellets had better SEV. It is attributed to the pellets with the lower Tg changed from glassy state to the rubbery state at the earlier stage of frying, therefore, the softened pellets had enough time to reach the equilibrate status of moisture and rehology within the whole pellet before the solidification of texture of puffed rice due to the moisture evaporated above 100°C.

Optimisation of rye malting for brewing purposes

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Cereal Foods World 52:A46

Arabinoxylans (AX) play an important part in the characteristics of rye malt as they limit the access of enzymes to the starch kernels. Furthermore, the water extractable AX cause very high wort viscosity and thus filtering problems. The objective of this study was to optimise the malting regime for brewing purposes with special emphasis on AX. Response Surface Methodology (RSM) was used to model the changes in parameters important for brewing. Rye was steeped in a Micro Malting plant to a water content of 45%, germinated for 2 to 6 days at 10 to 20°C and kilned. The malts were analysed for extract content, fermentability and viscosity using the Congress mashing system. Total Nitrogen (TN), Soluble Nitrogen (SN), Free Amino Nitrogen (FAN) and the activities of enzymes relevant for breakdown of polysaccharides were measured. Degradation of AX was followed by analysis of the contents of total and soluble AX and the degree of polymerisation. Extract content of the worts increased slightly with longer germination time. Fermentability was lower than in comparable barley worts. The amylolytic activities were highest after germinating the grains for 5 days. The wort's viscosity could be significantly decreased by using low temperatures and long germination times. The analyses of the AX support the connection between AX and the wort viscosity. TN and SN were hardly affected by the variations in time and temperature, FAN increased with longer germination time. In conclusion, this study shows the possibility of significantly lowering the viscosity of rye wort by applying right malting conditions. Although viscosity is still high, there is a potential for rye as brewing material as all other relevant parameters are favourable. Rye malt could also be an interesting ingredient for the production of functional beverages due to its high content of dietary fibre.

Fundamental studies on the effect of high pressure treatment of oat batters

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Cereal Foods World 52:A46

In recent years the demand for gluten-free cereal products has increased, as it is estimated that 1 in 100 people suffer from Celiac Disease. The only treatment for this condition involves a gluten-free diet that avoids ingestion of gluten-containing cereals and their products. Clinical data suggests that the majority of people suffering from celiac disease can tolerate oats. With a high nutritional content and the presence of beta-glucan, oats are ideal for the development of high quality gluten-free products. The objective of this study was to investigate the impact of high pressure (HP) treatments on the rheological and baking characteristics of oat based batters and breads. Oat batters, consisting of oat flour and water, were treated at different pressures and compared to a control where no pressure was applied. Rheological tests including amplitude and frequency sweeps and creep tests were performed. After baking, standard parameters such as bake loss (%), specific volume (SV) (ml/g) and crumb moisture (%) were evaluated. Crumb hardness was determined using texture profile analysis. Confocal Laser Scanning Microscopy (CLSM) and Scanning Electron Microscopy were used to characterise ultrastructural changes taking place during HP treatment of oat batters and breads. Rheological results showed an increase in elasticity with increased pressure for all pressure treated batters. Furthermore, there was an improvement in the structure of the oat bread with increasing pressure. However, at 400 and 500 MPa deterioration in the structure of the oat breads was observed which was indicated by the increase in crumb hardness, springiness and decrease in SV. Overall, the results of this study indicate that application of HP on oat flour has a positive impact on the rheological properties and also on the final structure of oat-based bread. Results are, however, dependant on pressure applied.

Impact of annealing on the structure and properties of *Dioscorea* starches

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Yam starches are presently not used in the food industry due to their poor functionality. Annealing has been shown to improve starch functionality. Therefore, the objective of this study was to determine the structural changes within the amorphous and crystalline domains of starches isolated from varieties of *D. esculenta* and *D. alata* tubers on annealing, and the impact of these changes on starch properties. The composition and granule morphology of all starches remained unchanged on annealing. The peak gelatinization temperature of *D. esculenta* and *D. alata* starches increased by 2.1–2.4°C and 0.3–1.6°C, respectively on annealing. However, annealing decreased gelatinization temperature range of *D. esculenta* and *D. alata* starches by 0.05 and 1.6–2.2°C, respectively. In all starches, the increase in gelatinization enthalpy was marginal. At 85°C, the decrease in amylose leaching and granular swelling was 54–59% and 38–45%, respectively in *D. esculenta*, whereas the corresponding values for D. *alata* were 71–100% and 53–64%, respectively. In all starches, X-ray pattern remained unchanged, whereas crystallinity changed only marginally. Peak viscosity and set-back decreased, but pasting temperature and thermal stability increased on annealing in all starches (*D. alata* > *D. esculenta*). Annealing decreased the extent of retrogradation 16–18% [*D. esculenta*], 9.6–9.9% [*D. alata*], and susceptibility towards acid 8–11% [*D. esculenta*], 9.6–9.9% [*D. alata*] and alpha amylase 7–17% [*D. esculenta*], 23–32% [*D. alata*]. The study showed that increased interaction between starch chains and changes to crystallite orientation on annealing influence starch properties. The increase in thermal stability and decreased extent of retrogradation on annealing makes some of the varieties ideal for food applications.

Factors influencing the quality of extruded floating aquatic feed pellets

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Extrusion processing is an important technology for producing floating feed for a variety of aquatic species including Tilapia and Catfish. This study focused on the effect of processing parameters on physical and stability characteristics of floating aquatic feed produced by single screw extrusion. The parameters studied were water injection site (only preconditioner, only extruder barrel or both), extruder screw profile (high, medium and low shear) and post-extrusion drying conditions (cooling only and drying followed by cooling). Steam (13%) was injected into the preconditioner for all treatments. The extruder die specifications were - 30:1 L/D ratio, 2.5 mm outlet diameter, 2.5 mm land length and 2.25% output area percentage. The optimum process parameters for floating feed production were water injection into both preconditioner and extruder barrel (9 and 5%, respectively), high shear screw profile, and drying for 10.5 min at 210°C followed by cooling for 5.5 min. The process and pellet quality data for these parameters were 196.6 kg/h production rate, 130.7 kJ/kg specific mechanical energy (SME), 332.9 kg/m^3 pellet bulk density, 2.28 expansion ratio, 5.14% final moisture content, 100% pellet floating percentage after immersion in water for 30 hours and 100% pellets water stability after 33 h. SME was the main factor that controlled the floating aquatic feed pellet quality. Moreover, water injection into both preconditioner and extruder barrel led to a better quality product because of greater moisture uniformity. Overall results indicated that optimization of extrusion processing parameters can lead to a drastic increase in floatability of aquatic feed, which in turn has several economic benefits including reduced feed waste and less costs for maintaining clean, disease-free aquaculture ponds.

Effect of different process technologies on microstructure, starch gelatinization and quality of floating and sinking aquatic feed pellets

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Conventional high shear and tempeature extrusion processing and pellet milling are two primary technologies for producing aquatic feed. In recent years, a promising new technology, supercritical fluid extrusion (SCFX), has been developed and utilized for producing products such as expanded snack and breakfast cereal, and continuously leavened bread. The primary objective of this study was to characterize the internal microstructure of floating and sinking aquatic feed pellets produced by these three processes, and to relate that to process and product quality parameters such as specific mechanical energy (SME) input, degree of starch gelatinization, water stability and durability. Pilot-scale single screw extruder, pellet mill and twin-screw extruder configured for SCFX operation were used to produce floating and sinking extruded aquatic feed with a wide range of internal microstructure. Starch gelatinization studies using differential scanning calorimetry and non-invasive microstructure data obtained by high-resolution X-ray micro-tomography (XMT) were very useful in understanding differences in pellet

quality. For conventionally extruded floating feed, time of floating decreased with reduction in average pore size and void fraction; and pellets extruded with water injection at both preconditioner (9%) and extruder barrel (5%) resulted in large average pore size and void fraction, and 100% floating percentage up to 48 hours. For sinking feed produced by SCFX, 37% in-barrel moisture, 5% steam injection in the preconditioner and 0.5% CO2 injection in the barrel led to best quality sinking feed product. For sinking feed produced by pellet mill and conventional extrusion, the internal microstructure was substantially different, and SME played a significant role in controlling starch gelatinization, microstructure and pellet quality.

Effect of decortication and protease addition on corn ethanol production

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Cereal Foods World 52:A47

Ethanol can be produced by dry milling of corn followed by yeast fermentation. Corn pre treatments are performed to increase the conversion of starch to ethanol. This includes mechanical methods such as decortication, which removes the bran (pericarp) layers from the kernel. Another pre-treatment, protease enzyme addition might have the potential to break the starch-protein matrix facilitating more rapid access to or improved cooking of starch. The objective of this study was to investigate the effect of decortication and protease enzyme addition pretreatments on corn ethanol production. Whole yellow dent corn and corn with 10% and 30% of the pericarp removed were used as raw materials. A slurry (containing 30% w/v solids) was prepared by mixing hammer milled corn (2mm mesh) and distilled water. The slurry was then partially liquefied using thermostable alpha-amylase and cooked on a hot plate for 1h from the time the slurry begins to boil. The samples were then cooled to 65°C and additional alpha-amylase and amyloglucosidase was added for saccharification. The mash was then fermented by adding yeast (*Saccharomyces cerevisiae*) innoculum. Samples were obtained from fermentation flasks over time, from 24h to 72h, and the ethanol concentration was determined using YSI 2700 Select Biochemistry Analyzer. The total starch contents of whole corn, 10% decorticated corn and 30% decorticated corn were 67.91%, 71.47% and 75.88% (wb), respectively. The total crude protein contents of whole corn, 10% decorticated corn and 30% decorticated corn were 7.3%, 7.3% and 6.4% (wb), respectively. The total crude fat contents of whole corn, 10% decorticated corn and 30% decorticated corn were 2.8%, 2.8% and 1.8% (wb) respectively. The ethanol yield of 10% decorticated corn slightly increased as there was more starch available for fermentation on a dry weight basis. Although the starch content of 30% decorticated corn was the highest, the ethanol yield was the lowest. This might be due to the lower crude protein content in 30% decorticated corn. Protease treatment resulted in higher ethanol values compared to untreated corn.

Whole grain barley and oat breads enriched with soluble fibers

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Cereal Foods World 52:A47

Barley and oat beta-glucans are recognized to reduce risk of heart disease. Whole grain consumption is also associated with decreased risk of chronic metabolic disease. In order to increase the consumption of whole grain barley and oat we have developed breads made up entirely of their flours enriched with 3–6% of soluble cellulose, a form of soluble dietary fiber. Soluble cellulose, hydroxypropylmethylcellulose (HPMC), is a linear glucose polymer of beta-1,4 linkages and related to the cereal mixed beta-1,4-beta-1,3 linkages. Like cereal beta-glucans they have been shown to reduce plasma cholesterol in published clinical studies. In addition to its healthful properties, soluble celluloses are a necessary substitute for the gas trapping protein, gluten, that is lacking in barley and oat. Nonwaxy barley bread enriched with 5% HPMC had twice the loaf volume compared to barley flour alone. The hardness, gumminess, and chewiness by TPA were decreased with HPMC addition. Sensory characteristics of barley and oat breads were compared to whole grain wheat bread. Formulations for waxy barley breads enriched with HPMC were also developed. Substitution of HPMC for gluten results in whole grain breads with reasonable loaf volumes, good texture and a 100% increase in soluble dietary fiber content.

Formation of nano-sized starch particles by complex formation with n-butanol

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High amylose corn starch was dissolved in 90% dimethyl sulfoxide solution (0.5% w/v). The starch solution was placed on upper compartment and n-butanol was positioned below in a container separated by a membrane filter (PTFE, 10μm). The container was kept at 70°C for 3 d for complex formation. Starch molecules in the solution slowly moved to n-butanol layer through membrane filter, and then starch-n-butanol crystals were formed. The complex crystals were gradually precipitated in the n-butanol solution. Under a DSC, the crystals melted in a range from 71.20 to 89.30°C, enthalpy 13.02 J/g. Crystal was mainly composed of amylose (91.75%) the average molecular weight of which was 2.69×10^5 in HP-SEC analysis. Morphology of crystals was platelet-like shape with a length of 50 nm and crystals were connected with some amorphous network under a transmission electron microscopy. To remove of the residual amorphous network, the complexed crystals were partially hydrolyzed using an alpha-amylase. Using the amylose complex formation and successive enzymatic treatment, nano-sized starch crystals (approximately 50 nm diameter) were effectively prepared. Utilization of the nano starch particles should be considered in future study.

Nature of channels within wheat starch A- and B-type granules

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While wheat starch A- and B-type granules are reported to possess different morphologies, compositions, structures, and physical properties, their respective granule microstructures (e.g., pore/channel structures) have not been fully elucidated. Prior evidence suggests that channels within wheat starch (A-type) granules are lined or filled with protein, while the existence of channels within B-type granules has not been established. This work investigated the nature of channels within native and protease-treated wheat starch A- and B-type granules using scanning electron microscopy (SEM) and confocal laser scanning microscopy (CLSM). SEM observation revealed that pores, which are generally openings to channels, were more frequently observed at granule surfaces of both A- and B-type starch granules following protease-treatment (relative to native starch granules). For A-type granules, pores were not only visualized along the equatorial groove, but were also observed randomly on all regions of the granule surface. Methanolic merbromin treatment, which is used to highlight external granule surfaces (including those of channels) under non-swelling conditions, revealed few, if any, channels within native A- or B-type granules (only very short channel-like segments occurred at the granule periphery). However, protease treatment of A- and B-type starch granules, followed by staining with methanolic merbromin, revealed channels connecting interior cavities to the granule exterior. This report represents the first visualization of channels within B-type granules. In short, both wheat starch granule types do possess channels, though these channels are at least partially filled with protein. Some degree of granule swelling or removal of protein would appear useful to facilitate passage of chemical reagents into the granule matrix via channels during chemical modification.

Reactivity of wheat starch A- and B-type granules

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Wheat starch contains at least two distinct granule populations (A- and B-type), which possess differential morphologies, compositions, structures, and physical properties. It has been proposed that wheat starch granule reactivity is likely influenced by granule size (e.g., specific surface area), reagent type (fast vs. slow reacting), and/or granule composition. This work investigated various factors impacting both the reactivity and granular reaction patterns of wheat starch A- and B-type granules. Isolated waxy and normal soft wheat starches were fractionated into their respective A- and B-type granule fractions. A- and B-type starch granule populations were assessed with respect to chemical composition, granule size, specific surface area, and structural/physical characteristics. Isolated starch A- and B-type granule populations of waxy and normal lines were subsequently chemically modified via substitution (propylene oxide analog) and cross-linking (phosphorus oxychloride ($POCl_3$)/fast reacting; sodium trimetaphosphate (STMP)/slow-reacting) reactions. Reaction patterns of modified starch granules were observed using reflectance confocal laser scanning microscopy. Native A-type granules possessed higher amylose and lower phospholipid contents than B-type granules, while specific surface areas were much larger for B-type (2.33 ± 0.22 and 2.76 ± 0.18 m^2/g for normal and waxy, respectively) granules relative to A-type (0.76 ± 0.05 and 0.86 ± 0.02 m^2/g for normal and waxy, respectively) granules. For cross-linking, B-type granules possessed slightly higher reactivity than A-type granules in $POCl_3$ reactions, whereas a minimal difference in reactivity was found between granule types in STMP reactions. Moreover, $POCl_3$ (fast-reacting) appeared to react initially at granule surfaces, whereas STMP (slow-reacting) appeared to access granule channels prior to reaction.

Determination of relative sprout resistance for selection of genetically desirable wheat cultivars via indium antimonide range Near-IR imaging

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Lack of dormancy in wheat kernels may cause preharvest sprouting under moist conditions in the field which has detrimental effect on functionality and economic value of wheat. Cultivars which have tolerance to sprouting and high level of dormancy are highly desirable for breeding. Sprout damage can be tested in different ways; destructive testing such as viscosity due to the presence of alpha-amylase is performed as an objective measurement of the damage; also, visual inspection is used subjectively. Early detection of wheat germination with Near-IR Imaging with a InGaAs array was shown be provided an advantage over visual examination and other testing methods, and it is found useful to the breeding program to assist in identification of sprout resistance and in producing varieties tolerant to germination. This study was done more improved instrument with Indium Antimonide (InSb) detector that covers a broader spectral range. Spatially resolved near-infrared rays in 1200-2400 nm range allow a better chemical definition contrasting developing embryo better. The Indium Antimonide (InSb) focal plane array range includes the information rich 1650-1800 nm regions, as well as the strongly absorbing and better defined combination bands at longer wavelengths up to 2400 nm, that are adjacent to the fundamental vibrational region of the mid-infrared spectrum. After exposure of kernels to moist conditions at different time periods (12, 24, 36, 48 hrs) the imaging method clearly distinguishes between sprouted kernel and the unsprouted control one nondestructively depending on the intensity, shape and the size of the developing embryo. A Go/No-Go decision is made on individual kernels from the image contrast produced by data from the log 1/R at a chosen wavelength or a principal component analysis factor.

Focal plane array chemical imaging of lipid associated with gas cell formation during dough fermentation

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Bubble formation takes place during fermentation step of bread making. Lipids presented in a liquid film around bubbles are considered as important in stabilizing and maintaining the integrity of gas cell structure. It is known that wheat flours with same protein quantity and quality have their loaf volume and crumb texture enhanced by nature's surface active agents, diglycerides. Both content and composition of the lipids are effective on bread making; polar lipids have desirable effects while nonpolar lipids have harmful effect in baking. Localization of lipid in bubble structure has been difficult to document, SEM and Confocal Laser Microscopy have been used previously. These techniques are complicated and time consuming. This is the first report using InSb Near-IR Focal Plane Array (FPA) Imaging Microspectroscopy to localize these lipid films and simultaneously to measure the bubble size and other physical properties. Chemical Imaging with InSb Focal Plane Array Spectroscopy is performed to see the localization and distribution of the lipid particles around gas cells and try to understand how the amount and the type of lipid affect the bread making process. Data is shown to demonstrate utility of this approach.

Production and processing of selenium enhanced wheat

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Selenium is a micronutrient that is receiving increased attention in nutrition and health. Natural enrichment of South Dakota wheat is being viewed as one way to enhance the economic and health value of a traditional crop. A two year study of HRS and HRW varieties grown in a variety of locations in SD demonstrated that growing location remained the singular factor influencing grain Se variability. No cultivar effect was discerned. A moderate to high selenium level of 1 mg per Kilogram (1ppm) wheat has been reported in the literature to be a good starting point for enhanced selenium wheat. A range of 0.5 to 1.9 µg/g was measured in wheat grown in 2005 and 2006 (n = 336) in South Dakota test plots. Levels of up to 10 ppm have been noted in selected growing locations. Specific growing locations (Kennebec, Wall, Selby) yielded high Se levels in the grain. Speciation of Se to determine selonomethionine and selenocystein content of high, medium and low selenium wheat are underway to determine the pattern of distribution of selonoproteins in several fractions. A variety of fractionation schemes including, roller milling, scarification and pearling were conducted to see if selenium concentrations were predictable. Processing by controlled abrasion of kernel layers yielded predictable Se in the grain. Dough development and gluten washing have yielded 7 ppm Se in the dried gluten fraction, a 3 fold increase in Se concentration. These procedures are being standardized specific to wheat. Our goal in this on-going project is to produce high selenium wheat fractions that have useful functionality. Functionality tests to be completed include experimental baking, texture analysis, and noodle strength of Se-fortified white wheat flours.

A response surface methodology study on the effects of reaction conditions on the physicochemical properties of cationic starches

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Cationic starches with DS ranging from 0.005 to 0.1215 were prepared from the reaction of native corn starch with 3-chloro-2-hydroxypropyltrimethyl ammonium chloride (CHPTAC) for 2, 5 or 24 h at pH 11 in aqueous phase without the addition of swelling-inhibiting salts. Response surface methodology (RSM) was performed to analyze the effects of reaction temperature (30, 40, or 50°C), amount of CHPTAC (molar ratio of CHPTAC/AGU (anhydroglucose unit) = 0.5-1.5) on the degree of substitution (DS), reaction efficiency (RE), pasting and thermal properties of the cationic starches. The samples reacted for either 2 or 5 h remained granular after the cationization, while two of the samples reacted for 24 h were not collected due to gelatinization under high temperature and amount of CHPTAC. Therefore the RSM was not performed on the cationic starches reacted for 24h. The results show that DS and RE increased with increasing in reaction temperature and in amounts of CHPTAC, but the relative contribution of the temperature turned from minor to prominent as the reaction time prolonged from 2 to 5 h. With the raise in DS, the decrease in pasting temperature (PT) as well as the increase in peak viscosity (PV) and breakdown (BD = PV – HV (hot paste viscosity)) were observed in cationic starches reacting for 2 and 5 h. However, the decrease in the final viscosity (FV) and setback (SB = FV - HV) with the increase in DS were only characteristic of cationic starches reacting for 2 h, instead of that for 5 h. For cationic starches reacted for either 2 or 5 h, the increase in DS corresponds well with the decrease in transition temperatures, but shows little correlations with the gelatinization enthalpy.

Dynamic aggregation behaviors for rice starch-Concanavalin complexes in terms of rice variety and starch property

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For some cultivars of rice starches, the differences in amylose content (AC) measured by between concanavalin A (Con A) complexation and iodine adsorption colorimetry are noteworthy and unclear. Fundamentally, the dynamic aggregation and resultant precipitation of starch-Con A complexes involve starch molecular property and the complexation condition (e.g. time course and starch-to-Con A ratio). Accordingly, eight Taiwanese rice starches (2–3 cultivars for each of indica, japonica, and waxy types) and their water-soluble (WS, amylose-rich) and insoluble (WIS, amylopectin-rich) fractions, which have well-known molecular properties, were investigated by dynamic laser light scattering measurements on their complexation phenomena with Con A. On the viewpoint of biopolymer particle size stability, the suitable complexation time was found for 0 or 5 hr rather than 12 or 24 hr. The major particle sizes were peaked at 75 and 25 µm, respectively, for freshly prepared pure Con A (72 ppm) and starch (24 ppm) dispersions during measurement at a stirring rate of 410 rpm. Once the starch disperions mixed with Con A, the average particle sizes became 2–7 folds for those of pure starch samples. However, the sysematic particle size changes with the mixing time were not easily found for the WS-Con A and WIS-Con A complexes. Among the 8 rice starches examined, the WS of Taichung waxy 70 (japonica waxy type; TCW70) showed the least and greatest average particle sizes before and after complexation. But for the WIS fractions, the particle sizes were the greatest for TCW70 WIS before complexation and for a low-AC indica starch (Taichung Sen 10) WIS after complexation. The Con A-equivalence for complexation were 0.27–0.47 and 1.15–2.29 (w/w) for WS and WIS, respectively. These results could be partly explained in terms of starch molecular property and composition.

Mixolab evaluation of starch damage content influence on the dough behaviour

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Flour starch damage content is related to wheat hardness and milling process, it is of a major importance in all wheat flour based products. It is generally agreed that a shortage of damaged starch causes low flour water absorption capacity, and on the contrary, an excess of damaged starch can cause sticky dough, and at later stage, flat underdeveloped breads with a very coloured (red) crust. The objective of this study is to evaluate, with the Mixolab, the

influence of starch damage content on the dough behaviour. The Mixolab capability to work with changeable temperature constraints permits to follow starch damage effect during different phases of dough modifications (from dough development until starch retrogradation). Four flours, with starch damage content between 19.6 and 30.5 UCD, are produced from the same wheat, then are analyzed with Mixolab (Chopin+ protocol). The obtained results confirm that flour water absorption capacity increases with the starch damage content (approximately 0.5% for 1 UCD). These results show also that gelatinization peak (C3) and stability at 90°C decrease when starch damage content increases. Starch damage effects are clearly measurable with Mixolab.

Mixolab evaluation of alpha-amylase influence on the dough behaviour

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Owing to their industrial interest, alpha-amylases are the most studied flour enzymes. When their activity is too high (sprouted wheat for example), amylose and amylopectin chains liquefy when baking begins and dough becomes sticky and rubbery. Consequently bread quality is affected. When their activity is too low, starch hydrolysis is insufficient to supply yeast with enough sugar. To correct this lack, it's possible to add exogenous alpha-amylase. The objective of this study is to evaluate, with the Mixolab, influence of three different alpha-amylases (fungal, bacterial and maltogenic) on the dough behaviour. The Mixolab capability to work with changeable temperature constraints permit to follow alpha-amylase effect during different phases of dough modifications (from dough development until starch retrogradation). The obtained results show that fungal and bacterial alpha-amylases modify both protein part (decrease of stability at 30°C) and starch part (decrease of C3, C4 and C5). Nevertheless effect on starch part is greater with bacterial alpha-amylase than with fungal alpha-amylase. Maltogenic alpha-amylase effect is perceptible only on the starch part (strong decrease of C4 and C5). Mixolab is also capable to evaluate influence of different alpha-amylases on the dough behaviour.

Mixolab evaluation of starch damage content influence on fungal alpha-amylase activity

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Exogenous alpha-amylases are commonly used to correct flour diastatic power. The objective of this study is to evaluate influence of starch damage content on fungal alpha-amylase action. It is generally agreed that starch damage content has an influence on amylase activity (damaged starch granules are more accessible to amylases than native starch granules). Four flours, with starch damage content between 19.6 and 30.5 UCD, are produced from the same wheat, then are analyzed with Mixolab (Chopin+ protocol). For each flour, two Mixolab tests are made: one on pure flour and one on flour with 10 ppm of fungal alpha-amylase. Then an Area index (A) is calculated. A index corresponds to the A1-A2 difference expressed in percentage of A1 (with A1 the surface area under the Mixolab curve without amylase and A2 the surface area under the Mixolab curve with amylase). The obtained results confirm that fungal alpha-amylase addition change the dough behaviour (decrease of protein stability and starch gelatinization) and show that these modifications increase when the starch damage content increases (A index increases from 9.7% to 22.2% when starch damage content increases from 19.6 UCD to 30.5 UCD). Mixolab confirms that fungal alpha-amylase action is also dependent on starch damage content.

Influence of laboratory mill Chopin CD1auto setting on quantity and quality of produced flours

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The CD1auto is a laboratory mill which permits to obtain flours which are representative of used wheat quality. This laboratory mill allows to produce automatically enough flour to realize analytical tests (Alveograph, Mixolab …) and Bread making test. The objective of this study is to determine settings (sieving aperture and beater positioning) which permit to optimize milling yield and to maintain produced flour quality (Alveograph, standard AACC 54-30A and French bread making values, standard NF V03-716). During this study, 1 wheat is used to determine the optimum settings, then 5 wheats, with different characteristics, are used to validate them. The final setting permits to increase milling yield from approximately 6% (from 65% to 71% on dry basis) and to keep the same flour quality. This study proves that it is possible to adapt CD1auto settings to answer user's specific needs.

Risk management and the application of multivariate statistics for animal feed

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As one of important steps toward application of science in regulatory oversight of feed industry, multivariate statistical techniques were applied for the assignment of routine surveillance samples. Data of three label violation-associated variables created by using a data set of label guarantee analyses, such as protein, zinc, phosphate, and calcium were subject to multivariate statistical techniques. In principal component analysis, the first and second principal components accounted for 88.2% of total variability in feed data. Feed firms with similar label violation history during the past three years were grouped into the same clusters by using Ward's minimum variance method in cluster analysis without outliers determined by the univariate analysis. Label violation groups were significantly different in sets of violation-associated variables in univariate and multivariate statistics of a linear discriminant model ($P < 0.001$). The correct classification rates of the model built with all feed data were greater than 90%. Besides, the overall estimated predictive ability of the classification model created by 80% of total observations was quite acceptable (93.4% correct classification rate). After determining the sampling percentage by considering the past overall manufacturing practice, the sampling frame stratified by cluster was created by the select procedure of statistical software using stratified random sampling option. As a result, inspection and sampling plan for new fiscal year can allow for more focusing on firms with poor manufacturing practice, which is expected to measurably reduce the budget and investigator's time and effort for routine surveillance sample inspection.

The development a good manufacturing practice scheme for the sanitary mass production of the commercial rice cake

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A factory production system of steam-cooked rice cakes was examined to provide a guideline for a good manufacturing practice (GMP) scheme. Two highly serious problems with steam-cooked rice cake in processing and consumption are its quality deterioration due to microbial contamination and staling by starch retrogradation of the product. In this research, the manufacturing flow of two small-sized rice cake manufacturing factories with 1,000 kilograms of daily output was examined for microbial contaminations. The manufacturing processes were: soaking glutinous rice in tap water (10 hr), milling soaked rice to flour followed by blending of all ingredients, steam-cooking (35 min), cooling down (2 hr) and cutting the cake lump into cubes (2´2´4 cm), covering each piece with soybean powder, and storage in a polyethylene bags at room temperature until final distribution. Soybean powder (total aerobes, 10^8 CFU/g; coliforms, 20~65 CFU/g), as a major source of contamination among ten raw ingredients needed a special superintendence against the initial microbial load. During processing, high-pressure steaming was very effective in destroying most of the microbes that originated mainly from the contaminated milling roll. However, the intermediate form of the rice cake with high water activity (>0.95) was very vulnerable to microbial proliferation. During the cooling and cutting operations, the total microbial count of the cake was raised up to 1.5×10^3~4.5×10^5 CFU/g. Coliforms (5.5~8.0×10^5 CFU/cm^2) were detected from milling roll, dishing towel, and knife and fungi were present in most of the utensils. Total aerobes were frequently detected from hands (2.0~2.5×10^2 CFU/cm^2) and disposable gloves (2.2~2.7×10^3 CFU/cm^2) of the workers. The vinyl plastic apron (1.8~8.0×10^2 CFU/cm^2) was more apt to be contaminated than cloth one. The broomstick, faucet, sink holder, worktable, display stand, and ventilation fan also called for intensive hygiene management.

Total plant sterols extracted from corn, grain sorghum and their DDGS using reflux and soxhlet methods

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High LDL cholesterol levels have been recognized to be a major contributor to cardiovascular disease. Plant sterols are compounds found in most plant-based foods. Several studies have found dietary use of these compounds lowers plasma LDL cholesterol levels. In this study, lipids extracted with hexane from corn and grain sorghum, as well as their dried distilled grains

with solubles (DDGS) have been found to be a potential source of plant sterols. Kernels of corn and grain sorghum in two different forms (ground and whole) were extracted with hexane using two methods (reflux and soxhlet). Additionally, DDGS samples from corn and grain sorghum, byproducts of ethanol production, were extracted using the methods mentioned above. Total plant sterol contents in the lipid extracts were determined by gas chromatography. Differences among yields of lipids extracted from the grains were found. The largest yields were obtained from the ground forms using the soxhlet method. For DDGS, extractions using soxhlet method from corn DDGS produced larger amounts of lipids than sorghum DDGS. Plant sterol content was greater in corn than in grain sorghum lipid extracts. In contrast to lipid yields, where soxhlet extractions provided a larger recovery, plant sterols yields from extractions using a reflux method were greater than those from using a soxhlet method. Thermal degradation of plant sterols may have occurred during soxhlet extraction. Plant sterols yields from DDGS and from ground kernels were similar contrasting to what was expected. During the process of ethanol production, non-starch compounds are concentrated in the DDGS by a factor of three when compared with kernel.

Reduction of the effects of Fusarium spp. infection on Robust and Legacy malting barley during malting and brewing

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Two six-rowed malting barley varieties, Legacy and Robust, from the 2004 US harvest, containing 4 levels of deoxynivalenol (DON) were studied for Fusarium trichothecene toxins in samples of the raw barley, malt in process, finished malt, wort and finished beer. The percentage of kernels with growth of Fusarium spp. and levels of DON in the samples were monitored throughout the entire malting and brewing process. Effect of treatments with ozone, sodium hypochlorite, NaOH, formaldehyde and hot water on the reduction of Fusarium spp. and level of DON were examined. A reduction in Fusarium spp. was observed for treatments with ozone, sodium hypochlorite, formaldehyde and hot water. However, negative effects on barley germination were recorded at higher concentrations and longer treatment times. In the malting process, Fusarium spp. were substantially reduced after steeping. There were some slight increases in Fusarium spp. during germination, but the levels were suppressed by the kilning process. All barley samples showed a slight increase in DON level in green malt during germination, but the increase was noted at different germination times for the different samples. Study results indicated a trend in DON reduction in barley throughout the malting and brewing processes regardless of the levels of DON in the barley. Also, the data on DON level in wort and beer suggested that some of the DON from the malt will be carried into wort through the mashing procedure. DON levels decreased further through wort boiling, cooling and fermentation.

Effect of acid-methanol treatment on the resistant starch content of high-amylose corn starches after annealing

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For elucidating the effect of acid-methanol treatment on the resistant starch content of annealed starch, high-amylose corn starches (Hylon V and Hylon VII) were treated in methanol containing 0.36% HCl at 25°C up to 30 days, and further annealing at 50°C for 72 h. The order structure and resistant starch content of starches before and after annealing, respectively determined by ^{13}C-CP/MAS NMR and AOAC methods, were compared. Results showed the weight-average degree of polymerization (DP_w) of starches after acid-methanol treatment profoundly decreased with increasing treatment time. The DP_w of starches ranged from 372×10^3 to 308 and 246×10^3 to 255 for Hylon V and Hylon VII starches, respectively. After annealing, the double helix content of acid-methanol treated starch was higher than that of the counterpart native starch. On the other hand, no obvious differences were found on the crystallinity of the starches. The resistant starch content of acid-methanol treated Hylon V and Hylon VII starches increased obviously. It was found that the resistant starch content of annealed starch linearly correlated with the log DP_w value of starch ($r^2 = 0.94$ for Hylon V and 0.93 for Hylon VII starch). Results suggest that the degradation of high-amylose corn starch molecules during acid-methanol treatment increases the double helix content, but not the crystallinity, of starch. The acid-methanol treatment also increases the resistant starch content of starch after annealing. Furthermore, the resistant starch content of annealed starch granule strongly depends on the molecular size of starch.

Structure analysis of resistant maltodextrin using NMR

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Resistant maltodextrins have been produced and used as an ingredient in low-caloric food products for intervention of overweight, obesity and diabetes. During the process of resistant maltodextrin, starch molecules undergo hydrolysis and repolymerization and to form a complex structure, giving a water soluble product with a considerate proportion of indigestible components. In this study, nuclear magnetic resonance (NMR) spectroscopy was applied to study the structure of resistant maltodextrins, and results were compared with that obtained using methylation reaction. The glycosidic linkages in commercial and laboratory-prepared resistant maltodextrins were characterized using the chemical shift-values reported in the literature. Anomeric configurations of the linkages, including alpha-(1→2), beta-(1→2), alpha-(1→3), beta-(1→3), alpha- (1→4), and alpha-(1→6), were identified, which were not revealed using the methylation method.

Effect of Moringa leaf on the physical and sensory attributes and acceptance of flavored extruded oat flour snack food

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Leaves of Moringa tree (Moringa oleifera) are an exceptionally good source of vitamin A, vitamin B, and C, minerals, and the sulphur-containing amino acids methionine and cystine which the flavor of Moringa leaf is difficult to accept. Extrusion cooking and puffing of cereals is widely practiced in food industry. In this study, blends of oat flour with Moringa leaf powder were used to produce expanded snack foods with a lab-scale twin-screw co-rotating extruder. The physical and sensory characteristics of Moringa leaf snack food with different Moringa leaf levels were explored. Physical characteristics (water activity and L*a*b color) and sensory characteristics (descriptive and consumer analysis) were evaluated on the experimental oat flour snack foods with 0, 15, 30 and 45% Moringa leaf levels. The water activity decreased and color (lower L values), color indensity, dryness and graininess with increasing Moringa leaf content increased for all Moringa leaf snack food. Using a 9-point hedonic scale, 15 trained panelists evaluated 4 levels of Moringa leaf snack for appearance, texture, flavor and overall acceptability. Our results showed that up to 30% substitution of oat flour with Moringa leaf might be feasible for manufacturing acceptable Moringa leaf snack food. Regardless of gender, coated Moringa leaf snacks with 0, 15% Moringa leaf were liked very much by both age groups, while 45% Moringa leaf snacks were the least accepted.

Analyses of complex mixtures of biopolymers using Rapid Visco Analyzer and Phase Transition Analyzer

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Rapid Visco-Analyzer (RVA) was used to determine the viscous properties of starch slurries as they undergo a standard time-temperature treatment. Phase transition analyzer (PTA) is a new tool to study the physical changes associated with the glass transition (T_g) and melt transition (T_m) in biopolymers such as starch and protein during thermal processing. The objective of this study was to determine the effects of these two analyzers on material properties of grain-based samples from oat flour, corn starch, oat flour mixed with Moringa leaf, extruded corn starch, oat floure with Moringa leaf, respectively. The combined results by RVA and PTA analyses showed that there were significant differences on gelling properties among the above materials. The viscosity of a paste depends on a large extent on the degree of gelatinization of the starch granules and the extent of their molecular breakdown. Viscosity values of extruded corn starch, oat flour with Moringa leaf were far lower than those of their corresponding unprocessed corn starch, oat four with Moringa leaf, oat flour, and corn starch. The decrease in magnitude of the peak viscosity might reflect greater degradation and gelatinization of starch. All extruded flours displayed a lower peak viscosity (30-120 RVU) compared with their unprocessed raw materials (75-300 RVU) and this indicated that ungelatinization starch polymers were present due to extrusion processing. The Moringa leaf has negative effect on the viscosity of unprocessed materials and extrudates. With more Moringa leaf additions, the lower viscosity was observed which the reason is the Moringa leaf cannot provide the viscosity properties of starch. The results showed the softening temperature (T_s) of oat flour with Moringa leaf decreased with increase of

moisture content. In the same level of moisture content, higher level of Moringa leaf addition got higher softening and flowing temperature.

Determination of modulus of elasticity of corn and wheat kernels using an ultrasonic method

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Important aspects of engineering involving processing of granular materials in operations such as transportation, screening, tempering, drying, packaging and quality control. The performance of those operations requires experimental values of basic mechanical properties of the grain endosperm such as modulus of elasticity, failure stress, and strain among others. Calculus of elastic modulus (Young modulus) in granular material requires uniaxial compression test. Penetration tests and crush resistance tests are performed on single kernel but have to be replicated with several kernels in order to obtain statistically representative results. The mechanical properties of grains are difficult to measure because of the differences in the morphology of different kernels and the intrinsic properties of the endosperm. The ultrasonic method turned out to be appropriate for materials with high attenuation and not very regular geometry, as is the case with cereals. The ultrasonic velocity (v) of a material is related to two of its most basic physical properties: its elastic modulus (*E*) and density (rho) according to equation v^2 = E/rho. On the basis of these principles, ultrasound can be used to measure properties such as elastic modulus, composition, structure, flow rate, and the physical state as well as being used as an analytical instrument. Preliminary data showed that elastic modulus increased with kernel hardness and decreased with increasing moisture content. The elastic modulus corn kernels with 9.5% moisture content ranged from 168 MPa in soft corn to 500 MPa in popcorn. In wheat kernels with 7.5% moisture content the elastic modulus was 145-150 MPa for soft wheat, 165-170 for bread wheat and 201-210 MPa for durum wheat. Performed experiments have shown strong influence of elastic modulus on the quality of corn and wheat products.

Evaluation of the effects of Lupin derivatives on the quality of cookies

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Mexico has serious nutritional problems, due low income of the population. Thus, this research will be contribute diminish that nutritional problems. The aim of the present work was to characterize the dough texture, adhesiveness and extensibility of cookies fortified with derivatives of Lupinus. A proximal analysis was developed. After that dough was prepared with Wheat Flour (WF) fortified with various levels of Lupin Flour (LF) (8, 12 and 20%), Lupin Protein Concentrate (LPC) (10, 20 and 30%) and Lupin Protein Isolate (LPI) (5, 10 y 15%). Later the rheological analyser (TPA, adhesiveness and extensibility) were performed by using a TA-HDi texture analyzer (Stable MicroSystems Ltd, Surrey, UK) in a compression mode. The chemical composition of the flour was 6.5% protein for WF and 39.4% protein for LF, 66% protein for LPC and 89.1% for LPI. The cookie fortified with 12% of LF and 20% of LPC had 8.4 y 9.7% protein respectively as compared to 6.4% in the regular product, which agreed with other results reported in the literature. The addition of 12 and 20% produced a decrease in the firmness and consistency, and an increase in the cohesiveness of the dough. Generally speaking, higher amounts of precipitate (30%) did not significantly affect the firmness, consistency or cohesiveness of the dough. The adhesiveness increased particularly in samples prepared with 20 and 15% of LF and LPI respectively. The presence of Lupin derivatives produced a excellent firmness and consistency of the cookies and an increase in its cohesiveness, which favours the production of a high-quality product.

Characterization of masa using thermal and rheological analysis to determine functionality of corn during nixtamalization

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Corn variety, environmental conditions, and processing parameters factor into the quality of masa. Food manufacturers have experienced problems with functionality of different corn varieties and the issue is partially crop-dependent. The objective of the study was to determine the functionality of corn by characterizing the physico-chemical changes that occur to the kernel during processing. Oscillating rheometry and thermal analysis including thermogravimetry (TGA) and differential scanning calorimetry (DSC) were used to study the yellow corn variety H-31. Rheological results showed that the masa's physical properties were independent of time and frequency, but displayed shear thinning at 25°C. TGA weight loss data showed that alkaline cooking increased the pericarp moisture content by five fold. The TGA derivative curves (Δ weight %/Δ temp) peak temperature of the pericarp increased ~15°C from raw to cooked corn, signifying that water became more difficult to remove while the hard and soft endosperm displayed similar peak temperatures (~55°C) to one another, but lower than the pericarp. The germ exhibited the highest peak temperature, suggesting water was the most entrapped in this fraction. Differential scanning calorimetry yielded 3-5 phase transitions in the corn throughout processing and details of these will be presented. Combining thermal and rheological data may provide insight into ways for characterizing and selecting suitable corn for masa production.

Viscoelastic characteristics of dough flours from Mexican soft wheat cultivars

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In Mexico, soft wheat is grown in the Bajío Region (the states of Guanajuato, Jalisco and Michoacan), and it is used to make cookies, cakes and tortillas. One of the most important quality characteristics of flour is the rheological properties of its dough. The objective of this research was to characterize the viscoelastic behavior of dough prepared from Mexican wheat cultivars. To obtain flours, 22 samples of soft wheat from cultivars Arandas, Cortazar, Salamanca and Saturno were cleaned, conditioned and milled. Protein content, ash conten, moisture content, dry gluten, sedimentation volume, falling number and farinograph parameters as water absorption, stability and development time were measured to evaluate the quality of flours. Dough viscoelasticity behavior at the linear region was evaluated using the dynamic test in a controlled strain rheometer. The viscoelastic characteristics measured were: the storage modulus, the loss modulus and the phase angle. A factorial experiment design with two factors was used: Cultivar and environmental growing conditions. The wheat cultivad had a significative effect on the dough viscoelastic characteristics and in the chemical and physical evaluations. According to the phase angle, the viscous characteristics predominated slightly over the elastic ones. Finally, the storage modulus, the loss modulus and the phase angle correlated significantly with the falling number ($r = -0.928$, $r = -0.933$ and $r = -0.9369$).

Aroma characteristics of variably parboiled rice samples

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A comparison of the volatile compounds observed in the headspace parboiled rice is reported. Rice was parboiled at 30, 50, 70 & 90°C for 4, 8 and 12 minutes. Aroma compounds were identified by solid phase micro-extraction followed by GC-MS. These included 2-decenal, linoleic acid (octadecanoic acid), nonanal, acetic acid, palmitic acid (hexadecanoic acid), hexanal, benzenacetaldehyde, benzaldehyde, 1-octen-3-ol, 2-heptenal, 2-pentylfuran and 1-hexanol. Compounds like palmitic (hexadecanoic) acid, linoleic (octadecanoic) acid and 1-hexanol were at very high relative levels in the raw sample, but the levels diminished significantly on parboiling. Consequently, these compounds appeared to only contribute significantly to the characteristic aroma of the raw-milled rice sample. The level of 2-pentylfuran was largely independent of the severity of the parboiling process. On the other hand, 2-decenal, 2-heptenal and acetic acid had low levels that dramatically increased on parboiling. These three compounds could therefore be important contributors to the characteristic aroma of Ghanaian parboiled rice. A key marker of microbial infection is the presence of 1-octen-3-ol. Although this can be produced through lipid oxidation, it is generally observed as a result of microbial infection. The fact that the levels of this compound decreased with increasing intensity of parboiling could be an indication that severely parboiled rice sample are less susceptible to microbial infection.

The role of corn starch, amaranth flour, pea isolate and *Psyllium* flour on the rheological properties of gluten-free doughs

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Gluten is the structure-forming protein in flour, responsible for the viscoelastic properties needed to produce good quality bread. The removal of gluten from bakery products in order to produce foods for individuals

suffering from celiac disease (mainly based on gluten-free cereal flours and starch, at present), impairs dough capacity to properly develop during leavening and baking; thus substances that imitate the viscoelastic properties of gluten are always required. The use of rheometry in studies of gluten-free dough rheological behavior has been rather limited up to now. The aim of the present work was to characterize seven experimental gluten-free systems containing different levels of corn starch, amaranth flour (to enhance the nutritional benefits), pea isolate (to increase the protein level) and *Psyllium* flour (as thickening agent), in order to evaluate the influence of the different ingredients on the rheological properties of the dough. A commercial gluten-free flour mixture was included too. Beyond the chemical characterization, dough samples where analyzed by both empirical and fundamental rheologies. Their ultrastructures were also investigated. The farinographic test emphasized the key-role of the hydrocolloid in assuring dough handling properties. Moreover, the presence of *Psyllium* (2%) enhanced dough consistency (G') at 30°C, enlarged the linear viscoelastic region of the dough and reduced starch gelatinization during heating (30–90°C, 4°C/min). Similarly, the partial substitution of corn starch with amaranth flour (40%) caused an enlargement of the linear viscoelastic region, an increase in G' (indicating a hardening of the dough) and greater changes in dough rheology during heating. The pea isolate, when present (6%), influenced dough consistency at 30°C but had no effect on dough rheology at temperatures higher than that of starch gelatinization.

An integrated procedure for the measurement of dietary fibre

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The procedures generally employed for the measurement of total dietary fibre (TDF) are AOAC Official Methods 985.29 and 991.43 and the correcponding AACC International methods. In these procedures, the sample is incubated at approx. 100°C and pH 8.2 with thermostable alpha-amylase, followed by protease at 60°C and then amyloglucosidase at 60°C and pH 4.0-4.5. Remaining protein and ash are measured on residues of duplicate samples and subtracted from the residue weight. However, it has been realized that this procedure underestimates resistant starch (RS), which is now recognized as an important component in the dietary fibre complex, and especially so in manufactured foods where RS can be added with no detrimental effects on organoleptic properties of the food. While a method for the measurement of RS (AOAC Official Method 2002.02) has been developed, the problem then is how to allow for the percentage of RS that is measured in the TDF method without double counting some of the RS. In this paper, I will discuss a method that resolves this problem by adapting the RS format to the measurement of TDF. This method also allows integrated measurement of non-digestible oligosaccharides and available carbohydrates.

Measurement of D-xylose and wheat flour arabinoxylan

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We now describe an alternative procedure for the determination of arabinoxylan using a specific, high purity beta-xylose dehydrogenase in the presence of xylose mutarotase. The beta-xylose dehydrogenase was identified through a targeted screening program. The gene was cloned and active recombinant enzyme expressed and purified from *E. coli*. Like all other beta-xylose dehydrogenases, this enzyme also acts on D-glucose. In the current procedure, arabinoxylan containing samples are acid hydrolysed and a sample pre-treated with hexokinase and ATP (to remove D-glucose). The sample is then incubated with beta-xylose dehydrogenase/xylose mutarotase. The amount of arabinoxylan can be calculated from the determined D-xylose value, knowing the ratio of D-xylose to L-arabinose in the sample.

A simple, quantitative method for the analysis of "available phosphorus" from phytic acid and inositol phosphates

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Phytic acid (IP_6) is the primary source of inositol and storage phosphorus in plant seeds. The abundance of IP_6 in cereal grains is a concern in the foods and animal feeds industries because phosphorus in this form is unavailable to monogastric animals due to a lack of endogenous phytases. In addition, the chelating characteristic of IP_6 reduces the bioavailability of other essential dietary nutrients such as minerals, proteins and amino acids. High IP_6 content feeds are generally supplemented with P_i, however this causes increased faecal phosphate levels and subsequent eutrophication of waterways. Alternatively, supplementation with commercial phytases is becoming increasingly popular since it reduces the requirement for P_i supplementation as well as the associated environmental issues. Currently, there is no commercially available, simple, quantitative method for IP_6 and while such measurement is relatively complex the generally accepted AOAC Method 986.11 has limitations. Each individual analysis requires cumbersome anion-exchange purification of IP_6 and a major inherent assumption here, is that only IP_6 is purified. While this is viable for non-processed grains it is not viable for processed grains which can contain higher levels of lower inositol phosphate forms that would co-elute with IP_6 and contribute to overestimation of the IP_6 content. Given the complexities of the purification and measurement of IP_6 separate from lower inositol phosphate forms, Megazyme has developed a simple, quantitative method (K-PHYT) to measure total "phytase-available phosphorus" released from food and feed samples that is amenable to high numbers of samples. This method involves acid extraction of inositol phosphates followed by treatment with phytase and alkaline phosphatase. Total phosphate released is measured colorimetrically and given as grams of phosphorus per 100 g of sample.

Characterization of oat bran from experimental oat lines with differing amounts of total beta-glucan

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New oat (*Avena sativa*) lines with increased concentrations of beta-glucan have been developed at Iowa State University. The objectives of this project were to characterize the bran component of these new oat lines for their dietary fiber contributions and potential health benefits, as well as for their potential function in foods. The oats were grown at the Iowa State University field station during Summer of 2005 and harvested in Fall of 2005. After harvest, the oat kernels were sent to the Quaker® Oats Co. processing plant in Cedar Rapids, Iowa, and processed under the same conditions as the oat bran found on retail shelves. The proximate analysis and beta-glucan concentrations of the processed bran portion, separated from the groat, were analyzed and compared to retail Quaker® Old Fashioned Quick Oats and Oat Bran. The beta-glucan concentrations in the bran from the four oat lines, analyzed by using AACC method 76-13, were as follows: 'Jim' bran, 6.4%; 'Paul' bran, 7.5%; IA95111 bran, 8.9%; and N979 bran, 10.8%; all on a dry-weight basis (dwb); compared with 4.2% in Quaker® Quick Oats and 6.2% in Quaker® Oat Bran. Proximate composition values (AACC methods 30-25 and 32-21) on a dwb were: starch – Jim, 58.2%; Paul, 54.6%; IA95111, 52.4%; N979, 50.3%; and lipid – Jim, 7.0%; Paul, 7.7%; IA95111, 7.8%, N979, 8.2%. Water holding capacity (WHC) values were: Jim, 141%; Paul, 179%; IA95111, 218%; and N979 212%, with significant differences ($P \leq 0.05$) between all results except IA95111 and N979. There were no differences in water solubility index (WSI). Future work is focusing on the application of the oat bran types for food systems and the *in-vitro* analyses of their physiological function.

Modification of amylopectin chain length in transgenic maize plants results in novel starches with altered hydrolysis properties

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Our goal is to create novel forms of starch with tailored digestibility for food, feed, or industrial applications by modifying the activities of specific maize starch biosynthetic enzymes in transgenic plants. This project focuses primarily on the effects of altering chain length distributions in the amylopectin component of the starch. Our hypothesis is that changes in the amylopectin chain profile directly impact starch granule crystallinity and thus the access of water and digestive enzymes to the granule, rendering the starch more or less susceptible to hydrolysis. Starches were screened for particular structural changes in the amylopectin by separating the linear chains with fluorescence-assisted capillary electrophoresis (FACE). Two novel classes of starch were identified, termed LCAPS for "long-chain amylopectin starch" and SCAPS for "short-chain amylopectin starch". LCAPS has fewer short glucosyl chains and more intermediate and long length chains compared with wild type starch, whereas SCAPS has more short chains and fewer intermediate length and long chains. In vitro hydrolysis of both types with alpha-amylase and amyloglucosidase revealed that resistance to digestion was enhanced in the LCAPS lines relative to wild type starch, whereas SCAPS lines were hydrolyzed more rapidly and at lower temperatures. These results indicate that FACE is an effective tool for predicting starch digestibility. Analyses of the texture, viscosity, and thermal properties of the novel starches are in progress to assess their potential utility as food ingredients, industrial material, or conversion feedstock. Also, human feeding trials are under way to

establish whether LCAPS is in practice more slowly digested than normal starch.

Impact of sodium chloride and moisture levels when toasting breakfast cereal products

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With equivalent heating regimes, the inclusion of sodium chloride gives rise to breakfast cereal products with significantly more colour. The L* values continue to fall as salt levels increase from 0 to 4.33% wet weight. It is known that the Maillard reaction rate is very much influenced by the mobility of the matrix. Sodium chloride, at high concentrations, is a known humectant and there is no reason why it could not act as plasticer in its own right. To study these complementary roles, a model system that mimics breakfast cereals in terms of colour and volatiles after heating was created. This model was composed of native maize starch, glucose and a mixture of 4 amino-acids (glucose/total amino-acid molar ratio = 1/1, initial moisture 20% w/w). The influence of sodium chloride on the relationship between water activity (Aw) and moisture for the models were measured using dynamic vapour sorption and the clear increase in moisture at higher Aws was noted. The isotherm shows a significant increase of 1.5% moisture (w/w) in the model systems in the presence of 5% salt at 75%RH. This decreases the glass transition temperature by 27°C. However, Tg was also affected by the presence of salt and hence both salt and increased water levels created a lower Tg for the model system, as measured by differential scanning calorimetry, phase transition analyzer and dynamic mechanical thermal analysis using pockets. To establish if the rate of water release was influenced by salt as the product was heated the weight of model systems were also measured using thermal gravimetric analysis. Loss of mass due to volatile generation had to be taken into account for water loss calculations.

Formulating with oat beta-glucan for heart healthy products

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Formulating heart-healthy products with beta-glucan may reduce the risk of heart disease, and lead to improved overall wellness throughout all stages of life. High dietary fiber intake, particularly water-soluble fiber, may also decrease the risk for heart disease. Most adults only consume 14–16 g of fiber each day, which is about half of the 28–35 g per day recommended by the Institute of Medicine. Today's health-conscious consumers are seeking natural alternatives, such as nutritionally-enhanced goods like bakery products, to balance cholesterol levels and increase fiber intake. A patented aqueous milling technology that maintains the integrity of oat beta-glucan has made possible the development of oat bran concentrates with high beta-glucan content. Oat bran concentrate application benefits include low use levels, heat and pH stability, moisture retention in bakery and bar applications, shelf-life extension and solubility improvement. The proposed mechanism for health benefits relies on the viscosity-building effect of oat beta-glucan in the digestive system, which slows stomach emptying, decreases the absorption of fat and prolongs the absorption of energy from a meal. Research indicates that these effects exert strong control over insulin release, which reduces cholesterol production, extends satiety and provides benefits for improved heart and glycemic health.

Dry milling of dehulled field pea prior to wet fractionation significantly improves the yield of starch and by-products quality

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Wet fractionated field pea grain components (i.e. starch protein and fiber) offer advantages in food applications. However, the industry is challenged with elevated cost of production due to extra processing steps in achieving acceptable yield and purity of grain components. The present study investigated the effect of dry milling of groats into flour prior to its wet fractionation. The hypothesis was that dry milling would better open up the grain tissue structure and would improve product yield and purity. Grains from two field pea cultivars were de-hulled and the groats were processed by two protocols: a) groats directly ground with water into slurry and fractionated into fiber, protein and starch concentrates (groat wet fractionation, GWF) and b) groats dry milled into flour and then wet fractionated using steps identical to that of protocol- a (flour wet fractionation, FWF). The yield (%, w/w) and composition (%, w/w) of starch, protein and fiber concentrates from both protocols were determined. The data indicated that FWF significantly improved starch yield (54.6–54.9%) as compared to GWF (32.7–32.9%). The fiber yield was lower in FWF (11.6–13.9%) than GWF (28.6–30.5%). Scanning electron micrographs of grain fractions from both protocols clearly suggested that better tissue fragmentation caused by dry milling may be responsible for better starch yield. The purity of starch fraction from FWF was lower (74.7– 77.2%) than that of GWF (76.6–79.9%). Furthermore the starch and protein contents of fiber fractions were found to be significantly different (57.6–59.4% and 6.3–7.9%, respectively in FWF and 65.8–67.4% and 2.9–3.5%, respectively in GWF). Minor variations in yield and composition of grain fractions were noted among cultivars. Brabender rheological properties of starches purified through both protocols were found to be identical.

Variation in grain hardness and associated traits in USA barley breeding lines

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Despite increasing interests in nutritional benefits of consuming barley food products, we have limited experience in systematic breeding and cultivation of appropriate barley varieties for food uses. Identification of food use traits of barley and establishment of screening methods are crucial for development of food barley varieties. Barley grain hardness may influence pearling and milling properties, flour particle size and eventually processing and product quality, as is intensively documented in wheat. Grains of 959 breeding lines of various classes contributed by ten major barley breeding programs in the USA as part of the USDA funded barley Coordinated Agricultural Project were evaluated for hardness using a single kernel characterization system (SKCS). Hulls of the hulled barley types were removed by abrasion before the SKCS test. Average kernel weight and diameter of barley grain ranged from 24.9 to 53.7 mg and from 1.7 to 2.9 mm, respectively. Hulled barley lines exhibited wider variation in kernel weight and diameter than hulless lines. Spring and winter lines were similar in distribution of kernel diameter and average values. The proportion of hull, as determined by the abrasive removal rate, ranged from 10.2 to 20.8%. The proportion of hull was <15.5% in 99% of winter lines and 80% of spring lines. Grain hardness ranged from 30 to 92 in hulled barley and from 42 to 91 in hulless barley. Eighty percent of winter and 30% of spring barley lines exhibited >67 in hardness. Average kernel hardness was 71 for winter and 62 for spring types. Large variation in hardness and other grain characteristics among barley classes and genotypes indicate the potential for the identification of genes or quantitative trait loci (QTLs) and of genetic markers for development of barley varieties possessing appropriate grain characteristics for food uses.

Determination of deoxynivalenol in soft wheat by immunoaffinity column clean-up and HPLC-UV detection: Interlaboratory study

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An inter-laboratory collaborative study was organized to assess the performance of a method employing immunoaffinity column clean-up followed by high performance liquid chromatography (HPLC) with detection by ultraviolet (UV) absorption. The method tested for deoxynivalenol (DON, 3alpha, 7alpha, 15-trihydroxy-12,13-epoxytrichothec-9-en-8-one) at levels bracketing 1 ppm, the current Health Canada guideline established for soft wheat destined for use in baby foods. The analytical portion of the sample was extracted with water. The sample extract was centrifuged, filtered, passed through an immunoaffinity column for clean-up and evaporated. The residue was dissolved in mobile phase (water + methanol [90.5 + 9.5, v + v]). The separation and determination of DON was performed by reverse-phase HPLC, with detection by UV absorption at 220 nm. This study was carried out to establish an official method fit for use in Canada that would address the levels allowed in wheat used in baby food and staple foods, levels which are currently under review. The wheat samples, naturally contaminated with DON, were sent to thirteen laboratories in eight different countries. Based on results for naturally contaminated samples (blind duplicates at five levels), the relative standard deviation for repeatability (RSD_r) in soft wheat ranged from 3.1 to 14.8%. The relative standard deviation for reproducibility (RSD_R) in soft wheat ranged from 21.0 to 32.9% and the HORRAT value range was 1.0 to 1.9. Test portions of a blank wheat sample matrix were spiked by participants at a level of 0.5 µg/g for DON. Recoveries ranged from 66–98% with an average of 84%. For spiked wheat samples (duplicates), the RSD_r was 5.4%, the RSD_R was 12.6% and the HORRAT value was 0.7. All HORRAT values were within the acceptable range. The within- and between-laboratory precision for soft wheat fell within the European Commission performance criteria range for deoxynivalenol. This collaborative method therefore showed acceptable performance.

Size reduction influence on lipid content of corn and grain sorghum

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The effect of the size reduction unit operation on lipid levels of grain sorghum and corn was investigated with a hammer mill. The geometric mean particle size, lipid concentration, and moisture content for ground samples of corn and grain sorghum at three grain feed rates and four levels of energy input through shaft rotation were compared with whole kernels. Grinding the whole kernels resulted in a significant decrease in moisture content and a significant increase in the extractable lipid. At a constant feed rate, a rotation level increase resulted in a shift in the particle size distribution from larger to smaller, and a decrease in moisture content, but no significant change in the amount of extractable lipid. Although particle size has been shown to influence the amount of lipid that can be extracted from ground corn and grain sorghum, it appears that changes in shaft rotational speed do not create a large enough shift in the particle size distribution for the amount of lipid extracted to be significantly affected.

Fermentation influence on lipid content for corn and grain sorghum

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Previous studies have indicated that the fermentation step of a dry grind ethanol process has an effect on the amount of lipids that can be extracted from the distillers dried grains for both corn and grain sorghum, hence a deeper investigation was required. Hammer milled corn and grain sorghum were adjusted in particle size distribution so that they were equivalent and then enzymatically treated and fermented. The amount of lipid extracted from the ground material, the solids fraction prior to fermentation and the solids fraction after fermentation were compared. The amount of lipids extracted from the solids fraction after fermentation was 200% of the amount of lipids extracted from the solids fraction prior to fermentation and 150% of the amount of lipids extracted from the whole kernel. During fermentation the amount of solids was reduced three fold, yet the amount of lipids extracted did not increase three-fold as expected. It appears that the yeast in fermentation process effect the amount of lipids that are extractable.

Dielectric studies of gluten

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Gluten has been widely utilized in the cereal-based products and plays a key role in determining the unique baking quality of wheat by conferring water absorption capacity, cohesivity, viscosity and elasticity of dough. Most of the research on gluten emphasizes on the chemical properties and little information is available on the dielectric properties of this substance. The dielectric properties of food materials are important; these properties affect the interaction of electromagnetic energy with the food. An understanding of the dielectric properties of food material will describe the behaviour of foods when subjected to high-frequency or microwave electric field in various applications such as microwave heating and material characterisation. This paper describes the dielectric studies carried out on gluten. The dependence of the dielectric properties of gluten on other variables is also discussed. Measurement techniques used for determining the complex permittivity of gluten are reviewed and graphical data is presented to illustrate the dependence of complex permittivity of gluten on frequency, moisture content, density and temperature. The dielectric properties are represented by the complex permittivity (e = e'- je''), where the real part e', or dielectric constant, characterizes the ability of a material to store the electric field energy and the imaginary part e'', or dielectric loss factor, reflects the ability of a material to dissipate electric energy in the form of heat. The dielectric properties of gluten were measured at microwave frequencies in the range of 8-12 Giga Hertz. Measurements were carried out in waveguide 16 cell using a microwave transmission and reflection technique. Results of measurements are presented as a function of frequency, moisture content, density and temperature.

Stability of colored compounds from black sorghum: Effects of pH and water activity

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Color is an important functional attribute of foods. Among cereals, special sorghums have the highest content of phenolic compounds, with unique 3-deoxyanthocyanins rendering them stable and thus natural food colorants. The objective was to determine the effect of pH and water activity on color stability of anthocyanins extracted from black sorghum bran, which is a rich source of 3-deoxyanthocyanins. After two hours of extraction, the supernatant was evaporated in a Speed Vac at low temperature. Dried extracts were reconstituted in aqueous ethanol and adjusted to 11 different pHs using 0.1-1N NaOH and 0.1-1N HCl. Sucrose solutions (a_w 0.80 and 0.90), glycerol (a_w 0.21) and distilled water (a_w 0.100,) with fixed concentrations of extracts were evaluated for the effect of water activity on color stability. Color changes at different pHs and different water activities were measured over time using a Minolta CT-310 colorimeter to obtain the L*, a* and b* (CIELAB) color space coordinates, hue and chroma. The L*, a* and b* values, hue and chroma remained relatively stable over the pH range investigated. A major visual color difference was observed as the pH increased to • 6 from bright orange in acid pHs to burgundy in basic pHs. The L*, a* and b* values showed no significant change over time from pH 1-6 while showing changes from pH 6-11. The stability of 3-deoxyanthocyanins compared favorably with the standard red colors FD&C Red # 3 and FD&C Red # 40. The L*, a* and b* (CIELAB) color space coordinates, hue and chroma for samples at different water activities were also stable. The stability of the 3-deoxyanthocyanidins from sorghum is good. They have potential use as natural food colorants.

Solvents for the extraction of 3-deoxyanthocyanins from sorghum

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There is an increasing interest in anthocyanins as natural food colorants with antioxidants and health benefits. The extraction commonly used for tannins and other phenolic compounds in sorghum is 1% HCl in methanol. This solvent is unacceptable for food applications. The objective of this study was to establish the most effective food-friendly solvent(s) for extraction of anthocyanins from black sorghum. Different combinations of acetic, citric and tartaric acids in ethanol were compared to the commonly used 1%HCl in methanol. Extractions were carried out for 2 hours and the supernatants were analyzed using HPLC-PDA. The extracts were analyzed for antioxidant capacity and total phenols using ABTs and Folin Ciocalteu respectively. The total amount of anthocyanins extracted by 1% HCl in methanol was 3598 µg/g of sample compared to a range of 2065 µg/g and 1834 µg/g of sample for various levels of acidified aqueous ethanol. Apigininidin and luteolinindin were the main anthocyanins detected. Antioxidant activity expressed as µmol Trolox equivalent (TE) antioxidant capacity per gram of sample (dry basis). Compare to 157 µmol TE of 1%HCl, different levels of acidified aqueous ethanol showed a range of 129-143 µmol TE antioxidant capacity per g of sample. Although acidified aqueous ethanol extracted relatively less anthocyanins compared to 1% HCl in methanol, it provides food friendly extraction solvents for the extraction of 3-deoxyanthocyanins from sorghum for food applications.

Sensory evaluation of extruded light red kidney bean (*Phaseolus vulgaris* L.) porridge

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A study was conducted to determine consumer acceptance of a new bean porridge that was developed by Michigan State University. The bean powder used to prepare the porridge was made with help of extrusion. Extrusion of raw ground light red kidney beans was accomplished using a corotating twin-screw extruder model JS30A manufactured in China by Qitong Chemical Industry Equipment Co, Ltd. Bean flour was extruded at 39% moisture content wet basis at a screw speed of 255 r.p.m. and a feed rate of 120g/min. Sensory evaluation of extruded bean porridge was conducted at the National University of Rwanda hospital located in the southern province of Rwanda. The 70-member trained panel, comprised mostly of adult low-income women, evaluated bean porridge and compared it with *sosoma*, a local expensive porridge that is a blend of corn, wheat, sorghum and soy. Both porridges were prepared in the ratio of 1:1:8 (w/w) for powder, sugar, and water respectively. The evaluation was conducted by scoring on a hedonic scale of 1–9 for poor to excellent respectively for the parameters, color, texture, flavor and overall acceptability. The bean porridge was highly acceptable and can be used as a partial replacement for *sosoma.* Bean porridge is easy to prepare and requires

less energy, as the powder is already cooked. Bean porridge is highly nutritious and can be eaten by persons of all ages.

Relationships of single kernel characterization system variables and milling quality and flour protein content in soft white winter wheats

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Single Kernel Characterization System (SKCS) was used to analyze 222 soft winter wheat samples harvested in 2005 and 2006 in Oregon. Among SKCS characteristics, kernel diameter had significant correlations with flour yield (FY, $r = 0.675$, $P < 0.001$), and flour protein content (FPC, $r = –0.565$, $P < 0.001$). Hardness index had significant correlations with break flour yield (BFY, $r = –0.424$, $P < 0.001$). Crush length was significantly correlated with FY ($r = 0.678$, $P < 0.001$), BFY ($r = 0.274$, $P < 0.001$), and FPC ($r = –0.572$, $P < 0.001$). Variables were also estimated by rheological interpretation of kernel crushing-response profile (CRP) data. The CRP (740 data points), Dy-histogram (101 data points), and conductance profile (147 data points) were obtained for each wheat sample and simple linear correlation coefficients were calculated with FY, BFY, and FPC. The CRP data point that showed the highest crushing force of kernel was significantly correlated with FY ($r = 0.669$, $P < 0.001$), BFY ($r = 0.336$, $P < 0.001$), and FPC ($r = –0.610$, $P < 0.001$). CRP force values around shell and endosperm collapse points had significant positive correlations with FY and BFY and negative correlations with FPC. Among CRP values, FY had a most significant correlation with 402th point ($r = 0.67$, $P < 0.001$), BFY with 23rd point ($r = 0.27$, $P < 0.001$), and FPC with 383rd point ($r = –0.53$, $P < 0.001$). Multivariate analyses were applied to develop prediction models of FY, BFY, and FPC, using SKCS variables. For calibration of model, 144 samples were randomly selected and the remaining 78 samples were used for validation. Calibration models showed R^2 value of 0.662, 0.466, and 0.712 for FY, BFY, and FPC, respectively. Validation showed R^2 value of 0.568, 0.556, and 0.665 for the same quality characteristics. These results suggest that SKCS could be applied for milling quality and protein content evaluation in soft wheat breeding program.

Stability of sorghum 3-deoxyanthocyanin-pyruvate complexes against SO_2 bleaching

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The degradation of anthocyanins by food additives like SO_2 limits their use as natural food colorants. The rare 3-deoxyanthocyanins from sorghum are relatively stable compared to other anthocyanins. The stability of six 3-deoxyanthocyanidin standards (apigeninidin, luteolinidin, 5-methoxyapigeninidin, 7-methoxyapigeninidin, 5,7-dimethoxyapigeninidin, and 5,7-dimethoxyluteolinidin) and crude black sorghum pigment extract against SO_2 bleaching at pH 2.6 was measured in the presence (50:1 molar ratio) or absence of pyruvate (which is known to increase the stability of anthocyanins in wine). Samples were incubated at 37°C for 5 days to synthesize the pyruvate adducts, and their SO_2 bleaching resistance investigated at 60ppm using a Shimadzu UV-1650PC spectrophotometer. Non-pyruvated samples were the controls. In absence of pyruvate, the non-methoxylated forms were more stable (15.25–23.13% color retention), than the methoxylated forms (3.44–10.40% color retention). The black sorghum extract sample was the least affected (68.50% color retention) at 60ppm SO_2 concentration. Addition of pyruvate significantly improved the stability of 3-deoxyanthocyanins against SO_2 bleaching. The non-methoxylated forms were more stable (77.72–84.64% color retention) at maximum SO_2 concentration (60 ppm), than their methoxylated forms (57.15–68.36% color retention). Black sorghum extract sample was the most stable (88.43% color retention). HPLC analysis confirmed the formation of these more stable 3-deoxy-pyruvate adducts at approximately 10% conversion. Crude sorghum pigments are more stable to SO_2 bleaching than the 3-deoxyanthocyanin standards. Pyruvate complexation with the sorghum 3-deoxyanthocyanins significantly improved their stability against bleaching.

Flour properties related to acid requirements for long life noodles processing

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The shelf life of boiled noodles can be significantly extended by dipping noodles in dilute organic acid, since microorganism is much less active in acid environment (pH<4.5). Excessive addition of acid, however, will affect the taste of noodles. It would be ideal that the pH of noodles can be adjusted to 4.5 or below with least amount of acid. Results of this study showed that the requirements of organic acid to low the pH of boiled noodles depend on the flour refinement and original wheat types. Five classes of wheat were examined. Western White requires least amount of acid, followed by Australia Standard White and US Hard Red Winter. Dark Northern Spring and Canada Western Red Spring need most amount of acid to adjust noodles pH to 4.5. It was found that refined lower ash flour requires less acid to adjust noodle pH than higher ash flour milled from same wheat. Protein content did not play a significant role in acid requirements, while addition of starch appears to have some impacts. Results of this study suggested that less acid is needed to adjust pH of long life noodles by using low ash flours milled from selected wheat classes.

High throughput separation and quantification of high-molecular-weight glutenin subunits

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Knowledge of glutenin-subunit composition is important for the prediction of the genetic potential of breeding lines because these polypeptides are known to be responsible for the main differences in breadmaking quality. High-molecular-weight glutenin subunits (HMW-GS) which are especially important for quality screening were commonly identified by SDS gel electrophoresis, reversed-phase high-performance chromatography (RP-HPLC) or capillary electrophoresis. Even if automatic sampling improves the efficiency of these techniques, high throughput analytic procedure must be developed. In this sudy, the use of a new Lab-on-Chip platform has been explored for a high speed qualitative and quantitative analysis of HMW-GS. 130 French common wheat varieties were used for the identification and the allocation of individual HMW-GS to Lab-on-a-Chip profiles. Furthermore, all the HMW-GS were individually quantified for genotype comparaison. As shows it the results obtained, the Lab-on-a-Chip platform used offers a unique high throughput (a 96 well plate can be analysed in a little over one hour) procedure with high resolution and high sensitivity. The microfluidic chips we evaluated appeared highy reproducible. This high throughput method appears to be extremely well suited for routine identification and quantification of HMW-GS especially for puposes of wheat quality screening and wheat cultivar development activities where large numbers of samples are typically encountered.

Physicochemical and technological properties of resistant starch obtained by autoclave

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Cereal Foods World 52:A55

The resistant starch (RS), which does not interfere with the food color, aroma or flavor, has the same therapeutic function as fiber. The aim of this study was to obtain RS of corn starch using an autoclave with the following process variations: cooking/cooling cycle (4 -10) and starch: water proportion (1:4 - 1:10), and to analyze the technological and physicochemical properties of the RS obtained. The response surface methodology (RSM) was used to optimize the process to obtain the best conditions for the production of RS. In the region of maximum productivity, it was evaluated the RS yield, the water solubility index (WSI), the water holding capacity (WHC), color (L*, hue and tone), viscosity, infrared absorption (IA), differential scanning calorimetry (DSC) and x-ray diffraction. The sample with the greatest amount of RS was compared with the native corn starch (NCS) and with a commercial resistant starch, brand *HI Maize 260*. The results showed that the autoclave processed starch with the greatest RS content (31.5%) was obtained using 7 cooking/cooling cycles and a 1:6 starch:water proportion. The process to which it was submitted caused different alterations in the physicochemical and technological characteristics when compared to NCS and *HI Maize 260*, such as an increased of WSI, WHC and cold paste formation, which are factors that are favorable to the application of this processed RS in instant products like soups and creams, although the color parameters L*, hue and tone indicated a yellowish product. The IA, x-ray diffraction and DSC analyses showed that the gelatinized starches produced in the microwave oven, containing 31.5% RS, presented structures similar to those of *HI Maize 260*, with no band alterations or structural pattern changes in IA.

The sustained release properties of chemically modified starches

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Biopolymers present a great potential in controlled release applications such as delivery of nutraceuticals because of their availability, biocompatibility,

and biodegradability. Among them, starch is the most widely used biopolymer because it can be readily modified to possess distinct functionality. This study attempted to understand the effects of starch source and modification on the controlled release properties of the resultant modified starches. Waxy corn, 70% high amylose corn, and potato starches were cross-linked at three levels and substituted with carboxyl and amino groups at two levels. Sodium benzoate and propranolol hydrochloride were used as the model drugs. The results showed that the type of starch played a major role in controlling drug release with potato starch displaying better controlled release property. The amylose content in corn starch predominantly determined the degree of cross-linking required to create a satisfactory matrix for controlled drug release. High amylose corn starch required a higher level of cross-linking than waxy corn starch for better release property. The highly branched amylopectin forms a strong and viscous matrix to sustain drug release. In contrast, the essentially linear nature of amylose could not support the formation of a network structure to better sustain drug release unless amylose molecules were extensively cross-linked. Substitution type and level showed a main effect on drug release. The drug release was very dependent on drug type. The release of sodium benzoate was independent of the matrix, whereas the release of propranolol hydrochloride varied significantly with the type of matrix. The study demonstrates that it is possible to produce satisfactory controlled release matrices from different starch types when combined with different modification conditions.

Slow enzyme digestibility of intact marrowfat pea cells and the importance of the integrity of cell walls

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Cereal Foods World 52:A56

Production of foods with lower glycemic indexes requires an understanding of why different starchy matrices digest at different rates. Isolated intact cells from marrowfat peas were used as a model plant cell system. Isolation conditions were determined to give good cell separation, whilst retaining some starch integrity. Isolated cells had enthalpies of 8.3 ± 0.7 J per gram of starch. A control was created by crushing intact cells, thereby destroying their cellular integrity. *In-vitro* starch amylase digestibilities, using both the Bernfeld and Englyst methods, showed that intact plant cells had significantly lower initial digestion rates compared with their controls. The majority of these assays were performed following a heat treatment of the samples (100°C for 40 minutes in excess water), thus making the model system relevant to domestic and industrial food applications. Variation between surface area, amylose leaching and the amount of starch cook in the pea cells and their controls could not explain the major differences in their digestibility. The dominant factor was the presence of intact cell walls. This conclusion came from a test measuring alpha-amylase depletion, where the intact cells excluded more alpha-amylase compared to crushed cells. To assess the effect of cell walls more directly, confocal scanning light microscopy with an acridine orange dye was used. Enzymatic starch hydrolysis inside a cell was visualised in real-time. Greater loss of starch was observed in the proximity of the breaches in the cell wall. Also the rate of hydrolysis within cells, once started, was much higher than that occurring at an intact edge of the cell. Therefore, cell walls of the intact cells act as a barrier to alpha-amylase and are essential for delayed starch digestion, and this gives the potential to provide low GI.

Production of bread enriched with commercial starch high in resistant starch

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Resistant starch (RS) offers an exciting new potential as a food ingredient. It has been shown to possess physiological benefits similar to dietary fiber. The current work investigates the incorporation of three different commercial starches (Hylon VII, Novelose330 and CrystaLean), known to be high in RS content, into bread formulation at three different addition levels (10, 20, and 30%) and evaluates their effects both on the properties and RS content of the breads. Bread samples were prepared according to AACCI Method 10-10B (AACC International 2000) using a hard wheat variety. Bread-firmness (N) and bread-quality parameters (crust color, crumb color, crumb cell structure and external appearance-symmetry) were determined. RS contents of commercial starch, flour and bread samples were measured using the Megazyme RS Kit according to Approved Method 32-40 (AACC International 2000). Starch-supplemented doughs were weaker and absorbed more water than doughs made from the base flour. RS contents of starch-supplemented breads increased significantly as the starch addition level increased. The commercial starches used did not have substantial deteriorative effect on crumb color values, external appearance, nor on symmetry of bread loaves. The starch-supplemented breads had better crumb cell structure than the control bread at 10 and 20% addition levels for each starch sample. Crust color values decreased at 30% addition level for Novelose and CrystaLean and above 10% addition level for Hylon VII supplementation. Loaf volumes of the breads decreased above 10% level for Novelose and above 20% level for Hylon VII and CrystaLean supplementation. Firmness of the breads increased above 10% level for Novelose and above 20% level for Hylon VII and CrystaLean supplementation.

Fracture behaviour of biopolymer films prepared from aqueous solutions

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In order to investigate the mechanism of fracture and crack propagation which occurs in solid biopolymer systems and their dependence on the water content, the fracture behaviour of cassava starch, gelatin and hydroxypropyl cellulose (HPC) films was studied and compared. The biopolymer films were prepared by casting from aqueous solutions and subsequent drying under relative humidity and temperature controlled conditions (18°C-50%RH). To calculate the speed of crack propagation, double-edge and single-edge notched (DENT and SENT respectively) specimens were submitted to tensile test while filmed with a high speed camera system Photron Ultima APX (6,000 fps). The pictures were synchronised with the displacement-load curve obtained from tensile tests. To evaluate the effect of water on the ductile-brittle transition of biopolymer films, the tensile tests were performed on the DENT and SENT specimens with different water contents. The brittle-ductile transition was evaluated via the length ratio of the stable and unstable crack propagation that was calculated for the three biopolymer systems. It was clearly demonstrated that despite the brittle behaviour of most of the starch films, the cassava starch films prepared from the aqueous solution without plasticizers can exhibit ductile fracture behaviour at high water content. Moreover, it was demonstrated that even at low water content the HPC films presented stable crack propagation. In contrast, the gelatin films did not exhibit ductile behaviour even at high water contents. The fracture behaviour of the biopolymer films was related to their structural particularities.

Food product development for Type II diabetics

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Diabetes mellitus is a heterogeneous metabolic syndrome with several different causes characterized by chronic hyperglycaemia with partial or total lack of insulin secretion and a reduced sensitivity to the hormone in peripheral tissues. The worldwide number of people with diabetes is expected to double in 30 years, increasing from 171 million in 2000 to 366 million in 2030. Diabetes mellitus classified on the basis of both *clinical stages* and *aetiological* and other categories of hyperglycaemia had been also adopted as standard and included in a report by World Health Organisation (WHO). American Diabetes Association recommendations on nutritional requirements for diabetes are similar to that of European Association for Study of Diabetes (EASD) which advises an intake of 60–70% of daily energy from carbohydrates (with sucrose intake limited to 10% of total energy) and 10% energy from fats with intake of saturated fats limited to 7%. The remaining 15–20% of energy requirement is satisfied by protein, dietary intake of fiber is encouraged and salt intake is limited to less than 6 g/day. The major objective of the medical nutrition therapy in the persons with diabetes is maintenance of optimal nutrition to fulfill the basic nutritional requirement for health, growth and development. A food product developed for diabetics prevent hypoglycemia or reduce postprandial hyperglycemia and reduces risk factors for development of diabetes complication due to presence of active food components. These food products commonly termed as functional foods, neutraceutical foods or medical food products are growing in number as they are formulated to address the nutrition concern of the people with diabetes or abnormal glucose tolerance. Different type of food products have been developed for diabetics viz. bars, beverages, breads, confectionary, chocolate, dessert, jam, biscuits, pasta products, traditional products like pongal. Some other categories of food products for diabetics which contain some bioactive component are categorized in the category of functional foods. These food products mainly include resistant starch, added fiber, added vitamins and minerals, flavones, saponins, antioxidants, fatty acids etc. The information available on diabetic food products is scarce and scattered. Therefore efforts are made to collect the available research information on the food products together to give an idea about diabetic food products, approach for their formulation, their functional features and mechanism of these functional elements and bioactive in diabetics.

The relationship between different biotypes and protein composition of hard red winter wheat flours and their affect on alkaline noodle color and texture

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Twenty-five samples of biotypes derived from two hard red winter wheat (HRW) cultivars, Centurk and OK102, were grown in a randomized complete block design at Mead, NE. The biotypes varied in their high molecular weight glutenin subunit (HMW-GS) composition with five different HMW-GS allelic combinations present across the samples (2*, 7 + 8, 2 + 12; 2*, 7 + 9, 2 + 12; 2*, 6* + 8*, 3 + 12; 2*, 6* + 8*, 5 + 10; and 2*, 7 + 9, 5 + 10). These lines were selected to determine the relationship between HMW-GS and protein composition on color and texture of alkaline noodles. Protein composition, including insoluble polymeric protein (IPP), soluble polymeric protein (SPP), gliadin, and albumin and globulin (AG) was found to vary significantly between the various HMW-GS combinations. Flour protein content was not significantly different between the various sets, however. For mixograph mixing time, 83.6% of the variation among the samples was explained by HMW-GS composition, while 89.0% of the mixing tolerance variation was. Most noodle color traits were not significantly affected by HMW-GS groups except for *a* and *b* values at 24 hr after production. For cooked noodle texture, water uptake was significantly affected by HMW-GS groups but cooking loss was not. Noodle texture profiles including hardness, springiness, chewiness, resilience, cohesiveness, and adhesiveness were significantly affected by HMW-GS types. Overall protein composition was significantly correlated with noodle texture: SPP % was positively correlated with hardness ($r = 0.83$, $P < 0.0001$) and negatively with springiness ($r = –0.77$, $P < 0.0001$), resilience ($r = –0.76$, $P < 0.0001$), and adhesiveness ($r = –0.44$, $P < 0.05$), whereas IPP% was negatively correlated with hardness ($r = –0.74$, $P < 0.0001$). Protein composition was also significantly correlated with cooking water uptake and noodle color.

Starch granule size distribution of hard red winter and hard red spring wheat: Their relationship to wheat, flour and breadmaking quality

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Starch constitutes the greatest weight portion of the wheat endosperm (65–75%), and contributes its own unique functional qualities such as texture, volume, consistency, aesthetics, moisture, and shelf stability to various baked products. Starch was isolated from 98 hard red winter wheats (HRW) and 100 hard red spring wheats (HRS). Granule size/volume distributions of the isolated starches were analyzed using a laser diffraction particle size analyzer. The distributions were compared and contrasted between the two classes, and correlations (r) compared to various quality parameters. There were significant differences in the bimodal size distribution between HRW and HRS. Starch granules (< 10 micrometer in diameter) occupied volumes in the range 28.5–49.1% for HRW (mean, 39.9%) while HRS starch granules occupied volumes in the range 37.1–56.2% (mean, 47.3%). The mean granule sizes of the distribution peaks less than 10 micrometer in diameter also showed a significant difference (HRW, 4.32 vs. HRS, 4.49 micrometer), but the mean sizes of the distribution peaks larger than 10 micrometer were not significantly different (21.54 vs. 21.47 micrometer). Numerous wheat, flour, and breadmaking quality traits also showed significant correlation to starch size distributions. Most notably, the total volume between 10 and 20 micrometer showed high correlation to loaf volume for HRW ($r = 0.498$, $P < 0.0001$) and HRS ($r = 0.710$, $P < 0.0001$).

Ingredient optimization of Sulgidduk, a Korean rice cake, with added barley sproutling using graphical and mathematical analytical tools

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A barley grass sproutling that is abundant in various vitamins and minerals was added to the *Sulgidduk* in the form of freeze-dried powder to improve the functional and nutritional densities of the product. For the preparatory recipe of the product, ratio of the major ingredients including water, barley sproutling, and sugar was optimally designed using statistical- and methematical analysis tools. The experiment was designed according to the D-optimal design of mixtures, showing 14 experimental points including 4 replicates for three independent variables (water 15~22%, barley sproutling powder 1~4%, and sugar 12~19%). The canonical form and trace plot showed the physico-chemical and organoleptic quality of the *Sulgidduk* product as influenced by the reciprocal action of each ingredient. Among response variables, the textural hardness, gumminess, and chewiness were significantly lowered ($P < 0.05$) according to the ratios of the added barley. At the same time, the decreases in the Hunter colorimetric lightness (L) and redness (a) values were also noted while yellowness (b) was oppositely raised as influenced by the brown tint of the dried barley. The sensory analysis result showed that the overall acceptability of the *Sulgidduk* was increasing with added barley sproutling up to 2% (w/w) levels. The optimum formulation obtained by both numerical and graphical methods showed the similar results as follows: water 18.2%, barley sproutling powder 2.0%, and sugar 14.8% against rice powder for ideal *Sulgidduk*, the most popular rice cake in Korea.

Effects of gluten incorporation on processing, cooking and textural properties of white salted noodles

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Wheat flour protein forms a continuous network during mixing and sheeting, making it possible to produce long, slender, unbroken strands of noodles. Protein also influences cooking and textural properties of Asian noodles. The effects of protein quantity and quality on noodle processing, cooking and textural properties have been indirectly estimated using wheat flours of various content and quality. To systematically and directly determine the role of gluten proteins in making noodles, 2–6% commercial gluten was incorporated into a hard and a soft white flour by replacement and used to determine the effects of added gluten on dough mixing and sheeting, cooking and noodle texture. Gluten incorporation (6%) decreased water absorption for making noodles by 3%, shortened the length of the dough sheet by 8 cm and increased the thickness of the dough sheet by 0.3–0.4 mm. Noodles imbibed less water and more slowly during cooking with gluten incorporation, which resulted in 3 min increase in cooking time in both soft and hard wheat flour. Despite the extended cooking time by 3 min, noodles incorporated with 6% gluten exhibited decrease in cooking loss by 15% in soft wheat and by 2.9% in hard wheat flour. Tensile force of uncooked and cooked noodles as well as hardness of cooked noodles increased linearly with increase in gluten incorporation, regardless of cooking time and storage time after cooking. While hardness of cooked noodles either increased or showed no changes during storage for 4 hr, tensile strength of noodles decreased significantly with greater rate in noodles incorporated with gluten.

Stabilized rice bran - Nutritional value & its health benefits

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Cereal Foods World 52:A57

Rice bran with the germ comprises 8–10% of the weight of the rice kernel and accounts for 65% of the nutritional value of the rice kernel. The global production of rice is approximately 600 million metric tones and 60 million metric tones of nutrient rich rice bran and germ is available as an underutilized by product of the rice milling process. Rice bran becomes rancid within 48 hours of the milling process due to the presence of an enzyme called lipase. NutraCea's proprietary non chemical technology to stabilize rice bran prevents lipolytic hydrolysis and oxidation in rice bran. For the first time in human history this plethora of nutrient rich rice bran is available for mankind! with a guaranteed shelf life of 12 months for this rich natural resource of nutrients. The nutritive value and the health benefits will be discussed.

Functional properties as affected by laboratory-scale parboiling of rough rice and brown rice

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Parboiling can be applied on either rough rice (RR) or brown rice (BR). The energy requirement for parboiling BR is lesser because of the removal of hull. This work compared the functional properties of parboiled rice prepared from RR and BR. Pre-soaked RR and BR from cultivars Bolivar, Cheniere, Dixiebelle, and Wells were parboiled under mild (20 min, 100°C, 0.0 kg/cm^2) and severe (25 min, 120°C, 1.0 kg/cm^2) laboratory-scale conditions. Head rice yield was lower for parboiled BR, particularly the batch subjected to mild parboiling. The head rice yield of parboiled rice samples from RR was comparable to that of a commercial sample and higher than the control (without parboiling). Parboiling resulted in lower head rice whiteness, lower apparent amylose content, and higher total lipids. Gelatinization temperature increased as a result of parboiling and the increase was higher for BR under the severe condition. Paste peak and breakdown viscosities were lower for BR than RR, and for severe than mild condition. Percentage gelatinized starch was higher for the parboiled rice from BR than the RR counterpart. The pasting and thermal properties of the laboratory-parboiled samples were

different from those of the commercial sample. Cultivar differences in parboiled rice functional properties were evident.

Cooked rice hardness and stickiness as affected by grain composition and structure of leached materials during cooking

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Cluster, correlation, and multivariate regression analyses were used to rationalize the effects of grain chemical composition and leached material fine structure on cooked rice texture by studying 23 U.S. long-grain cultivars. Cooked rice hardness and stickiness were measured with a texture analyzer. The amylose-amylopectin ratio (AAR) of the leached material during cooking was determined by high-performance size-exclusion chromatography. Amylopectin fine structure was characterized by high-performance anion-exchange chromatography with pulsed amperometric detection. Head rice composition was evaluated in terms of apparent amylose content, crude protein and surface lipids. Among the physicochemical variables evaluated, AAR was found to be an important determinant of cooked rice hardness and stickiness. Soft-cooking, high-amylose cultivars (e.g. Jodon and L-202) leached out more amylopectin than amylose (AAR<1). Dry-cooking, high-amylose cultivars (e.g. Newrex and L-205) leached out more amylose than amylopectin (AAR>1). Cultivar differences in leaching behavior were attributed to variations in apparent amylose content, crude protein, and amylopectin chain length distribution.

Gelatinization, swelling, and rice starch fine structure as affected by controlled surface peeling of granules in aqueous dimethyl sulfoxide

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Rice starch granules were peeled by surface gelatinization in aqueous dimethyl sulfoxide (DMSO) to better understand the effect of radial distribution in amylose and amylopectin on starch functional properties. Starches from waxy, low-amylose (Bengal), intermediate-amylose (Wells), and high-amylose rice (Dixiebelle) were subjected to three degrees of surface gelatinization (10–15%, 35–40%, and 70–75%) at 10–15°C with 90% DMSO. The gelatinized surface of the granules was removed by mechanical blending and the remaining granules were collected by centrifugation. Remaining granules were evaluated for swelling characteristics, thermal properties, amylose content, and amylopectin fine structure. Onset gelatinization temperature and gelatinization enthalpy decreased with increasing degree of surface removal, while gelatinization range, swelling power, and water solubility index increased. Amylopectin chain-length distribution changed minimally. Amylose content, amylopectin weight-average molar mass, and amylopectin z-average gyration radius tended to decrease as the degree of surface peeling was increased. These results are indicative of some differences in radial distribution of amylose and amylopectin from the periphery to the inner core of the granules.

Malt production from alternative cereals and lentils

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Cereal Foods World 52:A58

Only few publications mention alternative cereals and lentils for malt production and products made from those malts. Chemical and physical investigations on malts produced from seven raw materials (einkorn, emmer, purple wheat, amaranth, buckwheat, quinoa, and lentils) have been carried out. These raw materials show different unique properties. For instance emmer and einkorn have high protein and carotene contents, whereas the pseudocereals (amaranth, quinoa, and buckwheat) are very interesting due to their high protein quality, good fatty acid pattern, high content of minerals as well as their lack of gluten. Soaking, germination and kilning time were adapted to the different raw materials, which varied highly in degradation of starch. The results ranged from 4% (lentils) to 73.6% (einkorn). To evaluate the application of these malts for food production, blends of wheat flour with the different malt flours were used for the production of bread. The investigations showed that an addition of 5 and 10% of malt flour to wheat dough resulted in good tasting breads with interesting sensory and physical properties. Adapting the processing parameters and recipes could even improve the characteristics of breads with addition of malt flour from alternative cereals and lentils. These malts were also analyzed regarding their suitability for beer production. The analyzes showed that due to their low enzyme activity these malts alone are not suitable for the brewery process, but especially in combination with barley malt quinoa, buckwheat or purple wheat malt could offer interesting analytical and sensory properties.

Effect of high molecular weight glutenin subunits (HMW-GS) on wheat flour tortilla quality

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Tortillas are the most popular non-bread wheat based product. Flour used in tortilla production has been typically optimized for bread making. The flour properties that determine good quality bread do not necessarily provide good quality tortillas. In this study, the influence of high molecular weight glutenin subunits (HMW-GS) was investigated on tortilla quality. Two biotypes derived from the hard red winter wheat cultivar Centurk were used, which contained the following HMW-GS: 2*, 7 + 9, 2 + 12 and 2*, 7 + 9, 5 + 10. The flours were paired according to protein content of 10.02% (2 + 12) and 9.92% (5 + 10) in Group 1 and 10.30% (2 + 12) and 10.42% (5 + 10) in Group 2. Tortillas were prepared in a laboratory scale and analysis was carried out at days 0, 2, 4, 7 and 14. Diameter, rollability and textural properties using the TA-TX2 Texture Analyzer were determined. Tortilla diameter was statistically larger in tortillas made from low protein flour containing HMW-GS 2 + 12 ($P > 0.05$) among the four conditions. Independently of the protein content used, flour with subunits 5 + 10 showed a better overall rollability than flour with subunits 2 + 12. Texture analysis revealed no difference in tortilla stretchability among the flours. However, the Rupture Force (Fr) of tortillas was affected by flour protein content. When lower protein content was used, Fr was greater for tortillas made with HMW-GS 2 + 12, conversely, when higher protein content was used, Fr was greater for tortillas made with HMW-GS 5 + 10. These results indicated better tortillas were obtained with higher protein content flours containing HMW-GS 5 + 10.

Optimization of xanthan gum concentration in nixtamalized corn flours made by extrusion process: Effect on the rheological and textural properties of masa and tortilla

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The extrusion process could be an alternative one for the nixtamlized corn flour production. One advantage of this process is that not pollution is generated, main problem with the traditional nixtamalization process. However, tortillas made with corn flours obtained by extrusion became firmer and less flexible compared with traditional tortillas, and an alternative solution is to use gums. The objective of this research was to obtain the best combination of xanthan gum concentration, ground corn moisture content, and extruder temperature, to obtain extruded nixtamalized corn flour (ENCF), and to prepare corn tortillas with textural characteristics comparables to commercial tortillas. White corn was ground into grits, then mixed with lime (0.3% w/w), water and xhantan gum at different levels. The mixture was rested for 12 h, and extruded to obtain ENCF. The single screw extruder conditions were selected from factorial combinations of process factors: grits moisture content (H, 21.6–38.4%), xhantan gum concentration (XG, 0.16–0.85%), and extrusion temperature (ET, 103.2–136.8°C). Response surface methodology was applied as optimization technique on five response variables: water absorption of flours, masa viscoelastic characteristics (the storage modulus (G'), the loss modulus (G") and tan δ (G"/G')) evaluated with the dynamic test, and tortilla firmness. Contour plots of each response variables were used applying superposition surface methodology. The optimal variable combinations obtained were: H = 30.92%, GX = 0.61% and ET = 118.78°C. Tortillas from ENCF with XG had similar texture than those made with commercial nixtamalized corn flour.

Infrared heating and processing of whole Sorghum for use in RTE cereal bar

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Two sorghum varieties, sumac and white, were heated by a gas-fired infrared burner (Aluminous Gas Fired Infra Red Heater, Schwank Co.) and evaluated for potential use in a RTE cereal bar. The objective was to determine if infrared heating would sufficiently soften whole sorghum so it could be utilized in a RTE cereal bar containing rolled oats, nuts, and berries. Infrared heating partially gelatinized sorghum before eversion (popping). Infrared radiation penetrated the grain, excited water molecules, and caused rapid internal heating that increased water vapor pressure and molecular motion. This cooked the grain from inside out. Implementing sorghum in a RTE cereal bar improved nutritional attributes such as antioxidant activity, whole grains,

and fiber. Sensory attributes such as texture, appearance, color, and taste, were affected. Optimum moisture content, 50% prior to heating, and resonate time, 5 minutes, were determined. The use of gas-fired infrared burners softens whole sorghum so it can be implemented in a RTE cereal bar with acceptable texture.

Effect of enzymes and additives on the fracture behavior of bread crust

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Cereal Foods World 52:A59

Crispness is a relevant and complex attribute of baked products. Crispness behaviour is characterized by multiple fracture events accompanied by acoustic emission and low work of mastication on eating. In this study the influence of the formulation on crispness of bread crust was studied by using enzymes (amylase, lipase, glucose oxidase and xylanase) and additives (diacetyl-tartaric ester of mono- and diglycerides (DATEM) and hydroxypropyl methylcellulose (HPMC)). Instrumental crispness was evaluated by simultaneous analysis of the fracture behaviour and sound emission during breaking of the bread crust in the texture analyzer. Addition of lipase, amylase, glucose oxidase and HPMC improved crispness as they increased the number of force and sound events, which is indicative of higher crispness. The influence of the formulation water content and porosity of the crust were also studied because they are known to effect crispness and will be modified by the ingredients used during processing. All enzymes and additives used, with the exception of xylanase, decreased the water content of the crust and increased its porosity. Correlations between fracture parameters and water content and porosity were found (R^2 = 0.69 and 0.77, respectively). We will discuss if the observed positive effect of the enzymes and additives on the number of force and sound events is only due to an indirect effect via structure-water properties or if it is also caused by a direct effect of composition.

Relationship between structure and sensory perception of crispness of toasted rusk rolls

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Cereal Foods World 52:A59

Crispness is a salient textural attribute of toasted foods, which can be strongly related to food preference. Creation and retention of crispness is complex since several factors like water content, material properties (composition, physical properties of the components) and morphology affect crispiness. Moreover, sound emission during food crushing plays a key role in the perception of crispness. The aim of this work was to assess the effect of product morphology (coarse and fine crumb grain) and the modification of oral sound perception on sensory crispness grading of toasted rusk roll. In addition, the effect of water on the crispness of the toasted rusk rolls was studied by equilibrating the samples at relative humidities ranging from 30 to 80%. The sensory test showed that upon absorption of water the product became tough and soft and lost its crispness and consequently their acceptability by the consumer. The morphology of the product had a significant effect on crispness intensity. Products with a coarse crumb grain were rated as crispier by the panelists. The importance of the way in which the acoustic emission was perceived for sensory grading was also investigated. Sound emitted during eating a product is conducted via air, bones and soft tissues to the auditory organs. In this work the relevance of the air conducted sound was studied by neutralizing this contribution by using headphones that blocked the conduction of the air conducted sound to the auditory organs. The sensory test showed that the panelists rating of crispness was not significantly affected by the use of headphones. This shows that air conducted sounds are not essential for the grading of crispness.

Extrusion and characterization of starch films

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The objective of this study was to examine how corn starch functions as a thermoplastic, and how the properties of films made from it are affected by the content of starch and plasticizers. Granulated starch, at 45 to 55% by weight, was blended with glycerol and stearic acid, and extruded into films in a conical twin-screw Brabender laboratory scale extruder. The moisture, glycerol and stearic acid contents in the samples ranged from 9 to 24%, 20 to 50%, and 0 to 1%, respectively. The temperature profile of the extruder barrel was set at 50-120-120-120°C, while the screw speed was maintained at 45 rpm. The ingredients were extruded/sheeted into films of about 0.40 mm thick and 100 mm wide using a ribbon die. The films were dried on trays for 72 h and sampled. Films processed with less than 30% glycerol were brittle after drying. The films were conditioned at 50% RH and 23°C for 48 h, and tested for tensile strength, elongation at break and elastic modulus. The tensile stress at maximum load and the tensile strain at break were in the range of 0.39 to 2.75 MPa and 42 to 91%, respectively. The effects of starch, moisture, glycerol and stearic acid contents on the mechanical properties of films were investigated. Both glycerol and stearic acid functioned as good plasticizers for the films, and had significant effects on the mechanical properties of the films. To study the crystallinity of the extruded starch-films, selected samples were exposed to X-ray beams with a 2θ angle ranging from 5 to 35°. The plot of relative intensity versus 2θ showed two prominent peaks at 13-14° and 20-21°, respectively. However, the intensity of the crystalline peaks varied with the amounts of plasticizer and starch present in the samples. The crystallinities of the starch-films were reduced as the plasticizer content was increased. Conversely, the crystallinity of the starch-films increased with an increase in starch content.

Phenolic content and antioxidant activity of natural colored quinoa (*Ch. quinoa*), amaranth (*A. caudatus*) and cañihua (*Ch. pallidicaule*) grains

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Quinoa, amaranth and cañihua are pseudocereals grown in the Andean highlands. Besides their nutritional value, these Andean crops could be a source of functional compounds. Commercial grains of these crops are generally cream color, however, also occur in diverse shades of yellow or reddish colors. Color of quinoa grains (n = 6), expressed in CIELab color scale, was L* 18.3-63.5, a* 8.1-20.6 and b* 3.6-42.4; in amaranth grains (n = 5) was L* 19.5-49.4, a* 3.3-15.7 and b* 3.0-26.6; and in cañihua grains (n = 5) was L* 35.2-57.2, a* 3.1-13.5 and b* 12.0-28.8. Pigments in quinoa and cañihua were betalains as determined by spectra and acid-boiling and alkaline tests. Hydrophilic extracts were obtained by extraction with acetone:water (70:30) for 1hr x 2. Phenolic content in quinoa, amaranth and cañihua was 1.2-3.9, 0.6-0.9 and 2.4-3.5 mg gallic acid equivalent (GAE)/ g flour db, respectively. Tannin content, measured by the vanillin-HCl assay and expressed as mg catechin equivalent/ g flour db, was 0.14-1.98, 0.19-0.43 and 0.72-1.52 in quinoa, amaranth and cañihua, respectively. Antioxidant activity, measured by oxygen radical antioxidant capacity, was in quinoa 34.5-99.0, in amaranth 14.7-20.4 and in cañihua 49.7-82.0 μmoles trolox equivalent/g flour db. Grain cultivars with the highest phenolic content were tested for their capacity to inhibit peroxyl radical-induced oxidation of LDL initiated by 2,2'-Azobis (2-amidino-propane)-dihydrochloride descomposition. The IC50 concentration to prevent the oxidation of LDL was 15.5 μM for quinoa and 20.8 μM for cañihua. Amaranth extract appeared to inhibit LDL oxidation only up to 20% at 1 μM. Natural colored quinoa grains showed the highest variability in grain color as well phenolic content and antioxidant activity.

Fractionation and characterization of beta-glucan from rye whole meal

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There is continued interest in cereal beta-glucan because of its physiological effects and potential importance as an ingredient for the functional food industry. It has been clearly demonstrated that attenuation of blood glucose and insulin levels are viscosity related, and increased intestinal viscosity is also believed to be important for lowering serum cholesterol levels. Rheology of beta-glucan depends on molecular weight (MW), structure, and concentration in solution, and in complex foods may also depend on other components. The main non-starch polysaccharide of rye is arabinoxylan (AX), but rye contains significant levels of beta-glucan which unlike oat and barley beta-glucan is not readily extracted by water possibly because of entrapment within a matrix of AX cross-linked by phenolics. This study continues objectives to improve understanding of factors controlling the physicochemical behaviour of the cereal beta-glucans. Increasing concentrations of ammonium sulphate were used to separate beta-glucan from arabinoxylan and prepare a series of narrow MW distribution fractions. Composition and structural characteristics of the isolated crude beta-glucan and the eight fractions were determined using flow-injection analysis, and High Performance Size-Exclusion Chromatography (HPSEC) exploiting dye binding for detection, and HPSEC with the Viscotek triple detection system. Lichenase digestion followed by High Performance Anion Exchange Chromatography of released oligosaccharides was used for structural evaluation. Rye beta-glucan seems to be of lower MW than oat or barley beta-glucan but higher than wheat beta-glucan, and at about 1.3 million is much higher than previously published values. However, it proved very difficult to isolate a product of both high MW and high purity. The overall structure was

similar to barley beta-glucan and no structural heterogeneity was detected among fractions.

Effect of lyophilized jumbo squid (*Dosidicus gigas*) fin and mantle muscle on dough properties and bread making performance of a commercial wheat flour

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The effects of adding 2.5 and 5% of lyophilized jumbo squid (*Dosidicus gigas*) fin (JSF) and mantle muscle (JSM) on dough properties and baking performance of wheat flour were studied. Dough maximum resistance to extension (Rmax), extensibility (Ext), and deformation work (Area) at 45-min resting time were evaluated with a texture analyzer TA-XT2. Baking performance was evaluated by the straight dough baking procedure using 35 g of flour. Loaf volume was measured by the rapeseed displacement method. Acceptability of bread loaves was evaluated by an untrained sensory panel. Addition of 2.5% JSF tripled ($P \leq 0.05$) Rmax vs. control dough (i.e. 118.9 ± 6.4 vs. 40.6 ± 6.3), while 5% addition either JSF or JSM double it ($P \leq 0.05$). Ext decreased ($P \leq 0.05$) by addition of lyophilized powders. As animal protein was increased Ext decreased (i.e., 6.6 ± 0.5 for control vs. 4.0 ± 0.1 and 2.7 ± 0.2 for 2.5 and 5% JSF respectively; JSM showed similar results). However, 2.5% JSF or JSM addition increased Area ($P \leq 0.05$) 2.4 and 1.8 times that of control, respectively. Specific loaf volume (loaf volume/loaf weight) showed no significant ($P > 0.05$) difference vs. control; however, an inverse relationship was observed as animal protein was added. Sensory results showed that samples with lower level of addition were very close to control, suggesting this concentration (2.5%) could be used for this type of product.

Effect of addition of gums and polyols on tortilla stickiness

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Tortilla stickiness is undesirable for the tortilla and the food service industry. Difficulty in separating individual tortillas affects the consumer acceptance of these products. We have devised strategies to reduce the stickiness and surface energy of flour tortillas by adding GRAS ingredients. Tortillas were prepared with a variety of GRAS ingredients that favorably compete for water. Xanthan gum, carboxymethylcellulose (CMC), glycerol and propylene glycol were added individually and in combination to the tortillas. Instrumental stickiness of tortillas was measured using the TAXT2i texture analyzer. These results were linked to the surface chemistry of tortillas by contact angle measurements (VCAoptima Dynamic Contact Angle and Surface Tension System). We used differential scanning calorimetry (DSC) to determine the freezable water present, mechanical spectroscopy to characterize the phase behavior, and wide-angle x-ray scattering (WAXS) to understand the effect of crystallinity. Addition of gums and polyols, alone and in combination, to the formula made the dough more pliable and machinable. Tortillas containing gums and glycerol showed increased water retention, decreased water activity, and low freezable water. Addition of glycerol significantly reduced the water activity from 0.94 to 0.91. A lower glass transition temperature was observed when tortillas were made using polyols. Addition of gum and glycerol showed a reduction in the surface free energy, mainly the polar component, and reduced instrumental stickiness in tortillas. Understanding the effect of the addition of gums and polyols in controlling tortilla stickiness will provide the tortilla industry with new and useful tools to formulate and produce flour tortillas with reduced stickiness.

Effect of processing conditions on tortilla stickiness

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Tortilla stickiness is an undesirable attribute. Our goal was to understand the effect of processing conditions on tortilla surface energy and stickiness. To evaluate the influence of processing conditions on stickiness, tortillas were prepared using different combinations of dough resting times (10 and 20 min), baking temperatures (350 and 450°F) and cooling times after baking (2, 5, and 10 min). Instrumental stickiness of tortillas was measured using the TAXT2i texture analyzer. These results were linked to the surface chemistry of tortillas by contact angle measurements (VCAoptima Dynamic Contact Angle and Surface Tension System). We used differential scanning calorimetry (DSC) to determine the freezable water present, mechanical spectroscopy to characterize the phase behavior, and wide-angle x-ray scattering (WAXS) to understand the effect of crystallinity. A higher dough resting time allowed the dough to retain more moisture and subsequently increased the water activity and stickiness in tortilla. More freezable water was found in tortillas with a shorter dough resting time (10 min). Higher baking temperature, dough resting time and tortilla cooling time showed reduced relative crystallinity in tortilla. Tortillas baked at 450°F had higher total surface energy, mainly the polar component, and were stickier than tortillas baked at 350°F. A cooling time of 5 min was found to be more effective in controlling tortilla moisture content. Tortillas cooled for 5 min after baking had the lowest surface energies and were less sticky compared to tortillas cooled for 2 and 10 min. Recognizing the effect of processing conditions on tortilla stickiness will offer the tortilla industry novel and practical processing methods.

Effect of processing conditions on tortilla texture

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Tortilla texture is an integral component of tortilla quality. In fact, it governs consumer acceptance of tortilla products. To understand the effect of processing conditions on tortilla texture tortillas were prepared using different combinations of dough resting times (10 and 20min), baking temperatures (350 and 450°F) and cooling times after baking (2, 5 and 10min). Objective texture analyses were performed based on the tortilla burst rig test using a TAXT2i texture analyzer. The force and distance to break, toughness and elasticity were measured by the Texture Expert Exceed™ software and used as indicators of ultimate failure properties. Results were reported for a minimum of 10 replicates. Tortillas baked at a higher temperature (450°F) showed higher tortilla rupture force as compared to a lower temperature (350°F). Lower dough resting time (10 min) was found to increase tortilla rupture force. A dough resting time of 10 min showed higher tortilla resilience compared to 20 min. Tortillas with a resting time of 20 min showed reduced toughness. Increasing tortilla cooling time increased the rupture distance and toughness. A baking temperature of 450°F increased the value of the gradient for tortillas as compared to 350°F. Appreciation of the relation between tortilla texture and process parameters is important to produce the most desirable tortilla products. This understanding will give manufacturers the ability to create tortillas with the most favorable characteristics.

Effect of storage time and temperature on tortilla texture

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Texture affects the consumer acceptance of any food product. Storage time and temperature determine the freshness of all food products. In this study we tried to measure the effect of storage time and temperature on tortilla texture. Tortillas were prepared using the modified Bello et al method. Samples were packaged and stored at three different temperatures: room temperature (22 ± 1°C); freezer temperature (-19 ± 1°C); and refrigeration temperature (3 ± 1°C). Samples were analyzed after 5 days, 20 days, one month and 2 month of storage. TAXT2i texture analyzer was used to measure extensibility, tensile force and gradient value of tortillas. Tortillas stored at lower temperatures were thawed at room temperature (22 ± 1°C) for 5 hours before testing. Minimum of ten tests were performed and the results were reported. Extensibility was highest when tortillas were stored at freezer temperature. An increase in storage temperature and time showed reduced extensibility. Tortillas retrograded within 5 days when stored at room temperature. The extensibility value showed a sharp decline after one month of tortilla storage at freezer temperature. The force required to extend tortillas was lowest for tortillas stored at freezer temperature and highest for tortillas stored at room temperature. The rupture force value increased with extent of storage. Tortillas stored at freezer and refrigeration temperatures retained freshness which reflected with lower rupture force values. The gradient value increased with an increase in temperature and extent of storage. Highest gradient value was observed for tortillas stored at room temperature for 2 months. This tortilla self life study will help tortilla industry to select best tortilla storage conditions. It will also help them to predict the changes in tortilla texture with respect to storage time and temperature.

Measuring Dextrose Equivalents (DE) of liquefied slurry in dry grind corn process using Near-Infrared Spectroscopy

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Liquefaction is a unit operation in the dry grind corn-to-ethanol process, in which starch is broken down into lower molecular weight polymers using alpha amylase enzyme. The extent to which starch is hydrolyzed, during liquefaction dictates the amount of work left for other enzymes namely glucoamylase to convert dextrins into glucose. Glucose is then converted into ethanol by anaerobic fermentation by yeast. Dextrose Equivalent (DE) measures the number of reducing ends present in a sample as compared to that

of a standard glucose solution by means of a chemical assay. As the liquefaction process progresses the number of reducing ends increases due to hydrolysis of alpha 1-4 bonds in starch molecules. Thus, DE values indicate the extent to which starch is hydrolyzed into lower molecular polymers. Typically in a dry grind corn process a DE value of 12 to14 is achieved after liquefaction. DE values higher than 14 can be achieved with a higher enzyme dose. However, DE values higher than 14 do not translate into higher ethanol yields. Thus, DE values are used in a dry grind process to optimize the amount of alpha amylase required in liquefaction. Measurement of DE by chemical assays is a tedious and time consuming process which involves diluting, heating and cooling of samples prior to titration. In this study feasibility of building a calibration on a Fourier Transform Near-Infrared (FT-NIR) spectrometer to measure DE values for liquefied corn slurry was evaluated. Ten hybrids were liquefied for 3 hr with different amounts of enzymes (25, 50, 100 and 200 microliters/ 50 gm corn flour) to obtain DE values ranging from 5 to 25. Aliquots of liquefied slurry were obtained at different times (1, 2 and 3 hr) for DE measurement. Partial Least Squares (PLS) and Principal Component Regression (PCR) methods were used for building the calibration.

A differential scanning calorimetric (DSC) study of native starch phase transitions

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DSC has long been used as the preferred technique to investigate starch gelatinization and phase transition characteristics. Recent studies have shown that starch phase transitions, especially at low temperatures or in the initial phases of gelatinization, involve more complex processes than what is hypothesized by the order-to-disorder transition theory. The objective of this study was to investigate changes in starch characteristics, detectable by DSC, at specific temperatures during gelatinization. DSC was used to both apply thermal treatments and to immediately analyze treated samples; this minimizes the effects caused by delays between treatments and analyses. Native starch samples (regular corn, rice, potato and cassava) were hermetically sealed in DSC pans with excess water (~10 mg starch in ~55 µL water). Sealed pans were then heated for 30 min at specific temperatures (from 35 to 90°C; i. e., 35, 40, 45°C, etc. at 5°C intervals). After heating, samples were cooled and maintained at 25°C for 5 min. They were then rescanned from 25 to 120°C at 10°C/min. DSC endotherms shifted to higher temperatures, in all starches, as treatment temperatures increased. Starch samples displayed sudden drops in transition enthalpies after treatments; regular corn starch enthalpy dropped by 9.2 J/g, rice starch by 7.8 J/g, potato starch by 15.8 J/g between 60 and 70°C, and cassava starch by 14.9 J/g between 60°C and 75°C. The pattern of transition enthalpy changes before these sudden drops were distinctly different between the starches. Transition enthalpy disappeared in regular corn starch at 90°C, potato starch at 70°C, and in cassava starch at 80°C. Rice starch displayed a small (~1.5 J/g) endotherm at 90°C. Changes in starch structures during gelatinization occur in a sequence that depends both on the intensity of hydrothermal treatment and the type of starch. It appears that different starch sources undergo hydrothermal treatment induced endothermic structural changes in distinctly different ways.

Correlating flour analyses and dough rheological properties to elastic recovery during dough sheeting

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Dough rheological behavior of three typical flours with different chemical and physical properties was studied. The changes in thickness and snapback (thickness of the machined dough sheet relative to the roll gap) during sheeting were measured. Dough snapback was a function of the reduction ratio for roll gap, the dough rest time, and different flour properties. Flour properties were determined by the Farinograph, Mixograph, Extensograph, and Alveograph. The reduction ratio for roll gap was the main factor affecting the elastic characteristics of the doughs. Dough rest time showed an inverse relationship to snapback. The interaction of rest time and reduction ratio correlated significantly with dough snapback. Doughs made from stronger flours were more elastic than those made from weaker flours. Multivariate analysis of 50/50 blends made from two flours with different protein levels showed that dough snapback had intermediate values between the two original flours. Maximum snapback occurred in the strongest flour with the shortest rest time and the largest reduction ratio.

Effect of the addition of different levels of plantain starch on *in vitro* digestibility of white salted noodles

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White salted noodles (WSN) were prepared from durum wheat flour alone and three levels of isolated plantain starch (PS). *In vitro* starch digestibility using hog pancreatic alpha-amylase, and chemical composition of the noodles were investigated. Results of analyses for *in vitro* starch digestibility and chemical properties indicated that significance differences ($P < 0.05$) among noodles existed. Moisture (6.43–7.60%) and ash content (2.08–3.12%) increased with the addition of plantain starch. Due to the low fat content of PS, the noodles fat levels decreased from 0.41 to 0.31% as substitution of wheat flour increased. Pure wheat (control) noodles had higher protein content that those containing PS and this parameter decreased as the isolated starch fraction rose. Results showed a 7.39% lower total starch content in the control sample as compared to the noodle containing 30% PS. A similar pattern was observed for potentially available starch content, but the difference was greater (12.46%). Approximately 50% of the total resistant starch (RS) in the noodles was resistant starch associated to fiber (RSAF), showing that a part of RS is due to the physically inaccessible and retrograded starch fractions. The *in vitro* availability of starch was significantly lower ($P < 0.001$) at all incubation times. Initially the alpha-amylolysis rates were similar for the various noodles; the control preparation presented a greater final hydrolysis value, which is suggestive of potentially lower glycemic impact for the plantain/wheat products.

A fundamental investigation of transglutaminase and the interactions with gluten free cereals

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Application of Transglutaminase (TGase) on buckwheat (BW) and brown rice (BR) flours has shown significant improvements on the baking performances of these flours by promoting protein networks. In this study, the impact of TGase on the protein fractions of BW and BR flours was investigated in order to better understand the activity and specificity of the enzyme. Investigations were conducted on the total protein extract as well as on the albumin, globulin, prolamin and glutelin fractions incubated with TGase. Size Exclusion Chromatography (SEC), SDS-PAGE and two-dimensional (2D) gel electrophoresis were performed on each fraction. The albumin and globulin fraction of BW were extensively cross-linked by TGase and high molecular weight (HMW) protein aggregates were detected. In the case of BR, the glutelin fraction was extensively cross-linked. 2D gel electrophoresis confirmed that albumin and globulins for BW and glutelins for BR were extensively cross-linked. In conclusion, this study shows that the improvements in the baking performances of breads based on TGase-treated BW and BR flour are due to extensive cross-linking of albumin and globulins for BW and glutelins for BR, resulting in the formation of HMW protein agglomerates. Study financially supported by European Commission, 6th framework programme, project HEALTHGRAIN (FP6-514008).

Phenolic profile, antioxidant activity and anticancer properties of different types of sorghums and brans

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Cereal-based foods have great potential as source of important nutraceuticals because they are widely consumed and are part of the world's daily diet. Particularly, sorghum has high potential because of its genetic variability and can contain important phytochemicals such as tannins, flavonoids, anthocyanins, phenolic acids, phytosterols, carotenes and others. The aim of the study was to compare the phytochemical profile of 25 different types of sorghums/brans and determine their potential as anticancer agents using *in vitro* colon (Caco2), hepatic (HepG2) and hormone-dependent mammary cancer (MCF-7) cell lines. Sorghums were tested as whole grains and in some instances as decorticated brans. Genotypes included white (type I), red-yellow and black (type II), and high-tannin or brown (type III) sorghums. Additionally, the antioxidant activity was evaluated and correlated to the total phenolics, flavonoids, anthocyanins and tannins and to the inhibition of the three different cancer cell lines. Brans contained higher amounts of all types of phenolics. Extracts with higher anthocyanins not necessarily had the highest antioxidant activity as it has been previously reported. A significant correlation between tannin content and hormone-dependent mammary cancer cell inhibition was observed whereas anthocyanins correlated with hepatic and

colon cell proliferation. These results show that specific sorghum genotypes such as Sumac and Shawaya have potential as natural anticancer agents and that their anticancer activity is not correlated to the antioxidant activity. Further research is needed to isolate the most bioactive compounds.

Physico-chemical, and thermal properties of maize varieties and their relation to the dry and wet milling performance

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Corn is the most important food crop for subsistence farmers in Mexico. It is consumed in its original, unfractionated condition as whole meal for porridge, as popped corn, as tortillas after lime treatment, and as snacks among many corn products. Recent high corn prices have forced the dry- and wet-milling and daily industries to look domestic suppliers of corn and starchy grains. The farmers of State of Hidalgo in Mexico grow exotic maize varieties, either for domestic food or animal feed but some of those corn races have the potential to be used by the dry- and wet-milling industry. The objective of this work was the evaluation of maize varieties with good dry and wet milling performance. The samples were 45 corn genotypes of white, yellow and blue kernel color. Most of the white corn showed hard kernel and high to intermediate endosperm content with excellent performance for the dry milling. The material showed poor water absorption suitable for snacks production. The blue corn showed soft and very soft kernel with high endosperm content with high starch yield and can be suitable for the tortilla flour industry that require pigmented products. Functional and thermal properties were also evaluated and will be discussed related to specific components of the kernel (starch, protein, oil, fiber and solubles) and potential uses.

Evaluation of maize quality performace related to physico-chemical and thermal properties of tortilla from native races and commercial hybrids

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Maize is consumed in Mexico and Latin Amercan in form of tortillas and other products such as arepas, pinoles, atoles, snacks tamales and many other foods. The native races of maize had been selected by centuries for our ancestors by textures, flavor and aroma for different end-uses. On the other hand, the commercial hybrids had been selected by seed companies only by agronomic yield. The objective of this research was to evaluate the maize quality performace of native race and commercial hybrids of maize grown in the region of Querétaro, Mexico. The effect of the physico-chemical and thermal properties of 29 native races and 19 commercial hybrids of maize were compared by tortilla quality. The physical test such as kernel hardness, flotation index, soft and hard percentage of endosperm showed that the maize races presented soft endosperm compared to the commercial hybrids; Most of the races of maize presented soft endosperm that is suitable for the traditional nixtamalization process. Data of ohmic cooking indicated that commercial hybrids required most energy to cook and presented higher gelatinization temperatures compared to the maize races. Related to tortilla yield most of the hybrids present lower tortilla yield ($P < 0.05$) compared to the native races. From the 29 native maize samples, 21 showed soft to medium hardness and most of them presented tortilla yields superior to 1.7 kg/kg compared with hybrids that presented very poor tortilla yield and only 9 samples showed regular tortilla yield. Also races of maize produced a superior tortilla performance related to texture and shelf life compared to the commercial hybrids.

Microstructural, physico-chemical, thermal and viscoelastic properties and their effect in the popping of popcorn

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Popcorn is not only a favorite snack in many countries, but also is a nutritious since it is low in energy and high in fiber, protein, vitamins and minerals. The popularity of popcorn pops increased with the use of microwave ovens in homes. Even though the popularity of microwave popcorn, there remain certain problems, such as low expansion volume (EV) and a high number of unpopped kernels. The objective of the present work was to study the relation between microstructural, physico-chemical, thermal and viscoelastic properties, popping methods and their effect in the popcorn popping. The materials were 170 popcorn cultivars that represent most of the world variability. They showed a large range of EV from 1 to 5 cc. Physico-chemical characteristics of the popcorn kernels showed a positive correlation with the EV and the popping yield (PY). The preliminary studies indicate that PY depended mainly on the endosperm type and the kernel dimensions. Kernels of average size of 6 mm, spherical (0.66-0.71) and high density (1.3-1.4 g/cc) produced a higher (EV). The kernel moisture also was important factor to obtain a higher PY, values of 14% were optimum to produce a higher EV. Microstructural analysis with SEM showed that thick pericarp presented higher EV. The relative crystallinity of popcorn decreased with higher moisture content. Thermal and rheological analysis RVA with low values showed higher PY also DSC indicated greater values of enthalpy produce a smaller PY and a low EV. Microwave method showed 40% higher EV 2.5-4.0cc, PY 35-50cc and popping performance than conventional method. The conventional popcorn pops become more sticky and loss their crunchiness with longer shelf-life than those obtained by microwave method.

Dietary fiber and beta-glucan contents of extruded products prepared from barley blends with plantago and wheat bran

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Evidence has accumulated on the beneficial gastrointestinal effects of a diet rich in soluble and insoluble fiber content in the management of weight, diabetes, hypercholesterolemia, and hypertension. The objective of this study was to use plantago and wheat bran as sources of soluble and insoluble dietary fiber, to prepare extruded products from blends based on whole barley flour. Two varieties of barley were used: Merlin and Doyce. Blends were prepared using 10% plantago and 10, 30 and 50% wheat bran, with each barley variety. The blends were extruded using a twin screw extruder model ZSK-30 with a smooth barrel. Total, soluble and insoluble dietary fiber were determined in the raw materials, blends and extruded products. In the same manner, beta-glucans were also quantified in all treatments. Blends of both barley varieties with plantago (10%) significantly ($P < 0.05$) increased the soluble dietary fiber content in the extruded products. However, the insoluble dietary fiber content was significantly decreased in the same samples. Barley blends with wheat bran did not increase the content of soluble dietary fiber of any blends, but the insoluble fraction was increased. In general the beta-glucans content, of all extruded blends, was decreased. Barley blends with wheat bran (10%) showed a significant difference in the content of beta-glucans when compared to barley blends with plantago in the extruded products. The use of the variety Merlin blended with plantago is recommended due to its high beta-glucans content in the flour, and high soluble dietary fiber content in the extruded product. The availability of more choices of convenience foods enriched with soluble and insoluble fiber could influence the increased consumption of these products by consumers of all ages. This might be especially important to consumers with diabetes and cardiovascular problems.

Increasing whole grain in the elementary school menu

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The USDA school meals program provides over 28 million meals on a daily basis. However, there are no reports in the literature to document the effectiveness of a systematic approach to gradually incorporate whole grain foods into school cafeterias. The objective of this pilot was to incrementally increase the levels of whole grain flour in bread products over the course of a school year to determine if consumption by elementary school children differed by whole grain content, bread type, and menu category. Subjects included children in grades K-6th from two suburban elementary schools in a Midwestern metropolitan area. Bread products (hamburger bun-2 oz and dinner rolls-1.5 oz) were prepared based on method adapted from Finney

(1984) and a recipe provided by a local bakery (Great Northern Bakery, St. Paul, MN). These levels were increased over the school year from 0% to 91% whole wheat flour in 16 and 7 incremental steps for red and white wheat, respectively. Levels of whole wheat were determined based on difference-threshold tests with a panel of trained judges in a separate study. A cost analysis was conducted to document the economic significance of incorporating the modified grain products into the menu cycle over the course of the school year. Consumption as measured by plate waste on a school-wide basis did not differ statistically from the 0% level of whole wheat until reaching the 72% level for red and 67.5% level for white wheat (a drop from ~74% to ~ 57% consumption). Menu items influenced the consumption of buns and rolls regardless of wheat type or level. The incorporation of low levels of whole wheat flour into a variety of grain-based foods may serve as a framework to develop products that meet consumer taste profiles and yet provide a meaningful level of whole grain in the U.S. diet.

Iodine binding by granular corn and potato starch: Evidence for differential location of amylose

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The ability of iodine to complex with glucan polymers has been mainly used to elucidate the structure of dispersed starch molecules, but few studies have explored quantitatively iodine binding by molecules in granules. The objective of this study was to investigate the formation of iodine complexes with starch molecules in common corn (CS) and potato starch (PS) granules as a function of water content. We hypothesized that because iodine binding requires a certain minimal level of mobility of the linear molecules, different moisture levels would be necessary to sufficiently plasticize the starch for iodine binding. Differences in the iodine binding behavior would provide insight into the granular arrangement of molecules in the two starches. Variable water contents were achieved by equilibration over salt solutions at water activities (aw) of 0.33, 0.75 or 0.97, and also using Drierite (aw<0.15). The samples were then exposed to iodine vapor before determination of the K/S spectra (ratio of the absorption and scattering coefficients), and X-ray diffraction patterns. From the K/S spectra, strong iodine binding in CS granules was first evident at 14.1% moisture (0.75 aw), while it was first evident at 25.4% moisture (0.97 aw) for PS. Furthermore, the strong iodine biding partially destroyed the crystallinity of PS granules but not that of CS granules. We suggest that because PS has B-type crystallinity, with more associated water, a higher minimum water content is needed to accomplish iodine binding in PS compared to CS granules. The X-ray diffractograms are consistent with a partial involvement of amylose in the B-type crystalline structures of PS, but a lack of involvement of amylose in the A-type crystalline structure of CS. For the latter, the amylose would be in the amorphous regions and free to complex with iodine, without disruption of the A-type crystallinity.

Effects of gluten proteins on cooking properties, textural properties and ultrastructure of Chinese raw noodles

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The objective of this study was to evaluate the effect of gluten proteins on the textural profile analysis (TPA) parameters, stress relaxation properties by Texture analyzer TA-XT2 and on ultrastructure of noodles as observed by Laser Scanning Confocal microscope (LSCM). Two wheat varieties, Caledonia and NuHorizon, which differ in protein content, protein quality and noodle making properties, were selected. The wheat flour samples were fractionated into starch, gluten and water-soluble fractions. The fractions were used to obtain reconstituted flours with different protein contents (6.5, 8, 9.5, and 11.5%). Noodles were prepared from these reconstituted flours and tested for their cooking properties, texture and ultrastructure. Cooking data showed that increasing the protein content of the samples decreased the yield of cooked noodles and cooking loss. As protein content was increased, the hardness, gumminess and chewiness of the samples increased, adhesiveness was decreased, and cohesiveness was increased. Springiness and resilience of the samples did not show any definite trend. Stress relaxation data also showed that the F_{max} at 20% strain was highest with the maximum protein content of the flour sample. The LSCM z-sectioning and the quantification of proteins by Pascal software showed definite increase in the amount of protein matrix in the noodle samples as the amount of protein was increased. No other significant differences were observed with LSCM of the samples. Overall, both Caledonia and NuHorizon showed similar behavior with increases in protein content.

New rapid Glycemic TNO Index method (GTI) for prediction of Glycemic Index and measurement of carbohydrate digestibility

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

Alkaline stability of phosphorylated wheat starch

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Alkaline stability of phosphorylated wheat starch was investigated and related to its total dietary fiber (TDF) content. Phosphorylated wheat starch was prepared at 40% (w/w) in aqueous slurry using 12% sodium trimetaphosphate, 10% sodium sulfate at pH 11.5 and 45°C for 3 h. The starch slurry was filtered, washed and air-dried and the phosphorylated wheat starch gave 88% TDF content. The phosphorylated starch was then re-slurried in water (40%, w/w) at 40°C for 4 h with sodium hydroxide at pH 9.0, 10.0, 11.0, and 12.0, respectively. Total phosphorus content in the modified starch decreased from 0.37% to 0.29% after the starch was held at pH 12.0, whereas at pH 9.0, 10.0, and 11.0 phosphorus content decreased only slightly. Despite of the 20% decrease in phosphorus content at pH 12.0, TDF content of the treated starch was not significantly decreased. ^{31}P nuclear magnetic resonance (^{31}P NMR) spectroscopy showed that after the alkaline treatment at pH 12.0, cyclic phosphate and monostarch diphosphate disappeared, and monostarch monophosphate decreased from 0.13% to 0.086%. In contrast, distarch monophosphate increased from 0.17% to 0.20%. The decrease in total phosphorus content but the slight increase in distarch monophosphate (cross-link) content explained the fact that after alkaline treatment at pH12.0, the TDF content of the phosphorylated starch remained at almost the same level.

Structure and functional properties of sorghum starches differing in amylose content

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Molecular structure and functional properties of waxy, heterowaxy, and normal sorghum starches were investigated. Starches were isolated from grains of waxy, heterowaxy, and normal sorghum. In order to study the relationship between starch structure and its functionality and guide the applications of these starches, amylose content, amylopectin chain-length distributions, gelatinization and retrogradation, paste properties, dynamic rheological properties, and *in vitro* enzyme digestion of the starches were determined. Heterowaxy sorghum starch contained significantly lower rapidly digestible starch and higher resistant starch than the waxy starch, had intermediate amylose content, paste properties and dynamic rheological properties compared to waxy and normal sorghum starches. Heterowaxy and waxy starch amylopectin contained a higher proportion of chains with DP >24, and therefore a higher gelatinization peak temperature than normal starch. Strain sweep, frequency sweep, and stress relaxation were used to study the rheological properties of the cooked waxy, heterowaxy, and normal sorghum starches at 10% solids. These rheological properties were useful in explaining the texture of the starch pastes.

In vitro digestibility of starch in sorghum flours

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In vitro digestibility of starch in commercial sorghum flour as well as lab-made sorghum flours with different particle sizes and endosperm hardness were assayed by an Englyst resistant starch (RS) method. The commercial sorghum flour had a RS content of 32.0% (based on the weight of total starch) without pepsin-treatment step in the procedure and 19.5% RS with pepsin treatment, suggesting that the presence of sorghum protein reduced starch digestion. After the commercial sorghum flour was cooked at 50% solids at 90°C for 30 min, the RS content reduced to 12.1% without pepsin treatment and 7.5% with pepsin treatment. To further understand the effects of sorghum protein on starch digestion, sorghum kernels with single kernel characterization system (SKCS) hardness values of 61, 75 and 93 were each milled on a Udy mill and passed through a 0.25, 0.5 and 1.0 mm screen, respectively. The starch digestibility increased as the particle size of flour decreased, but no significant difference in starch digestibility was observed among sorghum flours milled from grains with different hardness. The effectiveness of pepsin on sorghum protein hydrolysis and the nature of the sorghum protein on starch digestion will be discussed.

Factors affecting quality of batter-based gluten-free bread

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While wheat bread has been extensively studied, the quality basis for gluten-free bread remains controversial. Common gluten-free breads are prepared from soft batters, and in such systems, intact and damaged starch, pentosans, added hydrocolloids like xanthan gum and hydroxypropyl methylcellulose (HPMC), proteins and lipids all have been shown to have some impact. However, their individual contribution and interactions in various formulations have not been well understood. For the present study, the effects of xanthan gum, HPMC and water level were examined in model systems and starch breads. The formation of a stable foam due to thickening and surface active properties of HPMC were most desirable. The effects of damaged starch, hydrocolloids, protein aggregation and degradation, and skim milk powder were studied in sorghum breads. Analogies between sorghum breads and European style rye breads were found. In both, no aggregated gluten network is present, while hydrocolloids with surface activity are crucial (pentosans or HPMC), and protein degradation within sourdough fermentation improves quality. Other differences from wheat bread include distinctly negative effects of skim milk powder on crumb properties, lack of success with the farinograph in consistency measurements and different information extracted from fundamental rheological tests.

Ingredient optimization of a sponge cake with added turmeric root powder

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A functional sponge cake was prepared by introducing a turmeric (*Curcuma longa* L.) root powder (TP), a raw material for curry powder and is known to assist in the various biological functions of the human body, as a sub-ingredient. The formula and process for the sponge cake with added TP was optimized using a D-optimal design of the response surface methodology. The responses showed 14 to 18 experimental points, each with 4 repetitive points against each of the independent. The F-test for the significance ($P < 0.05$) revealed responses of the instrumental and/or sensory characteristics followed a linear or quadratic regression model according to the cases. The optimized condition thus obtained were: sugar, 123.4%; TP, 1.6%; and oil, 14.9% per weights (w/w) of the all-purpose flour in the ingredient formulation and whipping time, 15.0 min; frequency of folding, 130 times; and temp of oil, 75°C for the processing conditions. The addition of TP caused slight decreases in loaf volume and textural softness of the cakes although the gaps disappeared or were reversed during storage. The introduction of TP into the wheat flour at 1.6% level caused increased consistency, water absorption, stability, and FQN and decreased development time and degree of softening in the Farinogram dough evaluation. The product also exhibited improved preservation during 4 days of storage at 20°C in the aspects of water-retaining, textural softness, and total microbial counts. The physiological effect of the TP level in the product on the testing animal needs to be further continued.

Reduction of orthophosphate crystals in refrigerated biscuit dough using various chemical leavening agents

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Orthophosphate crystals appears like glass to consumers when refrigerated for storage but are harmless and readily dissolve on baking. The aim of the study is to reduce conversion of pyrophosphate to orthophosphate using various chemical leavening agents and by varying the pH, pressure and baking volume. Fumaric acid, Calrise and Dimagnisium phosphate (DMP) were blended with SAPP–10 (slow reacting) and 100% SAPP-10, calculated using Neutralize Value formula. The acid reacts with $NaCO_3$ releasing CO_2, neutral salt and water. The reaction rate is determined by the liberation of carbon-dioxide using Gas Smart, as CO_2 affects the final baked volume. The dough was analyzed using deflection meter, pH, and farinograph. The pH and the can pressure are important variables which determines final baked volume and microbial factor. Each can was proofed in the proof room at 100°F and the deflection of all variants was measured at the end of 1.5hrs. The initial pressure measured ranged between 10-25 psi. DMP had the highest psi compared to others averaging 12.4 psi and the dough turned gray after mixing. The pH of the mixed dough ranged from 6.2-6.6. The samples were analyzed every 3 weeks for 15 weeks. At the end of 9 weeks there were no crystals found in any of the samples. Fumaric acid and Calrise have similar analytical results to the control. After baking DMP samples had white spots which were not acceptable. If crystals would be found, first test would be visual and then followed by microscope. The measurements for crystals would be done by taking $1cm^3$ of each biscuit and separating the crystals by dividing them in small, medium and large crystals.

Effect of resistant starch on dry grind processes

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Resistant starch (RS) is resistant to enzymatic hydrolysis in the dry grind process. RS measurement may help explain the weak correlations among corn starch content and ethanol yield in the dry grind process. RS content is affected by processing conditions. In conventional dry grind process, the first starch processing step is liquefaction at 90°C (pH 5.5 to 6) with alpha-amylase (pH 5.5 to 6.0) and the second processing step is simultaneous saccharification and fermentation (SSF) at 30°C (pH 4.0) with glucoamylase and yeast. Conventionally high temperature (90 to 105°C) and high pH (5.5 to 6) liquefaction enzymes have been used but recently novel enzymes that operate at low temperature (30 to 48°C) and low pH (4 to 4.5) conditions have been developed. RS may be affected in different ways with enzymes working at different temperatures and pH conditions during liquefaction and may change hydrolytic conversion efficiencies. Two starch samples (30:70 and 0:100 amylose:amylopectin ratios) and two corn samples (yellow dent and waxy corn) were liquefied with enzymes operating at different liquefaction treatments (temperatures and pH conditions) and subjected to SSF. Three enzymes treatments, enzyme 1 (48°C and pH 4.2), enzyme 2 (liquefaction at 90°C and pH 5.5) and enzyme 3 (liquefaction at 90°C and pH 4.5) were used for this study. RS was measured in the original samples, after liquefaction and after SSF. Initial RS contents for pure starch samples (100 g) with 0:100 and 30:70 amylose:amylopectin ratios were 1.67 and 15.39 g respectively. For 0:100 amylose:amylopectin ratio in starch the RS content after liquefaction and SSF were respectively: for enzyme 1 (liquefaction at 48°C and pH 4.2) 0.42 and 0.21 g; for enzyme 2 (liquefaction at 90°C and pH 5.5) 0.63 and 0.48 g; for enzyme 3 (liquefaction at 90°C and pH 4.5) 0.04 and 0.27 g. For 30:70 amylose:amylopectin ratio in pure starch the RS content after liquefaction and SSF were respectively: for enzyme 1 (liquefaction at 48°C and pH 4.2) 12.45 and 5.35 g; for enzyme 2 (liquefaction at 90°C and pH 5.5) 4.91 and 4.66 g and for enzyme 3 (liquefaction at 90°C and pH 4.5) 6.77 and 4.12 g.

The effects of soy protein addition on the physico-chemical properties of gummi-type confections

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Soft, chewy candies such as gummies are a large part of the US confectionery industry. Starch-set gummies offer an alternative to gelatin but are associated with shortness, a texture fault in gummi candies; therefore, the objective of this investigation is to improve the texture, and nutritional value, of starch gummies using soy protein isolate. Gummi candies made with fruit juice concentrate and set with modified wheat starch were compared to gummies formulated with a 50% starch-SPI substitution. Gummies were cooked in a batch process to a 65 °Brix followed by starch moulding and warm curing to 75 °B. Thermal, textural, and rheological analyses were used to characterize the physico-chemical properties of each formulation. Thermogravimetric

analysis (TGA) results showed that the substitution of starch with SPI caused an increase in bulk-like water. DSC results showed that the Tg midpoint at ~28°C did not change with SPI addition ($P > 0.05$, but the Tg temperature range widened significantly ($P > 0.04$) indicating increased system heterogeneity. Rheometric analysis showed that SPI incorporation induced rheopexy, possibly attributable to protein conformational changes (dilatancy observed in both formulations). Lastly, Instron texture analysis demonstrated that soy gummies exhibited more "gumminess", likely due to increased cohesiveness caused by less mechanically starch-bound water. All results indicate that SPI can positively impact textural properties of gummi-type candies.

Acceptor reactions of dextransucrase immobilized in alginate capsules

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The enzyme immobilization is the physical process by which an enzyme is associated with an insoluble material for use in industrial, medical, or analytical applications. Dextransucrase (EC 2.4.1.5) produces dextran by polymerizing the glucosyl part of sucrose and releases fructose as a by-product. Dextran, a polymer composed of glucose units, has 95% alpha-(1→6) linkages and 5% alpha-(1→3) branch linkages. Some acceptors such as maltose and isomaltose are very efficient leading to formation of more acceptor products. It is possible to obtain almost 100% acceptor products using high concentrations of sucrose and acceptors. If maltose is used as acceptor, isomalto-oligosaccharides with different molecular weight can be produced. Isomalto-oligosaccharides are commercially important oligosaccharides and have many biological functions such as promotion of the growth of *bifidobacteria* in the large intestine of humans and animals and reduction of the cariogenic effect of sucrose. There is a growing interest in cereal world for addition of those sugars into cereal products due to their health benefits. Isomalto-oligosaccharides can be produced by several different methods using such carbohydrates as sucrose, maltose, starch, and dextran. Starch is treated with alpha-amylase from *Bacillus subtilis* and neopullulanase to obtain a mixture comprised of glucose, maltose, panose, and isomalto-oligosaccharides. Dextransucrase is a quite difficult enzyme to immobilize. Entrapment of the dextransucrase in alginate beads and fibers are the successful methods, studied by various groups. The objective of the study was to investigate the acceptor reactions of immobilized *Leuconostoc mesenteroides* B-512 FM dextransucrase in alginate capsules using maltose as acceptor, and compare the produced oligosaccharide population differences among different immobilization methods. Dextransucrase in alginate capsules, bead and fiber was reacted with a substrate comprised of sucrose and maltose. It was found that the acceptor product composition obtained using dextransucrase immobilized in alginate capsule was different from that obtained using free, alginate fiber or alginate bead immobilized enzyme. It was also found that acceptor reactions of alginate capsule immobilized dextransucrase resulted in formation of four new oligosaccharides.

Starch characteristics of dry peas grown in North Dakota

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Starch from seven major dry pea cultivars grown in North Dakota (Miami, Nitouche, DS Admiral, Eclipse, Majoret, Cruiser and CDC Mozart) was isolated and its physicochemical properties were examined. Total carbohydrate percentage is variable among different legumes, 24% (winged beans) to 68% (cowpeas), and starch is the most abundant carbohydrate in the seed (22–45%). Currently, there is elevated focus on developing value-added food products from US legumes, such as low glycemic index food products. Therefore, the objective of the study is to form the basis of advanced research on physical and chemical modification to improve the functionality of dry pea starches grown in North Dakota. Amylose and amylopectin ratio was determined by HPLC-SEC and differs among different dry pea cultivars. Christillanity was determined using X-ray diffraction. All pea starches show C pattern. The Starch granule morphology was examined using SEM, and they were round to elliptical. Gelatinization characteristics were determined by DSC. The magnitude of enthalpy of retrogradation was different for each cultivar; Miami had the highest enthalpy (16.5144 J/g), whereas Mozart had the lowest enthalpy (9.5377 J/g). Pasting profile was determined using rapid visco analyzer and each cultivar had different pasting profile based on hot paste viscosity, cold paste viscosity and setback values. Swelling volume of dry pea starches infuenced by temperature was determined at 10°C intervals between 50 and 90°C with continuous mixing. It was calculated as gel volume per unit dry weight of starch. This study showed that dry pea cultivars grown in North Dakota have starch with different physicochemical characteristics, which have significant impact on the end-product.

Flour, dough, and baking quality attributes of hard red spring wheat cultivars grown in North Dakota

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The State of North Dakota is number one in the production of hard red spring wheat (HRSW) with approximately 7 million acres devoted to this crop. HRSW has superior characteristics for bread baking, and is used in blends with other wheat to improve the quality of the final flour. Nineteen different HRSW varieties (Glenn, Knudson, Saturn, Dapps, Trooper, Hanna, Oklee, Granite, Reeder, Briggs, Polaris, Traverse, Alsen, Freyr, BigRed, Granger, Norpro, Parshall, Steele-ND) were evaluated for flour, dough, and baking quality. Dough rheology and gelatinization properties of the flour were analyzed using the Mixolab instrument, and bread samples were objectively analyzed using the C-Cell instrument. The Rapid Visco Analyzer (RVA) instrument was used to determine starch pasting profiles. Protein content, wet gluten, gluten index, total ash, total starch, starch damage, falling number, and flour extraction values were determined for each cultivar. The objective of this study was to determine the relationships between Mixolab profiles and other quality characteristics (flour, dough, and baking quality) among different wheat cultivars. Mixolab technology will have a positive impact to in the development of new cultivars in wheat breeding programs. North Dakota wheat cultivars had variable gluten and baking quality traits, which were evident from Mixolab tests and correlations with flour, dough, baking, and C-cell traits. Based on results of this study, wet gluten percentage ranged from 35.4% (BigRed) to 42.9% (Dapps). Knudson and Oklee had the highest and lowest gluten index values of 99.2% and 72.1%, respectively. Granite and BigRed had the highest and lowest protein contents of 16.5% and 13.0%, respectively. RVA data indicated that cultivars showed different pasting profiles. According to Mixolab analyses, cultivars demonstrated significant differences in terms of C1 ($P < 0.001$), C2 ($P < 0.001$), C5 ($P < 0.001$) and gamma ($P < 0.05$), whereas alpha showed no variability. Reeder had the lowest C1 (1.06), whereas Saturn had the highest C1 (1.18). Alsen had the highest C2 score indicating strong gluten quality and baking performance, followed by Glenn. Norpro had the lowest C2. In addition, Alsen and Glenn had the highest stability, whereas, Freyr and Steele exhibited the least stability. Setback parameters showed variable results. Granger had the highest setback score, whereas, Polaris had the lowest score.

Functional properties of wheat and sorghum flour blends for cookies

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Cereal Foods World 52:A65

Sorghum is an important cereal crop grown in many developing countries that is potentially suitable for use in composite flours for baking. Earlier studies on the use of sorghum flour in cookies resulted in grittiness, which was attributed to the particle size of sorghum flour. The objective of this study was to investigate the effect of particle size on the pasting characteristics of composite flours and its baking quality. Sorghum flour was fractionated into two particle sizes (greater than 0.18 mm, and less than 0.18 mm). Water holding capacity was higher for coarser particle size sorghum flour that the finer sized. The pasting characteristics of starch from the fractionated and unfractionated sorghum flours varied considerably. The peak viscosity and final viscosity was lower for starch from coarser particle size sorghum flour than that from finer particle size sorghum flour. The farinograph quality number for fractionated sorghum flour blended with all purpose flour (wheat) at 0, 10, 20, and 20% levels increased significantly with increasing levels of sorghum flour and was higher for the coarser particle size fraction in comparison to the finer particle size fraction and the unfractionated sorghum flour. The cookies made with finer particle size sorghum flour blended with wheat flour were softer than those made from the coarser particle size sorghum flour wheat flour composites. The color of the cookies was significantly affected by the particle size and the amount of sorghum flour in the blends. The cookies made with fractionated sorghum flour blends were lighter and among those with finer particle size blends had lighter color on the top of the cookies.

Methods for characterization of starch residues in distiller's dried grains with solubles (DDGS)

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Corn distiller's dried grains with solubles (DDGS) are co-products obtained from dry grind ethanol production and are used primarily as ruminant animal

feed and protein source for other animals. Approximate contents of protein, fiber and fat in DDGS are 28–33%, 9–10% and 10–12%, respectively. Results have shown that significant amounts of starch (4–10%) were not hydrolyzed and fermented during the process, and remained in DDGS. The content and structures of starch residues in DDGS reflect the efficiency of starch conversion as well as the characteristic of corn material substrate. In this study, methods were developed to analyze the lab-scale and commercial DDGS samples to understand structures of starch residues. The results showed that defatting of the DDGS with haxanes resulted in up to 3–4% increase in total starch-residue content. Total starch residues consisted of soluble sugars and resistant starch. Soluble sugars were mainly glucose and maltose revealed using thin layer chromatography (TLC). Molecular-weight distributions of resistant starch were determined using gel permeation chromatography (GPC). Resistant starch in DDGS was collected by dispersing DDGS in hot 90% (v/v) DMSO, followed by precipitation with excess ethanol. The water-insoluble proteins in the precipitate were removed by repeating the precipitation process in hot deionized water, followed by centrifugation. Starch dispersion was filtered through a membrane filter of 5 µm pores, and then injected into a GPC column packed with Sepharose CL-2B. Deionized water containing 10 mM NaOH and 50 mM NaCl was used as the eluent. Each fraction was subjected to determine the absorption intensity of starch-iodine mixture at 630 nm (Blue value). The chromatograms showed that the resistant starch had two main peaks, consisting of intact amylopectin and partially hydrolyzed dextrins. The dextrin fractions showed a broad range of Mw distribution from 10^3 to 10^6 g/mol with a sharp peak at 1-1.3 × 10^4 g/mol. Determination of the starch content of each peak was based on complete hydrolysis of starch into D-glucose using alpha-amylase and amyloglucosidase, followed by glucose oxidase/peroxidase assay.

Phenolic content and antioxidant activity of supercritical carbon dioxide-treated and air-classified oat bran concentrate microwave-irradiated in solvents at varying temperatures

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In addition to health-beneficial beta-glucans, oats contain phenolic compounds (PC) and other antioxidant activity (AA). We investigate processing technologies to produce oat ingredients with concentrated levels of PC and AA. Oat bran concentrate (OBC) had lipids removed by supercritical carbon dioxide extraction (SCD), then air-classified into five fractions (< 15, 15-18, 18-24, 24-30 and > 30 micrometer particle diameter), dispersed in water, 50% or 100% ethanol and microwave-irradiated for 10 min at 50, 100 or 150°C. OBC without SCD and microwave irradiation was also extracted at 22°C. Most effective temperature during microwave irradiation for maximizing extraction of PC and AA was 150°C. SCD-treated OBC in 50% ethanol and microwave-irradiated at 150°C extracted greatest amount of PC and AA. OBC extracted in water or 50% ethanol at 22°C without microwave irradiation had similar PC and AA than OBC microwave-irradiated at 150°C, but much higher levels were observed for latter heat treatment using 100% ethanol. Air-classification showed potential to enhance PC and AA. This study demonstrated that enhancement in concentration of PC and AA of OBC can be achieved by microwave-irradiating at 150°C for 10 min in 50% ethanol, and SCD slightly decrease PC and AA obtained while utilizing coarse fractions obtained from air-classification may help enrichment of PC and AA.

The incorporation of brewer's spent grain as a source of dietary fibre in breadmaking

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Brewer's spent grain (BSG) is a main by-product of the brewing industry and contains a high level of dietary fibre. The effect of the addition of BSG into bread and its effect on the textural and nutritional properties have been studied. Dried and milled BSG at levels of 10–30% with particle sizes of 0.25 and 0.5 mm were added to the dough mix. A number of experiments have been studied: farinogram characteristics (dough development time, stability and degree of softening), water absorption, protein and fibre content, loaf volume, textural characteristics and colour of bread crumbs and crust and image analysis of bread slices (cell structure and slice dimensions). The results showed that addition of BSG decreased the loaf volume of baked bread, water absorption, stability time, degree of softening, area of bread slices and height, number and area of bread cells and holes while increased dough development time, content of protein and fibre. There was not a significant effect on hardness of the bread crumb and crust at higher level of BSG. Lightness and yellowness in crumb and crust were negatively affected by the higher level of BSG while crumb redness was positively affected and crust redness negatively. Different particle sizes of BSG had no effect on the quality of baked bread.

CP/MAS 13C-NMR evaluation of starch degradation in extruded starch-based packaging foams

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Biodegradable starch-based packaging foams were extruded in a single-screw laboratory scale extruder. Starch was blended with polystyrene in the ratio of 70:30, and extruded in the presence of 3% talc as nucleating agent. Extrusions were carried out at 18 and 20% moisture content, at two temperatures, and two screw speeds. The temperature of the mixing, kneading, and die sections of the barrel were maintained at 50-140-140°C or at 50-160-160°C. The extruder screw speed was maintained at 140 rpm or 160 rpm. The experiment was laid out in the split plot design. Cross-polarization/magic angle spinning (CP/MAS) ^{13}C solid-state nuclear magnetic resonance (NMR) spectroscopy was used to evaluate the extent of starch degraded in starch-based packaging foams, during extrusion. It is a rapid and non-destructive technique which requires little sample preparation. Solid-state CP/MAS NMR provides information about the chemical structure and molecular dynamics in the extruded material.

Positive or negative effect of group-1 chromosome deletions on dough strength in common wheat

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Seed storage protein composition and dough strength of nullisomic-tetrasomic, ditelosomic and chromosome deletion lines of group-1 chromosome were studied. Presence or absence of each protein of glutenin and gliadin was examined by SDS-PAGE and A-PAGE, respectively. Low-molecular-weight glutenin subunit (LMW-GS) composition was investigated by genetic markers. One of LMW-GSs from 1DS was disappeared in 1DS chromosome deletion line, S-5. This means chromosome breakage occurred in multi gene family on *Glu-D3a* locus. Dough strength was preliminarily evaluated by SDS-sedimentation volume and protein content. The protein composition was connected to the dough strength. Absence of 1AL chromosome significantly increased the dough strength, although the protein composition is not changed by varying the region of deletion chromosome because of 1AL carrying null allele, *Glu-A1c*. Overall, absence of 1BS or 1DS also increased the dough strength.

Relationship between the amount of protein-glutathione mixed disulfides in polymeric protein and their molecular weight distribution

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The polymeric glutenin fraction has often been correlated with bread making properties such as mixing time, extensibility, and loaf volume. The molecular weight distribution (MWD) of these polymeric proteins (PP), which is controlled to a large extent by the genotype with respect to the composition in high and low molecular weight glutenin subunits (HMW-GS and LMW-GS) of glutenins is related to their functionality. Glutathione (c-glutamyl-cysteinyl-glycine) which is the predominant non-protein thiol in plants may occur endogenously in wheat flour in the free forms as well as in the form of protein-glutathione mixed disulfides (PSSG). Moreover, the highest PSSG content in the different flour protein fractions was observed for the fraction containing mainly PP. The current study was undertaken to understand more precisely the function of glutathione for the formation of PP. The relationship between the PP-S-S-G level in PP and their molecular dimensions was studied for 130 French common wheat varieties using asymmetrical flow field-flow fractionation – multi-angle laser light scattering (AFFFF–MALLS) measurements. According to our results we speculate that glutathione may play a crucial role in controlling the degree of polymerisation of the polymeric protein, which has been shown to be extremely important in determining baking performance.

Separation of Tef (*Eragrostis tef* (Zucc.) Trotter) seed proteins by capillary electrophoresis

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Tef (*Eragrostis tef* (Zucc.) Trotter) is an important food grain in Ethiopia where it is used in the preparation of the tradional flatbread injera. Tef is also used in celiac-safe food products due to its gluten-free status. Limited research

has been reported on protein properties of this interesting grain. Previous reports have described multiple methods for examining seed protein polymorphism including SDS-PAGE, reverse-phase HPLC, and isoelectric focusing, either alone or in combination. A free zone capillary electrophoresis (FZCE) method was developed to separate tef prolamins. Optimization included sample extraction method, capillary temperature, buffer composition and additives. The optimal conditions for separation was found to be 50 µm i.d. × 27 cm (20 cm to detector) capillary at 12 kV (with a 0.17 min ramp up time) and 35°C. The optimum buffer was 100 mM glycine acetate pH 3.5 + 40% acetonitrile (v/v) (ACN) + 0.05% (w/v) hydroxypropylmethyl-cellulose (HPMC). Optimization was performed using commercial tef flour on prolamins extracted using 70% ethanol with reducing agents. Using the optimized method twenty-five lines grown in western KS, 18 Ethiopian lines and samples from Brazil, Japan, South Africa, Spain, and Yemen were analyzed. Results demonstrated that FZCE is a useful in evaluating seed protein polymorphism, and may be useful for identification of line and origin.

Effect of germination time on contents of bioactive components and quality of germinated brown rice of Khao Dawk Mali 105 cultivar

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Khao Dawk Mali 105, the popular non-waxy rice cultivar in Thailand was used to study the effect of germination time on contents of total phenolic compounds (TPC), gamma-oryzanol, ferulic acid, and gamma-amino butyric acid (GABA) in germinated brown rice (GBR). Brown rice grains were soaked in 0.10% solution of sodium hypochlorite for 15 minutes. The grains were rinsed and germination was made by soaking the grains in water with a ratio of 1:4 (wt/wt). Germination was made in 0, 24, 48, 72, and 96 hours at a room temperature, and new water was changed in every 24 hour intervals. Germination time influenced the contents of bioactive components in the GBR ($P \leq 0.05$). Increase in the germination time increased the concentrations of TPC and gamma-oryzanol in the GBR. Germination time for 96 hours resulted in TPC of 19.80 ± 0.90 mg/100g flour, and gamma-oryzanol of 9.88 ± 0.38-mg/100g flour. The highest concentration of ferulic acid (74.43 ± 2.65-mg/100g flour) was found in the 48 hour germinating grains. GABA of 20-mg/100 g flour was detected in the 96 hour GBR. Germination time was found to influence cooking time and water uptake ratio ($P \leq 0.05$) of the GBR. An increase in the germination time was found to decrease the cooking time and hardness of the GBR. Descriptive sensory evaluation of the GBR using 15 cm line scale was done by a trained panel (n = 8). Germination time influenced qualities of appearance, color, odor, cohesiveness, texture, hardness and taste of cooked GBR ($P \leq 0.05$). The cooked brown rice obtained from 24-hour germination was mostly accepted.

Physical, chemical, pasting and milling quality attributes of pea cultivars grown in North Dakota

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The State of North Dakota produces 65% of the dry peas in the US with 620,000 acres devoted to this crop. The objective of this study was to evaluate the physical, chemical and milling attributes of major commercial cultivars. Miami, Nitouche, DS Admiral, Eclipse, Majoret, Cruiser and CDC Mozart cultivars were used. Dry peas were milled with a hammer mill (Fitzmill). Particle size, color scores, protein, ash, total starch, damaged starch and resistant starch contents were determined. Cooking properties were determined with mixolab and rapid visco analyzer. Test weight results showed statistical differences within a narrow range (63.5-64.7 lbs/bu), Eclipse giving the highest and Cruiser the lowest test weight scores. Protein content varied ($P < 0.05$), Nitouche indicating the highest protein (% 24.2), whereas DS Admiral the lowest protein (% 22.5) content. In terms of color we observed statistical differences ($P < 0.05$). Yellow pea cultivars showed higher brightness scores (L) then green pea cultivars. Particle size analysis indicated similar milling properties and particle size index scores. Statistical differences ($P < 0.05$) were detected in terms of total starch, damaged starch, and resistant starch analysis. Miami had the highest starch content (% 43.9), followed by Nitouche (% 43.7), whereas Majoret had the lowest starch content (% 40.9). Damaged starch content of pea cultivars had a narrow range (% 1.42-1.76) but indicated statistical differences ($P < 0.05$). Cultivars had significant variability ($P < 0.05$) in terms of hot paste viscosity, cold paste viscosity and setback values. North Dakota dry peas had consistent milling quality attributes. However cultivars indicated a wide range in terms of chemical and pasting quality attributes.

Evaluation of the effects of HRS wheat flour on chemical and texture attributes of bean paste

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Bean paste is a staple mainly consumed as a ready to eat product in Latin American and Asian countries. The objective of this study was to evaluate the effects of HRS wheat flour (10–100%) on bean paste texture attributes. Navy bean flour was used. Protein, total starch and resistant starch analysis were performed. Bean paste was developed with a bench top scale frying process and stored at 7°C for 24 h. Mixolab tests were conducted for 45 min. at 80 RPM to determine the mixing and pasting attributes. Texture analysis was conducted by Brookfield Texture Analyzer. As the wheat flour percentage increased in bean paste, protein content, resistant starch content, firmness and adhesive force scores significantly decreased ($P < 0.05$), whereas total starch content significantly increased ($P < 0.05$). Wheat flour addition significantly altered firmness, adhesive force and deformation scores ($P < 0.05$). Paste firmness was correlated to apparent modulus (R_2 of 0.65), whereas adhesiveness was correlated to adhesive force and apparent modulus (R^2 of 0.98 and 0.36, respectively). The total starch content of pastes was correlated with adhesive force, deformation and adhesiveness scores (R_2 of 0.56, -0.47 and 0.55, respectively). However the total starch content was not correlated to bean firmness. Mixolab tests indicated that as the bean flour percentage increased, water absorption capacity (C1) and starch gelatinization (C3) and starch gelling properties (C5) increased ($P < 0.05$). HRS wheat flour significantly altered bean paste chemical attributes indicating softer paste firmness.

Characterization of the total starch, slowly digestible starch and resistant starch in flaxseed fortified extruded corn-bean snacks

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Resistant starch is the fraction of dietary starch, which is indigestible in the small intestine. It is measured chemically as the difference between total starch and the sum of rapidly digestible starch and slowly digestible starch. The objectives of this project were to characterize the resistant starch in flaxseed fortified corn-bean snacks and to evaluate the effects of flaxseed on the resistant starch formation. Pinto-corn and navy-corn curls fortified (% 5-20) with milled flaxseed (30 mesh) were extruded according to the standard method developed by Wenger. Rapid visco analyzer analysis indicated double peaks for all dry mixes. Pinto-corn mixes indicated significantly ($P < 0.05$) higher peak viscosity than navy-corn mixes. Milled flaxseed addition at % 5 and 10 increased ($P < 0.05$) setback values, whereas % 15 and 20 additions decreased for pinto and navy mixes. As the milled flaxseed fortification increased starch content significantly ($P < 0.05$) decreased in both dry mix and extrudates. Navy-corn control dry mix had higher starch content (% 62.2) than pinto-corn dry mix (% 60.6). Navy-corn and pinto-corn mixes had the lowest starch content with % 20 flaxseed addition (% 47.2 and % 47.9, respectively). Extrusion did not alter total starch content of navy-corn extrudates. However total starch content significantly ($P < 0.05$) increased in pinto-corn extrudates as the percentage of milled flaxseed increased. Resistant starch content of dry mixes significantly decreased with milled flaxseed addition in all dry mixes. However extrusion process significantly ($P < 0.05$) increased the resistant starch content. Control, % 5 and 10% milled flaxseed fortified navy-corn extrudates showed an increase in terms of resistant starch and slowly digestible starch content. Milled flaxseed addition significantly altered starch attributes of corn-bean extrudates.

Evaluation of the relationship between proximate quality, sugar, fatty acid and amino acid attributes of soybeans grown in North Dakota

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Quality of the 2005 and 2006 North Dakota soybean crop was evaluated for proximate, sugar, fatty acid and amino acid profile analysis. The objective of this study was to evaluate the relationship between proximate quality, sugar, fatty acid and amino acid attributes of soybeans. Soybeans analyses were conducted by DA 7200 Perten NIR. Protein content was negatively correlated ($P < 0.01$) to oil, crude fiber, ash, raffinose, stachyose, palmitic acid, linoleic acid and linolenic acid (r^2 = –0.66, –0.20, –0.41, –0.13, –0.28, –0.23, –0.20, –0.39 respectively). Oil content was positively correlated ($P < 0.01$) to ash, raffinose, stachyose, palmitic acid, linoleic acid, linolenic acid (r^2 = 0.62, 0.24, 0.43, 0.39 and 0.99 respectively). Sucrose was positively correlated ($P <$

0.01) to stachyose and raffinose (r^2 = 0.39 and 0.41 respectively). Linolenic acid was negatively correlated ($P < 0.01$) to oleic acid (r^2 = –0.86), whereas positively correlated ($P < 0.01$) to linoleic acid (r^2 = 0.31). However oleic acid was negatively correlated ($P < 0.01$) to palmitic acid and linoleic acid (r^2 = –0.33, –0.56 respectively). Protein was positively correlated with amino acid contents which were expected whereas oil attribute was negatively correlated with various amino acids, excluding cysteine and glutamic acid. Results indicated that as the protein content increased amino acid levels increased. North Dakota soybeans indicated various relationships among the quality attributes based on several factors such as climate, variety (farmer, elevator), district, and county.

Effects of germination time and temperature on contents of bioactive components in germinated brown rice

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Three Thai rice varieties, Khao Dawk Mali 105 (14.06% amylose), Chai-nart 1 (20.90% amylose) and Kaw-Kor 23 (27.04% amylose) were used to study the effects of germination time and temperature on contents of bioactive components in germinated brown rice (GBR). Paddy was dehulled, and brown rice grains were soaked in 0.1% sodium hypochlorite solution for 15 minutes. The brown rice grains were rinsed with water and then soaked for germination at a temperature of 25 ± 1 or 35 ± 1°C. The GBR grains were sampled for analyses during the germination periods of 0, 24, 48, 72 and 96 hours. Increases in the contents of total phenolic and gamma oryzanol in the GBR were found with increases in germination temperature ($P \leq 0.05$). An influence of the germination time was found with the increases in total phenolic, gamma-oryzanol, and ferulic acid in the GBR ($P \leq 0.05$). Profiles of free amino acids in GBR varied among the rice varieties, the contents of glycine, arginine, proline, tyrosine and isoleucine declined through germination time in both temperatures. Germination resulted in changes in texture, odor, flavor, and color of cooked GBR ($P \leq 0.05$). Sensory evaluation of cooked GBR conducted by trained panelists (n = 8) indicated that the eating quality of cooked GBR obtained from 24 hour germination was mostly preferred.

Characterization of starch granules isolated from pigmented maize

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Maize is one of cereals of word-wide importance and recently the pigmented varieties have received interest, since these have natural antioxidants. In other sense, the food products that are elaborated with pigmented maizes, such as tortilla, shows different characteristics than that prepared with white maize; pattern that may be related with the starch present in those varieties. The aim of the present study was to isolate and characterize the starch granules of pigmented (blue) maize. Two varieties of maize, white (WM) (as comparison) and blue (BM), were used. The starch was isolated manually from the endosperm of the grain, the morphology and size-distribution of granules, total starch content (TS), damage starch (DS), apparent amylose (AA) and gelatinization temperature (Tp), were determined. The TS content was 90.7% for BM and 93.8% for WM. In both samples the DS was low (BM: 4.5% and WM: 4.2%); these results agree with the Maltase cross observed under polarized light. The shape of starch granules was predominantly round in both samples, with a size of 1–18 μm for BM and 3–21 μm for WM; both samples showed a bimodal size distributions of large (> 10 μm) and small granules (1–10 μm), with higher proportion of small granules (BM: 59.6% and WM 56.2%). The WM presented higher AA level (26.3%) that BM (23.1%) that might explain the low staling of blue tortilla due to the amylose retrogradation. The temperature and enthalpy of gelatinization were higher in BM starch (Tp: 74.20°C; ΔH: 9.67 J/g) than WM (Tp: 70.74°C; ΔH: 8.93 J/g), important parameters during preparation of maize products. The calorimetric results suggest greater cristallinity for BM starch, that is related with the molecular structure of amylopectin, chain length distribution, branching degree and molar mass.

Development and characterization of flaxseed fortified extruded bean snack

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Extrusion is a unique food process which improves the quality of edible beans by inactivating anti-nutritional components and improving nutrient bio-availability. The objectives of this project were to develop a method for producing extruded snack products from omega-3 fortified dry bean flour and to assess the shelf life and sensory properties of the extruded bean snack products. Extrusion was conducted according to standard corn curl processing method developed by Wenger. Screw speed and water absorption levels were adjusted at 310 RPM and 0.128 kg/min respectively. Specific mechanical energy values significantly decreased ($P < 0.05$) as the cold milled flaxseed addition increased. Extruded snack quality analyses indicated that 5 and 10% cold milled flaxseed addition did not affect expansion ratio, bulk density, water activity and snack firmness parameters. However, significant differences were observed with 15 and 20% cold milled flaxseed addition. Bulk density scores significantly ($P < 0.05$) increased as the percentage of cold milled flaxseed increased in bean snacks. This might be related to the high levels of protein, oil, fiber and gums of flaxseed which affected puffing. In addition, cold milled flaxseed fortification increased water activity (a_w) values of extruded bean snacks. Extruded snacks fortified with 15 and 20% cold milled flaxseed addition significantly ($P < 0.05$) increased water activity values of extrudates. Shelf life stability of extruded bean snacks was evaluated by headspace volatile analysis. Gas chromatography was conducted and secondary metabolites of lipid oxidation were analyzed. Propanal the primary aldehyde of alpha-linolenic acid oxidation was detected in some extruded bean snack samples at 8-week storage. Extruded bean snacks could be introduced as high fiber and high omega-III products. Bean snacks fortified with 5 and 10% cold milled flaxseed showed superior quality parameters and shelf life stability.

Evaluation of *in vitro* glycemic index of fiber-rich extruded breakfast cereal produced with passion fruit fiber and corn flour

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The glycemic index (GI) helps classify foods on the basis of their postprandial blood glucose response. A reduction in the GI of starch-based foods can be obtained with the use of fibers. The aim of this study was to determine the influence of process parameters and passion fruit fiber (PFF) addition on the GI of an extruded breakfast cereal produced with PFF and corn flour, using the Response Surface Methodology (RSM) and Principal Component Analysis (PCA). Raw materials were characterized as to particle size, total fiber content and GI. A Brabender single-screw extruder was used to produce the extrudates, with the following independent variables: raw material moisture content (18–28%), 2nd and 3rd zone temperatures (120–160°C) and PFF (0–30%). *In vitro* GI was the response, using white bread as standard (GI = 94%). The PFF and raw corn flour had particle size ranging from 0.250–0.840 mm and 0.177 and 0.500 mm, total fiber content of 64% and 3% and GI of 45 and 48, respectively. When using RSM, no effect of the independent variables was observed on the GI, which presented an average value of 48.41. When using PCA, the GI tended to be lower when processing at lower temperatures (<128°C) and higher at higher temperatures (>158°C). The glycemic curve showed that the higher the fiber content, the lower the liberation of glucose in the first 60min, reaching similar values after 180min. It was possible to verify that the GI of the extrudates presented results similar to those of raw corn flour. This could be due to incomplete gelatinization and dextrinization of starch, the presence of PFF and retrogradation, preventing the action of amylases on starch. When compared to white bread, the extrudates showed a reduction of GI until 50%, being an interesting alternative to be used as breakfast cereal in weight and glicemia control diets, with a slower liberation of glucose.

Effects of beta-glucans and polyphenols components on hemato biochemistry of soy-oats cookies by in-vivo triad

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A group of young adults (8 M / 7 F) and male rats (Wistar) were feed for 2 and 6 weeks with a diet contenting 60-87meq/g soy-oats polyphenols, 0.5–2% of B-glucans from oats and 8% of fat from shortening, fish oil or olive oil. The variables responses studied were; viscosity of intestinal fluid (only on rats triad) and blood (Brookfield, CP40), total antioxidants (TAS 2332), erythrocytes aggregation (ACCU-SCOPE), blood lipid and glucose (Randox). The intestinal viscosity (male rats) increased 32% with significantly decreased on blood (24.4%) depending on diet composition and feed time. Rats feed with 50% oats and fish oil showed a decreased of 25% on blood viscosity. Intestinal viscosity showed a second order model depending on soy-oats consumption and time, in addition blood lipids parameters decreased. Total blood antioxidants increased depending on diet polyphenols concentration and time of consumption. The rats feed with 50% oats showed an increased of 66% blood antioxidants. The aggregation of erythrocytes decreased as the

concentration of diet polyphenols increased, these animals also significantly improved the form and separation among red cells. Combination of oat-soy diets improved viscosity and blood parameters over 42 days of consumption.

A new device for studying deep frying behavior of batters and resulting crusts

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Batters are used to coat many products to provide them, during frying, with a crust. Crust properties are of key importance to consumer acceptance of fried products. Therefore, knowledge of the process of crust formation during frying and the resulting properties of the crusts is important. However, the formation and properties of the crust are difficult to study, because; (I) Batter-pickup (the amount of batter adhering to a product) and core properties (i.e. surface roughness) effect crust formation and properties of the crust in such way that it is difficult to compare batters of different viscosity or cores with different properties. (II) It is often difficult and laborious to separate the crust/batter from the core. (III) Fried products often show poor reproducibility. We have designed a deep fried model (DFM) system making it possible to study crust formation and crust properties without the difficulties stated above. The device carries 4 aluminium cups which can hold all kinds of products; the cups are covered by a Teflon coated gauze on which the batter is pipetted. The DFM system allows the study of a wide range of batter-product combinations while the amount of batter can be kept constant. Moreover, crusts are easily separated from the gauze after frying. Two different batter types and three cores have been used to test the system. Obtained crusts were evaluated on several physiochemical properties and compared to crusts found around commercial deep fried products. Results show that crusts obtained with the DFM system are comparable with crusts of commercial products. The good reproducibility of the DFM crusts resulted in low variance in analytical results compared to commercial crusts. This high reproducibility, the versatility of the system and the ease with which the system can be used offer clear benefits for many potential applications. The DFM system can be used for scientific research or in more industrial applications for quality control and product development.

Effect of whole barley flour on the stability of flour tortillas

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Wheat and whole barley tortillas with and without preservatives were packaged in re-sealable LDPE/LLDPE bags and placed under room temperature and refrigeration for 13 and 25 days, respectively. Tortillas were periodically analyzed for changes in texture, color, water activity, pH, aerobic plate count (APC), and yeast and molds (YM). Tortillas without preservatives (NP) stored at room temperature and those with preservatives (WP) at both temperatures showed an increase in rupture distance (extensibility) overtime ($P > 0.05$). However, tortillas NP stored under refrigeration had an initial increase in rupture distance but remained constant thereafter. Tortillas NP showed no changes in lightness (L), redness (a) or yellowness (b) under refrigeration. Conversely, L and b increased while a remained constant at room temperature. Tortillas WP showed a decrease in L and b, and an increase in a at both temperatures. Water activity increased in tortillas NP stored at both temperatures, but it remained constant in tortillas WP stored at both temperatures. The pH of both tortilla types was constant at the studied temperatures with the exception of tortillas NP stored at room temperature, which showed an initial increase followed by a decrease overtime. Tortillas NP stored under refrigeration and tortillas WP stored at both temperatures displayed no growth in APC. However, tortillas NP showed a 3 log increase in APC at the end of the storage period at room temperature. Tortillas NP at room temperature showed a steady increase in YM, while the same tortilla type increased to <100 cfu/g on day 25. In contrast, tortillas WP at both temperatures showed no increase in YM overtime. Shelf-lives of 25 days and less than 48 h were observed for tortillas at refrigeration and room temperature, respectively. These results show promise to storing wheat and whole barley tortillas without preservatives under refrigeration.

Effect of pentosans and pentosanase on the baking quality of hard spring wheats grown under diverse conditions

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Total pentosans (TP), water-extractable pentosans (WEP), water-unextractable pentosans (WUP), and ratio of WEP to WUP were determined for wheat samples of the Canada Western Red Spring and the Canada Western Hard White Spring grown in 2003 (warm, dry, and well-matured) and 2004 (cold, wet, and late-matured) crop years. Baking quality of the wheat samples was evaluated with and without the additions of two commercial pentosanase preparations (xylanase I, xylanase II). The TP contents were lower and ratios of WEP to WUP were higher in the samples of 2003 crop than those in the 2004 crop. Addition of the two pentosanases improved the bread-making performance of all wheat samples and retard the process of bread firming over one week period. It was found, however, that the degree of effectiveness of pentosanase depended on crop year and wheat class. Both enzymes exhibited a larger improvement in specific loaf volume and less effect on bread firmness in the 2004 crop than in the 2003 crop. No significant correlation was found between the rate of bread firming and the natural pentosan composition/content of the flour samples. The practical application of the knowledge of wheat pentosan and pentosanase generated in this study will be discussed.

Predicting moisture and degree of cook in nixtamalized maize by near infrared spectroscopy

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The moisture content and degree of cook of nixtamalized maize strongly affect the processing properties and final quality of alkaline processed maize products. Rapid methods for measuring these properties are needed to allow effective process control. In this study, a near-infrared spectroscopy method was investigated to measure both moisture content and degree of cook in nixtamalized maize. Laboratory scale cooking of maize samples from two hybrids was performed using different combinations of temperature (80–95°C) and time (30–180 minutes). For each treatment, 200 g of maize were cooked in 900 ml water containing 2 g of lime. A total of 60 samples were prepared, and randomly assigned to calibration and validation sets of 38 and 22 samples, respectively. The moisture content of the nixtamalized corn was determined by oven drying at 103°C. Degree of cooking was determined by measuring the residual enthalpy (J/g) of the ungelatinized starch using differential scanning calorimetry (DSC). Samples were quick frozen in liquid nitrogen, then freeze dried and ground prior to DSC analysis. Residual enthalpies ranged from 1.07 to 7.50 J/g. A near-infrared (NIR) reflectance spectrum was also obtained from each cooked maize sample over 1100–2500 nm, using a Foss/NIRSystems 6500 spectrometer equipped with a high fat/high moisture sample cell. Both multiple linear regression (MLR) and partial least squares (PLS) regression were used to develop NIR calibrations for measuring moisture and residual enthalpy. For moisture measurement, MLR and PLS models using derivatized spectra worked equally well. When applied to the validation samples, the best calibration resulted in r = 0.979 and a root mean standard deviation (RMSD) = 1.52%. When measuring residual enthalpy by NIR spectroscopy, MLR and PLS models again worked equally well, but derivatization of spectra provided no advantage. The best model resulted in r = 0.963 and RMSD = 0.446 J/g for the validation samples. Based on these preliminary results, we believe that NIR spectroscopy can be successfully used as a rapid and practical method to monitor both moisture content and degree of cook in nixtamalized maize.

A rapid small-scale method to evaluate dough viscoelastic properties

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Dough viscoelastic properties are of special interest to bakers and wheat breeders. Dough extensibility (DE) and resistance to extension (RE) influence each step of the baking process as well as product end-use quality, and thus are important quality factors to consider in wheat breeding programs. The objective of this study was to develop a rapid small-scale method to evaluate dough DE and RE properties. A total of 20 hard red winter wheat flour samples varying in protein content (8.9–14.3%), Farinograph optimum water absorption (55.8–68.0%), Farinograph dough development time (4.5–23 min), and Farinograph mixing tolerance (7.0–59.8 min) were studied. Doughs were mixed to optimum at optimum water absorption by Farinograph. The standard Extensigraph method (AACCI approved Method 54-10) was compared to a small-scale method which utilized the Texture Analyzer (TA) equipped with a Kieffer rig. Correlation of determination (R^2) of DE measured by Extensigraph versus by TA was 0.77, while that of RE measured by each instrument was 0.46. The potential of near-infrared reflectance spectroscopy (NIR) for measuring DE and RE was also investigated. The NIR technique showed great potential in predicting both DE and RE as determined by Extensigraph. The highest R^2 was 0.84 for DE and 0.81 for RE, with a standard error of prediction of 49.34 and 9.66, respectively. Spearman rank correlation coefficients of DE and RE predicted by the Extensigraph-based model and TA-based model were 0.97 and 0.68, respectively. Results show that these two model's ability to differentiate DE was similar.

The rheological properties of wheat protein isolate PROLITE 200 suspensions

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Cereal Foods World 52:A70

Linear and non-linear rheological properties of wheat protein isolate PROLITE™ 200 suspensions were investigated as a function of concentration and pH. Linear dynamic viscoelastic properties for PROLITE™ 200 were strongly dependent on concentration and pH. The higher the concentration, the stronger the viscoelasticity of the PROLITE™ 200 would be. In the pH range of 4.0–7.0, higher pH resulted in the stronger viscoelasticity. PROLITE™ 200 suspensions exhibited viscoelastic fluid behavior at lower concentration and/or lower pH. However, at high concentration and high pH, PROLITE™ 200 suspensions showed some transition from viscoelastic fluid into viscoelastic solid, and displayed viscoelastic solid behavior at low frequencies. Concentration and pH ranges for the transition were narrow indicating that the property change for the PROLITE™ 200 was in evidence. The non-linear shear viscoelastic properties of PROLITE™ 200 were also found to depend on concentration and pH. Viscosities of PROLITE™ 200 displayed shear-thinning behavior, and fits by a power law constitutive model. Our results indicate that the PROLITE™ 200 structure in suspension changes over a small concentration and pH range, which suggest that PROLITE™ 200 could be important for adjusting and controlling dough viscoelastic behavior. The information of this work is useful in the development of more and new applications using wheat protein isolate PROLITE™ 200.

Increase conversion rate of high tannin sorghum to ethanol through germination

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Tannin plays a major role in retarding the starch degradation and protein digestibility in high-tannin sorghum cultivars. Starch degradation and protein digestibility are important factors for ethanol production. Germination has been used to improve nutritional values of grain sorghum for food applications. However, no research has been conducted on the effect of germination on conversion rate of grain sorghum in ethanol production. The objective of this research was to investigate the effects of germination on performance of high tannin grain sorghum in ethanol production. Ethanol fermentation was conducted on high tannin sorghum samples germinated for 0, 3, and 4 days. Samples were analyzed for tannin, starch, protein, free amino nitrogen (FAN), and glucose content. Endosperm structures and flour pasting properties of the germinated and non-germinated sorghum samples were examined by scanning electron microscope (SEM) and Rapid Viscoanalyzer (RVA). The results showed that germination reduced tannin content from 3.96% to negligible levels, increased the digestibility of starch by 13 to 20% and the digestibility of protein by 5 to 10 folds, and shortened the fermentation time by 24–36 hours and increased ethanol yields by 2 to 3%.

Dry solids and bile acid concentrations impact bile acid binding capacity of extruded oat cereals

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Directly expanded extruded breakfast cereals (EBC), processed from two oat lines (*Avena sativa*) with different beta-glucan concentrations, were employed to determine the impact of different test conditions of dry solids and bile acid concentrations (BAC) on *in vitro* bile acid binding (BAB) efficiency. The oats included one experimental line, N979-5-2-4 (N979), and one public cultivar, 'Jim', with beta-glucan concentrations of 8.7 and 4.9%, respectively. The finished EBC, with beta-glucan concentrations of 4.9 and 3.1%, respectively, were ground into slurries for analysis. Beta-glucan extracted from N979 EBC was more soluble than from Jim EBC. A full fractional factorial design with duplicate treatments was followed, with levels chosen for BAC of 0.20, 0.47, 0.95, 2.37, and 4.73 µmol/g of total EBC slurry, and concentration of dry solids in the slurries (DSS) of 0.8, 2, 3 and 4% (w/w). BA binding by amount (µmol, BABA), by percentage (%, BABP), and by gram of dry solids of ground EBC (µmol/g, BABDS) were measured and calculated. These three methods for reporting BAB resulted in different calculated interactions with DSS and BAC. N979 *in vitro* digestion slurries had greater BAB than Jim slurries at different DSS and BAC, with the differences being greater at DSS of 3% or above and at BAC of 2.37 µmol/g or above. No difference was observed for BABA and BABP between the two EBC slurry treatments at the lowest DSS of 0.8%, and for BABA and BABDS at the lowest BAC of 0.20 µmol/g. Effect of beta-glucan, indicated by the difference of BAB of these two EBC became comparable at 3% DSS or above and BAC of 2.37 µmol/g BAC or above. Therefore, we propose the parameters of 3% DSS and 2.37 µmol/g BAC be adopted to standardize the BAB conditions and, thus, the interpretation of studies evaluating the *in vitro* BA binding of beta-glucan.

Dough extensibility ranges on U.S. winter wheat cultivars and advanced lines

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Selecting for lines with balanced dough strength and extensibility properties can be challenging in wheat breeding programs since universal molecular markers have not been clearly identified. While in spring wheat one report of recombinant inbred lines showed a negative correlation of strength and extensibility, this relationship has not been systematically analyzed in U.S. winter wheats. Forty three winter wheat cultivars and advance breeder lines were analyzed for extensibility and mixing properties, wet gluten, gluten index, SDS sedimentation, bake test and HMW-GS allelic composition. The range values of micro-extensibility properties were Rmax mean 0.22 N (range 0.10-0.24 N), extensibility at Rmax 71.3 mm (53.8-85.0 mm) and area to Rmax 8.1 N.mm (4.2-11.9 N.mm). Three allelic combinations represented about 47% of the total frequency but they did not correlate with the extensibility properties. Partial correlation adjusted for protein variation showed a positive relationship of dough strength and extensibility ($r = 0.67$, $P < 0.01$) in the samples analyzed. All extensibility parameters were correlated to mixograph mix time and farinograph peak time; Rmax, $r = 0.72$, Extmax, $r = 0.44$, and area at Rmax $r = 0.66$; $P < 0.01$). Positive correlation of gluten index ($P < 0.01$) and negative correlation of wet gluten content ($P < 0.05$) with all extensibility parameters were obtained. The results suggest that current analytical methods are not successful in predicting baking performance, such as loaf volume, with large deformation extensibility tests. New approaches that are able to decouple elastic and viscous components during large deformation straining of dough may help in that regard.

Effect of particle size on rate of enzymatic hydrolysis of cellulose

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Cellulose is the most abundant polysaccharide on the earth and has been widely utilized in food, biofuel, and biomaterials. Degradation of cellulose to glucose, which is then fermented to ethanol, is one of the hot issues in utilizing cellulose for biofuel. The objective of this study was to investigate the effect of size on the rate of enzymatic hydrolysis of cellulose based on the production of glucose and cellobiose. Media mill was employed to treat cellulose suspension (3% or 7% cellulose). Increasing milling time decreased the average particle size. After 0, 15, 60 and 120 min milling, the volume average particle size of 3% cellulose suspension was 25.52, 5.54, 0.85 and 0.78 µm, respectively, and crystallinity index was 94.4, 87.5, 74.3 and 77.0%, respectively. While for 7% cellulose, volume average particle size was 25.52, 6.08, 2.66 and 2.07 µm, respectively, and crystallinity index was 94.4, 87.6, 76.0 and 86.5%, respectively. Milled cellulose was hydrolyzed by cellulase from *Trichoderma reesei* in sodium acetate buffer solution. As average particle size and crystallinity of cellulose decreased, Michaelis constant, K_m, decreased, and maximum initial hydrolysis rate, V_{max}, increased; while inhibition constant, K_i, did not show any significant difference. As the average diameter of cellulose was reduced to 0.78 µm, V_{max} was enhanced from 0.076 g/L-min to 0.304 g/L-min, K_m was reduced from 9.844 g/L to 1.877 g/L, and K_i was changed from 0.034 g/L to 0.016 g/L. In 24 hr hydrolysis, glucose yield was raised from 14.22% to 45.83%. The results showed that the reduction of particle size enhanced the hydrolysis of cellulose by enzymes.

Evaluation of stickiness in starch solutions

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Stickiness is a phenomenon that involves a bond between two surfaces that are placed in contact with each other. Starch stickiness is greatly impacted by water availability, temperature, and degree of cook. Solutions of corn starch in water w/w (8%, 16%, 24%, 32%, 40%, 48% and 56%) were prepared and heated in a 2L beaker from room temperature to 90°C in approximately 14 minutes. Samples were then split and stored in two different ways. While still warm, half the solution was stuffed into a 6.35 cm internal diameter casing and placed at –20°C for 12 hours. Samples were then thawed until they reached 25°C (12 hours) and cut with an electric knife to a 1.27 cm height. The remaining solution was placed in disposable Petri dishes and allowed to cool at room temperature until they reached 25°C (10 hours). Stickiness was

measured using a TA-XT2*i* Texture Analyzer in Adhesiveness Test Mode. Water activity and DSC parameters were also determined in samples after storage. Stickiness significantly ($P < 0.05$) decreased as the starch concentration increased. Frozen and thawed samples had significantly ($P < 0.05$) lower stickiness values than samples cooled at room temperature. Warm samples were observed to be stickier at higher starch concentrations. This suggests that temperature also plays an important role in stickiness. DSC enthalpy J/g significantly ($P < 0.05$) increased as starch concentration increased. Starch at higher concentrations did not gelatinize completely, as water became limiting. Stickiness is a phenomenon that involves a combination of cohesive and adhesive forces. These forces are impacted differently by temperature, water availability, and starch degree starch cook.

Milling behavior of the pretreated wheat for the different tempering conditions

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Cereal Foods World 52:A71

An enzyme cocktail, a combination of xylanase, cellulase, and pectinase, was studied for its effects on milling including the separation of bran from starchy endosperm, milling yield, and flour quality. The wheat was first prepared using a dilute acid or water pre-soak, and gentle air drying. Pre-soaking, combined with drying, was controlled for their possible role in enhancing enzyme action during tempering. The enzyme cocktail was applied in pH 5 water while tempering kernels to 16% moisture, and then incubated at 50°C for 4 or 16 hours. The changes in the wheat kernels caused by soaking-drying, and/or enzyme activity were studied with the single kernel characterization system, pearling, and lab scale milling. The pearling behaviors were observed visually after applying the May-Grunwald dye. Enzyme activity was measured on bran removed during pearling by a reducing sugar assay. Flour samples produced on a laboratory scale Buhler mill tested and compared for flour yield, bran particle size distribution, flour color, protein, and ash. Results indicated that water pre-soaking and drying made the kernel softer. Dilute acid pre-soaking and drying made the bran fragile and reduced the kernel softening effect. Pearling and staining showed that in all cases, bran removal was more effective on the end rather than on the sides. Significantly higher ($P < 0.05$) reducing sugar values were obtained from the enzyme-treated wheat bran indicating that enzyme action occurred. Milling showed that the straight grade flour yield from the enzyme treated wheat was significantly greater for the acid soaked kernels with longer incubation time. However, only soaking in dilute acid without enzyme treatment did not improve the yield. The flour quality suffered slightly though, as indicated by reduced brightness and higher ash. Longer Incubation time facilitated enzyme action.

Effect of wheat kernel physical characteristics on debranning

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Cereal Foods World 52:A71

Ultimate aim in milling is to separate anatomic parts of the grain (bran and endosperm) as cleanly as possible. In this study we investigated enzyme-assisted wheat bran removal prior to milling to improve ease of bran separation. Wheat kernels were tempered to 16% moisture with a carbohydrase enzyme cocktail in water at pH 5 rested for 16 h at 50°C. The enzyme cocktail consisted of 1:1:1 ratio of cellulase, xylanase, and pectinase by weight, with total enzyme loading at 1.5% w/w of temper water. Treated and untreated wheat kernels were debranned using a Strong-Scott barley pearler (Seedburo Equipment Co. Chicago, IL) fitted with a 30 grit carborundum stone and 8-mesh screen. Fifty g of wheat sample was fed into the machine through the top chute and pearled for 30 sec. Pearled kernels were sifted over a #18 mesh screen to remove small particles. 2 g pearled kernels were stained in May-Grunwald dye mixture (0.5% w/v methylene blue and 0.5% w/v eosin-Y in methanol) using six-min procedure: 1 min immersion in methanol, 1 min immersion in dye, 1 min each in 3 methanol rinses, and 1 min in distiller water. Grains were then air dried on absorbent paper at room temperature. Kernels with intact epicarp did not stain, because of cutin layer, while pericarp and endosperm stained green and pink, respectively. Scanned images of the stained grains were analyzed using an image analysis software (SigmaScan Pro 4.0). Percent debranning was determined as the ratio of the whole kernel area divided by area of pink parts corresponding to endosperm exposed as a result of pearling. Enzyme treated and control samples were compared for their degree of debranning. Kernel morphology such as size, shape factor, minor and major axis were also measured and correlated to percentage debranning.

Utilization of resistant starch to control theophylline release from tablets

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The effect of enzyme-resistant starch (RS) on theophylline release from compacted tablets of RS and pregelatinized waxy maize starch (PS) mixtures was investigated. The PS and RS ratios tested were 100/0, 65/35, 50/50 and 35/65, and theophylline content in the tablet was 30%. The starch and drug mixtures were compacted to tablets by compression (60kN), and then the swelling, erosion, drug release, and rheological properties and pore size distributions of the hydrogel in dissolution media containing alpha-amylase were measured. The hydrogel systems exhibited the storage modulus (G') higher than the loss modulus (G") for all the tablets tested, and the viscosity of the hydrogel increased by increasing RS content, revealing the ability of RS to form a strong gel network. The porosity of dry tablet and hydrogel decreased as RS content increased. However, swelling ratio of the tablet containing RS was higher than that containing only PS, indicating that the tablet swelling depended more on the hydration nature of polymers than on the porosity. During the initial stage of dissolution (up to 1 h), RS appeared suppressing the erosion, but the erosion rate was elevated by RS in the late stage (after 1 h), possibly due to the poor compaction behavior of RS. The degree of erosion was positively related to the swelling, indicating that the solvent penetration induced the enzymatic degradation and disintegration of the tablet. The theophylline release was most effectively retarded when RS and PS were equivalently mixed. The RS addition to the PS-based compacted tablets, therefore, could control the theophylline release effectively by retarding the tablet erosion in solution.

Changes in the ultra-structure of the endosperm in barley and proso millet during malting observed by Scanning Electron Microscopy

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Structural changes occurring during malting are very important for further processing of grains, as starch characteristics change due to enzymatic degradation. In this study, Scanning Electron Microscopy (SEM) was used to observe changes in proso millet and barley grains occurring at different stages of the malting process. In unmalted proso millet, starch granules are located in big polyhedron cells, surrounded by relatively thin cell walls. Small to large polygonal as well as very small spherical starch granules were observed in the streaky endosperm, whereas rather small spherical granules were present in the floury area. SEM images clearly revealed that the dense packaging in the endosperm causes strong indentations in the large granules. Small spherical protein bodies were attached on starch granules. These protein bodies were concentrated in the peripheral cells of the endosperm, becoming more scattered and less frequent towards the inside. In the loosely packed endosperm of barley, the difference between small and big starch granules was more apparent than in the more compact endosperm. During malting, the ultra-structure of both proso millet and barley is degraded. SEM proved that proso millet starch granules are attacked by pitting. The organization of the amorphous and crystalline regions of the granule structure was visible by SEM when proso millet starch granules were severely broken down. In barley, both small and large starch granules showed surface erosion and not pitting. Barley starch was mostly attacked near the equatorial groove, and both big and small starch granules were degraded, causing a loss of the closely packed arrangement. The breakdown of endosperm cell walls was more evident. In conclusion, the results of this study clearly show that SEM is a suitable tool to allow unravelling ultra-structural changes occurring during malting process.

Determination of the hydration behavior, phytic acid, total phenolic content and antioxidant activity of different varieties of beans

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Utilization of beans is influenced by hydration behavior and the existence of certain phytochemical such as phytic and phenolic acids. We investigated hydration properties, phytic and phenolic acid content of selected varieties of five bean types grown in one location. These included: six varieties of Navy beans, one variety of Pinto bean, one variety of Great Northern bean, two varieties of Black beans, and two varieties of Small Red beans. The moisture content for all beans was similar ranging from 4.46–5.98%. Navy, Pinto, and Great Northern bean types showed the best water hydration capacity with values from 84–117%; poor hydration for black and small red beans was related to a delay in hydration during the initial 6 hours of soaking. The amount of phytic acid present in the bean seeds analyzed was 1.7–2.7%. Small Red, Black and Pinto beans had the highest amount of total phenolic content

with values over 20 mg equivalents to Ferulic acid/g of sample. The three types of beans with the highest level of phenolic acids also had the highest antioxidant activity reaching levels of over 1000uM equivalent to Trolox. This work comprehensively identifies beans varieties suitable for whole seed processing based on hydration behavior and phytochemical content.

Phase separation and rheology of barley beta-glucan and soy protein isolate mixtures

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Cereal Foods World 52:A72

The thermodynamic incompatibility of protein and polysaccharides is a common phenomenon. Understanding these systems is important to food industry in terms of the texture, stability, and shelf life of food products. The objectives of this study were to understand the phase behavior of a mixture of barley beta-glucan (BG) and soy protein isolate (SPI), both of which are functional food ingredients with health benefits approved by FDA. In this study, beta-glucan was first purified from barley fiber concentrate to nearly 90% purity. Purified BG solution (0.2%-1%) and commercial SPI solution (4–10%) were mixed at 1:1 ratio at 20°C. at low total solids concentration, no visible phase separation was observed. However, concentrated mixtures of SPI and BG showed phase separation into a clear top phase and a milky bottom phase. Top phase was rich in BG with only 2% SPI. The bottom phase was rich in SPI with around 0.05% BG. Phase diagram was established for this system. Rheological properties of the system were also studied. The viscosity and flow behavior of the mixtures was mainly dominated by BG. At high BG concentration, the mixture exhibited pseudoplastic flow behavior and viscosity was as high as 450 mPa.s at 12.9 s^{-1}. At low BG concentration, the mixture showed Newtonian flow behavior and very low viscosity (20 mPa.s). The mixtures are also evaluated by differential scanning calorimetry. The findings provide direction for successful food and beverage product applications of BG and SPI mixtures. Combinations in the single phase region should be used to avoid phase separation with storage.

Nutritional property of cooked starches from maize mutants: A parabolic relationship between slowly digestible starch content and amylopectin fine structure

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Cereal Foods World 52:A72

The relationship between molecular structure of cooked maize starch and its slow digestion property were investigated. The results of the *in vitro* Englyst assay showed a range of rapidly digestible starch (RDS) (70.1–98.9%), slowly digestible starch (SDS) (0.2% ~ 20.3%) and resistant starch (RS) (0.0–13.7%) among the maize mutant flour samples. Further analysis showed that amylose content was significantly correlated ($R = 0.763$, $P < 0.001$) with resistant starch (RS) amount, but not with that of SDS, indicating that amylopectin is the starch molecule associated with SDS. Total starch debranching analysis revealed a parabolic relationship between SDS content and the weight ratio of amylopectin short chains (DP < 13) to long chains (DP ≥ 13), which means amylopectin with either higher proportion of short chains or long chains have more proportions of SDS. Specifically, fractions of DP > 30 is positively correlated with SDS content for samples with more long chains, whereas fractions of DP <30, particularly DP 5-9, are positively correlated to SDS content for samples with more short chains. Genetic mutants have a high potential to produce starch samples with desired nutritional properties.

Separation of plastic and elastic rheological behaviors of gluten and relationship to breadmaking performance

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Traditional instruments used to evaluate dough and/or gluten rheological properties do not provide unambiguous separation of elastic and viscous behaviors. Thus, it has been difficult to determine how pure elastic properties of gluten are related to breadmaking performance. Recovery after creep and cyclic large deformation tensile testing are two ways to decouple elastic and viscous effects. A large variation in the recoverable shear strain after preceding creep (7 to 28%) was seen for fifteen popular wheat cultivar glutens—prepared using the Glutomatic method—representing five US wheat classes. High recoverable strain was seen for both 2 + 12 and 5 + 10 hard wheat cultivars. The recoverable deformation ranged from 71 to 93% of the creep deformation, and the Zeleny sedimentation values ranged from 13 to 56 ml. However, the recoverable work dropped to <40% for these glutens when tested in a large deformation (500%) cyclic tensile test. The maximum force, residual deformation and patterns of the force-deformation curves also varied widely when these glutens were stretched in tensile mode. Comparison of the overall patterns of the creep-recovery results for gluten relative to several linear, amorphous synthetic polymers suggested that gluten lies in the rubbery flow region of viscoelasticity, which is characterized by viscous flow superposed over delayed elastic effects. Good to excellent test bake bread volume was obtained for several cultivars from this sample set. Apparently, optimized pup loaf breadmaking process can accommodate a fairly wide range of viscoelastic behaviors of glutens. This work defines those ranges objectively using creep-recovery and tensile testing.

The oxidative relationship of moisture and lipid extraction yield of whole grain flour

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Lipid oxidation changes with moisture content; oxidation is higher at lower moistures, and decreases with an increase in moisture (corresponding to RH% ~ 30%), then increases again with higher moisture content. The explanation of this U shaped curve may be partially the mobility of the lipid and/or effects of catalysts such as metal ions. The indigenous lipid of the whole grain flour, however, could be bound to other structures or components such as cell membrane, protein, starch, etc. This work studied the mobility change and extraction yield of the lipid in whole wheat flour with varying flour moisture contents. Commercial whole wheat flour was conditioned at room temperature over a range of RH% solutions to achieve final flour moistures of 1–15%. Lipid was extracted from 100 g flour with 500 ml hexane at room temperature for 2 h. The results showed that the extraction rate changes with flour moisture; highest for 10.8% moisture and lowest for 14.6% moisture, which explains the oxidation reaction rate change with flour moisture. These results may only apply to flours without high temperature treatment such as cooking etc., where the binding of the lipid with other structures and/or components could be changed or destroyed.

Ultrastructure and biomechanics of mitochondria and chloroplast DNA from wheat seed under X and Gama ray radiation with atomic force microscopy

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Biomechanics and the change of ultrafine structure are the both important parameters which can point out or explain the physical and chemical process in the biology, and these mechanical parameters may provide some critical proofs to Life Science. In order to explore the causes of the change of physiological condition and genetic results in biochemical process, biophysicists have tried to detect and collect these parameters with different equipments and methods, in which the atomic force microscopy can get the surface topographies of the sample and much more about the physical and mechanic properties may be most successful equipment and technique up to nowadays. Seed-breeding with nuclear radiation provides the important pathway to get the new products in high quality and quantity which acted mainly by changing the ultrafine structure and physical properties of genetic materials such as DNA molecules. As the common radiation sources, X/ϒ-rays in different dose have been set to act on the fresh wheat seeds from Guan-zhong Plain of Shaanxi province in 2006 summer. And the mitochondria and chloroplast DNA molecules isolated and purified followed the traditional methods from the control and samples. Then we deposited the DNA solution onto the fresh mica and prepared for the atomic force microscope. Have gotten the intuitive topographies of DNA molecules and strand-breaking mitochondria and chloroplast DNA induced X/ϒ-ray with tapping/contact modes in the air at 25°C. From the AFM images of DNA in different irradiation dose, we can see that the strand-breaking number of DNA increased as the irradiation strengthening and the compression elasticity of both DNA molecules increased with the intensification of irradiation. And the irradiation sensitivity of DNA from mitochondria was prominent to that from chloroplast in strand-breaking and compression elasticity. The genetic properties are tightly relating to the physical state and mechanic of the materials (DNA), it's a worth domain to discuss the coherence of the elasticity of the single molecules and the macro objects in the biophysicists' viewpoint. Research on the elasticity of single molecule can help to open out the dynamic rule which control the structure and the function, and explore the biologic secrets.

The effect of substrate concentration and lipase activity analysis in cereal grains

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Whole grain ingredients have higher lipase activity compared to their refined counterparts. Lipase activity level in whole grain ingredients and products influence the amount of free fatty acids and oxidative byproducts formed. The enzyme activity measured, however, is substrate concentration dependent. Substrate affinity and hydrolysis rate varies with the lipase botanical source. To assess the potential for lipid hydrolysis and rancidification, the intrinsic lipase activity of bran and germ mixture from rice, oat, corn, and wheat were analyzed with a spectrophotometric method using *p*-nitrophenyl butyrate (*p*-NPB) as substrate. The optimum substrate concentration was determined for each cereal grain such that each was assessed at their maximum rate of reaction and greatest sensitivity of measurement was obtained. The substrate concentrations were 0.1 to 2 mM. The results showed that at 0.5 mM of substrate the lipase of rice and corn reached maximum reaction rate, and at 1 mM for oat and wheat, when 0.1 g of bran/germ mixture was tested, to give a lipase activity range of 0–10 µmole butyric acid formed per hour (1u = µmole of *p*-NPB hydrolyzed/hour). The lipase activity of the bran and germ mixture of analyzed rice, oat, corn, and wheat were around 9, 6, 2, and 7 u/0.1 g, respectively. The results also indicated that the binding affinity of the lipase with the substrate (*p*-NPB) in these cereal grains were different, higher for that in rice and corn than that in oat and wheat.

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