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2008 Annual Meeting
Abstracts of Pre-Meeting Workshops

Abstracts submitted for presentation at the 2008 annual meeting in Honolulu, Hawaii, September 21–24. The abstracts are listed in alphabetical order by title of workshop and time order of presentation within each workshop. Abstracts are published as submitted. They were formatted but not edited at the AACC International headquarters office.

Dynamics of Health and Wellness: Emerging Trends with Focus on Grains as a Source of Functional Foods

Physiochemical diversity and bioactivity of dietary fiber
P. WOOD
Agriculture and Agri-Food Canada, Guelph, ON
Cereal Foods World 53:A1

Whether viewed from a nutritional or chemical perspective, dietary fibre (DF) shows considerable diversity of properties. Fermentation, fecal bulking, attenuation of postprandial blood glucose levels or lowered cholesterol levels are recognised physiological effects, but it is not clear to what extent these clinically observable effects are responsible for the lowered risk of developing type 2 diabetes, heart disease or cancer, the chronic diseases most often associated with lower intakes DF in observational studies. With our present state of knowledge we cannot say whether there are particular physico-chemical properties of DF associated with lowered risk of chronic disease, but there is little doubt that physicochemical characteristics affect some of the above noted physiological effects clinically observed as a result of consumption of DF. Rate and degree of fermentation of DF is dependent on constituent polysaccharide solubility and composition. Postprandial glycemic response, and probably also lowering of cholesterol levels, are dependant on development of viscosity. At the molecular level it is polysaccharide structure, which includes molecular weight, that controls physical characteristics such as interaction with water, solubility and rheology and self-association or association with other components. If the basis for the physiologically different behaviours is controlled by the physicochemical characteristics and state of the polysaccharides, then simple values from a DF analysis may not be a true measure of bioactivity. This will be illustrated by reference to studies in which measures of viscosity, solubility and MW, but not the amount of oat beta-glucan fed, correlated with physiological response.

Health benefits of whole grain phytochemicals
R. H. LIU
Cornell University, Ithaca, NY
Cereal Foods World 53:A1

Regular consumption of whole grains and whole grain products has been consistently associated with reduced risk of developing chronic diseases such as cardiovascular disease, Type 2 diabetes, some cancers and all-cause mortality. However, phytochemicals or antioxidants in whole grains have not received as much attention as the phytochemicals in fruits and vegetables. Our recent research found that total phytochemical content and antioxidant activity of whole grains have been commonly underestimated in the literature, and whole grains contain more phytochemicals than was previously reported. Most whole grain phenolics are in bound form, 85% in corn, 76% in wheat and 75% in oats. The beneficial effects associated with whole grain consumption are in part due to the existence of the unique phytochemicals that complement those in fruits and vegetables when consumed together. We also found that the majority of potential health beneficial phytochemicals of whole grains are present in the bran/germ fraction. Refined-wheat flour loses 83% of total phenolics, 79% of total flavonoids, 78% of total zeaxanthin, 51% of total lutein and 42% of total b-cryptoxanthin when compared to whole-wheat flour. Therefore, whole grains have greater health benefits when consumed as part of a diet, and help reduce the risk of chronic diseases. This presentation will cover our current research on whole grain phytochemicals and antioxidant activity and their unique contribution to the health benefits of whole grains.

Sad? Blue pigmented grains for happy health
C. YOUNG
Agriculture and Agri-Food Canada, Guelph, ON
Cereal Foods World 53:A1

My mother taught the need for three important characteristics of each and every meal: they should be good, nutritious, and present well. Guess what? The highly pigmented anthocyanins can deliver on all three. The anthocyanins are good in that most tests have shown them to be safe and to satisfy regulatory agency requirements. They are nutritious in that they have beneficial therapeutic and disease preventative properties, especially as anti-oxidants. They present well by virtue of their attractive colors, which range from salmon pink through red and violet to dark blue. These plant-derived constituents belong to the flavonoid group of compounds that are widely distributed through fruits, vegetables, flowers, grains, legumes, roots, tubers, and bulbs. Among other things, this presentation will touch on (1) recent developments in the occurrence of anthocyanins in grains as determined by liquid chromatographic-mass spectrometric analysis, (2) health benefits and their delivery, and (3) other uses, such as natural pigments to replace synthetic ones.

Critical examination of the evidence relating high fructose corn syrup and weight gain
M. STOREY
American Beverage Association, Washington, DC
Cereal Foods World 53:A1

The use of high fructose corn syrup (HFCS) as a caloric sweetener and the rate of obesity in the U.S. population have risen nearly in parallel over the past several decades. Some scientists observed this ecological evidence and suggested that HFCS has played a unique role in development of obesity. Three hypotheses were proposed to support this theory and the observed weight gain: 1) HFCS increased the fructose:glucose ratio in the food supply that led to adverse metabolic effects; 2) HFCS is sweeter than sucrose, which led to over-consumption of HFCS-sweetened foods; and 3) consumption of HFCS-sweetened beverages does not stimulate satiety signals, which led to over-consumption. Each of these hypotheses will be discussed. In addition, results from epidemiological studies and a meta-analysis of children's BMI and soft drink consumption will also be presented.

A synergistic approach to functional product development
M. E. CAMIRE
University of Maine, Orono, ME
Cereal Foods World 53:A2

Nutrition research tends to focus on evaluation of a single nutrient, phytochemical or food on one aspect of human health. Marketing of healthful foods likewise often emphasizes one health benefit or claim for a product. New approaches are needed to develop and promote foods that provide multiple health benefits for consumers. Food ingredients have been blended to provide complementary amino acids profiles. Could this model be adapted to create new foods with different types of benefits? Products could be formulated to target varying aspects of health. For example, a "heart-healthy" breakfast cereal could contain psyllium and oat bran for reducing cholesterol, cranberries for inflammation inhibition, and blueberries and added potassium and calcium to lower blood pressure. A line extension for gut health could substitute dried plums, wheat bran and probiotics. Another approach would be to combine ingredients that affect different aspects of health. A snack bar for weight loss and improved mood might contain dietary fiber, green tea and omega-3 fatty acids. Chinese traditional medicine employs the concept of helper herbs to aid the primary active ingredient. Foods for combating iron deficiency may have extra ascorbic acid to facilitate iron absorption. Other options may become available to increase phytochemicals' bioavailability and transport to target organs. Examples of synergistic foods from around the world and new possibilities for product development will be critiqued. Healthful grains provide the basis for many exciting new designed foods.

Opportunities for the Experienced Professionals

Semi-retirement recommended! An opportunity to pass knowledge to the next generation
C. WRIGLEY (1) and C. Walker (2)
(1) Food Science Australia, Sydney, Australia; (2) Kansas State University, Manhattan, KS
Cereal Foods World 53:A2

Semi-retirement offers senior scientists an excellent opportunity to extend their working lives while assisting the next generation, getting exemption from "administrivia" and finding time for family, leisure and community activities ... it is called "retiring gracefully". In contrast, it is a loss to the profession when an experienced scientist retires abruptly, without giving a thought to the possibility of mentoring up-and-coming researchers. Conversely, it is unfair to younger scientists when senior staff remain on full pay past their "use-by" date. The co-authors offer their own stories as examples of what is possible, plus the stories of several others. "Passing on knowledge" may involve writing or editing a book or encyclopedia, or at least writing up outstanding research findings, preferably together with a next-generation scientist. University and government research situations offer opportunities for supervising post-grads and post-docs; in these cases, the semi-retired person can provide more time than the full-time supervisor. International supervision and mentoring is especially attractive in semi-retirement, providing travel experiences, plus follow-up by e-mail, while helping to improve international relations. We exhort corporations, universities, government agencies and funding bodies to facilitate semi-retirement as a means of retaining the knowledge base of senior scientists, while also stimulating and educating younger scientists.

Consulting after retirement - YourEncore
J. KAMMAN
YourEncore, White Bear Lake, MN
Cereal Foods World 53:A2

With the increasing numbers of "baby boomers" entering or approaching retirement, companies are challenged as to how to retain and access the 25+ years of knowledge of these retirees without compromising pension law. In addition, retirees want to find a fulfilling way to stay connected to their field and contribute their knowledge base without a full-time commitment. YourEncore was founded in 2003 as a means to retain and recruit highly experienced and talented experts to help drive innovation in member companies. YourEncore membership now approaches 4000 Experts representing over 750 companies and institutions who are matched against the needs of our 25 world class Member Companies. YourEncore provides exciting opportunities that are available across numerous companies and industries and if your qualifications are appropriate, you make the personal decision to accept or reject project assignments based on personal interest, scope, time requirements, and match to your personal and professional life. Meanwhile, YourEncore manages all engagement, overhead, and marketing costs while supporting the expert during the assignment.

Surviving the age wave
B. TAYLOR
General Mills, Inc., Minneapolis, MN
Cereal Foods World 53:A2

The baby boomers are fast approaching what used to be the finish line. Many of them are excited to retire, but for most it's retirement with a twist. Most want to continue to participate in the workforce with different terms, rewards, or work content. Meanwhile organizations are increasingly concerned about how to creatively retain both people and institutional knowledge. What can be done when anticipated labor shortages meet these changing employee needs and demographics? Brad Taylor will present several successful initiatives at General Mills that have anticipated and effectively helped them to "survive the age wave".

Divided we fail: Addressing America's health and financial security challenge
B. BOTTORFF
AARP, Honolulu, HI
Cereal Foods World 53:A2

The United States is reaching a tipping point with millions of Americans concerned about their health and long-term financial security. We face many competing and compelling demands: affording health care, saving for retirement, sending children to college, and supporting aging parents. At the same time, soaring health care costs are constraining businesses' ability to grow and compete. To address these concerns AARP launched Divided We Fail, a national initiative designed to amplify the voices of Americans who believe that health and long-term financial security are the most pressing domestic issues facing the country. It's time for leadership and action. That is why AARP, Business Roundtable, SEIU and NFIB, organizations that often hold different views, are coming together to urge action. Collectively, these organizations, representing tens of millions of Americans, will promote broad-based, bi-partisan solutions to these challenges with the American people, elected officials and the business community.

How to stay engaged, productive and gratified after the job is gone
B. ATWELL
Cargill, Inc., Plymouth, MN
Cereal Foods World 53:A2

When a highly active, productive person retires, a void most often must be filled. Initially, all the things that one used to do to relax such as playing golf, traveling, or reading become more frequent activities. Since they are no longer special, after a fairly short time they can become less enjoyable and in some cases downright boring. What is needed are activities that provide the gratification that many found in their positions without the stress or the routine accompanying a full time job. Finding these types of activities may not be as easy as you think. Clearly, volunteering in a way that allows one to bring their expertise to bear is often an avenue to fill this void. The AACC provides many opportunities to volunteer that can keep one productive and make use of the expertise gained during a career in the food industry. One volunteer opportunity that will be discussed in detail is fostering the career of a young person by being a mentor in the AACC Mentoring Program. For many people, mentoring is one of the most engaging and gratifying experiences of all.

2008 Annual Meeting
Abstracts of Symposia Presentations

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Advances in Cereal Grain Processing Technologies

Food production with micro- and nanotechnology – small technology, big opportunities
R. BOOM
Wageningen University, Wageningen, The Netherlands
Cereal Foods World 53:A3

Application of micro- and nanotechnologies in the production of foods is a fundamentally new development in the way we can process raw materials to valuable products. These technologies may help us to prepare food ingredients and assemble foods with much greater accuracy, while making more effective use of resources. The technologies illustrated in this presentation enable us to work with much greater precision and under milder conditions that was previously possible. Separations can be carried out with high selectivity under mild, ambient conditions by using micro-engineered membranes; conversions can become very selective, while the efficiency of processes may be increased when implementing them in mass-parallelized microreactors. Application of nanotechnology for food structuring, by using a combination of self-assembly and directing the assembly process through precisely controlled process conditions, can lead to the formation of food materials which are structured down to the sub-micrometer and nanometer level. These new technologies may contribute to a number of the societal problems that will be important in the coming century: better nutrition for better health, for an ageing population, and to reduce the incidences of (mal)nutrition related diseases. In addition, it can help in making production processes more sustainable.

Potential and applications of advanced imaging and sensing techniques for cereal grain processing
S. PANIGRAHI
North Dakota State University, Fargo, ND
Cereal Foods World 53:A3

This presentation will describe computer imaging and other advanced sensing technologies for cereal grain processing. Computer imaging technologies in both visible and non-visible electro-magnetic spectral bands including NIR, infrared, X-ray, ultrasonic, Raman, and multi-spectral imaging will be discussed. Their applications for characterization and sensing of physical & rheological properties of cereal grains, identification of foreign objects in cereal grain, and quality & process control of different processing operations of cereal grains will be illustrated. Spectroscopic techniques and systems (NIR, IR, FTIR, Raman) and their potential uses for sensing/characterization of physical as well as chemical constituents (protein, sugar, fatty acids moisture, temperature etc.) of cereal grains will be discussed. Integration of spectroscopic techniques as complementary sensing techniques with imaging techniques for developing robust sensing and characterization systems in selected grain processing operations will be highlighted. Other forms of sensors (i.e. optical, electrical, electrochemical, MEMS and Nanotechnologies etc.) and their use in characterization of cereal grain (including GMO characterization, mold contamination detection) and process control during cereal grain processing will be illustrated.

Challenges in extruding healthful products
M. E. CAMIRE
University of Maine, Orono, ME
Cereal Foods World 53:A3

Extruders can produce a wide variety of foods that can be modified to deliver improved nutritional quality. Opportunities exist to create line extensions by tailoring nutritional benefits for a particular product to different demographic groups. Anthocyanins, phenolic acids, and other phytochemicals, as well as many vitamins, are affected by the combinations of heat, shear and pressure within the extruder barrel. Interactions of healthful compounds with iron and other metals from screw wear are also a concern. Omega-3 fatty acids and other unsaturated lipids are prone to oxidation that is accelerated in puffed products. Strategies to protect delicate compounds include encapsulation, injection near the die, and modification of extrusion parameters to minimize losses. Novel ingredients may have unusual rheological properties that complicate the extrusion process. Other materials, such as dietary fiber-rich ingredients, inhibit expansion, alternate ingredients may be necessary to retain desirable sensory characteristics. The prospect for new markets for healthful extruded foods remains strong.

Emerging technologies to increase the efficiency of the dry fractionation processes of wheat products
Y. Hemery (1), J. ABECASSIS (1), R. Havenaar (2), M. Noort (2), M. Chaurand (1), X. Rouau (1)
(1) UMR 1208 Agropolymer Engineering and Emerging Technologies, INRA, SupAgro, University of Montpellier 2, CIRAD, 2 place Pierre Viala, Montpellier, France; (2) TNO, Zeist, The Netherlands
Cereal Foods World 53:A3

Wheat grains are a potential source of bioactive compounds (fibres, micronutrients, phytochemicals) that are recognized as positive for consumers health. These compounds are mostly present in the outer parts of grains, where they are encapsulated in cellular structures and partly co-localized with detrimental compounds. Grain outer parts are excluded from foods based on white flour, the mass product of the conventional milling process. There is however a demand for nutritionally enriched cereal ingredients and foods that remains attractive and tasty for the consumers and convenient for processors. New dry-fractionation processes are being developed in order to convert bran into ingredients rich in molecules of nutritional interest. Ultra-fine grindings (by impact and jet-milling) were used to drastically decrease the bran particles size, to facilitate the separation of bran tissues and to increase the breakage of aleurone cell walls with the aim to make the aleurone cell compounds more bio-accessible. Cryogenic grinding was also used to prepare ultra-fine bran fractions for further evaluation of the impact of heat generated during bran grinding on these bioactive compounds. Moreover, these ultra-fine bran fractions were submitted to further separation (air-classification, electroseparation) to create new fractions exhibiting different compositions measured with a system of reliable biochemical markers of the different grain tissues and sub-structures. The impact of these processes were evaluated on the nutritional (antioxydant capacity) and sensorial (breadmaking tests) properties with the aim to produce health-promoting ingredients from wheat bran.

Application of high power ultrasound in the cereal industry
H. SINGH (1), F. MacRitchie (2)
(1) California State University, Los Angeles, CA; (2) Kansas State University, Manhattan, KS
Cereal Foods World 53:A4

The application of high power ultrasound (sonication) has been reported to produce chemical changes to molecules in solution and has led to a new branch of chemistry called sonochemistry. Two different mechanisms, cavitation and physical or shear effects have been found to be responsible for the exceptional chemistry. The compression and rarefaction cycle and collapse of microbubbles can produce extreme conditions of pressure and temperature at a micro level, a phenomenon referred to as cavitation. This can lead to free radical generation. On the other hand, shear effects produced during these conditions can depolymerize large macromolecules. Often, the simultaneous effects of cavitation and shear are observed. Sonication is a green chemistry procedure; i.e. it has potential to carry out specific chemical reactions while avoiding the use of environmentally unattractive reagents. It has been used for the breakdown of polymers, the production of micro and nano-emulsions, and the extraction and purification of starches and bioactive components. In the cereal area, sonication has been used to enhance solubility of proteins. This has assisted in the characterization of wheat and sorghum proteins with potential for their use in fortified beverages. Modification of cereal components to improve their properties as food ingredients is another possible application. Although a number of chemical reactions can be catalyzed by this technology, the application in industry has been limited due to scale up concerns. Availability of better design and scale up equipment in the last decade has generated new interest in this technology for future applications. Most of the instruments work at fixed frequency with variable power (watts), however, variable frequency and dual frequency instruments have now become available.

Supercritical fluid extrusion technology for generation of microporous products containing heat sensitive ingredients
S. RIZVI
Cornell University, Ithaca, NY
Cereal Foods World 53:A4

Porous cellular and microcellular structures are the key to creating a large number of novel and conventional expanded foods and extrusion cooking is a widely used, continuous process of choice for manufacturing many such low-density products. The market for and value of such products would be greatly enhanced if the process could be made amenable to utilization of heat and shear sensitive ingredients such as flavorings and bioactive nutraceuticals. Supercritical fluid extrusion (SCFX) is a hybrid process that uses supercritical carbon dioxide (SC-CO2) as a blowing agent, enabling extrusion at lower temperatures and shear. The formation of cell structure in SCFX is mainly governed by the amount of SC-CO2 that is solubilized in the melt, creating a single system, and the rate of cell nucleation. The solubility of supercritical fluids in solution is a function of pressure and its attainment is diffusion controlled (time-dependent). The rate of cell nucleation is proportional to the rate of pressure drop in the extruder die and is influenced by the rheology of the melt. Therefore pressure, SC-CO2 residence time, pressure drop rate and melt rheology play critical roles in determining the morphology and mechanical properties (texture) of extrudates and can be manipulated to produce products of different attributes. Other derivative advantages include composite microstructure of extrudates, preferential deposition of flavoring and bioactive materials on the internal cell wall and near inert internal atmosphere. The presentation will address the principle and practice of SCFX for delivering selected solutes via expanded food matrices similar to snack food, breakfast cereals and baked goods and some of the products characteristics will also be illustrated.

A commercial perspective on dealing with paradigm shifts in milling industry
G. WEAVER
ConAgra Foods, Inc., Omaha, NE
Cereal Foods World 53:A4

This talk will examine two items of interest that have created a paradigm shift in operations in the commercial milling industry. The first item focuses around dealing with changing expectation for microbial load in grain based ingredients targeted for the near-RTE categories. The processing considerations that need to be factored in and the specific targets for this sector of the food industry will be discussed. The second paradigm shift is the transition from bench-top evaluation to on-line NIR monitoring of processing attributes. Discussion will center on what needs to be considered for successful installation and improvement in quality monitoring of milling processes.

Applying High Tech Instrumental Approaches to Cereal Chemistry Part 1 – Chemical Imaging

FT-IR microspectroscopic imaging (Mid-IR)
D. WETZEL
Kansas State University, Manhattan, KS
Cereal Foods World 53:A4

High spatial resolution achieved by FT-IR microspectroscopy enables analysis at the cellular and subcellular level. Homogenates and stains are not needed, thus the process is less intrusive than traditional analytical methods. FT-IR microspectroscopy had it's origin in 1986 when the first research grade infrared microscope was developed, for forensic and materials sciences, and subsequently patented in 1989. Our first experiments on wheat (1987) included manually taking data across a specimen referred to as line mapping. At our request, a programmable, motorized stage was developed to enable x y mapping in time for an ICC Vienna meeting. When the first section of wheat was imaged, the effect of light scattering by starch granules overwhelmed the light absorption and the spectroscopic results were obscured in the raw data. Software writers of the Spectra-Tech Company came to the rescue by providing locally baseline corrected peak areas of organic functional groups accounting for lipid, protein and carbohydrate. An image of a wheat section resulted showing realistic populations of each of the chemical species at different places within the kernel. Throughout the 1990s, FT-IR microspectroscopy was used as a research tool to probe kernels of various grains, peppercorns, vanilla beans and other interesting materials. It has been our privilege to adapt FT-IR microspectroscopy for analyzing biological materials at the cellular and subcellular level. A single aleurone cell was mapped as early as 1992. Subsequently sharper images were produced using synchrotron radiation on corn aleurone cells. Biological tissue imaging included single cells, and has become routine for research use. The imaging procedure provides means to identify areas of interest from which individual pixels are obtained using high quality spectral resolution and spatial resolution. In our work with grain sections in situ virtually every boundary between botanical parts has be characterized to show chemical differences between them. With focal plane array instruments data is much easier to obtain than by raster scanning using a single detector. Examples presented include microspectroscopic imaging to study wheat before germination and after germination and a seven year study of protein quality related to secondary protein structure of experimental Kansas wheats.

Near-IR spectroscopic imaging
L. BREWER, D. Wetzel
Kansas State University, Manhattan, KS
Cereal Foods World 53:A4

Nearly 82,000 individual near IR spectra are collected in three minutes, with a state of the art focal plane array near imaging system. Near infrared chemical imaging is technology driven. Modern commercial instruments for near-IR chemical imaging, initially refereed to as hyperspectral imaging, are a direct spin offs from solid state array detector technology developed for defense. Imaging reveals where as well as what and how much of a chemical species is found in the specimen on the stage. The pioneering experiment in Cincinnati, October 10, 2000, by E. Neil Lewis and Curtis Marcott with a 64 X 64 array InGaAs camera and a conventional step scan FT-IR microspectrometer provided a 4096 pixel image. The 21st century commercial instrument of Spectral Dimensions/Malvern is available with a 350 X 256 array yielding 81,600 individual spectra. These are available in either InSb (Te cooled) or InGaAs. Another modern solid state device, a liquid crystal tunable filter (LCTF) uses electronic wavelength switching that requires no moving parts to scan these spectra. With x, y, z dimensions data cubes are the result. The current major use of this instrument has been in the pharmaceutical industry, where pure chemical compounds have a distinct molecular structure in the near-IR. In cereal chemistry, we are concerned with commodities and identifying them either after isolation from some process, such as milling, or their combination in a food or formulated feed. Because these commodities exist as a mixture their individual chemical definition is not distinct unlike the ingredients of pharmaceutical products. Harder work is required to reveal and define distinguishing features either using a single wavelength or multivariate expressions to define distinctive features of each component of a mixture. The system is applicable to mixtures of granular material, cross sections of seeds and even whole seeds. The spectrum of a given pixel is the key to identifying

that portion of the specimen as being predominantly of one particular composition. Single pixel analysis provides the mechanism for doing quantitative analysis by pixel counting. Examples presented include: nondestructive early detection of germination, endosperm vs nonendosperm in intermediate products in flour milling, components in a mixed formulation for food or feed product.

Raman microspectroscopic imaging
D. HIMMELSBACH
USDA Russel Research Center, Athens, GA
Cereal Foods World 53:A5

Raman microscopic imaging, although not as common as infrared imaging, has been used to effectively locate the major chemical component of several grain types (i.e. corn, wheat and rice). These chemical images have provided definitive locations of protein, starch and aromatic components in kernels with the advantage of avoiding the interference of water in the samples. Protein was observed primarily at 1655 cm^{-1} (Raman shift) due to the amide I band, starch at 480 cm^{-1} and aromatic components, such as ferulic acid, at about 1600 cm^{-1}. Other components of grains, lipids and cellulose, have been observed selectively at 2850 cm^{-1} and 380 cm^{-1}. Furthermore Raman can be used to probe cell wall composition and grain hardness. It can also determine detailed information such as protein conformation. Raman chemical images have been obtained from both Fourier-transform (FT) based systems utilizing a 1064 nm laser with a germanium detector or with dispersive systems using a 785 nm laser with a charged coupled device (CCD) detector. FT Raman was found to be most useful for the detection of aromatic components of grain that often fluoresce that can swamp out the Raman signal. Dispersive systems have been shown to be most useful observed the other chemical components of grains at high spatial resolution. The ultimate in spatial resolution has been obtained using atomic force microscopy (AFM) based con-focal Raman.

Applying High Tech Instrumental Approaches to Cereal Chemistry Part 2 – Separations and Determinations

Starch structure via small-angle X-ray scattering and wide-angle X-ray scattering
Y.-C. SHI, L. Cai, B. S. Hsiao, L. Rong
Kansas State University, Manhattan, KS
Cereal Foods World 53:A5

Starch, a polymer of glucose, is one of the most abundant carbohydrates on earth. As a natural, renewable carbohydrate polymer, starch is one of the most promising sustainable biomaterials. The structure of starch granule is organized on four different length scales: the whole granule architecture (1 – 100 micron), semi-crystalline growth rings (about 0.1 micron), the lamellae (9 nm), and the scale of the molecules (0.1 – 1 nm). All of these four length scales must be considered to understand the functional properties of starch. Small-angle X-ray scattering (SAXS) and wide-angle X-ray scattering (WAXS) are powerful tools to probe the structure of starch. SAXS covers the range 2–200 nm and occurs at low scattering angles (1–10°) while wide-angle X-ray scattering (WAXS) covers the angular range 7–60°. Linear short-chain amylose molecules with different degrees of crystallinity were produced by debranching of waxy maize starch. We will illustrate how synchrotron based SAXS and WAXS techniques are used to determine the structure of biopolymers such as starch. The high intensity of X-rays produced from synchrotron radiation sources enables us to obtain information on crystallite size, unit cell size, and thickness between the crystalline and amorphous regions. The high flux of synchrotron X-rays allows us to follow starch structural changes in a time-resolved manner.

Obtaining and interpreting the full size distribution of native starch
R. GILBERT, E. Girard, N.-L. Hoang, A. Landolfi, J. Peate, M. Gaborieau, P. Castignolles
Centre for Nutrition & Food Science, The University of Queensland, Brisbane, QLD 4072 Australia
Cereal Foods World 53:A5

Revealing the structure of isolated starch molecules is important for structure-property relationships relevant to human and animal nutrition, and industrial applications such as paper. Native starch has been separated over many years by size exclusion chromatography (SEC, also known as gel permeation chromatography, GPC) using diverse solubilization procedures and eluents, but no single technique has been developed with all of complete solubilization, absence of degradation, repeatability and reproducibility of both the dissolution and separation, and high recovery. Conditions are given for separation which overcomes these problems. We use a combination of polar organic solvents: dimethylsulfoxide (for complete dissolution with minimal degradation) and dimethylacetamide (to limit shear degradation). Covalent labeling on the glucose monomer unit is performed for the first time in mild (non-degradative) conditions to allow the use of UV detector with significantly higher sensitivity. It is important to realize that SEC separates by size, not molecular weight, and so one can never obtain an actual molecular weight distribution of a branched polymer such as starch, where molecules of different molecular weights and different branching structure can have the same size. Using the new methods with multiple detection (differential refractive index, UV, multiple-angle light scattering ands in-line viscometry) yields the size distributions of the number and weight distributions, and of the weight- and number-average molecular weights of native and processed starches. Treating the resulting data by comparison with an equivalent randomly branched structure gives considerable information on the changes in starch structure caused by milling and by digestion. This treatment forms the basis of the structure-property relations needed for improved foods and food processing.

Variety and defect identification by microfluidics
I. BATEY, S. Uthayakumaran, C. Wrigley
Food Science Australia, North Ryde NSW 1670
Cereal Foods World 53:A5

Microfluidic capillary electrophoresis provides the means for carrying out separations of biological macromolecules in very short times. Equipment is commercially available which can perform analysis of 10 samples in 30 minutes. It may be applied to protein or DNA samples. Sample preparation for protein analysis means that variety identification may be performed in about an hour. Sample preparation for DNA analysis takes longer. The capability to perform variety identification on a truck-by-truck basis at receival has long been a goal for cereal-variety identification. This goal was almost achieved by the deployment of a micro-fluidics bioanalyzer with protein analysis at grain-receival sites in southern NSW and Victoria during a recent harvest. Almost 300 wheat and barley samples were examined during a 10-day period at a number of stations. This equipment allows the confirmation of variety on the spot. For some difficult confirmations, it is necessary for DNA analysis to be applied at a central laboratory. The methodology has also proved suitable for quickly identifying the defects of sulfur deficiency and bug damage in wheat.

Basics and applications of modern LC/CZE-TOF-MS technology in the field of food research and quality control
M. PELZING
Bruker Daltonics
Cereal Foods World 53:A5

The role of mass spectrometry in food analysis and production control has advanced strongly in the past decade, raising its applications into the realms of the routine. Today, if you are working in industrial QC, toxicology or food safety analysis you will be experiencing increasing pressures to increase sample throughput, and the speed to result whilst maintaining high accuracy. These pressures have driven the development of new approaches based on mass spectrometry. The field covered by modern mass spectrometry in conjunction with separation methods like high resolution HPLC or electro-osmotic driven separation such as capillary zone electrophoresis (CZE) also includes fundamental research into the interaction of proteins and metabolites of an organism, through to quality control and food safety analysis. Whilst traditional single or triple quadrupole methods have remained common, they are limited in the number of targets which can be analyzed simultaneously, prompting a move to faster, more automated approaches using more recently refined technologies. Time of Flight (TOF) detector-based technologies have enabled a solution based on powerful accurate mass, high resolution Extracted Ion Chromatograms (hrEIC) and true isotopic pattern (TIP) data matched to a comprehensive library allowing for sensitive, quantitative and reproducible results. The analysis of data, using our novel TargetAnalysis software, provides routine labs with the ability to search for known metabolites, residues, and compounds. Furthermore, as libraries are updated, searches on stored and previously searched data, can be repeated. Beside the brief technical introduction in basics of modern Time of Flight mass spectrometry, and the technical advantages of hyphenation with separation methods, a wide number of application covering protein identification and quantitation, metabolomic studies of plant growing conditions using statistical treatment of data (such as Principal Component Analysis) and pesticide residue analysis in food and drinking water will be presented and discussed. As a future technology outlook, results of a complete integration of LC-NMR-MS workflow will be presented.

Biofuels and Biorefining/Biomaterials

The Bioeconomy – Will science make it a good revolution?
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Cereal Foods World 53:A6

The emerging Bioeconomy wherein agriculture replaces many nonrenewable resources, especially petroleum, is profoundly affecting global agriculture and world economies, not unlike the Industrial Revolution. The question is whether science and political decision-making will make it a "good revolution." Today's biofuel industries based on grains to ethanol and biodiesel will need to transition into tomorrow's biorefineries, which will use crop byproducts and cellulosic crops to supplement grain as feedstock and will produce industrial chemicals, biobased products and bioenergy, as well as biofuels. Advanced biorefineries may also shift from today's preferred automobile biofuels, ethanol, to better performing and more energy dense products, such as butanol or plant-based hydrocarbons. Biorefineries will need to use a variety of feedstocks to take advantage of the lowest cost inputs depending on location and time of year. Biorefineries will produce a diverse product mix and will alter daily the product mix depending on what the marketplace wants to maximize returns. Biological, thermochemical and hybrid conversions will be used to produce intermediates that then can be chemically converted. Biotechnology and plant sciences will need to alter feedstocks to enhance processing and conversion, produce biobased products with better performance properties, and to enable recycling nutrients to the soil. Sustainability will be key; it is unacceptable to replace the unsustainable petroleum system with another. Up to present days, agriculture has optimized crop production for food and feed, but now must transition to provide fuels, chemicals and biomaterials. Integrated, systems-oriented thinking will be required to solve the challenges that this new revolution will bring, especially for sustainability and minimizing environmental footprint. While there has been much recent criticism of biofuels, most critics offer no solution and advocate the status quo, which is also unsustainable. Will agriculture measure up to these challenges?

Changing dry grind ethanol production: New fermentation and coproduct technologies
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Cereal Foods World 53:A6

The dry grind corn processing industry has grown 350% from 2000 to 2008 due to demand for ethanol as fuel oxygenate, low corn prices and high ethanol prices. In 2007, corn prices were at record highs and ethanol prices were low, thus reducing ethanol plant profit margins. With shrinking margins, further improvements in fermentation technology, biocatalysis and process design are required to increase ethanol productivity, recover new coproducts and improve plant profitability. Corn process research at the University of Illinois is focused on modification and development of efficient dry grind technologies. Four technologies: 1) use of granular starch hydrolyzing enzymes, 2) corn fractionation prior to fermentation, 3) simultaneous liquefaction, saccharification, fermentation and distillation and 4) fermentation using dynamic controller will be presented. Compared to the conventional process, these technologies can increase the initial slurry solids content (40% dry solids), increase fermentation rate (100%), reduce glucoamylase use (35%), reduce substrate (glucose concentration less than 2% w/v) and product (ethanol concentration less than 5% w/v) inhibition and recover coproducts with higher market value ($0.25 to 5.00/lb).

Enzymatic conversion of cellulose
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Cereal Foods World 53:A6

Research and Development at Specialty Enzymes and Biochemicals company continue to work on developing an efficient, cost effective and energy saving enzyme process to convert cellulose into fermentable sugars and eventually into ethanol. The earliest process for producing ethanol from a cellulosic source took place in the late 19th century in Germany. It involved the use of dilute acid to hydrolyze the cellulose from wood waste to glucose. The process continued until the World War One when lumber production forced an end to this type of production. With crude oil topping $100/barrel, the race is back on to produce cellulosic ethanol. Today, the process used is an enzyme solution. The inherent difficulties have to do with what we actually mean when we say cellulosic substrate. These can include corn stover, used paper, switchgrass, other waste grasses, rice hulls, wood chips and more. The reality is that we are really talking about a complex of compounds, Cellulose, Hemicellulose, and lignin as the main componenst. Cellulase is the key component, but when we talk about cellulase, we are really talking about a group of cellulases. These are both endo- and exocellulases. Other non-starch polysaccharides, the hemicelluloses, are predominantly 5-carbon sugar based such as xylans, mannans, arabinogalactans, etc. As a result, typical yeast used for fermentation cannot produce ethanol from these complex polysaccharides. Of course, lignins are not saccharides at all but complexes of monolignols. Therefore, there one has to consider the potential options for processing. Do you process the substrate as a whole, separate the major components into three processing streams or do you find "bugs" that can convert 5-carbon pentosans into ethanol. All of these processes are being researched. At this juncture, cellulosic ethanol has yet to be cost effective.

Maize vs biomass, food vs fuel and the 2022 ethanol mandate
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Cereal Foods World 53:A6

The 2022 ethanol mandate anticipates that 79.5 billion liters of the 136.3 billion liters of ethanol will be produced to be from non-maize biomass. However, several technological barriers impede the development of a cost effective biomass to ethanol process. If these barriers are not overcome, can maize provide the necessary amount of biofuels without consuming maize acreage needed for food and industrial products? This analysis looks at technological improvements in dry grind ethanol, increased maize yield potential, stover and changes in crop rotation to see how much of the 136.3 billion liter mandate can be achieved with maize only. A spread-sheet model was used to calculate the gross and net returns per hector of different crop rotations. Results of the analysis showed that a continuous high oil maize-maize rotation using prefractionation of the germ and coarse fiber at the ethanol plant results in only 44% of the necessary biofuel but yielded 97% of the vegetable oil produced from a conventional maize-soybean rotation. Assuming a yield increase rate of 0.2 Mt/ha/yr, conversion of stover cellulose and using all additional maize produced on all hectors, can achieve 73% of the mandated 136.3 billion liters and 97% of the oil produced with a maize-soybean rotation. To achieve 100% of the 136.3 billion litters of ethanol will require the use of an additional 7.52 million hectors of maize on maize. The additional hectors could come from animal feed, carry over or export maize. Hectors representing food and industrial maize will not be needed for ethanol. At current maize and soybean prices, a crop of Miscanthus biomass would need to receive at least $79 per dry ton in order for the producer to receive comparable compensation to continuous maize.

Case Studies of Past, Present, and Future Applications in Biotech Crops

Conquering trans fats and other nutritional issues with molecular genetics: A success story for healthier soybeans
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Cereal Foods World 53:A6

Soybeans are grown as a commodity crop, valuable for both major seed components: the extractable oil and the high protein meal. The oxidative stability of soybean oil was previously improved by reducing the linolenic acid component in the oil through chemical hydrogenation. Hydrogenated soybean oil became the first choice for many baking and frying applications. However, subsequent nutrition research studies revealed that the trans-fats created during the hydrogenation process were a serious threat to heart health, and inclusion of trans-fats on food labels became mandatory in 2006. Soybean breeding efforts to reduce the linolenic acid content in soybean oil were successful in identifying soybean lines that contained significantly lower levels of linolenic acid in the seed oil. Incorporation of the low linolenic acid trait into elite varieties was confounded by the complex nature of the low linolenic acid trait. The objective of my research is to identify the molecular genetic basis of important soybean seed composition traits and translate that information into resources to more efficiently develop soybeans with improved quality traits. Using a candidate gene approach, a set of soybean genes were identified and characterized which code for fatty acid desaturase enzymes that synthesize linolenic acid. When mutated, these genes each contribute independently and additively to the low linolenic acid trait. We have developed molecular marker assays and novel soybean germplasm that allow for direct selection of desired alleles, and these resources enhance the ability to create elite soybean cultivars with the low linolenic acid trait. Low linolenic acid soybean oil is now one of the options for food companies to utilize as a trans-fat-free source of oil.

Future applications of crops developed using modern biotechnology
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Cereal Foods World 53:A7

Growers from around the world have chosen to plant more varieties of crops and larger percentages of their crops that benefit from the incorporation of biotechnology derived traits. First generation biotechnology traits have largely provided insect protection and herbicide resistance as the key benefits to the grower. Second generation biotechnology agricultural seed products with additional and/or alternative insecticidal modes of action and/or different herbicide resistance treatment options are currently being introduced. Products with quantitative agronomic traits resulting in increased yield and drought tolerance are scheduled for introduction on the near term. Future products with additional consumer health benefits such as food quality traits and improved nutritional qualities are also under development. Some of the new biotechnology traits are being developed using technical approaches such as RNAi (RNA interference) and transcription factors (proteins regulating genes). This presentation will highlight some of the new product types resulting from the use of biotechnology in agriculture and discuss some of the technical approaches used to develop the next generations of products.

Hawaiian transgenic papaya: Need, development, commercialization, and impact
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Cereal Foods World 53:A7

Papaya is widely grown in the tropics and is Hawaii's second most important fruit crop, behind pineapple. For many years, the Hawaiian papaya flourished in the district of Puna on the island of Hawaii, where 95% of the state's papaya were grown. However, in 1992 papaya ringspot virus, the most devastating virus of papaya worldwide, was discovered in Puna. Papaya ringspot virus is rapidly transmitted by aphid insects, severely affects production of papaya, and resistance to the virus has not been identified in *Carica papaya*. The virus spread rapidly in Puna and by 1998, papaya production in Puna had decreased by 50% from 1992 levels. Fortunately, research started in the mid 1980's had resulted in the development of a virus-resistant transgenic papaya in 1991 that expressed the coat protein gene of papaya ringspot virus. The transgenic papaya was subsequently released to Hawaii papaya farmers in 1998. This presentation traces the development, commercialization, and the impact of the transgenic papaya that virtually saved the papaya industry from destruction by the papaya ringspot virus.

Genomics strategies to improve abiotic stress tolerance in cereal crops
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Cereal Foods World 53:A7

Cereal grains are the major source of calories in human diet. Wheat *Triticum aestivum* L., is a major cereal crop around the world grown from the tropics to the edge of the Arctic circle. To allow cultivation under such diverse conditions wheat has undergone extensive breeding to optimize performance under local growing conditions. However, wheat is negatively affected by a wide range of abiotic stress conditions which affect plant growth, agronomic performance and yield. Low-temperature (LT) is one such abiotic stress which affects wheat yield in almost all climatic zones. However, the ability to withstand LT during winters is a major factor restricting winter wheat production in Northern latitudes. Genomics is a multidisciplinary approach to study whole genomes by combining genetic, biochemistry, and molecular biology with informatics and automation technologies. Recent advances in genetic and physical mapping have allowed identification of chromosomal regions and in several cases genes associated with abiotic stress in cereal crops. To understand the molecular mechanism of LT tolerance, we have genetically analyzed the trait in a doubled haploid mapping populations, and identified and partially characterized the LT associated quantitative trait loci (QTL) by BAC sequencing. Genetic mapping studies have identified a region on wheat chromosome 5A associated with LT-tolerance. DNA sequencing of the QTL located on chromosome 5A revealed the presence of a cluster of *cbf* genes. Quantitative gene expression studies showed that in winter wheat as compared to leaves, crown tissue consistently accumulated cold-responsive gene transcripts. Transcriptome analysis of crown and leaf tissue has identified several novel LT-induced transcripts, which are currently being characterized. A comprehensive model for wheat LT tolerance incorporating different genomic approaches will be presented.

Implications of global climate change for wheat-grain quality
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Cereal Foods World 53:A7

Increasing levels of carbon dioxide in the atmosphere are predicted to cause warmer temperatures (especially the daily minima), changed patterns of rainfall, and increased frequency and severity of heat-stress episodes, together with decreased frost frequency and rising sea levels. These trends imply a future of fluctuations in wheat yield and quality. Increased carbon dioxide is known to act as a "carbon fertilizer", raising biomass and grain yields, but lowering grain-protein levels. Higher growing temperatures may mean greater dough strength for cooler wheat-growing regions, but wheat is already produced in regions where growth temperatures are well above the ideal (15°C). Climate-change models indicate that heat-stress episodes (a few days with maxima over 35°C) will be more frequent during the grain-filling period, resulting in harvested grain with dough strength weaker than expected for the combination of variety and protein content. However, certain varieties show some tolerance to the dough-weakening effects of heat stress. Gluten proteins from heat-stressed tolerant varieties have a higher molecular-weight-distribution than proteins from susceptible wheats. This finding is consistent with our present knowledge of the relationships between protein composition and dough strength. However, it does little to clarify what heat stress has (or has not) done to cause these differences in protein composition. Genetic study of tolerant versus susceptible varieties should shed light on the molecular reasons for these differences, thereby providing a basis for creating heat-tolerant genotypes.

Dough Structure and its Relation to Bread Making Performance

Molecular basis of extensional rheology required for dough bubble stability in breadmaking
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Cereal Foods World 53:A7

The rheological properties of gluten are known to be important for the stability of the expanding gas bubbles during fermentation and baking, which are responsible for the texture and final volume of bread. Bubble wall stability in doughs has been shown to be related directly to extensional strain hardening, both experimentally and theoretically via the Considere criterion for instability in extension of polymers. This predicts that when strain hardening falls below a critical value, bubble walls are no longer stable and coalesce rapidly, leading to loss in gas retention and lower final baking volume and texture. Strain hardening in doughs has been shown to reach this value at increasingly higher temperatures for better breadmaking varieties, and is directly related to bubble stability and baking performance. Polymer molecular modelling using the Pom-Pom model has enabled prediction of the effects of changes in gluten polymer secondary structure on rheological behaviour. Gluten polymers were assumed to have a linear backbone made up of high molecular weight glutenin subunits, with branches formed by low molecular weight LMW-glutenin subunits along the main glutenin backbone, and their extensional rheology was predicted by the Pom-Pom model. The model predicts increased strain hardening and stability for dough bubbles with increasing strain rate (up to a critical limit), beyond which failure occurs at lower strains as strain rate is increased. An increase in the number of long chain branches from 2 to 5 increases strain hardening and the point of bubble instability. Bubble stability and failure strain is increased with increasing length and number of branches. The onset of instability occurs at increasingly higher strain hardening and with increasing chain branching and strain rates, which has been qualitatively related to the variations in baking performance with flour type and temperature. It is therefore suggested that branching along the linear polymer backbone of gluten is essential to produce strain hardening under large deformation and to promote increased bubble stability during proof.

The (physiological) origin of dough properties
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Cereal Foods World 53:A7

Since the first publication of Glutenin particles there has been some debate as to the nature of such particles. In this paper, we present a detailed comparison of Glutenin Particles as isolated from wheat flour (cv Cadenza) and Protein

Bodies, as isolated from immature seeds (15 DAF) of the same variety. The proteins in both fractions were compared at different length scales: at a compositional level both fractions consist of the same proteins with one exception: the Protein Body fraction also contains a 22 kD protein that was positively identified as triticin. This protein was not found in GMP/glutenin particles. SE-HPLC of sonicated protein extracts demonstrated a comparable pattern of oligomers and monomers. This was confirmed by Gel Electrophoresis of the different SE-HPLC fractions. A large contrast was observed when measuring the size of either Protein Bodies or Glutenin Particles. Protein Bodies are significantly smaller (D4,3 = 12 μm) than Glutenin Particles (D4,3 = 77 μm). Interestingly, when Protein Bodies were extracted with 1,5% SDS and centrifuged, a gel is formed. The size of the particles in this gel is not significantly different from the size of the initial protein bodies as measured in the absence of SDS. PB-derived glutenin particles however, do not contain triticin. Although our studies demonstrate a great similarity between glutenin particles and protein bodies in terms of their protein composition, oligomeric nature and ability to form a gel in SDS, the difference in size still required an explanation. We tested the hypothesis that during kernel maturation -more precisely during the desiccation phase when membrane integrity is lost- Protein Bodies can fuse within the confines of the endosperm cell. Since the endosperm cell also contains starch granules, this means that they have to compete with starch granules for space. A comparison of endosperm cell size distribution and glutenin particle sizes provides a first confirmation of this hypothesis. Data from a number of heat stressed wheat varieties provided further support: the volume of glutenin particles found was found to be proportional to protein concentration.

Mechanism of gas cell stability in bread making

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Cereal Foods World 53:A8

A stable gas cell structure of dough formed during mixing is a prerequisite for bread making. Expansion of dough and hence bread making performance is postulated to depend on a dual mechanism for stabilization of inflating gas bubbles. The primary stabilizing mechanism is due to the gluten-starch matrix surrounding the bubble. The secondary mechanism operates when gas bubbles come into close contact during later proofing and early baking. When discontinuities occur in the gluten-starch matrix surrounding gas bubbles, thin liquid lamellae stabilized by adsorbed surface active compounds, provide a secondary stabilization. A key parameter in the primary stabilizing dough film is thought to be the property of strain hardening. On varying the protein molecular weight distribution (MWD) of a control flour by addition of gluten rich fractions, the strain hardening index and the test-bake loaf volume increase with increasing MWD up to a point (optimum), after which they decline. At a given strain rate, the behavior at the optimum appears to result from slippage of the maximum number of statistical segments between entanglements, without disrupting the entangled network of polymeric proteins. Shift of MWD to MW higher than the optimum results in a stronger network with reduced slippage through entanglement nodes, whereas a shift to lower MWs will decrease the strength of the network due to a lesser number of entanglements per chain. Lipids and other surface-active components appear to control the secondary stabilizing mechanism. Incremental addition of different lipid fractions to defatted flour causes no change in rheological properties of the dough, although large effects on the loaf volume can be measured. Polar lipids and palmitic acid have positive or little effect on loaf volume respectively. Non polar lipid, linoleic and myristic acids have negative effects on loaf volume. The different effects of the lipid fractions are thought to be related to the type of monolayer that is formed. Polar lipid and palmitic acid form condensed monolayers at the air/water interface whereas non polar lipid, linoleic and myristic acids form expanded monolayers.

Elastic properties of wheat gluten and its relationship to breadmaking performance

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Cereal Foods World 53:A8

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 intercultivar variations in the pure elastic properties of gluten and in turn how these variations are related to dough physical properties and breadmaking performance. Recovery after shear creep and cyclic large deformation tensile testing are two ways to decouple elastic and viscous effects. A large variation in the recoverable shear strain preceding creep (~7.2% to ~28%) was seen for Glutomatic-obtained glutens from 15 U.S. popular wheat cultivars with varying HMW subunits. Zeleny sedimentation values ranged from 29 to 57 ml for 12 hard wheat cultivars and from 15 to 22 ml for three soft wheat cultivars. The recoverable strain ranged from 71 to 93% of the creep deformation. The tensile force at 500% deformation ranged from 0.12 to 0.67 N for hard wheat glutens and from 0.10 to 0.20 for soft wheat glutens. The recoverable strain was inversely correlated to the maximum force for the hard wheat glutens. However, the recoverable work dropped to <40% for all of these glutens in the cyclic tensile test, but was positively correlated to the total work of extension. These results highlight the important role that elasticity plays in explaining the large deformation rheological properties of gluten. This in turn, may be related to important functional properties such as gluten extensibility and "snap back". Additional testing of ten blended flours indicated that the elastic properties of gluten could be varied in a predictable manner by manipulating the weight percent of the individual cultivars in the blend. Good to excellent bread volume was obtained for several cultivars from this sample set. This suggests that by adjusting the flour blending and optimizing the breadmaking process compensated for the differences in elastic behaviors of these glutens. This work defines those ranges objectively using creep-recovery and tensile testing.

Studying (molecular) segmental motion of wheat gluten proteins with high frequency ultrasound

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Cereal Foods World 53:A8

Hydrated wheat gluten proteins are undeniably complex. Therefore, investigations of their effects on dough functionality should ideally be performed with a suite of techniques. Low-intensity ultrasound is one technique that, with other mechanical and biochemical approaches, provides new insights into the behaviour of the molecules that constitute the 'dough structure puzzle'. Ultrasonic velocity and attenuation are two independently-derived parameters that can be used to define the viscoelastic response of dough and gluten protein solutions to small deformation, and thus probe protein structure and properties. We have used two ultrasonic techniques to measure ultrasonic velocity and attenuation: through- transmission measurements on dough using transducers of different central frequencies in the MHz regime, and ultrasonic resonance measurements on gluten protein solutions in quartz resonance cells. We have observed increases in velocity and attenuation in dough as frequency rises and used a one-element Maxwell fluid model (a molecular relaxation model) to interpret the results. The relaxation times associated with the dynamic bulk viscosity were in the nanosecond time range, a result not incompatible with conformational rearrangements in glutenin within the dough matrix, and perhaps attributable to loop-to-train transitions induced by the strain energy oscillations of the ultrasonic pulses. Extremely precise ultrasonic velocity measurements from resonance methods, along with solution density determinations, allowed the compressibility of protein solutions to be obtained. By measuring velocity and density at different protein concentrations, the intrinsic compressibility of the protein molecules was deduced. In glutenin solutions we observed changes in protein compressibility as a result of adding salts from reacted chemical leavening agents. These changes were brought about by the rearrangement of the glutenin molecules in response to the different salts. Ultrasound is therefore a powerful tool providing novel information on the role of gluten proteins in dough structure.

Power law gels at finite strains – the nonlinear rheology of gluten gels

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Cereal Foods World 53:A8

Many complex fluids exhibit power-law responses in their relaxation modulus; examples include foods, soft solids, fractal gels and other polydisperse systems. In the present study we investigate the rheological characteristics of such materials beyond the linear regime using a gluten-water gel as a prototypical system. The material functions of gluten dough under finite strains can be described by combining the linear viscoelastic response of a critical gel (Chambon and Winter 1987) with a Lodge rubber-like network to develop a frame invariant constitutive equation (Winter and Mours 1997). This generalized gel equation is a simple but accurate description of the material functions in the linear regime and also at large strains, using only two parameters. We compare the model predictions with experimental measurements in transient shear and elongational flows of gluten gels over a wide range of deformation rates. We also use Large Amplitude Oscillatory Shear (LAOS) measurements to monitor the apparent thixotropic response that arises from the very broad relaxation spectrum. The generalized gel model is able to quantitatively describe the nonlinear rheology of the gluten

gels over a wide range of strains and deformation frequencies. From the rheological data, we find compelling evidence that indicates gluten to be a polymeric network consisting of flexible or semi-flexible chains between junction points with a typical mesh size of approximately 20 nm. An essential feature of both the experimental data and the generalized gel model is a strain/rate separability in the system response. Further modifications to the generalized gel equation can be made by incorporating a damping function to include non-linear strain softening effects seen in more complex gels such as wheat flour doughs.

Hydration and dough microstructure, kinetic and thermodynamic effects
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Cereal Foods World 53:A9

The role of water in dough development is a critical one. Optimisation of water content is vitally important in dough development. In frozen doughs the process of ice formation and the nature of residual unfrozen water continue to be a subject of debate. It will be argued that the dough system is not one at thermodynamic equilibrium so that effects such as order, rate and nature of the addition process will markedly affect the nature of the dough water interaction. In particular addition of water as liquid or vapour will have marked effect on the dough and osmotic pressure generated by liquid water on dry flour will have a mechanical effect. The formation of ice in frozen doughs will depend on the dough history and the amount of unfrozen water will reflect kinetic rather than thermodynamic constraints. A general theory for the mechanism of formation of non-frozen water based on these ideas will be offered. Despite these reservations there does seem to be critical water content of about 30% by weight below which the water dough interactions are significantly different to those above those point. A variety of spectroscopic and other evidence will be discussed to illustrate this.

Freaky Wheat: Underutilized Varieties and Their Potential for Commercial Use

Einkorn: Functional wheat for health promotion
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Cereal Foods World 53:A9

Einkorn (*Triticum monococcum*) is the most primitive cultivated wheat by mankind containing the simplest genetic makeup among wheat species. It has a pair of seven chromosomes set (e.g. 14 chromosomes or AA) compared to 28 chromosomes in durum (AABB) and 42 chromosomes in common wheat (AABBDD). Such simple genetic composition would be accommodating in the development of einkorn with enhanced quality and health aspects. In addition, einkorn grains exhibit exceptional morphological, compositional and functional characteristics that would make einkorn a potential candidate for the development of functional wheat. Einkorn is a hulled wheat that requires dehulling prior to processing for food use, but the presence of hulls would be beneficial to the seed during storage and cultivation. The kernel has no crease which would be a good feature in milling performance. Einkorn grains contain high levels of protein and carotenoids holding a promise for the development of high lutein functional foods. Such functional foods would play significant roles in the management of age-related macular degeneration, the causing factor of irreversible blindness in elderly people. Research has also shown that einkorn possesses less toxicity in celiac disease which would help understand the complexity of celiac toxicity in wheat. This might also lead to the development of non-toxic cereal foods for celiac patients. Celiac disease affects about 0.2–1.0% of the world population and the number is steadily increasing worldwide. These aspects and recent research on einkorn will be discussed.

Waxy wheat: The second biggest event in 8,000 years
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Cereal Foods World 53:A9

To better understand the end-use quality of wheat (*Triticum aestivum* L.), one should understand its genetics. Wheat is an "allo-hexaploid", meaning that it is comprised of three ancestral diploid genomes (AA, BB and DD). This genetic feature is important to end-use quality because the three ancestral species were closely related to one another with more-or-less the same genetic makeup, including the genes that regulate seed composition. The three genomes were added sequentially: AA and BB first formed a tetraploid, and then later (some 8,000 years ago) DD combined to form hexaploid wheat. Consequently, there are three copies of most genes, each originating from one of the ancestral genomes. An exception is the puroindolines which exist as a single copy. Originally, all wheat was soft kerneled due to the action of the puroindolines. Perhaps the single most important event in wheat's evolution was the spontaneous mutation of these puroindolines to produce hard-kerneled wheat. For nearly all other genes, such as the high molecular weight glutenins, the various gliadins, and granule bound starch synthase, there are three copies. Granule bound starch synthase (GBSS) is the gene/enzyme that synthesizes the amylose component of starch. If we select wheat varieties with a "dysfunctional" GBSS, amylose biosynthesis is reduced. Such wheats are especially well suited to producing the higher levels of starch swelling associated with udon noodles. When all three GBSS genes are 'null', there is no amylose synthesized and the granules are 100% amylopectin. The absence of amylose has a profound effect on the functionality of starch and flour produced from such wheats. As a relic of the original work in maize, the zero amylose phenotype is known as "waxy". The trait has nothing to do with wax but simply describes the unique appearance of waxy cereal grains. We combined three GBSS null alleles to produce waxy wheat. Waxy is indeed a 'freaky' wheat and presents unique opportunities to food processors never before available. Waxy starch pastes at a much lower (ca. 65C) temperature with very high granule swelling, resists syneresis and retrogradation, and forms translucent gels; product texture is crispy in low moisture products.

Creation and testing of novel puroindoline alleles to improve wheat end product quality
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Cereal Foods World 53:A9

The Hardness (Ha) locus controls grain texture and affects many end-use properties of wheat (*Triticum aestivum* L.). The Ha locus is functionally comprised of the Puroindoline a and b genes, Pina and Pinb, respectively. The lack of Pin allelic diversity is a major factor limiting Ha functional analyses and wheat quality improvement. Testing of novel Pin alleles from synthetic wheats could identify alleles useful for selecting specific levels of grain hardness for desired end product quality. A second approach to increase Ha diversity is the creation of new Ha alleles via in planta mutagenesis. Our initial results indicate both approaches are useful in creating new levels of grain hardness. Hardness data measured on wheat populations segregating for several synthetic wheat derived novel Ha loci indicate that hardness is increased with several of the tested Ha loci. Creation of novel Pina and Pinb alleles is being done via mutagenesis of a soft wheat cultivar. As an initial test of new mutagen derived alleles, grain hardness was measured on F2:3 seeds derived from a cross of each mutant back to the soft wheat parent variety. While several tested mutations did not affect grain hardness, others increased hardness to varying degrees. Creation and testing of these new alleles will expand the useful range of grain hardness values. The new alleles also will likely prove useful in improving wheat end product quality.

Progress in developing and characterizing high-anthocyanin spring wheat
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Cereal Foods World 53:A9

Phenolic compounds such as anthocyanins have been shown to have free radical scavenging properties and are consequently of increasing interest from a human health perspective. Antioxidants have been shown to be beneficial in the prevention of a number of diseases. Currently, there is only one registered anthocyanin-containing wheat cultivar in Canada, Laval-19. Over the last 10 years we have developed spring wheat lines with elevated anthocyanin levels in the bran by pyramiding the purple pericarp and blue aleurone genes. We have identified lines that contain in excess of 400 mg/kg anthocyanin in the whole grain; three times the level present in Laval-19 and other purple pericarp lines. Preliminary tests suggest that some of these lines show a 40% increase in antioxidant capacity relative to Canadian Hard Red Spring wheat cultivars. A set of 11 lines representing blue aleurone, purple pericarp and the stacked product were grown in field trials over a period of five years at two sites. The results from these trials will be presented along with data from a time course study of anthocyanin accumulation in the grain post-anthesis. Potential uses for anthocyanin-pigmented wheat will also be highlighted.

Club wheat: Functionally, the best sub-class and sub-species in soft wheat
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Cereal Foods World 53:A9

Club wheat (*Triticum aestivum* ssp. *compactum*) composes a subclass of soft white wheat, and is a component of two other subclasses, within the U.S.

grain grading system. Club wheat is grown almost exclusively in the Pacific North West (PNW) area of the U.S., representing about 5–10% of PNW soft wheat production, or about 360,000 tonnes/year. Only small amounts of club wheat are utilized as a pure class; it is mostly blended with soft white, forming the market sub-class "Western White". Club wheat does possess unique end-use qualities that may justify its use as an unblended, pure class: its flour yield is 2% (on experimental mills) to 3% (on a MIAG semi-commercial mill) greater than that of soft common wheat; its break flour yield is similarly 2–5% greater, despite having NIR and SKCS wheat hardness values similar to that of soft white. Club wheat kernels can be thought of as providing greater amounts of patent-grade flour than any other class of wheat. The milling properties of club wheats mean that mills necessarily need to re-balance their mill flow to accommodate increased flour yield early in the milling process to maximize extraction. Club wheats, bred specifically for reduced protein content, also have fewer HMW-glutenin genes. Typically, the null/6/2+12 pattern predominates. As such club wheat has less potential for gluten strength / elasticity or dough water absorption (3–5% less than soft white absorption). Club wheat flour is therefore eminently suited to production of cookies/biscuits, requiring less bake-out and producing a more tender product. Club wheat flour, however, is best used for cake-baking, especially Japanese sponge cake production, where cake volumes are greater than those of soft white wheats, which also produce excellent cakes.

The Genetic Basis of Cereal Quality

Osborne Award Address - Wheat quality improvement: State of the art and perspectives
D. LAFIANDRA
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Cereal Foods World 53:A10

Major targets of wheat breeding have traditionally been yield increase as well as traits satisfying end users' requirements. Functional characteristics that flour and semolina must possess in order to satisfy food processors' and consumer needs are influenced by several factors, such as protein content and composition, kernel hardness, starch and lipids. The selection of improved breeding lines has been aided by the knowledge gained of the biochemical, genetic and molecular bases of quality, which facilitates integration of conventional and biotechnological approaches. In this respect, genomics and related "-omic" technologies have resulted in major breakthroughs, greatly advancing our understanding of genes and gene products influencing quality traits. Increasing consumer awareness of the strong relationship between nutrition and health, and the increase in diseases related to poor dietary habits, are resulting in a broader crop quality concept, which is increasingly associated with industrial and processing properties as well as with human health and nutrition. In the light of these advances, the role of wheat kernel components such as starch, but also of health beneficial compounds, including vitamins, minerals and various phytochemicals, is more and more taken into account, with a consequent increase in demand for wheat cultivars with improved and diversified functionalities, capable of satisfying dietary needs and preferences and providing better food. The current state of the art on the manipulation of gluten proteins, starch, kernel hardness and a few minor nutrients will be presented.

Marker-assisted breeding for wheat grain quality and resistance to Fusarium head blight
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Cereal Foods World 53:A10

The recent establishment of four USDA-ARS Small Grains Genotyping Centers has made the powerful technology of marker-assisted selection (MAS) accessible to all public wheat breeding programs in the U.S. This followed more than 10 years of discovery of markers for genes and quantitative trait loci (QTL) influencing important traits such as disease resistance and end-use quality. Marker-assisted selection helps breeders by allowing for selection based on genotypes at any stage of plant growth or generation rather than waiting for phenotypic evaluations that often require near-homozygous lines with large amounts of seed for analysis, as is the case with most end-use quality traits. We have recently developed new markers for the high molecular weight glutenin genes encoded at the Glu-A1 and Glu-D1 loci. Different from the previously available markers, the new markers are co-dominant and compatible with the high-throughput genotyping equipment used in the Genotyping Centers. These markers will allow breeders to select for these important loci prior to the more expensive and time-consuming tests for dough mixing properties. Fusarium head blight (FHB) has caused significant yield and quality losses. We identified a major QTL, Fhb1, for FHB resistance and found that the effect of this QTL was large and consistent enough to justify MAS to complement our extensive phenotypic screening efforts for this disease. On average, this QTL alone reduces FHB severity by 25–30%. We developed a highly diagnostic marker, umn10, for Fhb1 and used it to genotype more than 6,000 plants from the University of Minnesota wheat breeding program in 2007. Additional genes and QTL for disease resistance and end-use quality traits are being discovered in 17 mapping populations as part of a nationwide USDA-CSREES-sponsored Wheat Coordinated Agricultural Project (WheatCAP). The new markers expected will further our ability to more efficiently breed wheat for specific end-uses. In the future, more efficient DNA extraction technologies and marker platforms will allow us to fully implement MAS in breeding programs.

Selection for specific quality attributes in wheat, based on individual protein markers
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Cereal Foods World 53:A10

Improving the end-product quality of cereal-based products is a major goal for all the participants in the food chain. Breeders, cereal chemists, millers, bakers, marketers and ultimately consumers provide this drive for better quality food. Different wheat-based products each require their individual specification for optimum processing. These quality attributes relate to protein, starch, lipids and enzymes. We are now able to identify specific marker proteins and thus marker genes, permitting improved approaches to selection in breeding programs. The desirable processing requirements for different end products will be discussed. Combinations of protein alleles to achieve a range of excellent end products will be suggested, based on our current state of knowledge. The wheat breeder can now select protein allele combinations for new wheat varieties that will potentially improve the quality of many wheat based food products.

Genomics and proteomics: Applications in cereal chemistry
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Cereal Foods World 53:A10

The change from the application of genetics and biochemistry to genomics and proteomics has been facilitated by developments in both chemical analysis tools and computing technology. Developments on both fronts have been very rapid in the last few years. The range of practical applications in cereal chemistry is continuing to expand. Examples to be discussed include testing for cereal variety identity and purity, analysis of protein, and prediction of starch properties and end-use quality. Grain quality in new varieties can be improved to new levels by combining the very best alleles at each key quality locus. These can be selected early in plant improvement programs, allowing better-quality varieties to be released to the market more rapidly. Complex combinations of quality traits that each previously required large samples and specialized equipment can now be screened at the DNA level using a common and automated platform. These advantages suggest that these technologies should also find application beyond breeding in cereal production and processing.

Transgenic approaches to enhancing cereal quality
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Cereal Foods World 53:A10

Enhancement of the functional and nutritional attributes of cereal grains has been an important goal of cereal geneticists, chemists, and most recently, molecular biologists. Genetic transformation is being used both to define the contributions of individual genes to cereal seed characteristics and to change genetic composition and thus the traits controlled by some of those genes. The creation of transgenic cereal plants supplies breeders with new germplasm with novel or enhanced processing and nutritional properties. Determining the sequences of the genes important for quality traits also provides breeders with perfectly linked molecular markers that can be used to follow inheritance of beneficial alleles. Such molecular information can often provide clues to the mechanisms by which genes influence seed and flour properties. The utility of genetic transformation will be illustrated with examples from wheat research, including the effects of increasing the levels of individual high-molecular-weight glutenin subunits on dough formation, and the isolation of a gene from wild tetraploid wheat that influences grain protein, zinc and iron contents.

Grains as a Source of Dietary Fiber for Human Wellness

An overview of FOSHU and recent progress in food function research in Japan
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Cereal Foods World 53:A11

In 1984 Ministry of Education of Japan conducted the studies on food functions called "Systematic Analysis and Development of Functional Foods". This was the first time the term "functional foods" had been used. For a growing health food industry, the Ministry of Health, Labor and Welfare (MHLW) has implemented a new regulatory framework called Foods for Specified Health Use (FOSHU) ("Tokuho" in Japan) in 1991. In addition to this "regular" FOSHU, Qualified FOSHU and Standardized FOSHU were introduced to facilitate applicant for FOSHU approvals in 2005. FOSHU is intended to be consumed for the maintenance / promotion of health or special health uses by people who wish to control health conditions, including blood pressure or blood cholesterol. In order to sell a food as FOSHU, the assessment for the safety of the food and effectiveness of the functions for health is required, and the claim must be approved by the MHLW. Today, FOSHU accounts for $6.8 billion and 765 foods are carrying FOSHU logo on its packages and Japan has become a model for functional foods in both new product development and regulatory aspects. Recent trend on Functional Food ingredients and topics of researches in Japan will be presented.

Dietary fiber and satiety
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Cereal Foods World 53:A11

Consumption of high fiber diets is linked to lower body weight and body fat and less weight gain over time in epidemiological studies. Dietary fiber may impact body weight by many mechanisms including hormonal, intrinsic, and colonic effects. Adding bulk to the diet with fibre will also reduce the energy density of the diet. Satiety signals are generated both pre- and post-absorptively so different types of fibre may be effective by different mechanisms. Diets low in energy and fat, such as those typically recommended for obese people, are poorly satiating. Adding fibre to low-calorie/low-fat foods may enhance satiety. But, not all dietary fibres have an impact on satiety. In general, insoluble fibers such as grains have been found to be most effective, but necessary dose to show effectiveness may be less than that typically consumed in Western diets. Viscous fibers such as oat and barley may prolong the intestinal phase of nutrient digestion and absorption and thus aid satiety. Efforts should be made to increase fiber consumption as an aid to weight management.

Resistant starch as a fiber source and its action in the colon
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Cereal Foods World 53:A11

Cereal starches, and starches in general, exhibit a range of digestion rates. Those that reach the colon undigested by the body's amylases and small intestinal glucogenic carbohydrases are called resistant starches and act as a fiber source in the diet. In more refined diets, the amount of resistant starch consumed is quite small unless added as an ingredient, however it is reported that in a traditional vegetarian diet that resistant starch amount likely meets or exceeds the non-starch fiber consituents. This well studied area has revealed important functions of resistant starch in the colon, some of which appear unique among the fermentable fibers. For example, fermentation of starch produces a high level of butyrate, a short chain fatty acid important to colonic epithelial cell health and an anti-inflammatory agent. It also has prebiotic-like properties of enhancing certain beneficial bacteria of the colon microbiota. Additionally, resistant starch has been investigated in relation to energy maintenance in the body, as well as influence on satiety. Cereal starch digestion and fermentation rate can be moderated through entrapment in matrices, and studies suggest that the beneficial effects of starch fermentation in the colon can be extended or amplified distally. An overview of starch digestion/fermentation kinetics, colon and general health effects of resistant starch, and new areas of interest will be presented.

The contribution of cereal to the intake of dietary fiber and antioxidants in the whole diet
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Cereal Foods World 53:A11

Dietary fiber (DF) and antioxidants may be critical dietary factors for primary prevention of chronic diseases. Grains are the major source of DF in common diets. The general tendency nowadays is to extend the concept of DF to include not only non-starch polysaccharides plus lignin, but also other compounds of proven resistance to the action of digestive enzymes such as resistant starch, oligosaccharides, resistant protein, polyphenols and other associated compounds. However, most grain DF contents recorded in food composition tables present some limitations arising from the still prevalent Trowell concept and AOAC analytical methodology. In addition, cereals and legumes possess significant antioxidant capacity (AC) derived from polyphenols associated to DF and Maillard compounds. Most records on AC may underestimate the actual antioxidant capacity of grains because the extraction solvents usually used yield an incomplete release of antioxidants. This communication address the content and composition of DF in grains by using an updated analytical methodology as well as an assessment of its total AC using chemical and enzymatic extractions. A whole-diet approach to DF and associated antioxidants may be useful to look at diets in connection with observational and epidemiological studies. In this line, the contribution of cereals and legumes to the intake of DF and antioxidants in some European diets is also presented. It is concluded that DF, considered as a wider concept than the traditional, may contribute to a better understanding of the health effects of cereals.

Dietary fibers, cardiovascular health & cholesterol
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Cereal Foods World 53:A11

Elevated levels of plasma cholesterol, LDL-cholesterol and triglycerides have been associated with increased risk of premature coronary artery disease, atherosclerosis and stroke. Dietary fibers from oats, barley and rice have been shown to lower cholesterol in a variety of animal species and hypercholesterolemic subjects. Soluble fiber, beta-glucans, phytosterols, tocotrienols, unsaponifiable matter and other dietary fiber components have considered being the active components. Possible mechanisms include an increased excretion of cholesterol, bile acids and lipid and an inhibition of rate limiting enzymes HMG-CoA reductase and 7-alpha-hyroxylase. The "healthful" potential of cereal fibers have been screened by evaluating bile acid binding capacity. The bile acid binding potential have been associated with the ability to lower cholesterol by reducing fat absorption and utilization of cholesterol to synthesize additional bile acids. Whole grain foods, rather than fortified refined foods with separated dietary fibers, are recommended. Increased consumption of whole grains and cereal dietary fibers would result in improved cardiovascular health in the world population by lowering lipids and lipoproteins. An increase of whole grain in the diet would also aid in maintaining a desirable body weight which would, in turn, improve cardiovascular health.

The role of fermentable carbohydrates in the health of the gastrointestinal tract
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Cereal Foods World 53:A11

Carbohydrates from grains and cereals have wide-ranging effects on the health of the gastrointestinal tract. Classes of carbohydrates relevant to the health of the gut include oligosaccharides [galactooligosaccharide (GOS), fructans (including fructooligosaccharides (FOS)] and the polysaccharides [starch, resistant starch (RS) and non-starch polysaccharides (NSP)]. Any carbohydrate that is not digested and absorbed in the small intestine will pass into the colon. In the colon undigested carbohydrates are fermented by the resident microflora. Indeed, many of the beneficial effects of carbohydrates in the gut are linked to the process of colonic fermentation. The major by-products of colonic fermentation include gases (CO_2, H_2, CH_4) and short chain fatty acids (SCFA- acetate, propionate and butyrate). The different classes of carbohydrate produce different effects in the gut. For example, cereal fibres such as wheat bran that are high in slowly fermentable long chain polysaccharides (NSP) are very good at promoting laxation. The rapidly fermented long-chain polysaccharide - RS is an excellent substrate for the bacterial production of the SCFA-butyrate. Butyrate is particularly important for the metabolic welfare of cells that line the colon. Some short chain carbohydrates (FOS and GOS) induce relatively selective proliferation of bifidobacteria. This 'prebiotic effect' may produce health benefits including suppressing the growth of potential pathogens in the colon, increasing the absorption of calcium and stimulation of the gastrointestinal immune system. Encouraging greater consumption of whole grains and cereals will contribute to our dietary intake of these protective fermentable carbohydrates.

Modeling of Sensory Perception of Texture and Flavor

A roadmap to correlating sensory measures of food texture to instrumental corollaries
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Cereal Foods World 53:A12

Texture of foodstuff has long been recognized as an important aspect of food quality. Sensory and instrumental tests are often carried out simultaneously with the aim of assessing correlations between the two methods. There are circumstances when sensory methods are not practical and when instrumental measures of food texture can provide valuable information. For example, instrumental texture methods are routinely performed in quality control environments as a way of monitoring products or processes. However, the successful development of instrumental methods for quality monitoring is often dictated by the quality of the relationship between sensory and instrumental measures of texture. We seek to address in this presentation some of the strategies recommended for maximizing correlations between sensory and instrumental measures. The nature of the relationship between sensory attributes and instrumental texture parameters is almost always assumed to be a linear relationship between a single instrumental measure and a single sensory attribute. This is the assumption that is made when correlations between a set of sensory data and a set of instrumental parameters are assessed. However, the failure to consider the possibility of a non-linear relationship can result in poor statistical correlations. We explore in this talk some of the psychophysical models used to relate the stimuli (the physical properties of the food) to the perception of food texture. A second key aspect of exploring these sensory-instrumental relationships deals with the optimization of instrumental test conditions maximizing correlations between instrumental and sensory measures. Because of the viscoelastic nature of most foods, deformation/loading rates have a non-negligible impact on instrumental texture measures. We will explore examples of such optimization in particular for deformation rates and ratios for uniaxial compression tests. Furthermore, recent research suggests that the use of several instrumental parameters for the prediction of a single sensory attribute is necessary to provide accuracy in the predictive models. Several examples will be discussed, including the use of alternative instrumental data treatments, such as Spectral Stress Strain Analysis. In the recent past, the use of multivariate analysis techniques, such as Partial Least Squares Regression and Artificial Neural Networks has enjoyed a great increase in popularity in research fields such as chemometrics. These techniques provide a new set of tools for correlating instrumental measurements to the sensory perception of texture. Because of the nature of these tools, the predictive models can be much richer but the predictive data is also much more complex which introduces to this field of research a new set of challenges. Among these, the hardest to overcome is to achieve stability in the predictive models developed.

Texture evaluation of rice products by chewing and swallowing measurements on humans
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Cereal Foods World 53:A12

Cooked rice cake is difficult to chew and swallow. Numerous elderly people have suffocated while attempting to eat rice cake. Recently, texture-modified rice cake has been commercially available, and a small piece of rice cake has been recommended for elderly people to prevent suffocation. A simple compression test using an Instron-type instrument has been commonly adopted to determine the firmness of food. Rice cake is not broken by a normal compression test and exhibits less mechanical resistance under a smaller compressive strain than that produced by real mastication in which a very large deformation is applied to food. Direct human measurements are superior in numerically expressing a difficulty in mastication, as an instrumental method alone cannot assess ease or difficulty, and quantitative treatment in a sensory evaluation is sometimes difficult. The difficulty in masticating and swallowing rice cake, cooked rice and rice gruel was evaluated by young subjects. The human measurements were performed by electromyography (EMG) of the jaw-closing and -opening muscles during chewing, as well as by EMG of the tongue muscle activity and throat movement using an array of three pressure sensors placed on the thyroid cartilage during swallowing. A small rice cake (3 g) was consumed with shorter mastication time, fewer the number of chews, and less jaw-closing muscle amplitude than a large one (9 g). We defined the mastication effort as the total muscle activities of jaw closing muscles required for swallowing, that is the product of muscle activities per chew by number of chews. A texture modified rice cake (9 g) also decreased the mastication effort than the standard product. However, no significant difference in swallowing characteristics was observed. These observations suggest that swallowing was induced when the bolus properties became suitable for swallowing, as healthy subjects could optimally adjust their mastication. Softly cooked rice or gruel containing more water is often served for the elderly to reduce the mastication effort. As water content of cooked rice became higher, rice became less firm and could be eaten with less mastication effort.

Characterizing crispiness of snack products by fracture and acoustic measurements
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Cereal Foods World 53:A12

For many cereal based snacks their crispy character is an important sensory attribute on which consumers base their appreciation. Crispiness is characterized by multiple fracture events accompanied by acoustic emission at relatively low work of fracture on eating. Crispy products behave as a brittle material, i.e. the fracture strain is low. In addition to the brittle behavior and the loudness of the acoustic emission, the number and size of the larger force drops and sound events are important aspects for sensory crispiness. A complicated factor in developing an instrumental measurement of crispiness is that consumers apply a high deformation speed of the products during biting (up to ~4 cm/s) and chewing. To register every fracture event in a crispy snack this would require a very high sampling rate of the force and acoustic data. However, humans are only able to distinguish sound events if they are at least separated in time by 5–10 ms. Biting of a product of 1 cm thick will require only 0.25 s so in that time consumers can at most distinguish 25–50 sound events. During biting a snack product the real number of sound events will be much larger implying that in reality consumers hear the loudness of overlapping sound events. Registration of all force events at human biting speed is also not totally possible due to instrumental constraints. One solution is to deform the food product at a much lower speed than the biting speed. However, this has as a disadvantage that the measured average loudness of the acoustic emission will be clearly lower than what consumers experience during eating. Moreover, especially in the transition region between crispy and no-crispy behavior one may get a clear underestimate of sensory crispness. These points together make that the execution of an instrumental test should depend on its goal. For product control, a test in which the number of force peaks is measured at a relatively low speed in combination with loudness measurements of the sound is most appropriate. For research purposes one has to use a test in which a higher deformation speed (>1 cm/s) is applied in combination with a high sampling rate of the force and sound data.

Combining sensory flavor evaluations with analytical techniques
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Cereal Foods World 53:A12

There has been a quest to understand how genetic, pre-harvest (e.g. environment, cultural methods) and post-harvest (e.g. drying, milling, storage, cooking method) factors affect the aroma and flavor of grains and their products and to relate these effects to the numerous volatile compounds in the grain. The desired outcome is to identify important marker compounds that will allow pre-harvest and post-harvest strategies to be enacted to assure that the processed grain will have the expected aroma and flavor. Most researchers have taken the approach of correlating pre- and post-harvest variables with changes in volatile compounds and have drawn conclusions as to which compounds possibly impact aroma and flavor based on concentration or aroma value (AV). Fewer have conducted preference or descriptive sensory analyses with concurrent volatile analyses. This presentation will give an overview of the approaches that have been taken to combine descriptive sensory evaluations with instrumental measures [e.g. gas chromatography/ mass spectrometry (GC/MS), gas chromatography/olfactometry (GC/O), electronic tongues, etc.] to model and understand grain flavor.

The odor of cooked rice: Identification and origin of odor active compounds
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Cereal Foods World 53:A12

Volatile compounds of cooked rice from scented (Aychade, Fidji) and non-scented (Ruille) cultivars grown in Camargue area in France were compared to that of a marketed Asian scented one (Thai) by gas chromatography-olfactometry (GC-O) and gas chromatography-mass spectrometry (GC-MS). GC-O analyses of the organic extracts resulted in the perception of 40 odorous compounds. Only two compounds, oct-1-en-3-one and 2-acetyl-1-pyrroline, were almost always perceived, including in the non-scented cultivar.

Hierarchical Cluster Analysis showed that most of the difference between rice odors was linked to quantitative differences with only 11 compounds being specific of some of the rice. 60 compounds were identified and quantified by GC-MS, but only odour active components were submitted to Principal Component Analysis. They clearly differentiate scented cultivars from a non-scented one, and scented rice cultivars from Camargue from Thai sample. Calculated Odor Active Values (OAV) confirmed that 2-acetyl-1-pyrroline is the most scented compound of scented rice but showed that (E,Z)-deca-2,4-dienal gives a similar contribution for scented cultivar from Camargue. This compound may originate from the degradation of linoleic acid. Another major difference between scented cultivar of different origin is the opposite contribution of 4-vinylphenol (absent in Thai) and 2-methoxy-4-vinylphenol with high OAV in Thai. These compounds may derive from cinnamic acid compounds, together with vanillin that is absent in raw rice. The origin and formation of these compounds will be discussed.

Understanding of food breakdown and flavour release using chewing simulation

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Cereal Foods World 53:A13

The chewing process is the main phenomenon leading to food breakdown and flavor release when eating food. These phenomena are shown to be dependant, on the one hand, on masticatory and salivary parameters, and on the other hand, on physico-chemical properties of the food matrix (Tarrega et al 2007). The understanding of in-mouth mechanisms should help to understand food breakdown and flavor release, and to relate them to temporal sensory data obtained *in vivo*. However, interindividual variability, low repeatability, panelists' tiredness and acceptability problems may occur and become important limitations for *in vivo* studies. Moreover, it is quite difficult to decouple each variable which could be useful for modeling studies. To overcome most of these limitations, we developed a chewing simulator that reproduced as faithfully as possible most of the physiological functions of the mouth (Salles et al 2007). The active part of the system is a special cell, precisely tooled using a biocompatible and inert material. It operates around three axes fully actuated and computer-controlled. The cell comprises several mobile parts that can accurately reproduce shear and compression strengths and tongue functions in real-time, according to data collected in-vivo. A study using peanuts was performed to test and validate the mechanical functionalities of the system. Comparable masticatory efficiencies were observed from *in vivo* and *in vitro* tests. Moreover, the modulation of compression and shear strengths showed that both were influent on food breakdown. Additionally, the mechanism of food airy products breakdown was considered. *In vitro* analyses made with the chewing simulator highlights a shift in the particle area distribution of cereal breakfast towards large area classes, indicating clearly a fragmentation stage which could be correlated and explained by *in vivo* measurements. Moreover, the fracture mechanisms during artificial mastication were found fully correlated to the mechanical properties of the studied samples. *In vitro* flavor release studies using model cheeses as food matrices, in decoupling oral parameters on the machine, will be also presented. Aroma release patterns obtained from *in vivo* (Taylor et al 2000) and *in vitro* experiments by connecting on-line the chewing simulator to the APCI-MS will be discussed.

Quality Perspectives of International Sections

Quality research and development of wheat for udon in Western Australia

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Cereal Foods World 53:A13

Early research in Japan and Australia highlighted the importance of the composition and functional properties of the starch component on the eating quality of udon. The early work emphasized the need to isolate the starch, but later development of the Rapid Visco Analyzer (RVA) and flour swelling volume (FSV) test showed starch quality could be characterized using flour and wholemeal. A technical visit to Japan in 1988 clarified a number of issues including the optimum noodle color. This visit and the earlier research provided the technical case for the introduction of a special noodle wheat segregation (1989/90 and separate pooling (1992/93) – this was the first wheat-cultivar-based segregation for export that was targeted at a specific product. A visiting experts program which commenced at the Department of Agriculture and Food Western Australia (DAFWA) in 1990 has involved visits by six Japanese noodle technologists. The program has led to an understanding of Japanese methods and the development of a panel with expertise in sensory assessment of noodles. This has provided opportunities for research on the wheat-noodle quality link using industry accepted reference methods. It has also enabled the development of protocols that allow Japanese industry participation in the assessment of new noodle cultivars. Recent developments at DAFWA include two new cultivars and a new near-infrared reflectance calibration for the prediction of FSV.

Australian methods and equipment for wheat quality evaluation

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Cereal Foods World 53:A13

The Australian wheat harvest delivers grain with some unique properties that has caused Australian Cereal Chemists to place greater emphasis on some quality measures than was common in other parts of the world. There are many examples however flour starch damage and grain alpha-amylase are two that illustrate this difference. The mixture of hard and soft grained varieties that traditionally made up the Australian crop resulted in the development of many ways of assessing grain hardness and later in the development of a range of approaches to measure flour starch damage. These culminated in the development of what is now the Megazyme kit for starch damage, an enzymic method that can give fast accurate and reproducible results and that is now used throughout the world. The growth of only white wheats has resulted in varieties that a readily susceptible to pre-harvest sprouting. Methods that can measure the enzyme content of grain and flour as well as instruments to measure the viscosity of ground grain or flour have been developed in Australia and allowed a variety of approaches by plant breeders and handling companies to be developed. The Rapid Visco-Analyser was originally developed for use in segregating high amylase grain and this remains a common use of its simpler models. Analytical methods and equipment are developed to provide measurements of characters that can influence end use properties, the diverse nature of parts of the Australian Wheat Crop has encouraged the development of methods that can describe that diversity.

Flour fortification in South East Asia

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Cereal Foods World 53:A13

The key drivers for Flour fortification in Indonesia, Malaysia and Vietnam will be presented together with the technology, and initiatives used in each part of the region. The current fortification levels used in each the different countries will be discussed together with relevant research projects currently conducted in the countries in this area.

Grain segregation strategies in Australia

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Cereal Foods World 53:A13

The fundamentals of Australia's wheat classification system are well known, with all classes being received into the central handling system according to what is effectively a single set of physical standards. It follows conventional classification principles that combine desirable quality traits aimed at extracting the best possible quality grain from the growing conditions in any given production region. The latter extend over massive ranges of latitude and longitude, and this combined with vastly differing soil types and rainfall patterns, creates a wide range of environments, and resultant wheat quality types. Breeding strategies have been largely driven by the market information gathering and classification guidelines promulgated by AWB Limited, until recently the monopoly wheat marketer, and grain segregation strategies have been similarly driven. However with the deregulation of the export wheat market, and the licensing of multiple wheat marketers, the Australian wheat landscape is likely to change dramatically. Bulk handling companies are expanding their marketing operations and are also integrating vertically with large Asian milling companies with quite specific quality requirements that do not necessarily align with those traditionally espoused by AWB. This will create challenges and opportunities for the breeding companies, who will now have to consider a range of potential quality targets. Similarly it will create major headaches for the bulk handlers, who will now have to accommodate a

number of clients who will be accumulating stocks to meet the needs of several domestic and export customers. Australia's grain handling system has been developed to accommodate a relatively small number of grains and grades, particularly at the country elevator level, so some pragmatism and cooperation will be required in order to meet all of the multiple demands that will soon eventuate.

Pasta and noodle quality in Japan – Meeting the demands of consumers
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Cereal Foods World 53:A14

The quality standards for food products are very high in Japan due to the demands from its consumers. Many Asian countries try to follow the Japanese food quality control systems. Because the processes used for most grain products are simple, the quality of raw material directly affects the quality of end products and becomes the dominant factor in quality control. In terms of the pasta processing, semolina and water are the only ingredients needed. Asian noodles are not much different, with flour, water, and salt as main ingredients. Therefore, the flourmills, i.e., wheat quality and milling practice, largely determine the quality of pasta and noodle products. Japanese consumers are very concerned about the foreign materials in pasta and noodle products, even at very small quantities. In response, Japanese flour mills use color sorters to remove black foreign materials, and pasta and noodle manufactures use spec counter to check black specks in the semolina and flour. The recent trends in consumers' quality requirements in Japan will be discussed.

The influence of extreme temperatures on polymeric and monomeric proteins in bread, biscuit and durum wheat
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Cereal Foods World 53:A14

Extreme temperatures during grain filling have been identified as a major source of variation in wheat quality characteristics. In this study one biscuit-, two bread- and one durum wheat cultivar were evaluated in two consecutive seasons for their reaction to extreme high and low temperatures during grain filling. In both years, the soft biscuit wheat cultivar showed the largest reaction to low temperature stress, where the monomeric proteins were significantly increased and the polymeric proteins significantly decreased. The effect of temperature stress was more pronounced in the second year, with an earlier planting date. The durum wheat reacted to both heat and cold stress in the second year, where the small polymeric proteins were significantly reduced, and the small and large monomeric proteins were increased with stress. The effect of wheat type was much more pronounced than the effect of temperature treatments on the protein fractions. The protein fractions of the tetraploid durum wheat were very different from the hexaploid cultivars, with much less polymeric proteins, and more monomeric proteins. The soft biscuit wheat had significantly less large polymeric proteins, and more large monomeric proteins than the bread wheat cultivars for both years.

Color evaluation of wheat grain, flour, and wheat products in Australia
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Cereal Foods World 53:A14

Since 1923 when Australian Agriculture Ministers agreed to only encourage the production of white wheats the Australian Wheat Crop has been exclusively white grained. This has led both Australian wheat breeders and cereal chemists to be very involved with color assessment and analysis. Initially manual observation of grain with or without the aid of caustic soaking was used. Flours were assessed by slick test and later by Kent-Jones colour graders and more recently with L*ab color colorimeters and spectro-photometers. The dry flour L*- b is now widely used in plant breeding and flour mill laboratories throughout Australia. Product color analysis was by visual assessment until modern color instruments became available. Now bread crumb, crust, Noodle and noodle sheet color, flat-bread and steam bread colors can all be objectively measured. The progress of the development of color measurement methods, the importance of sample presentation and the advantages of objective analysis will all be presented.

Changing demand for flour premix in the South East Asian region
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Cereal Foods World 53:A14

Consumer trends on the use of premix by manufacturers, bakers, and households will be presented. The analysis will identify the types of products currently available in the different markets of the region and discuss other potential products. The health and nutrition of wheat based products will also be discussed including Government regulations on labelling and health claims.

Rheological Properties of Whole Grains

Effect of bran on bubble stability
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Cereal Foods World 53:A14

Much progress has been made in recent years into understanding the creation of aerated structures in bread, from their origin in aeration and dough rheological development during mixing to imaging bubble evolution during proving and baking and quantifying gas cell structure in the final baked product. The overwhelming majority of these studies have been performed on white bread. Whole meal and high fibre breads are of great importance for diet and health, but their consumption is inadequate because of their unappealing aerated structure - bran and fibre damage bubbles in bread. This paper will review the mechanisms by which bran damages the aerated structure of bread, and will present recent studies on the interactions of bran with bubbles during dough mixing, proving and baking.

Phase behaviour of high molecular weight oat beta-glucan/whey protein isolate binary mixtures
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Cereal Foods World 53:A14

The isothermal (5°C) equilibrium phase behaviour of high molecular weight oat beta-glucan/whey protein isolate binary mixtures was investigated. The mixtures were studied at different pH values (3.0 and 7.0) in the presence or absence of sucrose (10% w/v) by means of phase analysis, electrophoresis, viscosity measurements, and fluorescent microscopy. The mixtures are incompatible in a wide range of concentrations as revealed by phase diagram construction. Decrease of pH to 3.0 from 7.0 and sucrose addition enhances miscibility, and the latter effect is more pronounced at pH 3.0. Viscosity measurements of the mixed systems revealed that flow is pseudoplastic at all concentrations studied and the behaviour changes from protein- to polysaccharide-controlled as the biopolymer concentration varies in the mixtures. This is also reflected in the topology of the mixed systems where a transition in the continuity of the microstructure is observed from protein- to bi- to polysaccharide-continuous.

Rice

Peering through the lens of diversity for different traits of rice quality
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Cereal Foods World 53:A14

Amylose content defines many eating and cooking properties of the rice grain. There are three classes of amylose based on iodine-binding of the amylose: >25% is considered a high amylose content, 25–18% is an intermediate amylose content and <18% are low amylose varieties. Currently, there are two screening tools available to classify rice. The CT repeat in the flanking region of intron 1 of the Waxy gene can explain around 80% of the variation in the U.S. germplasm. A G/T substitution at the splice site of intron 1 can differentiate between the low amylose content varieties (<18% amylose) and the high and intermediate amylose varieties (>18%), but is unable to differentiate between the high and intermediate amylose varieties. Amylose may be further classified by a second substitution identified within intron 1. Preliminary data suggests that the SNP is capable of differentiating between varieties of intermediate and high amylose content.

Efforts to capture high amylose in rice

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Cereal Foods World 53:A15

Screening of wild and cultivated rice in IRRI germplasm collection revealed that majority have intermediate apparent amylose content. It appears that ancient farmers selected rice based on texture of the lower amylose varieties, considering that the majority of rice consumers today prefer intermediate to soft-textured rice. Furthermore, 30% seems to be the natural upper natural limit of amylose levels in wild-type rice. If this is the case, the rich biodiversity of rice has been subjected to the bottleneck of domestication to select for grains that have superior cooking and eating but not nutritional or satiating qualities considering that the majority of rice consumers today eat rice three times a day. On the other hand, the amylose content of available rice mutants with deficient SBEIIb or an over-expressed GBSSI also revealed amylose levels of around 35% which is significantly lower by comparison with other high amylose cereals, whose amylose content ranges from 70–90%. Hence, to produce the high amylose phenotype in rice, one might need to target different sets of enzymes or regulatory pathways. Since increasing the amylose levels in rice might mean a concomitant increase in its resistant starch content and in its levels of satiety, and a decrease in its glycemic response, developing high amylose rice by biotechnology is imperative. This type of rice will be important not only in addressing the growing obesity epidemic which now also affects the developing countries but also as a basis of novel degradable biopolymers and for further elucidating the mechanisms of starch synthesis in the cereal endosperm. In this paper, we also present the status of our research project which aims to silence the expression of SBEIIa, SBEIIb and SSIIa singly or in combination using microRNA and RNAi silencing technologies with the aim of increasing the amylose levels in rice beyond its natural limits.

Metabolomics of aroma in different varieties of rice

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Cereal Foods World 53:A15

Aromatic rice is highly prized by most rice consumers, and many countries cultivate traditional and improved aromatic varieties. 2-acetyl-1-pyrroline (2AP) is the major aromatic compound in rice, and is believed to accumulate because of an 8 base-pair deletion in an allele at the fragrance locus. In this study, we quantified 2AP and determined the presence or absence of the fragrance allele (fgr) in 464 samples of traditional varieties of rice from the Genetic Resources Centre (GRC) at IRRI. We show that a number of aromatic varieties, primarily from S and SE Asia, do not carry the 8-bp deletion, and we identified 2AP in both raw and cooked rice of those varieties; we suggest that the 8-bp deletion in the fgr is not the only cause of aroma, and at least one other mutation drives the accumulation of 2AP. Aroma is a trait that is considered high quality in Lao rices, and one of our high quality varieties carries the fragrance gene and one does not. In a cross between these two, the segregation of 2AP values suggests that there are two independent pathways to aroma. Each pathway of aroma is being introgressed into an improved non-aromatic variety. Metabolomic profiling is being used to determine the chemicals in each of the pathways, with an eventual aim of finding markers to enable the capture of multiple sources of aroma into breeding programs.

Partnering sensory evaluation with rice production to improve rice flavor and texture

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Cereal Foods World 53:A15

Lack of a knowledge-base for predicting how genetic, pre-harvest (e.g. environmental), and post-harvest (e.g. maturity, drying, moisture content, milling, cutting, storage, microbial infestations) factors affect rice sensory characteristics results in producers and processors not having control over the sensory quality of their products and, consequently, consumer dissatisfaction. This has been experienced firsthand by rice industries worldwide. The approach we have taken at the USDA ARS Southern Regional Research Center to develop the needed knowledge-base is to correlate the intensities of flavor and texture attributes, as measured by descriptive analysis, to compositional data and genetic, pre-harvest, and post-harvest variables. Specifically, we have examined the effects of environment, drying, harvest and storage moisture content, degree-of-milling, drain and harvest dates, traditional and organic farming, nitrogen application, and genetic factors on rice flavor and texture. This presentation will be an overview of our research.

Whole grain ("brown") rice: Who likes it, who doesn't and why?

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Cereal Foods World 53:A15

The WHO reports that in the next few years noncommunicable diseases will be the leading cause of morbidity and mortality, worldwide. This change is associated with lifestyle changes such as increased intake of kilocalories, refined grains, and animal fats. Rice is one of the cereal grains that are primarily consumed in its refined form. It is believed by many that rice, historically, has been milled prior to consumption to increase its shelf life, and decrease its cooking time and need for chewing. But, others think that rice is primarily consumed in its milled form today, because it originally was a status symbol that only the wealthy could afford. However, the peoples of several world regions consider some rice cultivars with red- or purple-colored bran to offer nutritional advantage and others to hold ceremonial value compared to cultivars eaten as milled grain. Over the past few years, various governmental health promotion efforts have encouraged people to consume whole grains in place of refined grains due to the health-benefits associated with this dietary behavior. The question remains today, then, why do most consumers across the globe continue to choose milled rice over whole grain rice? We have surveyed rice eaters to begin to understand the answer to this question. This understanding will lay a foundation for the development of new educational, marketing, food processing or genetic enhancement approaches designed to increase the consumption of rice in its more healthy form, that is, unmilled.

Viscosity - What makes it flow

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Cereal Foods World 53:A15

Communication between rice breeding programs and end-users is often complicated by a lack of nouns to name traits and a subsequent lack of adjectives to describe the non-existent nouns. Viscosity of rice is described as being the most important index of quality for industries that process rice, but there are different components of viscosity, and viscosity at any one time depends on factors like hydration, shear and temperature. Thus, without specific nouns, it is difficult for rice improvement programs to select for things other than amylose content, gelatinisation temperature and gel consistency, and selection for metrics of those traits does not always, or often, produce a variety that completely satisfies industry. The most rapid method for determining viscosity, at least in a rice improvement program, is the RVA. The parameters of pasting temperature, peak viscosity, peak time, trough viscosity and final viscosity, and relationships between those, are used to distinguish different classes of rice. Rice flour is comprised of starch, protein and lipids. The structure and location of each component influences the parameters of the curve. Over the past few years, significantly more understanding of the processes that lead to each parameter of the RVA curve has emerged, enabling understanding of the structural features of the components of the flour. This knowledge is accumulating alongside a similar accumulation of knowledge of the genetics of starch synthesis. The objective of this talk is to combine the knowledge in these two fields, for each parameter of the RVA curve, and attempt to stimulate discussion between processors and chemists to move beyond the umbrella-term of quality, and to use more specific language to describe components of quality. Moving beyond the current plateau of amylose content, gelatinisation temperature and gel consistency to more specific traits will enable breeders and rice-traders to meet the needs of industry.

Variation in Analytical Methods

Accuracy and precision issues related to prediction or treatment comparison

D. BOYKIN
USDA ARS, Stoneville, MS
Cereal Foods World 53:A15

How good is your data? To answer this question, one must first ask: What do you want to know? To address your questions, two groups of inferential statistical methods will be considered: prediction methods used to estimate or predict values; and comparative methods used to compare treatments, measure a difference or a change in a value. Measures of confidence in experimental data such as accuracy and precision are affected by the group of inferential statistical methods used to evaluate data.

Managing outliers in collaborative studies
D. PALMQUIST
USDA ARS, Peoria, IL
Cereal Foods World 53:A16

A laboratory showing consistently higher or lower values than other laboratories over a range of materials in a collaborative study can be considered to have a bias. Laboratory bias can have misleading consequences when evaluating the efficacy of a method. The between-laboratory variation may be inflated and lead to the conclusion that a perfectly acceptable analytical method will be rejected. A simple technique for identifying outlier laboratories will be presented by ranking the laboratories' mean results for each material tested in the collaborative. A laboratory having an overall ranking outside the table value range (based on number of materials tested as well as number of participating labs) will be considered to be an outlier whose results can then be removed from the statistical evaluation of a method.

What do you mean by a mean?
P. WEHLING
General Mills, Inc., Minneapolis, MN
Cereal Foods World 53:A16

The simple average, mean or arithmetic mean is the oldest, most common, and best understood statistic in use today. The concept of the mean is well understood by the general public and professional scientists alike. This presentation will discuss a brief history of the mean from antiquity to present, and some likely applications for experimenters. Complications arise when we start combining other statistics. For example, it is usually always correct to calculate a mean of a mean, but in some cases a weighted mean may be more appropriate. Likewise, variances can be averaged, but here too, weighted means are generally better, but usually overlooked for this application. There are some statistics that should never be averaged, such as standard deviations, regression estimates, and some simple ratios. In the case of a ratio, a better way to combine multiple observations may be as a slope in a regression analysis.

The Joint AACC International - ICC Methods Harmonization Project
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Cereal Foods World 53:A16

Analytical chemistry was the basis of the formation of both the American Association of Cereal Chemists (AACC International as it is now named), and the International Association for Cereal Science and Technology (ICC). Both the AACC International and ICC have developed independent compendia of analytical methods for application to cereals and their products, and both associations have rigorous procedures for the approval of new, and of modifications to existing methods. To improve global communication, to avoid duplication of efforts, and to avoid confusion of users of the methods of both organizations, in 2002 the two associations agreed to initialize a harmonization process. At meetings held at AACC International Annual conventions, starting that year, it was decided that nine methods should be standardized. The development of coordinating the methods involved: a) identifying areas of the individual methods where changes were needed that would make the methods acceptable to all cereal laboratories, and b) making suggestions for the possible changes. The methods included ash content by incineration, Falling Number, Gluten Index (mechanical), moisture by air oven, protein content by Kjeldahl, Dumas (combustion) and Near-infrared Spectroscopy methods, wet gluten (mechanical), and the Zeleny Sedimentation test. The paper describes the methods that were addressed, and the main suggestions made for changes. It will also discuss possible methods for incorporation of the harmonized methods into the method compendia of both organizations.

Whole Grain Foods - Dealing with Impacts on Formulations, Processing and Sensory Attributes

Formulating whole grain foods for increased consumption
E. ARNDT
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Cereal Foods World 53:A16

Interest in formulating whole grain foods to include ancient and other exotic grains has rapidly increased. Food manufacturers are interested in using these grains to create a point of difference compared to traditional grains, as well as in using these grains in gluten free foods. The changing market will be discussed, as well as the aspects of product development in a range of grain-based foods. The product development aspects will focus on the impact of whole grain type and inclusion level on product functionality, flavor, nutrition and cost.

Functional ingredients used in whole grain baking
G. FENG
Caravan Ingredients, Lenexa, KS
Cereal Foods World 53:A16

Whole grain bakery products have enjoyed tremendous growth in recent years mainly due to their health benefits and their natural, appealing appearance. Depending on the labeling requirements, formulations of whole grain bakery products typically contain 30–100% whole grain ingredients. The high inclusion level of whole grain ingredients results in a number of adverse effects on the baking process, such as lowered machinaibility of the dough, decreased gas retention capability, coarser crumb grain, and shortened shelf life of the products. Many functional ingredients can be used to compensate for the detrimental effects of whole grain ingredients so that high quality whole grain bread can still be made. Examples of such functional ingredients are vital wheat gluten, dough strengthening emulsifiers, flavor enhancers, and various enzymes. These functional ingredients either improve the dough strength and baking process or increase the quality and extended shelf life of the finished products. The mechanisms and the applications of some of these functional ingredients will be discussed in more detail.

Whole grain high fiber cereals: A preliminary experimental design evaluating ingredients to improve textural and organoleptic qualities
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Cereal Foods World 53:A16

Whole grain cereals containing high levels of fiber are often compromised in texture and flavor because the inclusion of high levels of fiber decreases expansion, resulting in a product with lower sensory acceptability and decreased bowl life. To address this challenge, a designed experiment screening study was carried out with a number of ingredients that may have potential to improve textural and organoleptic properties. An uncoated whole grain cereal with corn and oat flours was formulated as the control (3.5% fiber) and corn fiber and resistant starch fiber were added to increase the total dietary fiber level of the cereal to 18.6 to 25.1% DB. Ingredients in the design to improve sensory and processing characteristics included pregelatinized whole grain corn flour, type 4 resistant starches, hydrocolloids, wheat and corn gluten, and modified waxy maize starches. Response variables measured included bulk density, color impact, hardness/crunchiness/bowl life by texture profile analysis, sensory and expansion index. Additionally, selected cereals were studied using microscopy. As expected, the total fiber level had the most negative impact on most of the response variables. Inclusion of resistant starch as fiber had significant effects on expansion, brightness and hardness. Hydrocolloids tested had little impact on dry cereal texture but a strong negative impact on bowl life. Corn fiber granulations (fine, medium, coarse) had relatively low impact on response variables. Results from this screening design will be presented in detail, along with recommendations for further research on optimization and improvement of extruded cereals with high levels of fiber.

Whole grain corn snacks
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Frito-Lay, Plano, TX
Cereal Foods World 53:A16

Presentation will review key challenges in product and process development of whole grain corn snacks. It reviews basic processes for tortilla chip products and extruded corn snacks and identifies processing opportunities for whole grain products.

Whole Grains: The Synergy of Cultural Diversity

Whole grains: What's in a name?
J. M. JONES
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Cereal Foods World 53:A17

Definitions of whole grain differ around the world. Yet there is a crying need for agreement by the scientific community in order to interpret research data on the health benefits of whole grain, for industry in order to formulate products with adequate whole grain and for harmonization of regulation and labeling. Currently, the meanings of words and what is considered whole grains differ dramatically, even in countries where English is the native language. Some interpret the term whole grain to mean that whole grains must be actually in an intact form. Others say that all the parts of the grain must be present in the same proportion as in the native grain and follow the AACC definition. This definition allows for grains to be processed in any number of ways to become part of a food. Yet the definition needs further clarification as traditional processing methods such as the nixtimalization of corn and the toasting and rubbing of barley introduce some loss to the grain so that the resultant product does not strictly follow the AACC definition. This presents another dilemma regarding the recombining of streams, the introduction of stabilization technology for the germ and/or bran, the actual proportion that is used since this varies by species, variety and agronomic conditions. The Whole Grains Task Force has been involved in looking at all these variations and trying to get feedback on how much loss can occur and still be a whole grain. All these issues will be discussed.

HEALTHGRAIN – European research project for healthy cereal foods
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Cereal Foods World 53:A17

The European integrated project HEALTHGRAIN (www.healthgrain.org) has the aim to improve well-being and reduce the prevalence of the insulin resistance syndrome by increasing the intake of protective compounds of grains. Intake of whole grain foods and grain fibre has been shown to be protective against chronic disease, and we aim to find new ways of using especially wheat and rye to deliver more of the grain to consumers. In addition to dietary fibre and slowly digestable starch, the project targets on means to modulate levels of lignans, phenolic acids, alkylresorcinols, phytosterols, folates, tocopherols and tocotrienols, other vitamins and minerals. Choice of raw material and development of new milling and bioprocessing technologies are the approaches to develop new ways of delivering grain foods protecting against metabolic syndrome. Biotechnology tools are developed to accelerate breeding programs. Cereal food factors important for phytochemical bioavailability, glycemic control and weight maintenance are studied using a range of methods reaching from *in vitro* experiments to human interventions. Consumer demands for healthy cereal foods are also examined. The project has an extensive dissemination and technology transfer program to interact with stakeholders interested in utilising the results. This study is financially supported by the European Commission in the Communities 6th Framework Programme, Project HEALTHGRAIN (FOOD-CT-2005-514008).

Whole grain research initiatives in North America
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Cereal Foods World 53:A17

With the recent emphasis on the concept of a "whole foods" diet, particularly as it relates to whole grains, many government, university and industry initiatives to promote whole grain consumption have increased rather dramatically. There is little doubt that consumption of whole cereals and other grains confers benefits to consumers, and a number of studies support the notion that health and wellness outcomes correlate positively to levels of whole grains in the diet. These benefits may be functions of dietary fiber levels, improved protein quality, excellent antioxidant and vitamin levels, or they may simply reflect the benefits of consuming these components in combination. What is not clear, however, is just how we must process whole grains to ensure that we are in fact producing true whole grain products, nor is it obvious what current common processes may do to the nutritional quality of whole grain products. Additional issues also relate to consumer acceptance concerns (e.g. taste, color, texture, aroma) that are commonly associated with whole grain products, and to the need to modify processes to optimize processing of high fiber, strongly flavored materials. Some of these challenges will be discussed, with some examples of modifications that may be needed in order to ensure continued increases in whole grain consumption.

Whole grain consumption and uses: A South American perspective
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Cereal Foods World 53:A17

The per capita consumption of whole grains in Brazil is the lowest in Latin America. Over the last 7 years, whole grain production has grown for instant breakfast cereals by 71%. The consumption of these products, reaches ~30% of Brazilian homes. The Brazilian Food and Drug Administration (Agência Nacional de Vigilância Sanitária - ANVISA) has not made specific pronouncements for legislation of whole grains. In Brazil general investments in marketing, research, factory reforms and adaptations for whole grain technology and product development reached almost 50 million Brazilian Reais in the past year. Several multinational food companies have continued initiatives to increase public appeal for wholesome food in Brazil and other Latin American countries. Two issues contribute to slow progress towards developing the whole grains market including limited consumer knowledge about the benefits, and, the whole grain specifications, definition, production and utilization are all ill-defined. Efforts have been made to publish scientific articles along with the submission of a whole grain health claim petition to authorities on behalf of our leading local cereal industries. In the attempt to have a more intense commercialization of common cereals such as wheat, rice and corn, the "whole grain" ingredients and products are manufactured by reconstitution. That is, combining the separate ingredients obtained from refined products. While this might be a step in the right direction, it may invalidate the true concept of "whole Grains" and their benefits. From a broader scope, the food industry represented by the Brazilian Association of Food Industries (ABIA) and the Ministry of Health are working jointly to implement healthy life styles with a nutritionally balanced diet. A technical group was developed to discuss and propose joint actions to improve the offer of food products to promote a healthy diet.

High fibre grains and health: Collaborative R&D in Australia
S. JOBLING
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Cereal Foods World 53:A17

Cereal grains are major sources of dietary fibre, an important contributor to human health. Dietary fibre fractions, such as non-starch polysaccharides (NSPs), have the potential to lower cholesterol, alter the glycaemic index of food as well as to promote regularity and improve bowel health. The High Fibre Grains Research Cluster is a Flagship Collaboration Fund program between The University of Queensland, The University of Adelaide and The University of Melbourne with CSIRO's Food Futures National Research Flagship. The aim of the research is to develop new grain varieties with fibre content tailored to optimise health benefits and offer value to industry. The research focus of the Cluster includes understanding the biological functions of NSP, what controls the synthesis of NSP and learning how we can manipulate their levels and composition in grains for enhanced human nutrition. The Cluster has been designed to have an international leadership position focused on identifying the key genes that control the synthesis of grain polysaccharides. Targeting alterations in these genes has the potential to deliver high value outcomes, such as high fibre wheats with enhanced nutritional and processing properties.

Cultural considerations in formulating and marketing locally processed foods: Kenya and Namibia
A. MARETZKI
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Cereal Foods World 53:A17

In Sub-Saharan Africa, a cereal grain is often the only ingredient in gruels used both as weaning foods and as a mainstay in the diets of individuals with HIV/AIDS. These gruels are cheap, easy to swallow and digest and unlikely to aggravate vomiting and diarrhea. However, they do not appropriately complement breast milk, nor do they adequately nourish adults with an increased need for energy and essential nutrients. In USAID-funded projects in Kenya and Namibia, we worked with women farmers to form nutri-business cooperatives to process and regionally market nutritious, culturally-appropriate, easy to prepare, shelf-stable porridge mixes using locally grown ingredients. In Kenya, these mixes are marketed as family porridges appropriate for older infants and young children, while in Namibia a mahangu (pearl millet) and cow-pea mix is sold to NGOs for distribution to AIDS-affected households. The ingredients in the Kenyan products were chosen by the women shareholders during workshops in which they prepared and sampled porridges they made from locally-grown commodities. Ingredient ratios were subsequently modified to approximate Codex Alimentarius standards for a cereal-based supplemental food. Nutri-business cooperatives in the Central and Rift Valley produce mixes with several common ingredients

(maize, beans, carrot or pumpkin flesh and amaranthus or pumpkin leaves), but there is a culturally significant difference. Wimbi (finger millet) flour is included in the Kipsigis mix while banana flour is contained in the Kikuyu mix. These key ingredients give the mixes a distinctive cultural identity and reflect women's traditional understanding of what is important to feed young children. When food technologists overlook the importance of indigenous knowledge associated with traditional food crops, the result may be a proliferation of commercial grain-based products in developing countries that closely resemble those sold in European and U.S. supermarkets. Such products are associated with the vicious pattern of chronic disease that Western countries are unsuccessfully working to combat.

Synergy and cultural diversity: At what level?

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Cereal Foods World 53:A18

To the Anishinaabeg, manoomin (wild rice) is a sacred gift, perfect in its natural form, and in part, defines their cultural identity as a people. To many European Americans, wild rice, like many other foods, is seen as a food resource to be domesticated and improved. European American worldviews tend to emphasize food in terms of its physiochemical and economic dimensions. Anishinaabe worldviews allow for physiochemical differences but also emphasize spiritual and metaphysical dimensions of food and health relationships. Here, we scientifically assess and compare the nutritional value of manoomin and cultivated paddy rice, but also explore the larger context of cross-cultural worldviews. The study offers two findings. First, wild rice is a healthy food source with several statistically significant nutritional differences between the natural stand and cultivated varieties. However these differences appear unlikely to be physiologically significant. Second, Anishinaabe worldviews, when considered alongside a biomedical worldview, may better define a holistic view of health. While a biomedical approach to nutrient analysis can help to explain the nutritional value and some health benefits of wild rice, it cannot capture a complete understanding of either the complex interrelationships or web of health effects between manoomin and humankind. The challenge here is to bridge the metaphysical divide between western and indigenous conceptions of health.

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Abstracts of Oral Presentations

Abstracts submitted for oral presentations at the 2008 annual meeting in Honolulu, Hawaii, September 21–24. 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.

Fuzzy modeling and evaluation of surface interactions and emulsions of selected wheat protein combined to iota-Carrageenan and gum Arabic solutions

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Cereal Foods World 53:A19

Gums and proteins are valuable ingredients with a wide spectrum of applications. Surface Properties (surface tension, interfacial tension, emulsion activity index EAI, and emulsion stability index ESI) of 4% deamidated wheat protein (DWP) in a combination with iota-carrageenan (0.05, 0.1, and 0.5%) or gum Arabic (0.5, 1, and 5%) were investigated. The surface and interfacial tensions were determined using ring tensiometer; whereas, the emulsifying properties of the protein mixtures were determined using the turbidity method. The results showed that the addition of iota-carrageenan to 4% DWP significantly increased the surface tension, interfacial tension, emulsion activity index (EAI), and emulsion stability index (ESI). Whereas, the addition of gum Arabic to 4% DWP significantly increased the surface tension, decreased the interfacial tension and EAI (except at 5% of gum Arabic). In addition, a fuzzy-based clustering model was used to predict the surface properties of the (DWP). The fuzzy model achieved accuracies of (3%, 10%, 3%, and 25%) for predicting (EAI, ESI, surface tension, and interfacial tension), respectively. This approach can be applied to predict many other parameters and properties in food industry.

Significant of using baking soda in the production of Al-Mashrouh bread

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Cereal Foods World 53:A19

Six levels of baking soda (zero, 1200, 1800, and 3600) ppm were selected for the study of dough characteristics. Four of these levels (zero, 1200, 1800, and 3600) ppm was evaluated by sensory testing of bread. The study aimed to study effect of adding sodium bicarbonate in the production of Al-Mashrouh (Tannouri) bread. The results of the Farinograph and Extensograph measurements showed significant effects on the rheoloygical properties of the dough. The stability of dough increased gradually from 5 in the control to 31 min at 3600 ppm level. Accordingly the time to break down increased from 4 to 30 min, whereas the mechanical tolerance index decreased from 55 to 30 Brabender units (BU). The energy as measured by the Extensograph increased from 115 at zero level to 145 cm^2 at 3600 ppm level. The extensibility increased from 153 to 165 mm and the resistance to extension increased from 440 to 520 BU at 3600 ppm level (after 135 min proofing). The addition of either 1200, 1800 or 3600 ppm to the dough resulted in facilitating the manual flattening and spreading of the dough pieces that are very basic to reach the desired thickness (few mm) of the loaf without having holes or being torn off. The baking time was reduced due to the addition of 1200, 1800 or 3600 to 9.5, 9.5, and 14% respectively. This resulted in a weight increase of the loaves from 1% at 1200 to 2.5% at 3600 ppm and a corresponding increase in the moisture content from 0.3 to 0.7%. However the rate of moisture loss was elevated proportionally to the level added. The sensory evaluation of the bread using ranking test showed an improving effect of adding 1200 and 1800 ppm sodium bicarbonate; where as 3600 ppm level decreased the overall quality of the Mashrouh bread. Keywords; Bread, Sodium bicarbonate, Dough, Rheoloygical properties.

A noval simultaneous method for inducing softness, increasing sweetness and viscosity by using lactase in fat–replaced biscuits

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Cereal Foods World 53:A19

Fat reduction is a prerequisite for health foods as many chronic diseases are associated with certain types of excess fat consumed in the diet. Fat–replacers are therefore a focus for inclusion in processed foods, such as in biscuits to decrease the caloric content through fat reduction. However, elimination of fat generates many undesirable effects on the end product including hardness in texture as the problem mostly remains unsolved even by using various combinations of fat–substitutes. The present paper examines the use of lactase in biscuit recipes where 50% of fat is replaced without affecting the flavor and texture. The experiments also demonstrated that autoproduction of maltodextrins released during limited hydrolysis of starch by alpha–amylase may reduce the amount of enzyme used. The results have illustrated that the viscoelastic properties of the dough, as indicated by the Viscoamylograph are increased by two ways, firstly the lactose present in the whey powder, used as part of the ingredients is hydrolyzed to glucose and glactose, that are more viscous and hygroscopic. Secondly lactose breakdown facilitate the mobility of whey proteins, known for their emulsifying capacity, foaming abilities and water absorption etc that help in appropriate dough development. The overall rheological behavior of the dough as measured by Farinograph was improved significantly and the hardness in the final product was reduced to desirable extent as shown by the texture analyzer. The lactose hydrolyzed monosaccharides consisting higher sweetening powders are responsible for a better impact on the sensory profile and for minimizing the quantity of sugar used. The effect of using lactose alone instead of whey powder was also studied. The bakery industries may implement the present process that will be cost effective in view of reducing fat and sugar as the raw materials. Keywords: Lactase, Fat–replacer, Sugar, Farinograph, Viscoamylograph, Texture Analyzer, Gluten index.

The development of a rapid dough bread baking method using a doughlab

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There are three major Western style bread production systems: long fermentation, sponge and dough, and a rapid process used extensively in Australia and in some export markets. Test baking methods are used for a number of purposes: they can be used to test variations in baking procedures, to test the influence of various ingredients on baking or, as is the case in wheat breeding programs, to establish the relative quality of wheat varieties and

crossbreds. In order to reflect baking practice within Australia when selecting new wheat varieties, an appropriate rapid test bake method was required. Bread manufacturers in Australia use a rapid dough development process for bread baking. The long fermentation test bake method such as AACC method 10:10 unreasonably discriminates against varieties that have more mellow gluten and perform well in Australian commercial practice. During the development of the rapid test bake process it was found that the pin mixer action did not mix dough sufficiently fast enough or transfer energy rapidly enough to simulate commercial rapid dough bake processing. At Wagga Wagga Agricultural Institute, a rapid dough method utilizing the Newport Scientific Doughlab has been developed for assessment of lines at the advanced stage of the breeding program. The target wheat protein range is 11 to 12%, reflecting Australian commercial practice. This work concentrated on developing a rapid process suitable for selecting new varieties suitable for the domestic industry in Australia and to test the suitability of the DoughLab for this purpose.

Identification and expression of genes encoding potential food allergens in developing wheat grain

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Cereal Foods World 53:A20

Wheat is one of the top eight foods responsible for IgE-mediated food allergies, but few wheat proteins that cause food allergies have been characterized in detail. A recent proteomic study revealed a group of endosperm proteins that increased in relative amount when wheat plants were subjected to high temperatures during grain development. DNA sequences corresponding to several of these proteins were obtained from EST databases and the allergenic potential of the encoded proteins was assessed by comparison with known allergens in the SDAP (http://fermi.utmb.edu/SDAP/) and FARRP (www.allergenonline.com) allergen databases. Two of the proteins were 9 kDa lipid transfer proteins (LTPs), members of the prolamin superfamily of allergens. LTPs are major food allergens in many plants and recent IgE-binding studies demonstrate that wheat LTPs react with sera from patients with confirmed allergies. Another two proteins were identified as PR-4 proteins called wheatwins. A sliding 80-mer alignment against the SDAP and FARRP databases revealed that wheatwins show significant identities to allergens from *Hevea braziliensis* and *Brassica rapa*. Other proteins that increased in response to high temperature were similar to globulin-2 proteins from maize. These proteins fall into the cupin superfamily of plant food allergens and show significant identities to 7S globulins that are important allergens in sesame, tree nuts, legumes and peanut. Gene expression was evaluated during grain development under moderate and high temperature regimens by quantitative RT-PCR. Transcripts corresponding to two LTP genes, two wheatwin genes and two globulin-2 genes accumulated during the latter half of grain development and maximum transcript levels for all genes were notably higher when grain was produced under high temperature regimens. Increased amounts of LTP, wheatwin and certain globulin-2 proteins also were detected in flour from grain produced under high temperatures by 2-DE. The characterization of genes that encode potential food allergens is a first step in developing methods for detection of food allergens in flour and food products.

Molecular Minutemen deployed in metabolic wars: Proteolytic trimming and Mass Spec proteomics of starch granule surface lipids unveil a platoon of antifungal proteins; puroindoline is not alone in the arsenal

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Cereal Foods World 53:A20

Incident solar radiation is converted by photosynthesis into starch granules. Immediately, metabolic wars utilizing sophisticated molecular armaments ensue between the cereal embryo and its panoply of pathogens. This Systems Biology approach to discover how organisms monitor the Starch Granule Surface (SGS) and manage to ward off pathogens is instructive: presence of puroindolines, GSPs, xylanase inhibitors, globulin 2, ribosome inactivating proteins, peroxidase etc allude to there being complex defence maneuvers at the macromolecular level to prevent invasive microbes from lysing the amylose lamellae. Just as Scanning Electron Microscopy captures the 'systems' landscape of water-washed wheat starch granules, we have used mass spec to probe the surface of the granule, asking "Who's there? What are they doing?" Fractional solvent stripping of the Lipome-Proteome attached to wheat starch granules shows that SGS harbors not only the lipids of this planar/concentric subcellular 'organelle' but many plant defense proteins also. The juxtaposition of so many innate immune proteins in this SGS 'organelle' as sentinels or "Molecular Minutemen" indicates a novel, rich source of biodiversity for starch-interacting proteins. Many such SGS-associated proteins may encode targeting signals or peptide domains with cryptic functionality in food systems (e.g. beer foam). One such cryptide is the tryptophan-rich domain of PuroINdoline. Since the first cDNA cloning of such tryptophan-rich proteins from the softest grains (Fabijanski et al 1988 Biochem Physiol Pflan 183:143-152), there is mounting evidence that puroindolines are targeted to the interface of SGS and protein matrix. To mark the 20th anniversary of Trp-rich domains in cereal chemistry we mined this 'front line' of the metabolic war zone to better understand how wheat defends its carbon stores against catabolic enzymes of scavenging heterotrophic pathogens. The implantation onto and orientation of puroindoline at the SGS was assessed using proteolytic 'trimming' and MS. Starch granules were extracted from wheat, water washed, and subjected to tryptic digestion of surface proteins. The remaining surface-bound peptides derived from starch granule-associated proteins were identified using HPLC ESI-MS. The tryptophan rich domain (TRD) of PIN is embedded in the SGS. This proteomic approach simultaneously identified additional peptides of SGS associated proteins which may impart even stronger affinity for the SGS 'organelle' than that of PIN TRDs. Food and pharma applications will be discussed.

Effect of environmental stress on ethanol production efficiency from grain sorghum

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Grain sorghum is one of the agricultural resources used in ethanol production. Annually the U.S. ethanol industry consumes 15% sorghum and is expected to increase further. Sorghum is one of the most drought-tolerant grain crops and is a model crop species for studying mechanisms of drought-tolerance. As a biofuel resource often exposed to drought stress, it is imperative to understand the effects of stress on biofuel production efficiency. To this end, we evaluated the effects of drought stress and high temperature on sugar levels and the efficiency of ethanol production from grain sorghum. The effect of drought stress on the reproductive phase was assessed by exposing plants to four water treatments: i) fully irrigated control, ii) drought stress from boot leaf emergence to flowering, ii) drought stress from flowering to seed-set and iv) drought stress from seed-set to mid seed fill. Effect of high temperature stress was assessed by growing plants at daytime maximum/night time minimum temperatures of 32/22°C until 30d after sowing (DAS) under fully irrigated conditions. Thereafter, plants were exposed to 40/30°C (high temperature) for 10d at different stages: i) 10d prior to flowering, ii) at flowering, iii) 10, 20 and 30 d after flowering. Drought stress significantly decreased glucose and sucrose content (mg g^{-1}) and ethanol production (%, w/w). Ethanol production was lowest when stress occurred at early and mid stages of grain filling compared to pre-flowering or later stages of grain filling. High temperature stress did not affect sugar content. However, high temperature stress at 10 and 20d after flowering resulted in lowest ethanol production. Our results suggest that environmental stress during grain growth and development could impact biofuel production efficiency.

Effect of an oxygen scavenger on the stability of flour tortillas free of preservatives

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The shelf life stability of commercial wheat flour tortillas free of preservatives was evaluated using an oxygen scavenger system (OSS) under different storage conditions including accelerated storage (AS) (40°C, 75% rh), room temperature (RT) (22°C, 57% rh), and refrigeration (R) (4°C, 42% rh). The OSS consisted of a multi-layer co-extruded bag paired with an oxygen scavenger. A resealable bag made of LDPE/LLDPE was used as a control. Diameter, thickness, lightness, water activity, pH, stretchability, elasticity, and microbial growth were measured. Weight and thickness under RT were maintained with the OSS. Lightness of OSS tortillas was superior to control under R ($P < 0.05$). Almost all texture and microbial parameters were improved by the OSS. Less staling as measured by maximum force was observed over time under AS and RT. The OSS favored elasticity under all conditions evaluated. It also showed its potential in controlling APC and Y&M under AS and RT, especially Y&M. There were no changes in APC or Y&M with either the control or OSS during the first 15 days of testing under R.

Affect of functional ingredients on pasta quality and *in vitro* starch hydrolysis

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With growing awareness of the beneficial effects of a healthy diet on the quality of life, many initiatives have been taken to develop food products with special health-enhancing attributes (functional foods). Our work involves the development of pasta as a functional food by incorporation of ingredients such as pollard, inulin, guar gum, carboxymethyl cellulose (CMC), resistant starch (RS), high amylose starch (HAS), and beta-glucan concentrate (BG) in pasta formulations made from durum semolina. Semolina was mixed with ingredient at various concentrations and made into spaghetti. The cooked pasta was evaluated for quality and enzymatic *in vitro* starch hydrolysis. Substitution with 40–60% pollard increased the antioxidant content of cooked pasta, but had negative impacts on pasta cooking loss, decreased water absorption and lowered pasta yellowness. *In vitro* starch hydrolysis of the cooked pollard pasta was increased relative to 100% semolina pasta, suggesting pollard inclusion increases the glycaemic index of pasta. Inulin had a minor impact on pasta quality, giving reduced firmness and higher cooking loss with increasing inulin content and some changes to sensory scores. Starch hydrolysis of the inulin pasta reached a minimum at 5% inulin then increased to higher levels than the control at 20% inulin. SEM images of cooked pasta support the hypothesis that up to 5% inulin encapsulates the starch granules in a protective coat, while higher inulin appears to disrupt the starch/protein matrix. Guar gum (GG) addition to semolina (0–20%) increased farinograph water absorption continuously. GG probably competes with gluten for water. Substitution with 15–20% GG greatly increased pasta stickiness, increased cooking loss and water absorption. Starch hydrolysis of GG pasta decreased continuously with increasing GG. It is possible that GG acts as a barrier to reduce access of alpha-amylase during digestion. In general, substitution of pasta with CMC at the concentrations investigated had little positive or negative effect on pasta quality. Starch hydrolysis decreased continuously with increasing CMC, suggesting CMC inclusion decreases the glycaemic index of pasta. Details on the affects on quality and starch hydrolysis of BG, HAS and Novelose 330J RS will be discussed. In conclusion, the ingredients investigated show a range of affects on pasta quality and starch hydrolysis of pasta with possibilities to further lower the glycaemic index of pasta.

Characterisation of a functional ingredient requires multiple assessments

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Cereal Foods World 53:A21

The food industry relies on high market share, market exclusivity, or first to market advantage for functional ingredients. Researchers test individual ingredients (added to traditional and non-traditional delivery foods), often at high doses, to confirm health benefits. Unfortunately, testing the activity of an ingredient alone does not necessarily define how it functions in foods, and a single test, such as that of glycaemic index, does not address all food functionalities. In addition, food functionality may be affected by a variety of factors including storage, methods of preparation, endogenous enzymes in other food ingredients and concentration. We found in a recent meal test for effects of beta-glucan on appetite control that results varied for blood glucose and insulin, appetite hormones and subjective appetite ratings. Depending on the outcomes assessed, the fibre dose which "decreased appetite" varied. Ingredient testing showed all doses (approximately 2-5 g) had high viscosity and solubility, likely to increase gastrointestinal transit time. Repeated measures analysis of variance (RMANOVA) for glucose variation unexpectedly showed no significant effects at varied doses, while insulin secretion decreased with increasing fibre dose ($P = 0.011$). Some appetite hormone measures (ghrelin) showed no dose response while others (cholecystokinin) showed promising results. Subjective satiety was apparent at low dose (RMANOVA, $P = 0.039$), but subsequent meal intake only decreased at high dose. Combining the results of all assessments provides comprehensive evidence for the use of an ingredient. Research addressing only a single measure, may greatly under- or over-estimate ingredient functionality.

Anthocyanin composition and oxygen radical scavenging capacity (ORAC) of milled and pearled purple, black and common barley

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The importance of anthocyanins to the total antioxidant capacity of various fruits and vegetables has been well established in various works. However, consumption of fruits and vegetables represents only a small fraction of the typical North American diet compared to that associated with cereals products (FAO, 2008). This reality underlines collaborative research efforts among plant breeders and food scientists aimed at developing cereal grain varieties and value-added cereal products rich in anthocyanin compounds. The objective of this work was to quantify the antioxidant capacity and anthocyanin composition of acidified methanolic extracts (pH = 1 N) obtained from the bran (10% outer kernel layers) and whole ground kernels of three barley genotypes (Peru-35, EX-83 and CI-1248). Phenotypically, Peru-35 represented a blackish grain with a hull-less caryopsis, EX-83 a hulled light yellow colored grain and CI-1248 a hull-less purplish grain. To measure antioxidant activity, the oxygen radical scavenging capacity (ORAC) procedure was employed while separation and identification of anthocyanins was accomplished using high performance liquid chromatography (HPLC). HPLC retention times of nine anthocyanin monomeric standards, delphinidin-3-glucoside (Dp-3-glc), cyanidin-3-galactose (Cy-3-gal), delphinidin-3-rutinoside (Dp-3-rut), cyanidin-3-glucoside (Cy-3-glc), cyanidin-3-rutinoside (Cy-3-rut), petunidin-3-glucoside (Pt-3-glc), peonidin-3-glucoside (Pn-3-glc), malvidin-3-glucoside (Mv-3-glc) and cyanidin-chloride (Cy-Cl), were used to identify the anthocyanin profile of the barley extracts. Results indicate that the antioxidant capacity (μmol trolox equivalents per 100 g, on a dry weight basis), as measured by ORAC, for the bran fractions of genotypes Peru-35, EX-83 and CI-128 were significantly ($P < 0.05$) higher (9,710, 12,030 and 10,990, respectively) than for the whole ground kernel (5,600, 3,940 and 5,430, respectively). Total anthocyanin content (mg per 100 g) in the whole ground kernels of genotypes EX-83 and CI-1248 (9.8 and 38, respectively) were significantly ($P < 0.05$) lower than in their corresponding bran fractions (183 and 401). No anthocyanin was detected in the genotype Peru-35. Anthocyanin composition in the barley samples varied according to genotype and for the same genotype, within the kernel tissues. HPLC analysis detected 2, 9, 4 and 13 anthocyanin compounds in EX-83, EX-83 bran, CI-1248 and CI-1248 bran, respectively, from which only 2, 4, 2 and 3 anthocyanin monomeric compounds, respectively, were positively identified based on the retention times of Dp-3-glc, Dp-3-rut, Cy-3-glc and Pt-3-glc. Results demonstrated that barley kernel color was a good indicator of anthocyanin content, with CI-1248 having higher anthocyanin content than EX-83. Though its whole kernel yielded a milled fraction with the highest antioxidant activity, the so-called antholine Peru-35 had no detectable anthocyanin compounds, suggesting that phytochemicals other than anthocyanins were responsible for the observed antioxidant capacity of this black colored hull-less grain. Results from the present study indicated that barley fractions containing as much as a hundred times more anthocyanin per unit weight than in the whole grain can be obtained by removing outer tissue layers from the kernel through an abrasive reduction process, such as pearling.

Assessment of crumb hardness using a model of cellular solid; a mechanical approach of crumb staling

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The evaluation of the hardness of the crumb during staling remains a challenging measure. Some relation exist between the mechanical property of the constitutive material of a cellular solid (Young Modulus) and the porosity of the cellular solid. Depending on the porosity of the crumb (which is related to fermentation and baking condition mainly), the hardness of crumb will be affected. To prevent this artefact (impact of the porosity) and also to have a better control of the baking condition, a specific protocol has been set up. This very new protocol consists in baking fermented but degassed dough between two Peltier elements. Such an installation allows an excellent control of the baking condition. The thin sheet of baked dough (3 mm) can then be evaluated as the constitutive material of the crumb without the artefact induced by the porosity of the baked crumb. The crumb can then be evaluated as a solid material with more flexibility in term of procedures. Compression tests for example and relaxation tests allow the measurement of selected mechanical parameters such as the Young Modulus and the relaxation parameters. Assessing the evolution of these parameters during staling can be related to the hardening of the crumb during storage. In addition, DSC tests allow the assessment of the crystallisation of amylopectin during storage. Based on the mechanical properties of the baked degassed crumb, it is envisaged to develop mechanical models that will mimic the cellular structure of the bread crumb and to better understand the real impact of porosity and of mechanical properties on the texture of the crumb. Selected examples are proposed to present this new methodology.

Value-added expanded extruded snacks formulated with lentil and nutritional yeast flours: Physico-chemical evaluation and acceptability

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Lentil based formulation containing 4, 8, 12, 16, and 20% of SaFlavor Plus nutritional yeast were extruded using a Clextral EVOLUM HT-32-H twin screw extruder, run at die temperatures of 140 and 160°C and constant screw speed of 500 rpm, to produce a cylindrical snacks-type product. In general, the SME (KWh/Kg) of the process decreased with an increased concentration of nutritional yeast, under both die temperature studied. However, the diameter, bulk density, and expansion ratio of the extrudates was not significantly ($P \leq 0.05$) different among the lentil-nutritional yeast extrudates. Exemptions to the previous determinations were observed for those products containing 8 and 12% nutritional yeast and extruded at 160°C, which demonstrated greater diameter and expansion ration and lower bulk density. A multisample difference test was used to evaluate the sensorial attributes of the developed lentil-nutritional yeast extruded snack-type products. The incorporation of nutritional yeast into lentil-based formulations produced extruded snack-type products with enhanced textural characteristics and acceptability than control extrudates. The development of value-added expanded extrudates, formulated with lentil and nutritional yeast, have a great potential to provide the population with highly nutritional, healthy and convenient food.

Effects of lipids on pasting properties of commercial wheat starch during repeated heating and cooling

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Starch is a major component of many food products, and its rheology is very important in its processing. The Rapid Visco Analyser (RVA) is an effective instrument for measuring the viscous properties of cooked starch, for relating functionality to structural properties, and for studying effects of additives on rheology of starch systems. Starch-lipid complexes can be formed directly in the RVA and their formation was shown to be correlated with viscoelastic parameters of starch pastes. Most studies to date used standard RVA profiles with single heating and cooling step and only limited number of studies reported using modified RVA protocols. In the present study, commercial wheat starch and a range of saturated and unsaturated monoglycerides were subjected to RVA protocol consisting of 15 heat-cool 12-minute cycles. Starch pastes with added non-complexing lipids, similarly as pure starch paste, displayed stable temperature-dependent viscosity traces. In contrast, starch pastes with complexing lipids showed significantly different behavior. Saturated monoglycerides caused increase of viscosity in the first few heat-cool cycles followed by steady decrease of viscosity until reaching a stable state. In contrast, unsaturated monoglycerides with *cis* configuration of double bond in their fatty acid chains used in this study did not cause significant increase of viscosity in the first heat-cool cycles. Additionally, continuous shear under repeated heat-cool cycling did not lead to establishment of an equilibrium state. Transition of disordered amylose-lipid complexes (type I) to crystalline structures (type II) was found to have major effect on the viscoelastic behavior of starch pastes under repeated temperature cycling. Secondary effects such as chain length of the fatty acid in the monoglyceride, configuration of the double bond and amylose aggregation were found to exert further influence on the rheology of starch pastes. Results are discussed in relation to latest theories on amylose aggregation, phase separation and starch-lipid complexation.

Valorization of the co-products of cereal processing industries by hydrolytic enzyme technology

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Developments such as the ageing of the population, the increased incidence of the metabolic syndrome, demanding food and environment legislations, and increased production costs ask for increased valorization oriented research efforts relating to the production and characterization of both technologically relevant and health promoting functional components in food systems. Many co-products of cereal processing industries are rich in non-starch polysaccharides and proteins and therefore are a potential source of such functional components. Much research has focused on the valorization of these components as such, generally with limited success. Recent developments in hydrolytic enzyme technology allow transforming these co-products into functional oligosaccharides and peptides. The aim of our work is to provide a broad science and technology basis for valorization of functional oligosaccharides and peptides. Thoroughly characterized co-products (e.g. brewer's spent grain) are separated into their protein and carbohydrate components. After that, different hydrolytic enzyme systems are screened for their potential to obtain protein and carbohydrate hydrolysates with distinct characteristics. Both the techno-functional characteristics of these components as well as some of their bio-activity effects are explored. Based on the obtained information, generic structure – function relationships for protein and carbohydrate hydrolysates are sought.

Impact of whole grain inclusion on dietary intake and risk factors for cardiovascular disease in a large-scale randomised, controlled dietary intervention (the WHOLEheart study)

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Background: Epidemiological evidence suggests that increased whole grain (WG) consumption is linked to reduced risk of cardiovascular disease (CVD), but this has not been tested in large-scale, randomised, controlled intervention studies. Methods: 316 overweight participants (age 18–65y, BMI > 25 kg/m^2 but otherwise healthy) who habitually consumed <30 g WG/day were recruited in 2 UK study centres (Newcastle and Cambridge). Participants were randomised to 3 groups: Control (no dietary change), Int. 1 (consumed 60 g WG/day for 16 weeks) and Int. 2 (consumed 60 g WG/day for the first 8 weeks, followed by 120 g WG/day for a further 8 weeks). Duplicate fasting blood samples were taken at weeks 0 (baseline), 8 and 16 of intervention. Dietary intake was assessed by food frequency questionnaire. Plasma was analysed for lipid profile (total, LDL and HDL cholesterol and triglycerides), insulin and glucose. Differences between study groups were compared using a random intercepts model with time and WG intake as factors. Nutrient intake and food frequency for Int. 1 and Int. 2 were compared with the Control group by 2-sample Wilcoxon-ranked sum test. Results: Mean WG consumption was <20 g/day at baseline. The mean (SEM) WG intake for each group during the intervention was: Control 19 (2.2) g/day across the intervention, Int.1 74 (3.3) g/day for weeks 8 and 16, Int.2 76 (3.1) g/day at week 8 and 115 (4.5) g/day at week 16. WG inclusion resulted in a significant increase (all $P < 0.001$) in intake of dietary fibre, B vitamins and some minerals (Fe, Mg, Mn and Zn), and also resulted in higher intakes of total energy and sodium at some time points. At the highest WG intake the frequency of fruit consumption was reduced ($P = 0.045$). WG inclusion in the diet had no impact on any of the plasma parameters tested ($P > 0.05$). Conclusions: WG inclusion both positively and negatively influenced diet and nutrient intake. Inclusion of WG foods, over 16 weeks, in the diets of an overweight but otherwise healthy UK population had no effect on a range of CVD risk biomarkers. Dietary intervention data do not match epidemiological observations on WG and CVD risk. [This study was funded by the UK Food Standards Agency (N02036)].

Effect of fertilizer source and rotation on grain quality in non-flooded rice

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Cereal Foods World 53:A22

Water use is becoming a major issue in rice production. One way farmers are trying to conserve water is by growing rice in irrigated rows instead of permanent flooding. There is no information as to the affect that this management practice will have on rice grain quality. Also, urea which is used as a nitrogen source in rice production is very volatile and may be lost if it is applied to a wetted soil surface. CLXL 730 was grown under flooded conditions and in irrigated rows using urea, Agrotain, and a slow-release N fertilizer. In another study, CLXL 730 was grown under flooded conditions and in irrigated rows in two different rotation systems. Growing rice in rows was associated with a decrease in gelatinization temperature, and an increase protein content in the grain. It also was associated with a change in the Rapid Visco™ Analyser (RVA) profile by decreasing the peak, trough, and final viscosities. Breakdown viscosity was also reduced. Planting rice in rows had no affect on apparent amylose content or setback. Type of fertilizer used had no affect on any of the parameters tested. Therefore, planting rice in irrigated rows may affect the protein content and therefore, cooking quality (RVA and gelatinization temperature) as compared to permanent flood conditions. However, using slow-release N fertilizer or Agrotain over urea had no affect on protein content in the grain or cooking quality.

Are cereal grains lignified?

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Cereal Foods World 53:A23

Although some quantitative dietary fiber methodologies exclude the determination of lignins, they are generally regarded as dietary fiber components. Lignins are suspected to have important health effects within the dietary fiber complex, including as antioxidants and carcinogen adsorbents, and they may be partially converted to mammalian lignans. Application of the Klason lignin methodology to food led to the conclusion that cereal brans are highly lignified. Since the Klason lignin methodology is unspecific, the aim of our studies was to prove that cereal grains are indeed highly lignified and, moreover, to characterize lignins from cereal grains. In our studies we enriched wheat, rye and corn dietary fibers in their "lignin" contents by partial degradation of cell wall polysaccharides and isolated "lignin" fractions from wheat and rye bran insoluble dietary fibers as well. Fibers enriched in "lignins" were used to prove the existence of lignin in cereal grains and to determine the overall monolignol composition by applying the DFRC (derivatization followed by reductive cleavage)-methodology and fibers were classified according to their syringyl/guaiacyl ratios. However, the yields of liberated lignin monomers were surprisingly low, suggesting either low lignins contents or lignin structures which are not susceptible to DFRC cleavage. "Lignins" were isolated from wheat and rye bran by using widely accepted lignin ex-traction protocols. The acetylated lignins were analyzed by 2D-NMR. In contrast to lignins from pear which were isolated as positive control, "lignins" from wheat and rye did not allow substantive structural profiling. The spectra only weakly reveal beta-ether unit and resinol structures, but the large majority of signals was not related to known lignin structures. Subsequent chemical characterization of preparative isolated Klason-lignins from cereal brans also showed that more than 50% of the isolated Klason lignin from e.g. wheat bran are not attributed to actual lignin but to proteins, wax-like and cutin/suberin-like components. In conclusion, it appears that lignin contents of grains have been overestimated by using the Klason lignin methodology. It is likely that the insoluble fiber material from grains contain materials that can at best be described as lignin-like.

Semi-continuous ozonation of grain and end-use products

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Cereal Foods World 53:A23

Previous trials of ozone treatment for post-harvest food grains have proved ozonation as a potential non-chemical, non-residual and environmentally friendly alternative for treatment of stored food grains and end-products. A properly designed ozonated airflow system is important for the effective movement 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 a semi-continuous ozonation system with maize. The primary objective was to determine the engineering parameters to design a counter-flow semi-continuous ozonation treatment system in a grain bin in order to ozonate the grain mass at a faster rate compared to the previously used batch ozonation system. The procedure of the counter-flow semi-continuous ozonation system consists of removing each grain layer with a tapered unloading auger after each layer reaches the desired ozone concentration to achieve insect mortality, mold reduction, and/or odor removal. The treated grain is subsequently transported to a storage or shipping bin. The basic setup for ozonation in grain storage structures consisted of generating ozone at a constant rate with commercially available generators, introduction into the bin with a fan with a minimum air velocity. A monitoring system for ozonation was designed to quantify and control the ozone concentration throughout the grain mass consisting of multiple monitoring lines distributed throughout each grain layer. Air velocity was quantified for each grain layer to determine the theoretical ozone concentration. Ozone concentration was allowed to build up for 60 to 120 minutes in the bottom grain layer. As the layers of grain were removed, the ozone concentration in each layer increased until the maximum value was reached. Below a certain grain depth, ozone concentration in each layer decreased after 12 hours due to the dilution effect as ozone was escaping out of the top layer caused by a decrease in resistance to airflow. The comparison of the theoretical and measured values for ozone concentration resulted in a significant difference at each grain depth due to the difference in the ozone producing capacity of the generator and the measurement error of ozone concentration in the monitoring system. A counter-flow semi-continuous ozonation system was successfully tested and proved to be an important tool for properly ozonating grain at a faster rate than with a batch ozonation system.

Avenanthramides in oats: Localization and concentration within the grain relative to their potential role in preventative cardiovascular health

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Cereal Foods World 53:A23

Avenanthramides, of which over 35 distinct components have been found to date, represent the major readily-bioavailable, soluble phenolics present in the oat kernel These hydroxycinnamoyl alkaloids are found only in oats and have been shown to not only act as antioxidants but also to inhibit the pro-inflammatory processes associated with atherosclerotic disease progression. Based on recent but very limited *in vivo* pharmacokinetic results in humans and *in vitro* human vascular cell culture models, effective concentrations of avenanthramides that might be required to influence vascular antioxidant status and the inflammatory response can be provisionally projected. Threshold response levels of avenanthramides (approximately 30 to 60 mg from a dietary source delivery system such as a 50 g serving of oat bran) would require an oat product with at least 600 to 1,200 ppm total avenanthramides. This is a significantly higher concentration range than those currently recorded for existing oat varieties or existing whole grain oat products. However, if the avenanthramides are confined to specific tissues within the grain, oat products with substantially elevated avenanthramide levels might be possible. This has necessitated an in-depth evaluation of their in planta localization. Abrasion milling (i.e. Satake "pearling") of an experimental hulless oat variety exhibiting high avenanthramide levels was used to selectively and sequentially remove the outer layers of the grain. Qualitative and quantitative HPLC analyses of abrasion milling fractions were carried out to generate avenanthramide profiles. Previous microspectro-photometric-based distribution profiles, using transverse sections of the kernel, were confirmed by the wet chemical analyses. Although all abrasion milling fractions showed the presence of avenanthramides, the concentration gradient decreased rapidly from the outside aleurone/sub-aleurone tissues to the inner endosperm. Outer (i.e. bran-enriched) fractions exhibiting levels as high as 550 ppm total avenanthramides were produced. The consequences of these findings from the standpoint of preventative nutrition involving dietary oat products and ingredients will be presented.

Effect of repeated heating and cooling cycles on the pasting properties of starch

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Despite many reports on the pasting properties of starch in the Rapid Visco Analyzer (RVA), little information is available on the use of the instrument to investigate food processes that involve more than one heating and cooling cycle. In this report, we describe a new temperature profile based on repeating a standard heating and cooling cycle five times. This profile was developed to increase our understanding of starch pasting properties during processing, and also to give additional information on characterizing complexes of starch with various lipids. The changes in the viscosity of starches from four wheat varieties with amylose content ranging from 23–27%, and waxy starches of wheat, rice and maize were examined using the starches alone and the starches mixed with monopalmitin (MP) or lauric acid (LA). MP was chosen because of its common use in bakery products, whereas LA was used because of its water solubility. The results show that starch gels form and melt reproducibly during repeated heating and cooling cycles. However, the pasting viscosities of the starches alone and when mixed with lipids, differed, which we propose is related to differences in the fine structure of the starches. The results obtained with the waxy starches provided no evidence for the presence of amylopectin-lipid complexes.

Wheat kernel associated xylanases: Presence and impact on wheat based processes

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2008 Young Scientist Award

Arabinoxylan is only a minor constituent in wheat. Nevertheless, it can have a determining impact on wheat processing or on final product yield or quality, hence the use of xylanases to optimize wheat applications. In the last 20 years knowledge on xylanase functionality has been gradually building up. The presence and impact of wheat kernel associated xylanases has, however, largely been overlooked and was the object of several studies. Results of these studies indicated that xylanases associated with wheat kernels consist of wheat endogenous xylanases on one hand and kernel-associated microbial endoxylanases on the other hand. Levels and ratios between different types of

enzymes were shown to vary significantly with harvest year and wheat variety. In some cases, wheat kernel-associated microbial endoxylanases accounted for over 90% of the total wheat-associated xylanase activity. The impact of these xylanases on two systems, i.e. refrigerated doughs subjected to longer term storage and wheat bread doughs subjected to a normal fermentation process, was investigated. Using debranning as a tool to remove the majority of kernel-associated microbial xylanases prior to milling, we were able to show that the onset and extent of dough syruping (the undesirable appearance of a brown liquid) during refrigerated dough storage was drastically reduced when using flour samples which contained reduced levels of xylanases. In normal bread doughs, mainly inhibition insensitive endogenous xylanases were active, and led to increased solubilization of arabinoxylan in the dough, probably affecting the end product. In conclusion, we can say that wheat kernel associated xylanases should not be neglected and that they can add to batch to batch and year to year variability in performance of wheat.

Quantification of branching ratios in waxy rice (*Oryza sativa* L.) by nuclear resonance spectroscopy

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Cereal Foods World 53:A24

Amylose has been identified as the most important component of starch affecting the cooking and eating properties of different starches. However, different varieties with similar amylose contents have been observed to have different cooking and eating properties; the cooking properties of waxy varieties, also vary significantly. Since amylopectin comprises the bulk of starch in the grain, it is important to quantify differences in the functional properties of rice when amylose is lacking, and to determine reasons for the different effects of amylopectin on the functional properties of rice. A set of waxy rice varieties, observed to have significantly different functional properties, was used in this work. The differences in functional properties are attributed to differences in starch structure, which can be explored at various levels. Amylopectin can be separated into two fractions of solubility: hot water soluble (HWS) and insoluble (HWI). The proportion of HWS components associates with components of viscosity. At the level of individual chains, amylopectin, and the fractions of solubility, can be characterised by their chain length distributions obtained by fluorophore-assisted capillary electrophoresis. The ratios of chains DP 6-12 and DP 13-17 to DP 24-35 are statistically different in the HWS and HWI fractions of four waxy rice varieties used in this study. DP 6-12 are designated A-chains, while DP 13-35 are short B1-chains., and DP 24-35 are long B1-chains. These chains all fit in one crystalline lamella. The variations in the ratios of A- and short B1-chains to long B1-chains indicate a difference in the branching frequencies between insoluble and soluble fractions, which has implications for solubility. Branching frequencies of molecules in each fraction are the next structural level. A technique used for studying the structure of starch at this level is nuclear magnetic resonance spectroscopy (NMR). This method quantifies the alpha-1,4 and alpha-1,6 linkages. Branching ratios can then be computed. The structure of amylopectin at these higher levels is explored, and differences in structure at these levels are interpreted based on the known functional properties of the different varieties.

Assessing aging processes in egg-white foams

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Cereal Foods World 53:A24

The structure of angel food cake made from egg white foams is highly dependent on the mixing process, with the void fraction and bubble sizes substantially affecting the porosity and texture of the cake. However, as soon as a foam is made, it begins to break down. Foam instability with time is governed by events such as disproportionation, coalescence and liquid drainage. We studied foam aging using two noninvasive techniques – ultrasonic spectroscopy and electrical conductometry - with a view to understanding aging mechanisms that would affect the quality of the final product. A simple angel food cake foam recipe of just sugar and liquid egg whites was used. Foams of different void fraction (0.65 and 0.79) were created by mixing for different times. Ultrasonic pulses were transmitted through foam samples of three thicknesses at 2 minute intervals, and the phase velocity and attenuation were extracted from the signals using Fourier techniques. At frequencies from 20 to 40 kHz the phase velocity of egg-white foams varied only slightly during the first 20 minutes of aging, in contrast to a synthetic foam (Gillette foamy) where the velocity showed a marked decrease. Large increases were found in the attenuation with aging time, with the rate of increase being faster in the higher void fraction foam. These time-dependent changes are consistent with both liquid drainage and disproportionation in the foams, with the latter dominating in the high void fraction foam. Measurements of the electrical resistance were performed at different heights of a column of foam to determine how resistivity changed with aging time. After a certain time, the resistivity in the lowest part of the foam column decreased dramatically, while resistivity increased in the upper parts. These changes occurred sooner in the low void fraction foam, giving quantitative information on liquid drainage in the foam. These ultrasonic and resistivity measurements provide complementary information on aging processes in cake batter foams, and will thus permit us to understand how to retard quality impairment events in the manufacture of high volume cakes.

The interplay of starch, starch degrading enzymes and gluten proteins in bread crumb firming and loss of resilience - An integrated view

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When fresh bread is stored, it loses palatability and, already after a few days, its crumb reaches a firmness which makes the product unacceptable to the consumer. Estimates on the percentage of bread which is not consumed because of the perceived firmness vary, but figures of up to 8 percent have been mentioned. It follows that bread firming represents a great economic loss. The measures which the baker can take to reduce bread firmness and firming include the use of emulsifiers such as monoacyl glycerols as well as the inclusion in the ingredient bill of some amylolytic enzymes. They clearly point to a role of starch in the establishment of bread firmness. However, not only firmness but also the crumb resilience, i.e. its power to recover to its original shape and size after removal of the strain which causes deformation, is an important quality attribute. While some amylolytic enzymes are successful in reducing bread firming rate, they fail in maintaining crumb resilience. In this lecture, bread firmness and firming will be discussed as will the impact that amylolytic enzymes have in the breadmaking process. As the bread firming phenomenon is far from understood at present, the presentation will inevitably contain some speculative views.

Attachment and mixing speed study for dough optimized by NIR for mix time

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Cereal Foods World 53:A24

Determination of optimum dough development in a laboratory mixer is often difficult, complicated by style variations of mixing attachments. Most common attachments for laboratory mixers, used for white pan bread, are two or three pronged but a few spiral attachments exist as well as the common dough hook for larger batches. Most often, laboratories are equipped with only one attachment, which leaves little choice for performing inter-laboratory comparisons when non-similar attachments are used. An established NIR method of determining dough development provides a reasonably level playing field for true comparisons. In this study, NIR was used to determine optimum dough development for three types of attachments, 2 prong, 3 prong and spiral. Replication enabled statistical analysis of the results. In addition, two speeds were tested to relate mix speed to quality of finished product. The results showed that 2 and 3 prong attachments yielded breads with better internal score but the spiral attachment resulted in significantly better loaf volume. Furthermore, little difference was noted for mixing times at low speeds for the various attachments but differences diverged as mixing speed increased. At higher speeds, the 2 prong attachment demonstrated a significantly shorter mix time.

Dietary fiber - Validating approved and official methodology in an era of advancing science driving an updated definition

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Cereal Foods World 53:A24

From a nutrition perspective, dietary fiber is unique in that its nutrition benefits relate to its resistance to digestion. Consequently, dietary fiber consists of a digestion resistant complex mixture (mostly carbohydrate) of components that vary by source, preparation, and processing. Serious research on dietary fiber in the 1950's resulted in a definition by Trowell et al in 1976. AACC validated Approved Methods 32-05, 32-06, 32-07, 32-20, 32-21, and 32-25 as well as AOAC International validated Official Methods 985.29, 991.42, 992.16, 993.19, 993.21, and 994.13 are commensurate with that

definition. Scientific advances in the subsequent two decades resulted in the conclusion that additional components such as resistant starch and non-digestible oligosaccharides are validly included in the Trowell definition on a physiological bases, and Approved Methods 32-22, 32-23, 32-28, 32-31, 32-32, 32-33, 32-40, and 32-41 as well as Official Methods 992.28, 995.16, 997.08, 999.03, 2000.11, 2001.02, 2001.03, and 2002.02 for these components have been validated. Recently, the CODEX Committee on Nutrition and Foods for Special Dietary Uses (CCNFSDU) has produced a clarifying definition of Dietary Fiber (see ALINORM 6/29/26) that combines the scientific findings of the past 5 plus decades into a single, concise definition. AACC and AOAC International scientists will validate an all inclusive method commensurate with this definition. The history and current status of the definition will be covered. Ref: "Historical Perspective as a Guide for Identifying and Developing Applicable Methods for Dietary Fiber" (JAOAC International (2005), Volume 88, No 5, pp 1349-1366).

Evaluation of ozonated water as an antifungal and antimicrobial treatment of durum wheat grain

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Cereal Foods World 53:A25

Ozonated water is reported to be effective in reducing microbial load in foods such as fruits and vegetables. Ozonated water may also be an effective alternative to chlorine in treating durum before milling. Therefore, durum wheat was washed with ozonated water and analyzed for yeast, mold and aerobic bacteria. A system was developed for generating and continuously monitoring ozonated water. The effect of water quality (tap, distilled and ultra-pure water), water temperature (25, 15 and 7°C) and water pH (6.5, 4 and 2) on dissolved ozone concentration and half-life of ozone in water was evaluated in order to attain a stable, high ozone concentration at the outset of washing. Ozonation of distilled water at 7°C resulted in 17 ppm ozone and an 8.7 min half-life. Addition of 7% acetic acid (pH 2) further increased ozone to 21.8 ppm and half-life to 9.7 min. Next, a comparative effect of wheat washing was studied with five distilled wash water types: 1) 17 ppm ozone; 2) 20 ppm ozone, 1% acetic acid; 3) 700 ppm chlorine; 4) 1% acetic acid; and 5) distilled water (control). The wheat grains were washed for 3 min (wheat: water is 1:2) and were analyzed immediately for yeast and mold count and aerobic plate count. A 0.5-1.0 log reduction in yeast and mold count was observed using ozonated water as compared to distilled water (control).

Investigating the textural properties of starch gels treated with iodine

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The goal of our research is to use iodine as a tool to understand the structural, architectural and functional behaviour of starches from different botanical sources. The objective of this study was to investigate the effects of different levels of iodine on the textural properties of Corn (CS), Waxy Corn (WCS), Potato (PS), Waxy Potato (WPS) and Wheat (WS) starches. Iodine at different concentrations ranging from 0.1% to 2% dry starch basis were added to starch (8% db) in a RVA at room temperature or at 95°C. Gel firmness was measured following storage at room temperature (RT) for 1 day and following 7 days at refrigeration by using a TA.XT Plus Texture Analyser. Both the waxy starches remained a viscous paste and did not form a gel even after 7 days of storage at all treatment levels. For the normal starches, as expected, the gel firmness increased with time for both the control and treated gels. Furthermore, gel firmness in the treatments where iodine was added at 95°C was lesser than the corresponding RT treatments due to the additional water introduced during the treatment. However, significant differences were observed in gel firmness of normal starches following different treatments. The highest level of iodine concentration where gel formation was observed was different for different starches at RT and at 95°C. PS was able to form a gel at 5x and 20x iodine concentration at RT and 95°C, respectively, compared to the other starches. Furthermore, the extent of staling of the gels treated with iodine was different for the different starches as well. These observations suggest that despite the similar amylose contents of the starches from different botanical sources, there was dissimilarity in the gel formation and retrogradation. This can be associated with the contrasting pasting properties of these starches as a function of the granular architecture, and the differential extent of polymer leaching and the ability of the starch polymers to bind iodine.

How to measure rheological properties of whole grain dough?

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Cereal Foods World 53:A25

For assessing the rheological properties of wheat flour dough, usually white flour is used. However many products are made from whole wheat flour dough, or flour with bran fractions added, like brown bread. When trying to measure the rheological properties of such a dough the rheologist is faced with several problems: 1) in small scale extensibility testing, small pieces of bran can cause the dough string to break prematurely 2) in gluten testing the bran may form a layer around the gluten 3) when trying to assess gasholding capacity by blowing a dough bubble, leaks at nearby bran particles hamper proper testing. These practical problems are difficult to solve using existing methods, therefore it could be of interest to develop new methodology. One of the methods we evaluated was flow relaxation of dough. In a flow relaxation test the flow-relaxation half-time gives a parallel with the visco-elasticity of the dough. In a survey we measured how bran addition lowers the flow-relaxation properties of dough. Using a washed bran we noted that also the water-soluble parts of bran affect dough visco-elasticity. The rheological properties measured with flow relaxation helps in understanding final product properties. Another method we evaluated was a dough compression test, using unlubricated and lubricated flow conditions. Also here we were able to measure various differences in rheological properties of the flour + added bran dough systems. Although for this method two measurements are required to compare: lubricated vs. unlubricated, to assess elastic properties. This may make flow relaxation a bit easier and practical over compression testing. In a similar way the methods also reveal the rheological properties of gluten dough samples with added bran.

Commercial evaluation of a continuous micronutrient fortification process for nixtamal tortillas

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Cereal Foods World 53:A25

The corn tortilla plays an integral role in the Mexican diet and is an ideal vehicle for micronutrient fortification. Approximately 60% of corn tortillas in Mexico are produced from nixtamal, with the remainder prepared from masa flour. A process for continuous fortification of nixtamal tortillas was evaluated in two commercial mills in Mexico. A commercial powder dosifier was used to add micronutrient premix -- containing iron, zinc, folic acid, niacin, riboflavin, and thiamin -- to nixtamal (1g/kg) as it was milled. Following training and preliminary sampling, mills produced fortified tortillas unassisted for four weeks. Masa flow rates over a four day period ranged from 10 to 12 kg/min in both plants. Premix flow from the dosifier showed good stability with an average coefficient of variation of 1.67%. Initial results indicated good process control, with significantly increased variation during the four week production period. Fortified tortillas had significantly higher levels of all nutrients tested. Micronutrient losses were less than 11% in all cases except folic acid, which showed an 80% loss. Despite processing losses, fortification resulted in a nearly five-fold increase in folic acid compared to control tortillas. The new fortification process is technically and economically viable and was well received by millers.

Development of the phenotype during grain filling of wheat/barley endosperm mutant seeds as studied by comparative spectroscopy and chemometrics

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Cereal Foods World 53:A25

Cereal seeds are an important component of both human and animal diet, and the chemical properties determine seeds value as food or feed. The quantity and quality of the various chemical compounds in the endosperm is determined during grain filling. During this period photoassimilates are translocated to the endosperm and synthesised to a range of important metabolites such as starch, fibres, lipids and minerals. In this study wheat and barley seeds were harvested during grain filling from flowering to maturity in order to study changes in the metabolic profile. Results will be reported from Near-infrared spectroscopy, Infrared spectroscopy, Raman spectroscopy and proton high-resolution magic angle (HR MAS) NMR spectroscopy and validated using reference chemical analysis of beta-glucan, starch, and amylose content, as well as number of seeds on the spikes, fresh seed weight and seed weight after freeze drying. All data were evaluated with advanced multivariate chemometric data analysis: interval principal component analysis (PCA) and interval Extended Canonical Variates Analysis (iECVA) for classification and interval partial least squares regression (iPLS) for calibration of the reference analysis. The study reveal, for example, that mutant specific NIR patterns are established already during early seed development and despite varying content of specific seed storage compounds, the patterns are conservative throughout seed development and thus used for genotypic classification. Moreover the

water activity in the cells is of crucial importance for all the enzymatic processes and hence, a changed water activity due to e.g. a higher content of beta-glucan or hydrophilic proteins result in indeterministic and unpredictable changes in the phenotype (phenome). The differential expression of water content during seed synthesis in barley mutants partially explain a range of pleiotropic effects including large changes in beta-glucan, higher content of fat, alterations in E-vitamin composition and in protein composition compared to a control variety.

Zymographic analysis of sorghum malt proteases: Effects of variety, pH, protease inhibitors and malting conditions

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Cereal Foods World 53:A26

Proteolysis during cereal malting processes is critical to the success of the beer brewing process. A total of 7 to 15 different protease isozymes were observed protease extracts from malts of eleven Botswana sorghum cultivars were analyzed for their protease profiles on gelatin substrate gels. Sorghum malt protease profile varied among the varieties with the cultivars Lekgeberwa and Marupantsi displaying the highest (15) and lowest (7) amounts of protease isozymes respectively. Sorghum malt protease profiles were significantly influenced by incubation pH whereby the largest amount of protease bands were detected at pH 4.6 followed in sequence by pH 6.2 and pH 7.0. Incubation with 4 different protease inhibitors indicated that the sorghum malt proteases were made of serine-, cysteine-, aspartyl- and metallo-proteases. Cysteine-proteases (27-60 KDa) constituted the major sorghum proteases. Inclusion of 1, 10 phenanthroline in the assay medium inhibited sorghum malt metallo-protease significantly more than EDTA suggesting that these enzymes were zinc-dependent. Like the overall profile of sorghum malt proteases, protease subclass profiles were influenced by assay pH. Analyses of the effects of malting conditions showed that the time-course of individual enzyme development, as well as the overall sorghum malt protease profiles were significantly influenced by drying conditions as well as the inclusion/absence of air-rest cycles during steeping.

Creation and functional analysis of *in planta* mutant *Puroindoline* alleles in wheat (*Triticum aestivum* L.)

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Cereal Foods World 53:A26

Variation in wheat (*Triticum aestivum* L.) grain hardness is the single most important trait that determines wheat end-use properties. Grain hardness variation is controlled predominantly by the *Hardness* (*Ha*) locus, which is functionally comprised of the *Puroindoline a* (*Pina*) and *b* (*Pinb*) genes. In order to overcome the lack of *Pin* diversity, our goal in this study was to create more allelic variation for these proteins via *in planta* mutagenesis in hexaploid wheat followed by marker-assisted backcrossing of new alleles to the non-mutants parent. A population of 2300 EMS-induced M_1 single head derived M_2 families was created in the soft white spring cultivar 'Alpowa'. Screening of the population for both *Pin* genes identified 68 missense and 22 truncation mutations. The creation of segregating F_2 populations via crossing each mutant back to the 'Alpowa' allowed us to test the impact of the segregating new mutant alleles on grain hardness and to restore seed weight and vigor. Functional analysis of 45 missense and 8 stop codon mutations via F_2 segregating populations will be reported. Initial results indicate that the new mutations may be useful in creating defined grain hardness levels which was a particular goal of this research. In conclusion this project will allow us to accomplish two goals; first to reveal the regions of PINA and PINB proteins critical for conferring softness and second to improve wheat end product quality via incorporation of a broader range of *Pin* alleles into both soft and hard wheat varieties.

Grain and flour characterization of four different sorghum varieties

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With an increasing number of people with celiac disease, the need for gluten-free products is on the rise. Sorghum is a grain tolerated by celiac patients which can be used in gluten-free foods. The grain and flour of four sorghum varieties were characterized through physical and chemical means. Varieties included: Fontanelle-625 (F-625), Fontanelle-1000 (F-1000), ATx631xRTx2907 (NE#20), and 5040C. Grain characterization included Single Kernel Characterization System (SKCS) and abrasive hardness index. Flour characterization included flour and starch particle size distributions, total starch, amylose content, starch pasting properties, moisture, crude protein, and ash content. Significant differences were found ($P < 0.05$) among varieties for each test except total starch. The average SCKS hardness indexes and abrasive hardness indexes ranged from 72.14 (5040C) to 82.67 (NE#20) and from 8.353 (5040C) to 12.707 (F-625), respectively. NE#20 had the largest particle diameter at each volume for both flour and starch. F-1000 had significantly higher starch damage at 3.02 ($P < 0.05$) compared to the other three varieties. Amylose content (%) ranged from 20.15 (NE#20) to 27.32 (F-1000). F-625 had a significantly higher moisture content (14.997%) than the other varieties. The lowest moisture content coincided with NE#20 (11.438%). Crude protein values and ash content (%db) ranged from 8.61 (F-1000) to 10.53 (NE#20) and 1.198 (F-1000) to 1.445 (F-625), respectively. These characterizations can be used to find differences among sorghum varieties which could help predict sorghum flour quality for use in gluten-free products.

Evaluation of four sorghum varieties in the utilization of sorghum flour tortillas

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Gluten-free flour tortillas were made with five different sorghum flours to evaluate flour quality. Four sorghum varieties were used along with a commercial sorghum flour. The four varieties were: Fontanelle-625 (F-625), Fontanelle-1000 (F-1000), ATx631xRTx2907 (NE#20), and 5040C. The tortilla weight, diameter, thickness, color, pH, Aw, and moisture content were measured along with extensibility and stretchability. A descriptive panel was trained and used to analyze the five samples. Significant differences were found ($P < 0.05$) among samples for color, pH, Aw, and moisture content. Significant differences were also found ($P < 0.05$) among samples for extensibility and stretchability. Extensibility was a more effective test in studying quality. Extensibility force and distance values ranged from 534.940 g (TVM) to 664.678 g (F-625) and 0.385 mm (F-1000) to 0.516 mm (F-625), respectively. The sensory panel found significant differences ($P < 0.05$) for grain specks, angle of bend, rancidity, sweetness, springiness, hardness, and grittiness. The commercial flour had the highest score for angle bend (12.92) and springiness (3.50) and was, therefore, utilized in a consumer study. When compared to a gluten-free wrap already in the market, the sorghum flour tortilla made from this study scored significantly higher in all attributes, including overall acceptability with an average score of 5.94. The commercial flour preformed better than the other four samples due to its smaller particle size and greater starch damage allowing an increase in water absorption.

Effect of HMW-GS and LMW-GS on viscoelastic properties of intact wheat kernel and their relation to functional properties of wheat dough

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Gluten protein composition, and more specifically that of the high and the low molecular weight glutenin subunits (HMW-GS and LMW-GS, respectively) are the main factors determining the visco-elastic properties of wheat dough. The mechanical and visco-elastic properties of twenty-nine samples of intact wheat kernels differing in HMW-GS composition were evaluated with load-compression tests. The mechanical and visco-elastic properties of twenty-nine samples of intact wheat kernels differing HMW-GS encoding loci (GluA1: null, 1, 2*; GluB1: 7, 7+8, 7+9, 13+16 and 17+18; GluD1: 5+10, 2+12) and LMW-GS encoding loci (GluA3: b, c, d, e; GluB3: f, g h i; GluD3: a, b c, and d) were evaluated applying the theory of elasticity using load-compression tests. Comparison among all loci of HMW indicated that glutenin subunits 1 and 2* and 7, 7+9 and 17+18 and 5+10 showed the largest kernel elasticity values and generally possessed hard grain. The subunits null, 7+8 and 2+12 of respectively were found in soft kernels, showed lower elastic work values. HMW glutenin subunits 1, 7+18 and 5+10 gave large SDS values and better functional dough properties than null, 7+8, and 2+12. Also kernel hardness was correlated to SDS index, mixing time, work and gluten force. The influence of LMW-GS in kernel hardness was significant for GluA3 b, c, and d with hard kernel and e, GluB3 with f and i and GluD3 with a and b that generally possessed hard grain and high elastic behaviour than the LMW-GS e, g and h, and c with small elastic work and poor functional performance. The kernel hardness seems to be affected directly by the presence of plasticizers like gliadin and water because of the high correlation with the

plastic work. The stress was highly correlated to the plastic work. There was a negative correlation between plastic work and mixing, tenacity and P/L ratio of alveograms. On the other hand SDS index, was related more to gluten protein due to high correlation to elastic work of the load deformation curve. This means that hard wheat follows the hookean behaviour better than soft and bread wheat. The influence of HMW-GS and LMW-GS on other fundamental mechanical properties of wheat kernels, such as modulus of elasticity, yield point, yield stress, compressive strength, and rupture will be presented.

Lipid profiling of near-isogenic wheat lines and starch containing different puroindoline haplotypes

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Cereal Foods World 53:A27

The physical hardness of wheat initially determines its intended end-use. Wheat kernel hardness is caused by the absence of two 15kDa proteins found on the surface of water-washed starch granules. These proteins (puroindoline a and b) are found in greater amounts on water-washed starch from soft wheat than on water-washed starch from hard wheat. Similarly to puroindoline proteins, a general pattern exists among polar lipids on the surface of starch granules. Glycolipids and phospholipids are found in greater quantities on water-washed starch from soft wheat than from water-washed starch from hard wheat. However, a full profile of the lipid species found on the starch granule surface has not been reported. The objective of this study is to characterize the specific lipid species found on the starch granule surface. Two near-isogenic wheat lines were used in the analysis; a hard cultivar (Hi-line) and an experimental soft line (HGAB18). Water-wash starch was isolated using a modified batter method. Tandem mass spectrometry was used to identify the lipid species found in both the flour and starch samples. The results indicate that water-washed starch from HGAB18 contains a greater amount of phosphatidylcholine (32:0, 34:1, 34:2, 36:2, 36:3, 36:4 and 38:2), lyso-phosphatidylcholine (16:0, 18:1 and 18:2), phosphatidyl-ethanolamine (34:2, 36:4 and 40:2) and lyso-phosphatidylethanolamine (16:0 and 18:2) lipid species. The amounts of glycolipids (mono- and digalactosyl diglycerides) were generally found in equal amounts between the Hi-line and HGAB18 starch samples. Surprisingly, the starch from Hi-line contained a considerable greater amount of phosphatidic acid species (34:1, 34:2, 36:3 and 36:5) than the starch from HGAB18. To reinforce the results, further analysis of additional wheat samples containing different puroindoline haplotypes are being conducted along with analysis of other lipid species.

Troubleshooting bakery mix and formulation problems with the Chopin Mixolab

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In troubleshooting problems with commercialized bakery products and taking newly developed products into production, understanding product dough chemistry can be very helpful. Rheology profiles, taken at fixed or ramping mix bowl temperatures, provide information on protein stability, starch gelatinization strength, and enzyme activity. These profiles may be obtained from instruments such as the Chopin Mixolab®. From this data, better decisions can be made about required flour strength, the influence of individual ingredients, and the effects of proposed formula changes on dough viscosity and handling. First, a dough rheology profile of the flour alone should be obtained. One may then add the chosen concentration of malt and observe the significant effect it has on the dough's viscosity profile. Each ingredient used in the formula may be added individually to the flour at its chosen concentration to observe its effect on the resulting dough. Alternatively, the ingredients may be added sequentially to the flour to gradually build to the final mix formula itself, while testing the resulting dough rheology at each addition. Gluten, salt, sugar, shortening, malt and dough conditioners all have significant effects on dough chemistry and rheology. With such characterizations at hand, problems in operations and questions about ingredient quality can be more readily resolved by running these same tests on the problematic ingredient combinations and comparing the results to established standards. Examples of building such a database and using it to solve real-world problems will be given.

Genotype and growing environmental influences on Chickpea (*Cicer arietinum* L.) seed quality

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Preliminary studies towards genetic improvement of seed quality in chickpea (*Cicer arietinum* L.) involved seven desi varieties (ten environments) and nine kabuli varieties (seven environments) grown to assess the effect of environment on selected seed quality traits. Sites were chosen to represent the range of environments in the chickpea production areas of the Canadian prairies. Starch, amylose and protein were estimated by megazyme, high performance and size exclusion chromatography and AACC combustion method, respectively. Genotype by environment interaction effects on starch, amylose, protein (desi only) and seed yield were significant. This suggests that the varieties did not perform consistently relative to each other in the different environments. Starch concentration was negatively correlated (rkabuli = –0.25, $P < 0.05$; rdesi = –0.16, $P < 0.05$) with protein concentration in both chickpea market classes. However, the repeatability estimates of starch, amylose and protein concentration were low and inconsistent across chickpea market classes, possibly due to multiple genes in the biosynthetic pathways for these constituents. This demonstrates that testing for quality traits over a range of environments will be required to characterize seed quality in individual chickpea varieties. The negative relationship between quality and yield indicates that selection for chickpea cultivars with high quality may require compromise and indirect selection. Keywords: *Cicer arietinum* L., desi, kabuli, genotype, environment, grain quality, starch, amylose, protein, seed yield.

Flour properties in relation to dumpling quality

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Cereal Foods World 53:A27

Dumplings are a traditional wheat flour based food that is consumed in many Asian countries. Dough wraps prepared for dumpling processing should be bright white or creamy white in appearance. They must be strong enough to hold the fillings and not break up during and after boiling. The surface of cooked dumplings should be smooth with limited swelling. The preferred texture has a good balance of firmness and elasticity with low stickiness. These features are largely dependent on wheat and flour quality. Guidelines for laboratory dumpling processing and quality evaluation are described. Fifteen flour samples milled from wheat sourced from Canada (5), China (7), Australia (2), and USA (1) were evaluated for dumpling processing. Dumplings with high appearance scores were mostly made from flours milled from Canadian, Australia, and U.S. wheat samples. Wraps made from these flours were very bright, with white or creamy yellow colour. Their surfaces were uniform with limited swelling after cooking. Dumpling wraps made from most Chinese flour samples were not as bright, and swelled significantly more after cooking. Flour samples with lower protein and reduced amylose contents produced dumpling wraps with very elastic texture, but had lower firmness and higher stickiness. Dumplings made from higher protein, strong gluten and with normal amylose content flours had a firm texture with low stickiness and low elasticity.

Whole wheat flour: Evaluation and specification of attributes important to commercial soft wheat formulations - Part II

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Cereal Foods World 53:A27

Whole grain ingredients and products, which incorporate all the goodness of the grain, including vitamins, minerals, phytochemicals and complex carbohydrates, offer protection to the consumer against many diseases. However, consumers require excellent eating quality as well. Whole Grain flour ingredient must be functional enough that meaningful levels of whole grain can be assimilated into whole grain products that deliver taste, texture and appearance. Physical properties of whole grain flour ingredient such as solvent sorption, particle size distribution, macroscopic nutrient retention (i.e. fiber) influence baking function and finished product attributes such as color, geometry, and baked moisture loss. Flour ingredient and product freshness/shelf-life must be maintained to assure

quality. We discuss the functional attributes of whole grain flour and potential methods to assess whole grain flour quality and conformance in cookies and crackers.

Utilizing variation of *Ag. elongatum* and *Ae. geniculata* for wheat end product quality improvement: Challenges ahead

Abstract withdrawn.

Viscosity and *in vitro* bile salt-binding properties of barley beta-glucans as influence by quaternary ammonium substitution

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Cereal Foods World 53:A28

Cereal beta-glucans from barley benefit human cardio-vascular health. Upon consumption, solubilization of beta-glucan in human gut and the formation of beta-glucan molecular network that traps and excretes bile salt have been reported to be the major mechanism of action. The present study investigated how chemical cationization of barley beta-glucans using a quaternary ammonium compound would influence its viscosity and *in vitro* bile salt binding capacity. It was hypothesized that cationic charge of the modified beta glucan would attract the negatively charged bile salts and thereby would improve the bile salt binding efficiency of beta glucan. Bile salt adsorption capacity of quaternized barley beta-glucan was tested and compared to that of native barley beta-glucan, cholestyramine (an antihypercholesterolemic drug) and purified cellulose fiber (insoluble fiber). Native barley beta-glucan concentrate (>60%, w/w, purity) was chemically modified by (3-Chloro-2-hydroxypropyl) trimethyl-ammonium chloride (CHPTAC) to quaternize the barley beta-glucan molecule. Further purification of barley beta-glucan from native and modified concentrates was performed in order to obtain higher purity beta-glucan concentrates (>80%, w/w). The viscosity and *in vitro* bile salt adsorption capacity of native and quaternized barley beta-glucan were then evaluated. Oscillatory flow behavior tests demonstrated that highly modified Quaternized barley beta-glucan behaved like dilute solution, while unmodified barley beta-glucan displayed typical pseudoplastic behavior. At higher DS levels, a significant decrease in viscosity was observed, indicating the negative effect of quaternization on beta-glucan network formation and viscosity development. Quaternized-barley beta-glucan demonstrated 1.96 µmol taurocholate adsorption per mg of fiber as compared to 2.56 µmol taurocholate adsorption per mg of cholestyramine. However, the native barley beta-glucan demonstrated 0.92 µmol taurocholate adsorption per mg of fiber. The data suggested that quaternization of beta-glucan enhance the bile salt adsorption capacity due to ionic interactions between positively charged beta glucan moieties and negatively charged bile acids.

Isolation of wheat FK506-binding proteins (FKBPs): Exploring roles for FKBPs in the wheat thylakoid

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The FK506-binding proteins (FKBPs) belong to the peptidyl-prolyl cis/trans isomerase (PPIase) class of enzymes that catalyse the rotation of the proline peptide bond, while they also operate as molecular chaperones for specific partner proteins. The FKBPs are ubiquitous to all organisms studied and they vary in protein size, structure and complexity. FKBPs perform a variety of cellular functions, from protein folding and trafficking to signal transduction and stress response. The higher plant genome encodes around twenty FKBPs and half of these are targeted to the chloroplast thylakoid lumen (TL), comprising the largest group of proteins in the lumen, although a role for the TL FKBPs remains largely undefined. A cleavable N-terminal signal peptide serves as the chaperone domain for one lumenal FKBP in Arabidopsis, which interacts with a subunit of the thylakoid electron transfer complex, while several other TL FKBPs have also been linked with assembly and stability of the photosynthetic apparatus. Despite their potential for photosynthesis regulation, the cereal TL FKBPs remain unexplored. We present the first characterisation of cereal thylakoid FKBPs with the isolation of the genes encoding FKBP13, FKBP16-1 and FKBP16-3 in Triticum aestivum. The translated coding sequences of these genes share 50–60% identity with their Arabidopsis orthologues, including conservation of cleavable target peptides that indicate thylakoid translocation and provide potential chaperone domains. The features that confer PPIase activity and redox sensitivity to the Arabidopsis lumenal FKBPs are also well conserved in the wheat orthologues. Isolation and analysis of promoter regions of the wheat FKBP genes has revealed elements that indicate light-regulated, stress-regulated and endosperm-specific expression of these genes. We propose that the wheat FKBP13, FKBP16-1 and FKBP16-3 operate as molecular chaperones in light- and redox-regulated assembly of the photosynthetic apparatus.

A non-image based method for detection of insect damage in wheat kernels using x-ray

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An x-ray inspection system using an array of photodiode based x-ray detectors in a linescan configuration whose outputs are combined would be simpler, faster, and more economical than existing systems as the data collection process is reduced from a two dimensional image to a much simpler one dimensional signal. In addition, processing and classification of the resulting signal would be faster and simpler than conventional image processing. The cost of increased speed and simplicity of this system is the loss of spatial information along the second dimension contained in an image. This study tests the hypothesis that for certain inspection tasks, such as the detection of infested grain, the resulting loss of spatial information is not a deterrent to correct sample classification. Film x-ray images of wheat kernels infested with the granary weevil were processed to simulate expected signals from such a system by averaging pixel values along each column of the image. Images of infested kernels were classified as small, medium, large, or non-infested, depending on the stage of development of the larvae as determined by visual inspection of the x-ray images. One hundred images of each class (400 total) were processed and the resulting signals were subjected to a classification algorithm. The algorithm consisted of a simple correlation of each signal with a calculated ideal signal from a non-infested kernel. Classification results compared favorably with those reported in a number of studies using more complicated image based approaches, such as discriminant analysis and neural networks based on features extracted from the images. The results indicate that for inspection of wheat for insect infestation the approach investigated here provides the potential for more simple and economical x-ray inspection systems.

Comparison of functional properties of isolated amaranth, quinoa and buckwheat starches

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Amaranth, quinoa, and buckwheat are interesting alternatives to wheat because of their valuable nutritional composition. In particular the protein composition with its high amount of amino acids and high biological value has to be mentioned. Additionally they do not contain gluten, have a high amount of unsaturated fatty acids and minerals. Characteristics of starches isolated from amaranth, quinoa and buckwheat were evaluated. The first step in starch isolation involved milling to flours (Pinmill, Pallamnn laboratory

Mill), Then the protein was removed by steeping in NaOH solution and centrifugation (alkaline method). Amylose contents of the amaranth, quinoa and buckwheat starches ranged from 4.4–28.72%. Buckwheat starch showed the lowest water binding capacity (WBC) (239%) and highest swelling power (15.91 at 95°C) among the starches studied, while amaranth starch had a constant swelling power and its rate of solubility increased only slowly at temperatures higher than 75°C. Pasting temperatures (Brabender viscograph) of amaranth, quinoa and buckwheat starches were 67.7, 62.9 and 66.7°C, respectively. Turbidity values of gelatinized starch pastes increased during refrigerated storage. The freeze-thaw stabilities of starch pastes were studied by freezing starch gels (pastes) at –7°C over night and then thawing them at 30°C for 2 h. This freeze-thaw stability was determined for four cycles. It was found that amaranth starch paste had lower syneresis values (percentage of water separation) than other starches. The order was amaranth<quinoa< buckwheat starch paste. The results obtained in this study establish the fundamental characteristics of amaranth, quinoa and buckwheat starches and suggest further exploration of its potential use in various food applications.

The potential of non-wheat cereal prolamins to function in bread making
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Cereal Foods World 53:A29

Corn zein was previously shown to become viscoelastic when moistened and brought above its glass transition temperature. We showed a concomitant increase in beta-sheet structure with formation of the viscoelastic complex that was similar to that which appears in wheat gluten, however there was rapid loss of this protein secondary structure as well as rheological properties during relaxation. Addition of isolated wheat HMW glutenin, at 10% of total zein, stabilized this property much like in wheat gluten with retained beta-sheet structure over time, as well as increased storage and loss moduli. Moreover, an alternative non-wheat protein, or co-protein, was found to function equally well as HMW glutenin and was found to be effective down to 3% of total zein. In bread making experiments, these combinations produced yeast-leavened breads with similar properties to wheat breads, albeit with some inferior qualities. This technology holds promise for an alternative viscoelastic protein for baked products for wheat-intolerant individuals. The potential for tropical developing countries to use non-wheat grains such as sorghum for comparably high incorporation into wheat breads has been investigated with some success and will also be discussed.

Benefits of durum wheat flour in the production of fresh or refrigerated yellow alkaline noodles
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Canadian amber durum wheat varieties of various protein content were milled to yield straight grade (73–76% extraction) and patent (64.5–69% extraction) flours and processed into yellow alkaline noodles (YAN) using a 1% w/w kansui (sodium and potassium carbonate 9:1) solution. Canada Hard White Spring (CWHWS) and Canada Western Red Spring (CWRS) flours normally used for YAN production were included for comparative purposes. The durum wheat YAN exhibited colour advantages (~ 9-20 unit greater b*) over noodles prepared from CWRS and CWHWS at 2 and 24 hrs due to their greater endogenous yellow pigment and flavonoid contents. Low levels of polyphenol oxidase (PPO) and peroxidase (POD) resulted in durum YAN displaying excellent brightness and significantly fewer specks at both time periods than CWRS. Cooked durum wheat YAN texture was equivalent or slightly superior to CWRS and CWHWS. Raw YAN stored for 1, 2, 3 and 7 days at 4°C prior to cooking exhibited significantly better noodle brightness, L*, yellowness, b*, and significantly reduced speckiness than CWRS at all storage periods. Cooked noodle texture showed a general increase in maximum cutting stress (MCS) with storage at 4°C over a 4 day period. Noodles prepared from AC Commander flour displayed MCS values exceeding those of CWRS as well as the highest resistance to compression (RTC) and recovery (REC) measurements. The visual improvements in noodle brightness, enhanced yellowness and reduced speckiness, in combination with equivalent to improved cooked noodle texture compared to common wheat flour, suggests that durum flours are an ideal material for fresh and or refrigerated yellow alkaline noodles.

Whole wheat flour: Evaluation and specification of attributes important to commercial soft wheat formulations - Part I
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Cereal Foods World 53:A29

Whole grain ingredients and products, which incorporate all the goodness of the grain, including vitamins, minerals, phytochemicals and complex carbohydrates, offer protection to the consumer against many diseases. However, consumers require excellent eating quality as well. Whole Grain flour ingredients must be functional enough that meaningful levels of whole grain can be assimilated into whole grain products to deliver taste, texture and appearance. We studied enzymatic activity, free fatty acid formation, solvent sorption; particle size distribution, and nutrient retention in whole grain flour influencing nutrition, cookie baking function, and finished product attributes such as color, geometry, and baked moisture loss. Conventional methods such as Solvent Retention Capacity (AACC method 56-11) and Wire-cut cookie baking (AACC method 10-53) are used to predict flour function. New protocols for alveograph mixing are evaluated for utility in predicting whole grain flour performance. We found the functional attributes of whole grain flour to be greatly influenced by particle size and amount of starch damage starch during milling. Heat/moisture treatment of the bran-germ resulted in significant reduction of lipase activity and fatty acid formation in whole flour. We discuss opportunities with respect to whole grain flour testing and quality improvement.

Efficient, cost-effective networking of NIRS Instruments
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Near infrared spectroscopy (NIRS) is a widely used technology for quality determinations of agricultural products as well as foods and other natural products. Advances in chemometric software and instrument hardware have resulted in large networks of closely matched instruments often times installed over a wide geographic area. A new networking software has been developed that will configure, manage and monitor a network of remote instruments over an intranet or internet connection. The networking package can be on-site installed, or the network can be hosted on a commercial server. The network program delivers rapid and complete control of all instrument settings from a central location, positively distributing updates and eliminating the possibility of local changes. Additionally, the network program allows for thorough surveillance and monitoring of all instrument diagnostic tests, assuring proper instrument operation and validation. The result is complete quality assurance giving high performance and cost effective operation of multiple remote NIRS instruments.

Is the wheat flour supplemented with malted barley flour or fungal alpha-amylase affecting the Asian noodle quality?
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Cereal Foods World 53:A29

Asian noodles have become a popular product in the U.S., but specially marketed noodle flours have limited availability. Most of noodle manufacturers in the U.S. use bread flour for producing Asian noodles. Bread flour is commonly supplemented with malted barley flour or fungal alpha-amylase to improve baking performance. However, there are some concerns to the noodle manufacturers whether these added malt or fungal alpha-amylase have a negative impact on noodle color and texture because amylases may breakdown the starch and soften the boiled noodle texture, and possibly make noodle color less stable. In this study, four commercial classes of U.S. wheat - soft white, hard red spring, hard red winter, and hard white wheat, were milled using a Miag pilot mill to produce straight-grade flours (~70% extraction) and 60% patent flours. Malted barley flour was added into each flour to achieve ~250 s falling number and fungal alpha-amylase was added to each flour according to the manufacturer recommended dosage based on each flour's initial falling number. These flours were made into Chinese fresh white salted noodles on a pilot scale noodle line, and the noodle color and boiled noodle texture were measured. Preliminary results indicated that both the malted barley flour and fungal alpha-amylase did not significantly affect the cooked noodle texture measured with a TA.XTplus Texture Analyzer, but the fungal alpha-amylase significantly reduced the fresh noodle color stability (lightness L* and yellowness b* values) from 0 to 48 hr. As the amount of malted barley flour in the wheat flour was increased to achieve the falling number of 180-200 s, the noodle lightness L* reduced significantly, but the cooked noodle texture was little changed. These results suggest that the supplementary malted barley flour has little influence on the fresh white salted noodle quality. Wheat flour supplemented with malted barley flour can be used for making fresh noodle products; nevertheless, flour supplemented with fungal alpha-amylase is not desirable for producing fresh noodles because it makes noodle color duller and yellower.

Hydrolysis of wheat straw biomass via catalytical thermal treatment in subcritical water

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Lignocellulosic biomass being a non-edible abundant plant source is a promising renewable energy source for producing hydrogen gas and/or synthesis gas via the mild processing technique of Aqueous Phase Reforming (APR) provided that it can be solubilized in water. Water under subcritical conditions (100°C < T < 374.2°C and P: high enough to keep water in liquid state) creates an attractive reaction medium for biomass hydrolysis. Wheat straw an abundant byproduct from wheat production was used as representative lignocellulosic biomass in the present work. The aim of this study is to solubilize wheat straw in subcritical water for further gasification by APR. The hydrolysis efficiency was examined with respect to several parameters such as ultrasonication of wheat straw/water mixture before thermal treatment, changing temperature and pressure of the hydrolysis process, adding carbon dioxide as pressurizing gas and using a catalyst during the solubilization. The hydrolysis efficiency was determined by measuring total organic carbon (TOC) content of the solution, solubilized polysaccharide/oligosaccharide molar mass distributions, analysis of monosaccharides and the amount of residual solid biomass. Hydrolysis of the wheat straw was more effective at higher temperatures. The use of CO_2 as pressurizing gas accelerated the hydrolysis process. For instance, hydrolysis of wheat straw under 4061 psi CO_2 atmosphere at 150°C, 200°C and 250°C was 38.0%, 51.2% and 78.2%, respectively based on the non-solubilized biomass left after hydrolysis. As TOC results indicated, higher operation temperature increased the solubility of wheat straw. The molar mass of the solubilized products formed at higher operation temperatures were lower than the corresponding products obtained at lower temperatures. The molar mass of polysaccharide fractions obtained at 150°C, 200°C and 250°C at the peak maximum (Mp) of the elugrams in wheat straw hydrolysates were I: 64341, 25028 and 2273 Da; II: 56988, 15787, 8552 and 3184 Da and III: 7046 Da, respectively. Ultrasonication pretreatment of wheat straw/water mixture enhanced the solubilization process. Solubilization of wheat straw biomass was performed efficiently using subcritical water, which is suitable for further gasification by APR technique. Besides wheat straw, kenaf (*Hibiscus cannabinus L.*), an annnual herbaceous plant was also tested and both could be used as a potential lignocellulosics for hydrogen and syngas production.

Economical dual-wavelength sorting device

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A high speed, non-destructive, dual-wavelength sorting device has been developed to separate pistachio product streams. Because pistachios and cereal grains have similar material handling characteristics, this device also holds potential for providing low cost sorting solutions for cereal grains. Unlike most commercially available dual-wavelength sorters, which rely on computers to analyze signals and implement a decision function, this device uses a simple electronic circuit to analyze multiple wavelengths and make a decision. Based on pistachio reflectivity spectra in the visible and NIR ranges, a discriminant function was determined to separate pistachio kernels from inshells and shell halves at 670 nm and 1440 nm. The function was implemented through simple circuitry by adjusting the gain of each signal to attain appropriate values corresponding to discriminant coefficients, summing them, and comparing them to the value of the function to make a decision. For 1000 each of kernels, shell halves, and inshells, the dual-wavelength sorter correctly classified 96.4%, 96.1%, and 99.3% respectively for an overall error rate of 2.7%. This error rate is favorable to a previously reported single-wavelength device (3.3%) and slightly higher than a commercial dual-wavelength sorter tested at the same wavelengths (1.6%). While the error rate is more than that of a commercial sorter, the new dual-wavelength device offers the potential of higher speed and reliability due to its simple circuitry, with a significant reduction in cost of required parts.

Characterization of enzyme-resistant maize *ae*-mutant starches during kernel development

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A new high-amylose (*ae* mutant) maize line, GEMS-0067, was developed from the USDA-ARS Germplasm Enhancement of Maize (GEM) Project. Starches of GEMS-0067-derived lines contained large amounts of resistant starch (37.3–43.4%), determined using the AOAC Method 991.43 for total dietary fiber. The objective of this study was to understand how starch structures developed during kernel maturation affected the enzyme-resistance of the starch. The maize kernels were harvested on 15, 20, 25, 30, 35, 40, and 54 (mature) days after pollination (DAP). The total starch content of the endosperm increased from 36.6% on 15 DAP to 79.7% on 54 DAP, and the resistant starch contents of those endosperm starches increased from 8.2% on 15 DAP to 30.5% on 54 DAP. The content of a mixture of the amylose and intermediate-component (IC) of the endosperm starch increased from 55.2% on 15 DAP to 87.4% on 54 DAP with slight fluctuation. The resistant-starch content of the endosperm starch was positively correlated with the content of amylose and IC mixture ($r = 0.95$, $p = 0.0012$). Two gelatinization thermal-transition peaks were observed on the DSC thermograms of the endosperm starches harvested on 20 DAP and later days. The temperature of the first peak was ~78.0°C, which was the major peak for samples of 15, 20, 25 and 30 DAP. The temperature of the second peak was ~97.2°C, which was the major peak for samples of 35, 40, and 54 DAP. The conclusion temperature was 105.0°C for the sample of 15 DAP and increased to 117.8°C for the starch sample harvested on 54 DAP. The crystallinity of the endosperm starches decreased with the maturation, from 24.8% to 15.8%. Starch granules of 15 DAP were smaller and had fewer rod/filamentous granules than those harvested at later developmental stages. These results suggested that the first DSC thermal-transition peak, which decreased with kernel maturation, corresponded to the gelatinization of amylopectin crystallites present in spherical granules. The second peak, which increased with kernel maturation and had higher melting temperature, was likely the melting of amylose/IC crystallites mainly present in the rod/filamentous granules and was highly resistant to enzyme hydrolysis at 100°C.

Modified omega gliadins as chain terminators in Pegaso near-isogenic lines

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Unextractable polymeric protein (UPP) is a parameter that gives a relative measure of the molecular weight distribution (MWD) of the polymeric protein, based on solubility. For any glutenin subunit to participate in a growing polymer, it has to have at least two cysteine residues. Modified (mutated) omega-gliadins with one cysteine residue, LMW-GS having an odd number of cysteines or LMW compounds having one thiol group can act as chain terminators. This would be expected to shift the MWD towards lower values that, in turn, would be reflected in lower UPP values. Thus a higher number of modified omega-gliadins, cross-linked to glutenins, should correlate negatively with UPP. Twenty four near-isogenic lines with the background of Pegaso bread wheat having combinations of variation at Glu-1, Gli-1/Glu-3 and Gli-2 loci were used for the investigation. The goal of the study was to seek evidence for the 'role of chain terminators in decreasing UPP values' and to examine the influence of chain terminators on the MWD of gluten proteins. A novel method was developed to extract the omega-gliadins. Capillary electrophoresis (CE) and SEC-MALLS were used to quantify the omega-gliadins and to estimate the MWD, respectively. The moderately high negative correlation ($R2 = 0.65$) between reduced (SDS-RA) polymeric protein and modified omega-gliadins in CE suggests that these omega-gliadins act as chain terminators, resulting in smaller polymers, thus causing a reduction of UPP values.

Characterization of the anti-mold factor excreted by a lactbacillus that grow in a mother dough of the Italian sweet bread, Panettone

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Panettone is the traditional sweet and sour bread in northern Italy. Though recently the bread starter is commercially prepared for bakeries, originally the mother dough has been preserved in a cycling renewal for more than sixty years at each individual home as the traditional baking method. The predominant micro-organisms, yeasts and lactobacilli in such a mother dough are presumed to be originated from natural resources such as fruits, vegetables and so on. Usually a Panettone made with the traditional baking method has the long shelf life for few months without the use of any food preservatives. As for one of the explanation why even the mold can not grow in the bread for months, we expect the presence of the anti-mold factor excreted by the micro-organisms living in the dough. In order to obtain the micro-organism that excretes the anti-mold factor, we screened Panettone yeasts and lactobacilli which were isolated from the mother dough. As a result, several yeasts and lactobacilli excreting the anti-mold factor were obtained. In this presentation, properties of the factor excreted from a lactobacillus are shown. The factor was less than 500 MW size, heat-tolerable and was able to be frozen. It inhibits the growth of molds and bacteria. The factor was produced in MRS

liquid medium more efficiently under higher DO level. The factor was extracted with the ether. Trials for identifying the chemical structure are on going.

Human lung and breast anti-cancer properties of peptides obtained from heat stabilized defatted rice bran by enzymatic hydrolysis

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Rice bran is a co-product of rice milling having low utility and low cost and, with nearly 20 percent protein it could be a possible source for bioactive peptides. Identifying and characterizing rice bran peptides that can arrest human cancer cell proliferation formed the basis of this study. The specific objectives were to extract, evaluate rice bran peptides for anti-cancer activities and characterize them. Heat stabilized defatted rice bran was treated with endoprotease, alcalase. The resulting hydrolysates were treated with simulated gastric and intestinal juices to obtain resistant peptides. The peptides were fractionated into molecular size ranges of >50, 10-50, 5-10, and <5 kDa using ultrafiltration. Preliminary studies revealed that gastrointestinal resistant peptide hydrolysate fractions (<5 kDa) showed anti-cancer activities on cultured human colon (Caco-2) and liver (HepG2) cancer cell lines compared to controls. In this study human breast and lung cancer cells were grown *in vitro* to test the efficacy of rice bran peptide hydrolysate fractions and peptides for anti-cancer effects. Proliferation of lung and breast cancer cells were inhibited by <5 kDa peptide fractions, and also by peptides purified from <5 kDa fraction. A cell titer assay that uses the tetrazolium dye (3-(4,5-dimethylthiazole-2-yl)-5-(3-carboxymethoxyphenyl)-2-(4-sulfophenyl)-2H-tetrazolium, inner salt (MTS) and an electron coupling reagent, phenazine ethosulfate (PES) was conducted to confirm the anti-proliferative effects of the peptides. Characterization was done employing reverse phase preparative HPLC, amino acid analysis and mass spectrometry. The anti-cancer peptide fractions thus may possess the potential for use as functional food ingredients for health benefits particularly against breast and lung cancer.

Development and evaluation of fruit and vegetable-based extruded snacks

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There is a global trend towards the development of healthy snacks. The incorporation of fruits and vegetables in extruded snacks represents a strategy to increase consumption of this food group while greatly increasing the nutritional value of snacks. The objective of this work was to develop and evaluate fruit and vegetable-based extruded snacks. Dehydrated powders of pumpkin (*Cucubita moschata*), lotus stems (*Nelumbo nucifera*), kulfa leaves (*Portulaca oleracea*), curry leaves (*Murraya koenigii*) or Indian gooseberry (*Emblica officinalis*) were added individually to whole cornmeal in two levels (25% and 50%). The mixes were extruded on a twin-screw lab scale extruder under typical conditions for directly expanded extruded snacks. Cornmeal was used as a control. The dietary fiber content of the dehydrated powders ranged from 14.5 g/100 g (lotus) to 51.5 g/100 g (kulfa). Increasing the powder level from 25 to 50% caused decreased radial expansion for all extrudates, except for gooseberry. Void fraction (determined by X-ray microtomography) was correlated to radial expansion ($r = 0.72$) and also to flow temperature ($r = 0.82$) of the dry mix (measured on a Phase Transition Analyzer). Both soluble and insoluble fiber had a negative correlation to radial expansion ratio ($r = –0.68$, $r = –0.60$, respectively), while only soluble fiber was negatively correlated to flow temperature ($r = –0.67$). Breaking force (3-point breaking test) of gooseberry, pumpkin and curry snacks was lower than the control. Powder level did not influence breaking force. A sensory test was conducted by 30 panelists (women, 40–50 years) using a 9-point hedonic scale. Although the control had the highest overall acceptance score (5.9), it did not differ from the snacks with lotus, kulfa or gooseberry at either powder level ($P < 0.05$). Snacks at both powder levels were equally accepted for all 8 sensory attributes and all 5 fruit and vegetable powders. The selected fruit and vegetable powders caused great impact on physical and structural characteristics of extruded snacks; however based on equal sensory acceptance, 50% of cornmeal can be replaced by the nutrient-dense powders of lotus stems, kulfa leaves or gooseberry.

Functional oat ingredients - opportunities and challenges for food technology

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Oats is well-known as a superior source of dietary fibre. Especially the soluble dietary fibre, beta-glucan has gained a special position with the health claim related to the cholesterol lowering properties. Furthermore, studies have shown that oats is very well accepted among consumers and the palatable oat flavour is regarded beneficial. However, several challenges are related to the use of oats in different food applications: 1) Traditionally oats has been consumed as porridge, bread and breakfast cereal of which only porridge typically contains 100% oats. However, due to the changes in consumer habits and the way of life, new types of product are needed to fulfil the consumer requirements. 2) beta-glucans are technologically very challenging compounds due to they ability to form sticky and slimy gels even at very low concentrations. Therefore, oats itself but especially beta-glucan rich ingredients are not suitable for all applications without technological modification. 3) Oat lipids are known to easily form rancid flavours due to high native lipolytic activity in oat. 4) The fractionation processes of oats are seldom feasible enough. Too often beta-glucan fraction is the only fraction with a significant market value. To overcome these challenges, new processes and technology has been developed to produce oat ingredients with value-added properties. The core technologies for production of oat ingredients have been milling and further fractionation by air-classification. The resulted fractions include fiber fractions with over 40% beta-glucans, and concentrated protein (up-to 75% protein) and starch fractions. All fractions have a long shelf-life. The technological properties and their potential in applications are summarized in the presentation. In addition to fractionation, malting has been used to improve sensory properties, stability and the content of bioactive compounds (e.g. avenantramides) of oats and to produce ingredients especially for breakfast cereals and snack foods. Controlled enzymatic reactions and fermentation can also be used to further modify the solubility, sensory properties and stability of oat fractions in food and beverage applications. As a conclusion, with developed technologies novel types of oat ingredients can be produced to better meet the technological challenges related to use of oats in various applications. The preliminary feasibility studies also show the production costs of developed oat ingredients can be competitive in the present market situation.

Whole grain barley and oat breads enriched with soluble cellulose change hepatic fat metabolism gene expression in hamsters

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Whole grains and soluble dietary fibers are recognized to promote health and prevent cardiovascular and other diseases. Whole grains are good sources of both dietary fibers and phenolic antioxidants. In Western countries the fiber and other beneficial nutrients of wheat are milled out to make white bread. Oat and barley flour enriched with 5% soluble cellulose, as a gas trapping agent, were made into bread with good loaf volumes and consumer sensory acceptability. The whole wheat, oat and barley breads were fed to hamsters on hypercholesterolemic diets for 3 weeks. The soluble cellulose also lowered plasma total and LDL cholesterol in hamsters compared to diets that contained the insoluble cellulose, microcrystalline cellulose. In order to understand the effects of soluble cellulose enriched breads RT-PCR was used to analyze hepatic gene expression. The expression of genes for cholesterol biosynthesis and LDL receptor were upregulated and the genes for fat metabolism favored oxidation rather than storage in hamsters fed soluble cellulose compared to unenriched breads. The expression of nuclear receptor genes that broadly control nutrient metabolism were also determined.

Ozone and amino acids combination effects on rice starch pasting properties

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Oxidizing chemicals for starch modification can create waste problems and leave undesirable residues in final products. Ozone, a powerful oxidizing agent, may be a good alternative to chemical treatment as ozone does not leave any solvent residues in food products. Previous studies have shown that amino acids can modify starch properties. The objectives of this study were to evaluate the effect of ozonation and amino acids in combination on pasting properties of rice starches. Compared to no additives, addition of 6% aspartic acid to commercial rice starch (CS) increased peak viscosity (PV) and breakdown (BKD) by 208 and 367 cP, but reduced minimum viscosity (MV), BKD and total setback (TSB) by 160, 367, and 282 cP. Addition of 6% of aspartic acid to CS treated for 15 min with oxygen (PO15) reduced MV, final viscosity (FV), and TSB, but increased BKD compared to PO15 with no amino acids resulting in less cooking stability. Aspartic acid (6%) addition to CS treated with ozone for 15 min did not influenced PV, FV, and TSB.

Leucine (6%) addition to PO15 and OZ15 showed similar behavior compared to treated CS with no additives. Aspartic acid in PO30 (oxygen 30 min) CS starches increased BKD by 186 cP, but decreased FV and TSB by 314 and 224 cP compared to PO30 with no additives. However, aspartic acid (6%) did not affect pasting characteristics of OZ30 (ozonated 30 min) CS starches compared to OZ30 with no additives. Addition of leucine (6%) in PO30 and OZ30 starch samples did not influence paste viscosity much except slightly reducing TSB for PO30 samples. Addition of aspartic acid (6%) to laboratory isolated starch (WSI) increased PV and BKD by 152 and 208 cP. Leucine (6%) did not affect pasting properties of non-treated WSI except for increasing TSB. The presence of aspartic acid in PO15 increased BKD by 286 cP, but reduced MV, FV, and TSB by 278, 480, and 202 cP, resulting in less cooking stability and less rigid starch gel compared to PO15 with no additives. Aspartic acid (6%) in OZ15 WSI increased BKD 193 cP, but decreased MV, FV by 256 and 357 cP. The addition of leucine (6%) in PO15 and OZ15 did not affect pasting properties of WSI, which was similar to commercial starch.

How to predict product quality from rheological measurements

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Nowadays it is fairly easy to produce a great amount of analytical information on food products. This includes textural and rheological results. But how does this information relate to everyday quality such as texture and taste, shelf life, processing, etc? It will be demonstrated how it is possible to make connection between the various results through the use of multivariate date analysis and evaluate the quality of the results by use of 50-50 MANOVA. The case is centered around texture of whole grain bread. It will be illustrated how the texture can be designed by use of ingredients such as enzymes, hydrocolloids, emulsifiers, etc and how discrete rheological parameters as well as complete rheology curves can be used to understand the functionality of the ingredients. It will also be illustrated how the results can be used in optimization of recipes and in the development of new products.

100% whole grain wheat bread: A new concept at Finnish healthy bread market

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Cereal Foods World 53:A32

Nutrition recommendations in most Western countries recommend to increase the intake of whole grain products. Consumers as well are aware of health trends, but find it difficult to find such whole grain products that contain significant amounts of whole grains as well as taste good. That is why wheat breads containing 100% whole grain wheat were developed for Finnish market. The development work included careful choice of raw material as well as development of the baking process. Bread and other cereal products are the most important sources of many essential vitamins and minerals. That is why vitamin and mineral contents of 100% whole grain wheat bread were analyzed in an external research laboratory and compared to traditional wheat breads made of refined wheat. Analyses showed that among other things thiamine, niacin and folic acid content of the whole grain bread is 2…3-fold compared to traditional refined products, and are at the same level with traditional Finnish whole grain rye bread. Magnesium and phosphorus content was also 2…3-fold in the newly developed bread compared to traditional wheat bread. When the breads were launched, a wide communication programme was carried out to create understanding among target groups about 100% whole grain wheat bread and its role in nutrition as part of total well-being. The new products were surprisingly well received by Finnish consumers: in four months two new 100% whole grain wheat breads gained 4% market share of total white bread in Finland. In sliced breads the market share after four months was over 20%. The continuation of the success story of 100% whole grain wheat breads will be described and their contribution to whole grain intake will be discussed.

Factors affecting dietary acceptance of wholegrain foods in non-wholegrain consumers taking part in a dietary intervention (the WHOLEheart study)

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To date, almost no data exist on consumer acceptance of wholegrain (WG) foods. This research examines the factors affecting the acceptance of WG foods consumed by participants as part of a dietary intervention study to examine the effects of increased WG consumption on cardiovascular disease risk factors. The 'WHOLEheart Study' provided a unique opportunity to explore the acceptability of incorporating WG, as a novel category of ingredients, into the diet that were either absent or present in small quantities prior to the study. Over 300 volunteers (aged 18–65y and BMI > 25 kg/m^2 but otherwise healthy) were randomised to one of three experimental regimes: 1) the incorporation of 60 g WG/day into the diet for 16 weeks 2) the incorporation of 60 g WG/day into the diet for 8 weeks, doubling to 120 g WG/day for the following 8 weeks; 3) a control group (no dietary intervention). Thirteen focus groups, comprising 53 study volunteers (4 control and 9 intervention groups) were held one month post-intervention. These discussions explored knowledge of WG foods and experiences of incorporating the two levels of WG into the daily diet. The discussions were audio-recorded and fully transcribed. NVivo7 computer software was used to facilitate analysis. Using 'constant comparison' methods, key factors affecting the acceptability of and barriers to WG consumption were derived. The results indicated that ultimate incorporation of WG into the diet is dependent upon 'dietary acceptance'. Dietary acceptance refers to the complementarity of WG with the structure of existing meal patterns and the substitutability of WG foods for existing foods. Consumption of 60 g WG/day was viewed as highly achievable, particularly for participants who regularly ate breakfast. By contrast, consumption 120 g WG/day was viewed as unsustainable. Here diets were described as being less varied with WG foods often displacing fruits and vegetables. Notwithstanding the compatibility of WG with meal patterns and meal ingredients, a number of personal, product and situational barriers potentially prevent sustained intake. These include family taste preferences, cooking skills, price, health versus food aesthetics and availability of WG. [Funded by the UK Food Standards Agency (N02036)].

Oxidative gelation of solvent-accessible arabinoxylans occurs during chlorination of soft wheat flour

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Arabinoxylans and glutenins are two of the critical network-forming biopolymers of wheat flours, functionally related to mixing and baking performance and baked goods quality. For soft wheat flour applications, the solvent-accessible arabinoxylans play a dominant role in both sweet and savory products. It is well documented that aqueous extracts of wheat flour arabinoxylans form permanent gels when treated with oxidizing agents at room temperature. Chlorination is an essential soft wheat flour treatment for production of high-ratio cakes in the USA, frequently with a post-milling treatment to reduce flour particle size. Effects of milling yield, extent of chlorination, and flour particle size on cake flour functionality and batter viscosity were explored by solvent retention capacity (SRC) and Bostwick flow. The effects of the extent of chlorination were dramatic, but milling yield and additional milling to reduce particle size were less significant factors. Bostwick flow showed a characteristic pattern as a function of the extent of chlorination: a significant increase in flow for lightly chlorinated flours, due to the large decrease in glutenin network swelling (decrease in lactic acid SRC); but a dramatic decrease in flow for heavily chlorinated flours, due to the exaggerated increase in arabinoxylan network swelling (sharp increase in sucrose SRC) caused by oxidative gelation of solvent-accessible arabinoxylans. The difference in Bostwick flow, without and with added hydrogen peroxide, exactly mirrored the pattern measured by sucrose SRC, suggesting oxidative gelation of solvent-accessible arabinoxylans had occurred during chlorination. Treatment with endoarabinoxylanase resulted in increased Bostwick flow and decreased SRC values in water and sucrose. The increased flow was much greater for heavily chlorinated flours than for lightly chlorinated flours, suggesting significant depolymerization of oxidative gels that were created during extensive chlorination. Most importantly, addition of hydrogen peroxide after incubation with endoarabinoxylanase caused no further change in Bostwick flow.

The influence of extreme temperatures on polymeric and monomeric proteins in bread, biscuit and durum wheat

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Extreme temperatures during grain filling have been identified as a major source of variation in wheat quality characteristics. In this study one biscuit-, two bread- and one durum wheat cultivar were evaluated in two consecutive seasons for their reaction to extreme high and low temperatures during grain filling. The cold treatment was applied at the soft dough stage of the primary tiller. The pots were placed in a cold room at 5°C. After 30 min the temperature was reduced to –3.5°C, and then it was reduced by 1°C every 30

min until it reached –5.5°C, where it was left for three hours. Then the temperature was increased to –2°C and after 30 min to 0°C, then to 2°C and after 30 min to 5°C. After another 30 min the pots were placed back in the greenhouse. The heat treatment consisted of a 32°C/15°C day/night treatment at the soft dough stage for three days. Proteins were extracted from the wheat flour with a procedure developed by Gupta et al (1993). Samples were analyzed with size exclusion HPLC, run for 30 min with a flow rate of 0.2 ml/min. The following was measured on the samples in both years: SKCS (single kernel characteristic system)-seed weight (AACC method 53-31), SKCS-seed diameter (AACC 53-31), SKCS-hardness index (AACC 53-31), flour protein content (AACC 39-11) and sodium dodecyl sulphate sedimentation. In both years, the soft biscuit wheat cultivar showed the largest reaction to low temperature stress, where the monomeric proteins were significantly increased and the polymeric proteins significantly decreased. The effect of temperature stress was more pronounced in the second year, with an earlier planting date. The durum wheat reacted to both heat and cold stress in the second year, where the small polymeric proteins were significantly reduced, and the small and large monomeric proteins were increased with stress. The effect of wheat type was much more pronounced than the effect of temperature treatments on the protein fractions. The protein fractions of the tetraploid durum wheat were very different from the hexaploid cultivars, with much less polymeric proteins, and more monomeric proteins. The soft biscuit wheat had significantly less large polymeric proteins, and more large monomeric proteins than the bread wheat cultivars for both years.

Wheat quality improvement: State of the art and perspectives

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Cereal Foods World 53:A33

Osbourne Medal Address. Major targets of wheat breeding have traditionally been yield increase as well as traits satisfying end users' requirements. Functional characteristics that flour and semolina must possess in order to satisfy food processors' and consumer needs are influenced by several factors, such as protein content and composition, kernel hardness, starch and lipids. The selection of improved breeding lines has been aided by the knowledge gained of the biochemical, genetic and molecular bases of quality, which facilitates integration of conventional and biotechnological approaches. In this respect, genomics and related "-omic" technologies have resulted in major breakthroughs, greatly advancing our understanding of genes and gene products influencing quality traits. Increasing consumer awareness of the strong relationship between nutrition and health, and the increase in diseases related to poor dietary habits, are resulting in a broader crop quality concept, which is increasingly associated with industrial and processing properties as well as with human health and nutrition. In the light of these advances, the role of wheat kernel components such as starch, but also of health beneficial compounds, including vitamins, minerals and various phytochemicals, is more and more taken into account, with a consequent increase in demand for wheat cultivars with improved and diversified functionalities, capable of satisfying dietary needs and preferences and providing better food. The current state of the art on the manipulation of gluten proteins, starch, kernel hardness and a few minor nutrients will be presented.

Reaction kinetics of heat-induced gluten protein cross-linking and its importance in bread making

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Cereal Foods World 53:A33

Heat treatment of wheat gluten proteins and the resulting changes in rheological properties are of considerable importance for the characteristics of baked products. The changes induced by heat eventually lead to larger gluten protein aggregates with the formation of gliadin-glutenin bonds. The aim of this study was to increase the insights in heat-induced gluten protein polymerization and to evaluate its importance during bread baking. The Rapid Visco Analyser (RVA) was used as a simple model system allowing easily applying temperature profiles to gluten-water suspensions, simultaneously monitoring RVA viscosity changes. SDS-extractability and molecular weight distribution of the proteins were analysed with SE-HPLC at different points during RVA analysis. Changes in specific gliadin and glutenin fractions were determined with RP-HPLC and Dumas analysis. During thermal treatment, first glutenin polymerizes through oxidation and, at higher temperatures, gliadin links to glutenin by a sulfhydryl-disulfide exchange mechanism. This mechanism considerably decreased both alpha- and gamma-gliadin solubilities in 60% ethanol at 80°C, 90°C and 95°C. No changes in omega-gliadin solubility were observed. The decrease in alpha- and gamma-gliadin concentrations could be modelled according to a first-order reaction. From these results, reaction rate coefficients, half lives, and activation energies of the sulfhydryl-disulfide exchange reaction were calculated. Finally, the relevance of these findings for the phenomena occurring during the breadmaking process is discussed.

Changes in physicochemical properties of gamma irradiated corn starch upon heating

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The native corn starch (NS) and gamma-irradiated corn starch (IS) at 10KGy in an open vessel was heated in a convection oven at 170°C for up to 12 hr. The moisture content of NS and IS decreased upon heating and remained ~0% after heating for 4 hr. Hunter's 'L' value decreased, whereas values of 'a' and 'b' increased for both NS and IS. The color difference (delta E) indicated that color of NS noticeably changed after 3 hr heating, but that of IS was noticeably different from NS upon gamma-irradiation treatment. The absolute density of NS, which was determined by xylene displacement method at 30°C, was 1.502 g/cm^3 which was rapidly decreased to 1.388 g/cm^3 after 2 hr heating, and then to 1.359 g/cm^3 after 12 hr heating. The similar pattern of decrease in absolute density for IS was observed with somewhat lower values compared with NS. Intrinsic viscosity of starch determined with a capillary viscometer at 25°C was 1.956 g/mL and 0.788 g/mL for NS and IS, respectively, which was decreased respectively to 0.500 g/mL and 0.205 g/mL upon heating for 12 hr. The gamma-irradiation treatment of starch resulted in the increase of solubility and swelling power at 80°C, which was more pronounced in IS. DSC data indicated that the range of gelatinization temperature of starch was broadened upon heating, which was more pronounced in IS. The changes in enthalpy decreased upon heating for both NS and IS. The analysis in pasting properties by Rapid Visco Analyser (RVA) revealed that gamma-irradiation treatment resulted in the lower values in all parameters. All RVA parameters decreased as heating time increased for both NS and IS. The peak viscosity of NS linearly decreased from 258.46 RVU to 167.04 RVU during heating up to 4 hr, and continuously decreased there-after to reach 41.46 RVU after 12 hr. On the other hand, peak viscosity of IS rapidly decreased up to 2 hr heating from 213.17 RVU to 18.04 RVU and slightly decreased to 9.22 RVU after 12 hr. The log peak viscosities of both NS and IS heated at 120–170°C for 12 hr followed Arrhenius relationship and the activation energy calculated was 14.5 and 17.5 kcal/mol, respectively.

NMR study of ingredient characteristics and hardening of high protein bars

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Cereal Foods World 53:A33

The characteristics of three powdered proteins (soy, dairy, soy-dairy blends) in three high protein food bar models (sugar syrup, polyol syrup, reduced-sugar syrup) were studied. Textural changes during accelerated storage were used to evaluate the overall protein performance, which was found to be a strong function of the syrup model (R2 = 92.33%). Nuclear magnetic resonance (NMR) relaxometry was used to measure relaxation times (T2, T2^{star}, T1) at 20°C and to create state diagrams (temperature- T2^{star} curves) to calculate related parameters, namely transition temperature Tg, slopes before and post transition temperature Kbefore Tg and Kafter Tg, for the individual powdered proteins and syrups over a temperature range from –35°C to 50°C. Increases in relaxation times for powdered protein samples indicated better overall protein performance, while increases in relaxation times for syrup samples were associated with increases in moisture content and concentration of polyols. Increases in water activity of the bars suggested an elevated hardening rate for polyol-containing bars. The results showed that proteins could be classified into four types (A, B, C, D) based on the shape of the temperature-T2 state diagram curves, and each type demonstrated different stability characteristics. Type D proteins (SUPRO® 313, SUPRO® 430) offered the most versatility and, when blended with other proteins, often induced synergistic softening effects in the nutrition bars which led to an extended product shelf-life. The relationship between relaxation parameter T2^{star} and protein bar hardening rate was analyzed and found to be helpful in choosing ingredients for high protein bar recipes with desirable texture and shelf life.

Total anthocyanin and dietary fiber contents from blue corn as affected by the baking process

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High fiber and anti-aging foods are a major focus in the food industry and are drawing more and more attention in the marketplace. Dietary fiber promotes

beneficial physiological effects including laxation, and blood cholesterol and glucose attenuation. Anthocyanins, a group of pink to purple water-soluble flavonoids, are well known as health-enhancing substances due to their antioxidant activity and anti-inflammatory, anticancer, and hypoglycemic effects. However, anthocyanins are sensitive to degradation by pH, light, and heat. Fruits like grape and blueberry, etc. contain high contents of anthocyanins. Blue corn also has the potential to contribute both dietary fiber and antioxidants. Cookies are popular snacks and might serve as a vehicle to deliver fiber and anti-oxidants. Commercially grown whole grain blue corn and wheat pastry flours were blended and made into sugar snap cookies (AACC method 10-50D). Guar gum was added at various levels to increase the water retention capacity and dietary fiber content. Adding 1%, flour weight basis, of guar gum increased the apparent total dietary fiber from 3.4% to 3.9%. The whole-grain milled blue corn flour contributed a total anthocyanin content (cyanidin 3-glucoside) of 237 mg/kg, which is largely present in the pericarp. After baking, the center of the cookie still displayed a bright blue color and contained 35 mg/kg anthocyanins, while the top and bottom surface layers of the cookies appeared medium brown in color and contained 24 mg/kg. Cookies containing up to 80% blue corn flour could be made. Their appearance exhibited a traditional surface crack pattern with an objectively scanned crack ratio of 1.25 and a spread ratio of 6.6. Other cookie quality indices were collected as well, including texture, moisture content, and brightness.

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 (Ts) and flowing temperature (Tg) 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.

Relationships in particle size distribution, compositional and color properties between ground corn and distillers dried grains with solubles (DDGS)

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A major process for making ethanol from corn is dry-grind method, by which, the first step is to grind corn into powder whereas the last step is to recover a co-product, distillers dried grains with solubles (DDGS). Oftentimes, corn processors believe that ground corn and DDGS are interrelated in certain quality parameters. Yet, previous studies, although rather limited, have shown no scientific basis for it. In this study, six ground corn and resulting DDGS samples were collected from different ethanol processing plants in the U.S. Midwest area. Particle size distribution (PSD) by mass was determined using a series of six selected U.S. standard sieves: No. 8, 12, 18, 35, 60, and 100, and a pan. The original sample and sieve sized fractions were measured for contents of moisture, protein, oil, ash and starch, and surface color. Total carbohydrate (CHO) and total non-starch CHO were also calculated. Results show that the geometric mean diameter (dgw) of particles was different among corn and DDGS samples, and that dgw of DDGS was larger than that of corn (0.696 vs. 0.479 mm, average values), indicating that during conversion of corn to DDGS, certain particles became enlarged. For dgw and mass frequency of individual particle size classes, the relationship between ground corn and DDGS varied, but particle size distribution was well correlated between corn and DDGS (r = 0.807). Upon conversion from corn to DDGS, on an average, protein was concentrated 3.59 times; oil, 3.40 times; ash, 3.32 times; and total non-starch CHO, 2.89 times. There were some positive correlations in contents of protein and non-starch CHO and in L value between corn and DDGS. However, actual variations in nutrients and color attributes were larger in DDGS than in corn, and for the same sample, variation was larger in sieved fractions than in whole fraction. Raw material, processing method and addition of yeasts are among major factors considered for causing large variations in these attributes of DDGS, whereas raw corn exerted its effect through concentration resulting from starch depletion. The study partially supports the common belief by processors that quality attributes of corn affect those of DDGS.

Optimization of amylases concentration in wheat bread formulation

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Staling caused an increased in bread crumb texture. Even though the exact mechanism of staling is not yet fully understood, the incorporation of amylases is known to help in reducing the hardness of bread crumb. This research aims at optimizing different types of amylase (fungal alpha-amylase and maltogenic alpha-amylase) concentrations in wheat bread formulation, in order to reduce the occurrence of bread staling. This was modeled by Response Surface Methodology (RSM) by using a Central Composite Rotatable Design (CCRD) with two independent variables (amylases concentration and storage time). The dependent variable or response measured for each treatment was the reduction in bread crumb hardness over storage time (day). The response surface and contour maps of both amylases showed that optimum hardness reduction can be achieved with combination of 79.55 ppm of fungal alpha-amylase and 920.44 ppm of maltogenic alpha-amylase at 5.5 days of storage time.

Different processing of whole-grain breads influences colonic butyrate production

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High whole-grain consumption has been associated with reduced risk of chronic diseases including colorectal cancer. Among the wide diversity of fermentation metabolites in the colon, special attention has been paid to the formation of short chain fatty acids (SCFA). Butyrate is the SCFA that provides the major energy to the epithelial cells of the large intestine and it is considered as the most health-promoting metabolite for prevention and reduction of cancer development. The aim of this study was to monitor the production of SCFA during *in vitro* fermentation of digested whole-grain breads compared to a control white bread. A dynamic computer-controlled gastrointestinal model (TIM-1) was used for the digestion of the breads. The ileum deliveries from the model, that represent the material being delivered to the large intestine, were collected during 6 hours of digestion. The residues in the compartments of the model after the end of digestion were also collected and pooled with the ileum deliveries. This pooled sample from TIM-1 was used for the fermentation experiments performed on a dynamic model of large intestine (TIM-2). This model was inoculated with a pooled intestinal microbiota of healthy human volunteers. Luminal and dialysate samples were collected during 24 hours of experiment and SCFA were analyzed. The results show that the whole-grain breads with added bran that was pre-treated, by either fermentation with lactic acid bacteria or hydrolytic enzymes, increased the amount of butyrate production compared to the control white bread, whole-grain bread and whole-grain bread with added native bran. Butyrate levels became similar when the administration of the digested breads was finished and replaced with the standardized bacterial medium. It can be concluded that the colonic metabolic responses of whole grains can be influenced by optimized processing. Pre-treatments by lactic acid bacterial fermentation or enzymatic treatment of bran, and its use in enriched bread products can potentially benefit colonic health. Acknowledgement: This work is financially supported by the European Commission's HEALTHGRAIN Project (FOOD-CT-2005-514008). It reflects the author's views.

Mixing and baking challenges of breads formulated with high whole grain and dietary fiber content

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Cereal Foods World 53:A35

Mixing characteristics of doughs for whole grain (WG) breads using different sources of WG as a part of the formula were studied. Also strategies for achieving claim levels of 5 g of total fiber (TDF) and high levels of WG (24+ g per serving) were studied to optimize the sensory and nutritional characteristics of these breads. With most WGs, Farinograms® showed that dough stability was reduced. With 20% triticale flour in a whole white wheat flour (WWF) dough formula, the stability decreased to 5 min vs. 9.5 min for dough made of WWF as the sole WG source (Control). Water absorption exhibited similar behavior (75% vs. 75.8% for Control), arrival time was unchanged at 4.5 min and development time was reduced only slightly (7 min vs. 8 min for Control). In contrast, with 20% cracked triticale, the differences were dramatic. The water absorption decreased by 9.6% to 66.2% and arrival time, development time and stability increased dramatically to 7.5 min, 13.5 min and 29 min respectively. Contrary to the Farinogram, the dough actually was not stable and bread with good loaf characteristics could not be made, especially when the dough was mixed considerably beyond the arrival time of 7.5 min. Likely mechanisms will be discussed. Water absorptions of grains and flours were determined, using a soaking and centrifugation method. Amaranth, Teff grain, and triticale flour had water absorptions similar to WWF (81% to 93%). Commercial multigrain mixes, Teff flour, rye grain, and triticale grain in contrast had high water absorptions (104 to 162%). The moderate water absorptions of Teff grain and triticale flour made them a good choice for inclusion in the formula in contrast to the higher absorbing grains. When certain whole grains are used as the sole source of whole grain in bread, 16 g of the WG component will contribute only 0.6 to 3.1 g TDF to a serving of bread. Thus, strategies for obtaining 5 g of TDF in conjunction with 24+ g of WG per serving were developed and representative formulas will be discussed to articulate appropriate strategies.

Interlaboratory evaluation of an integrated procedure for the measurement of dietary fiber

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A new procedure for the measurement of dietary fiber, including resistant starch (RS) and non-digestible oligosaccharides (NDO), as published by one of the authors (McCleary, 2007), is currently the subject of a joint AOAC International/AACC International interlaboratory evaluation. In this procedure, incubations with alpha-amylase/amyloglucosidase and protease are performed in such a way as to give the most accurate measurement of the level of resistant starch in the sample. Also, the aqueous ethanolic phase is recovered after filtration, concentrated, deionised and analysed for NDO. The interlaboratory evaluation involves approximately 20 laboratories worldwide. In a preliminary study, six samples are being analysed as part of the process of familiarizing the analysts with the method, assure method ruggedness across laboratories and countries, and allow for minor adjustments, should they be found necessary. This study will be followed by any necessary training that may be required. The full interlaboratory study will then be initiated with 16 samples (eight blind duplicates). If this study is successful, a third study will be included where a range of DF samples will be analysed, covering a wide range of materials likely to be analysed in food laboratories.

Biochemical methods for carbohydrate determination

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2008 Edith Christiansen Award

Enzymes have found widespread application in the modification of polysaccharides and in the production and characterisation of oligosaccharides. In this presentation, I will discuss some examples of these applications, but will mainly focus on the use of enzymes in the measurement of mono-, oligo- and polysaccharides. Successful application of enzymes in analytical procedures requires that the enzymes are highly purified and free of contaminating activities. Traditionally, this has required extensive purification formats or the development of specific affinity chromatographic procedures. These requirements are now circumvented with the advent of molecular biology that allows the production of large quantities of very pure enzymes with greatly reduced effort. Enzymic methods are generally based on the hydrolysis of a given oligosaccharide or polysaccharide to their monosaccharide constituents followed by enzymatic determination of the specific monosaccharide. Methods for the measurement of glucose have been available for decades, but those for other sugars such as D-galactose, L-arabinose and D-xylose were either non-existent, or very slow. In this presentation, methods for the measurement of polysaccharides (beta-glucan, starch and arabinoxylan), oligosaccharides (fructan and raffinose) and monosaccharides (D-glucose, D-galactose and D-xylose) will be described.

Variation in single kernel hardness within the wheat spike

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Variation in wheat kernel hardness is influenced by several factors; including genetic expression and environmental conditions. However, these factors explain only a portion of the observed variation. Thus, there are still unknown contributors to this important physical property. Therefore, the experiments investigated kernel position in the spike as a source of hardness variation. Four of Kansas's top commercial hard red winter wheat varieties; Jagger, Jagalene, Overley, and 2137 were chosen for evaluation. In total, 370 spikes were collected from three sites participating in the Kansas State University Research and Extension-Crop Performance Trials (2007 crop year). For the analyses, each kernel was removed from its spike and cataloged by spikelet and floret position. A total of ~10,000 kernels were identified by site, variety, rep, spike, spikelet and floret position. Using the SKCS 4100, kernels were crushed singly, and the data were used to describe variation attributed the various parameters. Significant differences in hardness were found between sites, varieties, and positions within the spike. Results indicate that gradients of hardness exist in the spike, as well as the existence of areas that exhibit no variation. Findings from this experiment may contribute to the development of improved methods of single kernel analysis.

Economic analysis of arabinoxylan and ethanol co-production in an integrated wheat biorefinery

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This study investigated the economic feasibility of co-producing an arabinoxylan (AX) product with ethanol from wheat, in order to establish whether, under plausible scenarios, it was realistic that a commercial source of wheat AX could be established. The possibility of recovering wheat bran for AX extraction via pearling was also investigated. Process flowsheets describing three scenarios were created using SuperPro Designer: conventional wheat-to-bioethanol production with Distillers Dried Grain with Solubles (DDGS) as the principal co-product; bioethanol production with co-production of AX using conventional hammer milling and sieving to recover the bran for AX extraction; and the use of pearling technology to recover bran for AX extraction. Full economic analysis of each of the three scenarios, considering all capital and operating costs, was undertaken, basing comparisons on a constant return on investment in order to estimate the production costs of AX. Simulation of the integrated processes indicated that an AX product of 80% purity could be co-produced with ethanol in the UK context at a cost of around US$7-9 per kg. This is within the range of comparable viscosity-enhancing ingredients used in the food industry, but is towards the top end of the range. In order to establish a market, AX would therefore need to offer some additional functionality. The research indicates that creating a market for AX is feasible in terms of production costs if the AX is co-produced with ethanol. On this basis, further research is justified to investigate the functionality of AX from different sources, to optimise the AX extraction process and to establish the potential of AX as a food or pharmaceutical ingredient.

Barley kernel hardness: Affects of genotype and environment and association with other physical traits

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Cereal Foods World 53:A35

Kernel hardness of barley may influence post-harvest handling, pearling and milling properties of grains, flour particle size distribution and eventually the processing and product quality, as well documented in wheat. However, we have limited understanding of genotypic variation and environmental influence on kernel hardness as well as the basis of kernel hardness variation.

The objectives of our study were to determine the influence of genotype (G) and environment (E) on kernel hardness of barley and to explore the association of kernel hardness with other grain characteristics including size, shape, density and vitreousness. G and E effects on physical characteristics of barley kernel were determined using 14 genetically diverse barley lines grown in 12 locations with 3 replications. The proportion of hull, measured as percentage removal of the outer layer after 80 sec abrasion, SKCS kernel hardness, weight and diameter showed normal distributions and were 12.2-25.4%, 19.2-87.4, 18.6-44.3 mg and 1.3-2.6 mm, respectively. G, E and GxE were all significant sources of variation for hardness, weight and diameter with environment playing the greater role based on mean square values. Ten barley lines of varying kernel hardness (30.0-91.2) were selected to determine the association of kernel hardness with thousand kernel weight, test weight, density, vitreousness and kernel crease dimensions. Thousand kernel weight, test weight, density and crease dimensions showed no significant correlation with kernel hardness. Vitreousness alludes to the internal packing of kernel and is greatly influenced by the growing conditions. Dehulled barley grains were observed on a light box and vitreousness was visually assessed on a scale of 1–5 so as to give 1 to the opaque and 5 to the translucent kernels. Vitreousness determined by visual observation showed a positive relationship with kernel hardness. Brightness (L*) of kernel was also determined as an indicator of grain vitreousness, since vitreous kernels reflect less light giving lower L* values than opaque kernels. L* values varied from 61.9–65.9 and showed significant negative correlation (r = –0.824) with kernel hardness. Overall, these results suggest that barley kernel hardness is strongly affected by environment and associated with vitreousness.

Effect of defatted maize germ flour on serum biochemical profile in Sprague Dawley rats

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Defatted maize germ (DMG) is obtained in large amounts as a residue after oil extraction from maize germ and is generally used for animal feed. The use of DMG for human food is a stimulating perspective but no known published data is available regarding the effect of DMG on serum biochemical profile. The main objective of the present study was to investigate the effect of DMG flour diet on serum composition in Sprague Dawley rats. DMG was extracted, ground and sieved to prepare food grade DMG flour. The flour thus obtained showed very good nutritional profile (composition) with respect to protein, minerals and fiber. The DMG flour, was then fed along with basal diet to two groups of Sprague Dawley rats for the period of 45 days. Four rats from each group were decapitated fortnightly to collect blood samples. The serum was separated from the blood and stored at –21°C unless used for selected serum profile analysis. DMG flour diet had significantly positive effect on calcium and potassium status of serum as against the basal diet while serum sodium was not affected with respect to diets and study period. There was non significant increase in serum total protein, albumin and globulin levels of DMG fed rats whereas diet and aging have no effect on serum albumin/globulin ratio. DMG flour diet also showed significant and favorable impact on serum glucose and lipid profile. Serum glucose, triglyceride, cholesterol and LDL concentration decreased up to 6.50, 12.45, 6.80 and 16.19 percent respectively with DMG flour diet compared to basal diet. Good cholesterol (HDL) content in serum improved (5.54%) with treatment diet with study period. DMG flour did not influence the liver and kidney functioning determined by SGOT, SGPT, ALP, creatinine and urea tests. The results for all the parameters investigated in serum were within the published (safe) limits for rats. It can be concluded from this study that nutrient dense composition of DMG flour with positive influence on serum biochemical profile has a potential to be incorporated in food formulations.

Cereal (1-3,1-4)-beta-D-glucans – functional properties and molecular interactions

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Cereal Foods World 53:A36

Rheological properties of barley (Glucagel™) and oat (PromOat™) beta-glucan (BG) products and molecular interaction with small molecules (aroma compounds) were studied in order to exploit the food functional properties of BG. Product composition of impurities and BG was characterised by gel-permeation size-exclusion chromatography (GPSEC) as well as Fourier transformed-infrared (FT-IR) and 1H nuclear magnetic resonance (NMR) spectroscopy. Proton NMR analysis revealed no differences in the ratio of beta-(1→3) to beta-(1→4) linkages in BGs from Glucagel™ and PromOat™, but identified residual carbohydrate residues in both products including alpha- and beta-glucose and alpha-dextrins. PromOat™ is the least purified product. The viscosity of Glucagel™ and PromOat™ were studied at variable solution concentrations (1, 2.5 or 5%), temperatures (10–80°C), and shear rates (1-30 s-1). Viscosity decreased with temperature and increased with concentration for both products. Activation energy (Ea) was calculated from the Arrhenius equation and it was found that the relative large dextrin to BG proportion in PromOat™ had an unexpected impact on product stability at low solution concentrations and around starch gelatinisation temperature (60°C). Glucagel™ was determined as a low viscosity BG product with Newtonian flow behaviour and PromOat™ was determined as a high viscosity BG product with shear thinning flow behaviour at elevated concentrations. In order to investigate BG affinity to small molecules equilibrium dialysis, molecular modelling and chemometrics was used. It was found that binding of the small molecules to BGs depend on multiple characteristics that are not captured by a single molecular descriptor. The fact that aroma retention in BG matrixes increased with incubation time suggests that network formation of the BG polymers is a crucial factor in aroma retention/release. This work constitutes the background for developing a culinary attractive BG enriched functional food product for testing in a human intervention study.

Mechanical behavior of crisp wafer breads before and after contact with different emulsion type spreads

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Three wafer breads of different composition based on wheat flour (pure-wheat), potato starch/buckwheat flour (gluten-free), or wheat flour/rye bran (fibre-enriched) were investigated by fracture tests for their mechanical behavior before and after equilibration at 22°C and 55% r. h. for 24 h. The mechanical parameters maximum force to fracture (F_{max}), compression length (L_{Fmax}), work to fracture (W_{Rm}), and elasticity module (E) were specific for each of the wafer breads. The equilibration treatment enhanced fracture stability and increased elasticity. Two different emulsion type spreads, a water-in-oil type (butter) and an oil-in-water type (processed cream cheese) were applied to the wafer breads and equilibration was performed as above. Fracture measurement results indicated that butter increased further the mechanical stability but cream cheese decreased it, accompanied by a considerable increase of elasticity. Although water activity of the wafer breads increased during all treatments, water uptake from the air or the different spreads did not correlate to mechanical parameters but seemed rather dominated by the composition of the bread. The application of these findings to the prediction of the mechanical stability of crisp wafer breads by contact with different emulsion types is discussed.

Regulatory and chemical considerations of using azodicarbonamide as a flour additive and/or dough conditioner

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Azodicarbonamide (ADA) has been used commercially as a flour-maturing agent and dough conditioner since 1962. Code of Federal Regulations (CFR) 21 Parts 136.110, 137.105, 137.200 and 172.806 regulate ADA and limit its use to not more than 0.0045% (45 ppm) by weight of flour. In 2004, it was shown that semicarbazide, a reported animal carcinogen, is a product of the thermal decomposition of ADA. Since that finding, a number of researchers have established a clear link between the use of ADA and the presence of semicarbazide in bread. Our recent work has shown that semicarbazide does not form as a direct by-product of ADA decomposition, but through the stable intermediate, biurea. One consequence of this reaction pathway is that semicarbazide is formed only during baking; therefore, changes in dough processing conditions have not been found to alter semicarbazide concentrations in the baked product. Additionally, results showed a direct, linear correlation between the amount of ADA (5–45 ppm) added to flour and the semicarbazide concentrations determined in bread (30–400 ppb). During research on the semicarbazide formation pathway a limited number of commercial bread products were analyzed. Semicarbazide residues were detected in products with and without ADA listed as an ingredient. Because no other sources of semicarbazide contamination in bread have been identified or proposed, such residues clearly establish the use of ADA. Based on 21 CFR 101.4(a)(1), ingredients such as ADA must be declared in the statement of ingredients. In addition to unlabeled products the survey also identified a small number of products which contained high levels of semicarbazide (> 600 ppb). Residues at these concentrations are indicative of ADA concentrations in excess of the 45 ppm regulatory limit.

How to make a healthy fibre rich bread that tastes good

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Most consumers prefer products of refined white flour to whole grain products, because they perceive the textural properties of whole grain products to be less attractive. For health reasons a higher daily consumption of whole grain products is desired. The best way to stimulate the consumption of whole grain products is by improving their perceived attractiveness. In this study the nature of the adverse effects of wheat bran fractions on bread was studied. Negative effects are related to a high water absorption, but also to direct effects of bran on the formation of a gas holding dough. Two fractions of the bran, representing different tissue layers and having different composition, were used. The particle size of the bran fractions was varied by various milling techniques. All fractions were added to white flour. Water addition was adjusted to obtain dough with a constant consistency and compensate for possible differences in water absorption. Both dough mixing properties and bread making quality were affected by the addition of bran. The influence of the added particles varying in size, interaction surface and composition provided information on the nature of the effects. Interestingly, our results demonstrated that the adverse effects on bread quality are related to negative effects of bran on gluten network formation. With respect to bran properties, two effects were identified: the higher the ferulic acid content of the fibre, the stronger the negative effect and the smaller the bran particle size, the larger the negative effect. Although research continues as to the nature of these interactions, these results already provide clear avenues to prepare high fibre wheat bread with attractive sensory properties. *Acknowledgement: This work is financially supported by the European Commission's HEALTHGRAIN Project (FOOD-CT-2005-514008). It reflects the author's views.*

The use of silica gel in drying small samples of rough rice

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The objective of this study was to determine the adsorptive capacity of silica gel in closed samples of rough rice and the duration required to dry rice samples from harvest moisture content to a desired 12.5% (wet basis). The experiment incorporated the use of silica gel in 1- and 5-g, packets mixed with small samples of rough rice in plastic bags. Drying was carried out at ambient temperature. The average adsorptive capacity of the silica packets in closed samples of rough rice was established as 27% (i.e. 0.27 g of water/1 g of silica gel). There was minimal variation (12.5 + –0.1%) in the final moisture content of the rice samples dried using the silica gel packets.

Characteristics of glutenin macropolymer extracted from sheeted noodle doughs

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Alkaline (Na2CO3) noodle doughs are stiffer than those of their salted (NaCl) counterparts, even when doughs are made from the same flour. The aim of this study was to begin to search for a molecular basis for this increased stiffness. Glutenin macropolymer (GMP) was isolated from the flours of 4 wheat varieties. GMP was also isolated from the resultant doughs at 4 processing stages. GMP isolated from alkaline dough was gummier and stickier than GMP isolated from salted dough. GMP gumminess increased after compounding for both dough types. GMP weight decreased after mixing and continued to decrease to a minimum value after sheeting for both types. The decrease was greater for GMP extracted from alkaline doughs but this decrease in weight was not as great as that observed in other studies when mixing high-water, breadmaking-type doughs. GMP weight increased significantly after the 24 h rest for salted doughs, but increased only slightly or not at all after resting for alkaline doughs. Results suggest that alkali increased GMP depolymerization during sheeting, and hindered GMP repolymerization during resting. Storage moduli of the GMP gels (GMP-G') were higher for alkaline doughs than they were for their salted equivalents. Salted dough GMP-G' increased to a maximum 1.5 to 2 times higher than flour GMP-G' at the compounding or sheeting stages, declining after resting back to levels similar to flour GMP-G'. Alkaline dough GMP-G' increased throughout the process, reaching a maximum only after the 24 h dough rest. Maximum GMP-G' from alkaline doughs was 3 to 9 times higher than flour GMP-G' depending on variety and the increase was proportionally highest for GMP extracted from the alkaline dough made from the weakest flour. Cooked alkaline noodles were more solid-like (lower delta values) and had conspicuously higher storage moduli than cooked salted noodles. These results suggest that the molecular basis of the stiffer physical properties of alkaline noodle doughs and their resultant cooked noodles may reside in the GMP fraction of gluten and further work will focus on the characteristics of that fraction.

The power of a global artificial neural network calibration for the determination of protein and moisture in wheat and barley by near infrared transmission

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Near Infrared Technologies has become a powerful, indispensable tool in the quality assessment of whole grains and flours. In many cases instruments are operated in local or regional networks using artificial neural network (ANN) prediction models, to allow a fair trade and enhance an optimum use of grains and flours. Annual interlaboratory studies for the European Grain Network (EGN) have been performed by FOSS since more than a dozen years. The original purpose was harmonization of the different local/regional grain networks, to see whether there were differences between the master labs, make adjustments of data to be included in calibrations, if necessary, and to serve members with information about their own values. In autumn 2007 a slightly modified format for the study has been applied, following the ISO 5725-2 protocol and including wheat and barley samples. Reasons for this modification were to give the members improved information and to prepare for a standardization of the large and increasingly stable grain ANN calibration. The study included the determination of moisture and protein in whole kernel wheat and barley samples from the 2007 harvest using reference analyses methods presently used in the master labs of the European grain networks, using NIR calibration models presently in use in the different networks and the FOSS ANN calibration model WB003034 for the simultaneous determination of protein and moisture in wheat and barley. Results will be presented that indicate that the FOSS ANN model WB003034 can be used without loss in accuracy and performance. In addition the 18 participating laboratories from 12 different European countries submitted data for their reference analyses on the following parameters: Falling number, Mass per hectoliter, Sedimentation index (Zeleny), Wet gluten, Starch and Hardness.

Effect of dough rheology on gas cell stability and baked product microstructure

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The quality and functionality of baked foods rely on their cellular foam structure. Dough exhibits extremely complex rheological properties which affects the number of bubbles and their size distributions. The ability of the gas cells to resist failure and remain stable throughout the proofing and baking process is critical to final bread texture and volume. In this study we developed an experimental protocol which allows us to capture micro structural properties of dough systems made from three different wheat flours. Doughs were prepared according to AACC Method 10-10B optimized straight-dough bread-making method. Sections from unproofed (0 min), underproofed (19 min) and optimally proofed (38 min) doughs were carefully cut and frozen at –80°C. Several small specimens of frozen dough were cut from each loaf prior to microstructural analysis. Dough samples were scanned using a high resolution desktop X-ray micro-CT system, Skyscan1072 (Skyscan, Belgium) consists of an X-ray tube operating at a voltage of 75 kV and current of 98 µA, an X-ray detector and a CCD-camera. X-ray images were obtained from 100 rotation views through 180° of rotation. The scanning process was controlled by a software package, which also allows microtomographical reconstruction using a filtered back-projection algorithm. Angular projections were used to generate 2-D cross-sectional images. 3-D objects were then reconstructed from multiple 2-D images and virtually sliced for quantitative analysis. Hundreds of reconstructed cross sectional images were analyzed using CTAn (v.1.7) processing, and analysis software. The gas bubbles were clearly visible within the dough matrix by their low grey value (low absorption coefficient). 3-D analysis of the bubbles indicated that the dough void fractions changes dramatically during proof time. Gas cell size distributions ranged from 0.29 and 0.43 mm for the underproofed and optimally proofed doughs, respectively. A corresponding increase was observed from 61.1% to 73.7% in void volume fraction. Average cell wall thickness decreased from 0.10 mm to 0.09 mm during proofing. Fully proofed doughs were baked and gas cell structure in the final baked product was characterized using C-Cell imaging system. The biaxial extensional rheological properties of dough measured using Stable Micro Systems Ltd. D/R Dough Inflation System were correlated with microstructure of both proofed dough and final baked product.

Attempt to predict wheat quality using synchrotron powered FTIR microspectroscopy

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Microspectroscopy is a technique which combines the microscope with the spectroscope. During the last 15 years, the use and capabilities of FTIR microspectroscopy in biology and materials sciences have substantially increased, including applications to plant and cereal science. Mid-infrared spectroscopy covers the range of electromagnetic spectrum from ~25,000 to 2,500 cm^{-1}, and is associated with the rotational-vibrational structure of chemical bonds in molecules. In the breeding research programs it is desired to have a quick micro-method to determine quality of grain in 3rd generation when the availability of grain is very limited. It is well known that dough functionality and bread volume is highly dependent on grain protein, its composition, and secondary/tertiary structure. In our studies we attempted to predict wheat quality from the FTIR spectra. 8 varieties of Ontario hard winter wheat were analysed. The complete set of grain and flour quality tests were performed on each sample. Using synchrotron powered FTIR microspectroscopy, we have mapped/localized in situ proteins in three different tissues of mature grain: endosperm, subaleurone layer, and aleurone layer. Amide I peak was deconvolved and the ratios of alpha-helix form to beta-sheets forms were calculated. We have found that correlation between the ratio of alpha-helix to beta-sheets forms in mature grain endosperm is strongly (r2 about 80-87) correlated with farinograph stability, water absorption, mixing tolerance index and loaf volume. It sesms, that FTIR microspectroscopy can be a very useful tool to predict the quality of wheat.

Effect of malting on selected phytochemicals in wheat, rye, barley and oats

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Malting is an effective way to modify the chemical composition of cereals. Besides the dramatic changes in the formation of hydrolytic enzymes, macromolecules (e.g. starch, proteins and beta-glucan), the increase in the amounts of health promoting compounds is of great interest. The effect of germination on benzoxazinoids and alkylresorcinols was studied using three wheat and two rye varieties, on hordatines and alkylresorcinols using four barley varieties and on avenanthramides and saponins using three oat varieties. Two germination times, two moisture contents and two temperatures were used as variables in this study. After the germination step all samples were subjected to a drying process used for pilsner malt production, with a final drying temperature of 83°C. The biggest changes on the studied phytochemicals were normally achieved using longer germination time, higher temperature and higher moisture content. The amount of alkylresorcinols in wheat lowered 5–46% from the original values and in two rye varieties lowered 4–16% or increased 12–26% from the original values. In three barley varieties the amounts of alkylresorcinols lowered 4–16% or in one increased 22% from the original values. The amount of benzoxazinoids in wheat increased 46–102 times and in rye 6.3–8.9 times from the original values. The amount of avenanthramides in oat varieties increased 1.8–4.5 times from the original values and the amount of saponins 2.1–3.2 times from the original values. Interestingly the amount of hordatines in barley remained constant in two varieties and increased 1.4–2.1 times in the other two varieties. Upon germination the production of certain plant defense compounds, such as benzoxazinoids, avenanthramides, saponins and hordatines, is induced. Some of these compounds have also health promoting properties, so this could offer opportunities to increase the usage of malted cereals in health-food formulations.

Enzymatic modification, isolation and analysis of flour lipids

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It is a recognised fact that wheat lipids make a significant contribution to the baking effect of wheat flour and that especially the polar lipids are favourable compared to the non-polar fraction. These lipids play a significant role with regards to the impact on dough stability as well as specific volume of bread obtained by the flour. Lipases (EC 3.1.1.3) are well-known enzymes studied to assess their potential benefits in bakery applications. In the past 1,3 specific lipases were used in bakery applications for modifying flour tri-glycerides, however development of lipases modifying the flour galactolipids and phospholipids are now brought into focus. Modification of main polar flour lipids such as galactolipids as well as phospholipids by use of enzymes make it possible to create even more polar and surface active lipids in-situ in the dough system. By increasing the polarity and surface activity of the lipids an even better dough stability and specific volume is obtained. The purpose of this study was to investigate a lipase with galactolipase activity in dough and bread. By use of strong centrifugation it has been possible to fractionate the dough into a liquid phase, gel phase, gluten/protein phase as well as a starch phase. These fractions were then extracted and analysed by GLC and HPLC/MS with regards to key polar and non-polar flour lipids. Besides lipid analysis also surface tension/activity has been determined of each fraction. These studies showed that the use of a lipase with galactolipase activity is able to modify the galactolipids especially found in the gel and protein phase and thereby strengthening the interaction between lipids and gluten, resulting in a stronger and more elastic gluten network providing improved crumb structure and bread volume. The work also concludes on results of the lipid extraction linked to the baking performance of the lipase.

Relationship between structure and sensory perception of crispness of cellular solid foods

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Crispness is a salient textural attribute of several European types of bread, toasted bread and battered foods which is 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 crispness. Crispness is characterized by multiple fracture events accompanied by acoustic emission and low work of mastication on eating. The main problem of crispy foods is the rapid deterioration of the crispness resulting from the increase of water upon storage. The aim of this work was to assess the effect of product morphology on sensory crispness grading of cellular foods. The effect of the morphology on crispy rolls was studied by varying processing conditions. Crispy rolls were baked after different volumes of gas produced during proving. This resulted in a modification of the bread structure. The effect of the morphology on the migration of water in the product, from the wet crumb to the originally dry crust was studied by following the increase of moisture content of the crust. A sensory test showed that upon storage crispy rolls baked with a lower proving volume kept their crispness for a longer time. This was due to the lower water content of the crust after cooling. We hypothesize that processing conditions affected the structure of the crispy rolls and delayed the migration of moisture from crumb to crust and, therefore, improved the retention of crispness.

Processing of oat bran based foods influences the glycemic response to meals with similar nutrient compositions

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Oat bran and oat fibre extracts have been studied as a source of viscous fibre in a number of clinical trials. The mixed linkage beta-glucan found in oats, (1-3)(1-4)-beta-D-glucan, has been reported to attenuate post-prandial blood glucose levels and reduce serum cholesterol concentrations, a specific effect generally attributed to viscosity. The variability of both glycemic and lipid response to different foods in clinical trials has frequently been attributed more generally to a "matrix" effect. In other words, interactions between the food components, and the microstructure of the foods, influence the digestion of the food and the rate of absorption of the nutrients. To investigate how food processing affects glycemic response, four foods were formulated to have the same nutrient compositions and beta-glucan content. Pasta, porridge, granola and crisp bread containing 4 g oat beta-glucan/serving were prepared. Peak blood glucose rise was measured in eleven healthy subjects, after eating each meal, using a randomized clinical trial design. The glycemic responses to the foods were quite different despite the similarity in composition. Crisp bread had the highest glycemic response and pasta the lowest. The molecular weight and solubilities of the beta-glucan in the foods were assessed using an *in vitro* digestion protocol to estimate viscosity development in the gut. Depolymerization of the beta-glucan was observed in the pasta and the bread. Solubility was low in the granola (10%) and higher in the bread (60%). Both depolymerization and reduction in solubility of beta-glucan would reduce the viscosity of the gut contents. The differences in distribution of beta-glucan and starch in the different foods account, at least partially, for the differences in glycemic response.

Effect of fresh meat as a protein source on expansion and kibble structure of an extruded canine diet

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Single screw extrusion is commonly used for producing dry, expanded dog food. Recent market research suggests a trend towards greater consumer concern about ingredient quality in pet food, resulting in increased willingness to pay more for higher-end products. Fresh meat as a protein source in dog food would satisfy a more quality-conscious customer, but the high moisture content of fresh meat causes problems in extrusion. The primary objective of this study was to investigate the effect on kibble structure and expansion when replacing poultry by-product meal (PBM) with fresh meat (FM) in increments (0%, 25%, 50%, 75%, and 100%), and find an optimum level for substitution of FM for PBM. Expansion and kibble structure were investigated using bulk density, expansion ratio, texture analysis, and noninvasive, microstructure analysis using X-ray micro tomography (XMT). Bulk density decreased and expansion ratio increased as the FM percentage of the protein fraction of the diet approached 50%, however bulk density increased and expansion ratio decreased as FM percentages increased beyond 50%. The range of the bulk density was 226.67 to 299.27 g/L, and the expansion ratio ranged from 2.46 to 4.02. Specific mechanical energy (or SME) input during extrusion processing ranged from 215.75 to 302.23 kJ/kg, with the highest at 50% FM. Crushing force measured in the texture analysis ranged from 0.94 to 5.44 kg and was the smallest at low to medium fresh meat contents, which corresponded to greater expansion. XMT gave data on the internal structure of kibbles, which consists of the average diameter of air cells, the void fraction of the kibble, relative cell wall thicknesses, and overall cell size distribution. XMT data along with bulk density, expansion ratio, and texture analysis suggest that a medium amount of fresh meat substituted for PBM is optimal.

Phytochemicals and other healthy components of sorghums

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This presentation provides a review of the healthy components that exist in significantly high levels in special sorghum varieties and hybrids. Sorghums from the world collection were found that have very high levels of phytochemicals. Black sorghums contain significant quantities of 3-deoxyanthocyanins that are found exclusively in sorghum. They provide consistently high levels of 3-deoxyanthocyanins that can be concentrated several-fold by decortication of the sorghums. They produce stable natural colorants for use in food systems. Sorghums with high levels of flavonoids compared to fruits and vegetables exist. In addition, the starch digestion of sorghums with condensed tannins is reduced significantly. This has promising applications in foods for type II diabetes and weight loss programs. They contribute excellent natural color and other components that improve the quality of whole grain foods. Thus, special sorghums are excellent sources of antioxidants and colorants and they are slow to digest in foods. Several studies have found that sorghum with brown or black bran may prevent colon cancer in rats.

Potassium bromate: New voluntary guidance and a quick test for measuring residues in baked goods

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This paper will provide an update on newly revised industry guidance on ways to control potassium bromate (PB) residues in the baking process. The paper will also provide updated information on a "quick test" method that is in development to ensure that PB residues remain below safe levels, determined by FDA to be 20 ppb. This voluntary guidance provides a framework for bakers to control critical production processes that ensure PB residues remain within safe limits. This new program has been the effort of a collaborative partnership between the American Bakers Association and the American Institute of Baking for the safe use of PB. PB, used in bread making for many years around the world, helps bread to rise in the oven and creates a good loaf texture and quality that is pleasing to consumers. The ABA/AIB guidance recommends testing to be undertaken periodically on a set schedule, using the HPLC (AOAC Int. Peer Verified Method:2000) or equivilent testing method, to ensure that the bakery consistently follows the correct product formulation during production. A proposed quick test had been developed for a practical in-plant aid for bakeries or corporate labs, and requires mainly standard laboratory equipment. The method is based upon aqueous extraction of bromate residues from bread samples followed by a convenient cleanup and pre-concentration with solid phase extractors and determination by chemiluminescene. The method has so far been validated on testing with five types of commercial white bread products that are most likely to use PB as a dough conditioner. *Lee Sanders, Maureen Olewnik and Katsuichi Himata will all speak briefly at the session on key aspects of the guidance, application and research.

Will salt reduction benefit consumers?

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Cereal Foods World 53:A39

Salt (sodium chloride) has been prominently featured in the news for many years because of the purported link between its consumption and cardiovascular disease. This multi-decade long debate has been characterized by considerable misinformation, which, in turn has led to a loss of perspective on the part of consumers and in certain cases on the part of regulators. In the last few years, the salt content of foods and has taken on a much greater profile because of three highly publicized initiatives. The Food Standards Agency (FSA) of the UK has instituted a highly aggressive anti-salt campaign directed at the food industry. The Center for Science in the Public Interest (CSPI) has petitioned the FDA to remove the "GRAS" status of salt and have it regulated as an additive in foods with a negative labeling association. Finally, the Canadian government has just established, a Multi-Stakeholder Working Group to discuss and arrive at strategies for dietary sodium reduction. Salt is our oldest known food preservative and, aside from water, is the most ubiquitous ingredient used in the global food industry. The impact of legislated reductions in salt intakes or the salt contents of foods has enormous consequences for food production, international trade and the overall health of consumers. This paper will present the latest medical and scientific evidence surrounding the salt and health debate including the results of research on salt and cardiovascular events in Finland and provide evidence-based guidance for future policy-making efforts.

Impact of increasing protein content on gluten strength testing methods and prediction of cooked spaghetti firmness

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Protein quality and quantity are well known to be important in the production of pasta, but the interrelationship between protein content and protein quality is not as clear. While protein quantity is easily determined, various protein quality testing methods including the Alveograph, Mixograph, Gluten Index (GI) and SDS sedimentation are used to provide an indication of gluten strength characteristics. Although used as selection tools in breeding programs and for quality specifications in the durum trade, the relative effect of protein content on protein quality characteristics measured by these methods is not obvious. Therefore, to investigate the impact of increasing protein content on protein quality characteristics, Canada Western Amber Durum (CWAD) samples were collected from annual Canadian Grain Commission (CGC) harvest surveys and composited to provide samples with protein contents ranging from 9.5–16.5%. Composites were milled, assessed using a variety of gluten strength tests, and processed into spaghetti. Wheat and semolina protein and dry gluten content were highly correlated with SDS sedimentation (r~0.90). Alveograph parameters L and W were also highly correlated with semolina protein content (r = 0.87 and 0.86, respectively), as was Mixograph peak height (r = 0.91). In contrast, semolina protein content was negatively correlated to gluten index (r = –0.65), Alveograph P/L (–0.58) and Mixograph development time (r = –0.78). As expected, wheat and semolina protein and dry gluten content were strongly correlated to cooked spaghetti firmness for spaghetti dried at 70 and 90°C (r = 0.92, 0.97, and 0.97, respectively) as was SDS sedimentation volume, Alveograph L and W, and mixograph peak height. In contrast, GI and Alveograph P/L showed negative correlations with firmness. These results are discussed in relation to their impact on the selection of breeder lines and the commercial durum industry.

Effect of dry-heated prime starch and tailings fractions in wheat flour on pancake springiness

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Cereal Foods World 53:A39

The four flour fractions (water solubles, gluten, prime starch and tailings fractions) were separately dry-heated at 120 degrees Fahrenheit for 2 hrs, and the pancake baking test was performed with the reconstituted wheat flour. It

was found that dry-heated (120 degrees Fahrenheit, 2 hrs) water solubles and gluten fractions did not improve the pancake springiness, while dry-heated prime starch and tailings fractions did. It was observed that dry-heated prime starch and tailings fractions each showed oil binding ability, and an interaction between them occurred due to their hydrophobic nature. The positive effect of dry heating on pancake springiness would be caused by interaction between flour prime starch and tailings fractions.

Study on saccharification experiment for extrusion cooked barley, wheat and maize degermed as beer adjuncts

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The influence regularity of the parameters of the extrusion cooking system for barley, wheat and maize degermed as beer adjuncts on indexes observed was studied by experiments. These parameters include the diameter of nozzle, barrel temperature, moisture content percentages of the barley, wheat and maize degermed, screw speed and the distance from the internal surface of die plate to the end surface of the end of the whole screw. The indexes observed include the filtration speed of wort, the recoverable ratio of wort extract and iodine value of wort. The research results indicate the extruded barley, wheat and maize degermed may be used as beer adjunct. The recoverable ratios of wort extract for extruded barley, wheat and maize degermed are respectively 72.04%, 74.38% and 70.44% more than that of the traditional non-extruded barley, wheat and maize degermed, which are respectively 61.61%, 65% and 68.81%. Meanwhile the recoverable ratios of wort extract for extruded barley, wheat and maize degermed are all more than that of the traditional non-extruded rice adjunct, which is 67.98%. This technology has been applied for the invention patent technology and authorized in China in 2003. Keywords: Extrusion, Cooking, Wheat, Barley, Maize degermed, Saccharification, Adjunct. References: 1. Dale, C. J, T. W. Young and A. Makinde. 1989. Extruded sorghum as a brewing raw material. Journal of the Institute of Brewing, 95:157-167. 2. Delcour, J. A., M. E. Mechtilde and H. R. Vancraenenbroeck. 1989. Unmalted cereal products for beer brewing. Part I. The use of high percentages of regular corn starch and sorghum. Journal of the Institute of Brewing, 95:271-276. 3. Qin Risan. 1990. The application of extruded beer adjuncts to beer brewing. Brewing Science and Technology, 2:19-20. 4. Frame N. D. 1994. The technology of extrusion cooking. Printed in Great Britain by St. Edimundsbury Press. 5. Dechao Shen. 1996. Test study on feasibility of extruded maize used as beer adjunct. Transaction of Chinese Society of Agricultural Engineering, 12(3):196-198. 6. Dechao Shen. 1999. Test Study on Extruded maize with germ used as beer adjuncts. Transaction of Chinese Society of Agricultural Engineering, 15(2):202-207. 7. Dechao Shen. 2001. The processing method, processing equipment and saccharification method of extruded adjunct. China Patent No. 00122033.0. 8. Dechao Shen. 2002. Test study on extruded rice used as beer adjunct. Transaction of Chinese Society of Agricultural Engineering, 18(1):132-134. 9. Dechao Shen. 2004. Analysis of glucide component for wort and beer of extruded rice beer adjunct. Transaction of Chinese Society of Agricultural machinery, 35(6). 10. Dechao Shen. 2007. Analysis of saccharification process for extruded rice beer adjunct. Transaction of Chinese Society of Agricultural Engineering, 23(1). 11. Dunyi Guan. 1985. The handbook of beer industry (middle volume). Beijing: The Chinese Light Industry Press. 12. Gouxian Gu. 1999. The technology of brewing Wine. Beijing: The Chinese Light Industry Press.

Vacuum distillation of ethanol during high solids fermentation

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Two limits for controlled fermentations are substrate and end product inhibition. For modern dry grind ethanol production, glucose inhibition restricts slurry total solids content to 32% (w/w) while ethanol inhibition constrains maximum ethanol concentration to 20% (v/v). Granular starch hydrolyzing enzyme (GSHE) converts raw starch directly to dextrins at $\leq$48°C and replaces the energy intensive cooking process with a gradual liquefaction carried out simultaneously with fermentation. While conventional dry grind methods produce initial glucose concentrations at 16% (w/v), GSHE fermentations produce 5% (w/v). Therefore, using GSHE avoids concerns with substrate inhibition and permits higher solid slurries. Accordingly, fermenting at higher solids produces higher ethanol concentrations and causes earlier onset of ethanol inhibition. For example, after 24 hr, 25% solids fermentations will produce about 9% (v/v) ethanol while 40% solids fermentation will produce about 14% (v/v) ethanol. In situ removal of ethanol, using technologies such as vacuum distillation, could improve yeast productivity and conversion to ethanol by delaying ethanol inhibition. A bench scale vacuum distillation and fermentation system was constructed and applied to fermentations using GSHE at 30 (control), 40 and 50% (w/w) solids. Slurries at 40 and 50% solids were prepared with 38 and 61% less water, respectively, than control. Vacuum cycling was applied at 50 mmHg for 0.5 hr at 12, 18, 24, 36 and 48 hr; runs were considered complete at 72 hr. Without vacuum treatment, 40 and 50% GSHE fermentations showed effects of ethanol inhibition, characterized by a gradual increase in glucose concentration. Whole stillage produced from the higher solids beer could reduce dewatering requirements.

Pilot scale fiber separation from distillers dried grains with solubles (DDGS) using sieving and air classification

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Cereal Foods World 53:A40

Distillers dried grains with solubles (DDGS) is the coproduct from fuel ethanol production from corn and other cereal grains such as wheat using the dry grind process. DDGS is mainly used as cattle feed and is used at low inclusion levels in poultry and swine diets because of high fiber content. The increase in DDGS supply due to the rapid growth in U.S. fuel ethanol production has resulted in a need for opening up of new markets for DDGS. Recently, Elusieve process, the combination of sieving and air classification (elutriation), was developed in lab scale to separate fiber from DDGS and produce two valuable products: 1. enhanced DDGS with lower fiber and higher protein and fat contents, and 2. Elusieve fiber. In this study, a pilot plant was assembled to evaluate fiber separation from DDGS on a continuous basis using commercial sifter and aspirators. A rectangular rotary sifter (Model 484, Gump, Savannah, GA) with a sieving area of 1.8 m2 (19 ft2) per deck and consisting of 3 decks for stack sieving was used to produce 4 size fractions. The 3 largest size fractions were air classified using 3 multi aspirators (Model 6DT8 2, Kice, Wichita, KS), which were equipped with rotary air-lock valves in the cyclone outlet to enable continuous operation. Commercial DDGS was fed at a rate of 0.25 kg/s (1 ton/hr). The screens used for this DDGS were 16M, 24M and 34M, with openings of 1184, 868 and 582 μm, respectively. In the first trial, air velocities in the aspirators were adjusted, by changing the position of the air outlet damper, to obtain 5% weight yields of lighter fraction from each size fraction. The neutral detergent fiber (NDF) content (db) of the lighter fractions varied from 52 to 55%. In the second trial, the air velocities were adjusted to obtain 15 to 25% weight yields of lighter fraction. The NDF content (db) of the lighter fractions varied from 43 to 51%. Trends in NDF, protein and fat contents of fractions were similar to those found in earlier lab scale studies. Elusieve operation for fiber separation from DDGS on a continuous basis was demonstrated in pilot scale as a step towards its plant scale implementation.

Extrusion of high fiber cereals using bamboo, wheat bran, or resistant starch: Comparison of morphology using microscopy and X-ray tomography

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Creating high fiber cereals with desirable organoleptic properties is challenging because the inclusion of high levels of fiber decreases expansion, resulting in a harder, less acceptable product with decreased bowl life. In this experiment, high fiber corn cereals were created with bamboo fiber, wheat bran, type 4 resistant starch and compared to a control sample produced with 100% corn grits. Bamboo fiber and wheat bran had the largest affect on reduced expansion, while the resistant starch had the least impact as shown by expansion index and texture profile analysis for the dry product and bowl life tests with milk. To investigate the fine structure of the cereals, corn puffs were sectioned, stained and examined using microscopy. Samples were also studied using X-ray tomography. Cross polarized images of the bamboo and wheat bran fibers clearly show these fibers (with a high aspect ratio) align linearly along the cell walls, which may explain the decreased expansion. Resistant starch micrographs show the starch as a round particle, in some cases partially gelatinized, confirming the lessened impact on expansion with the ability to contribute to structural support of expansion. No alignment along the cell wall was observed for resistant starch. X-ray tomography shows a three dimensional representation of density and air cell size. In contrast to resistant starch samples, corn puffs with bamboo and wheat bran were shown to have smaller air cells resulting from the reinforcing nature of the fibers in preventing further air expansion. These results demonstrate the morphology of particular fibers under extrusion conditions have a significant impact on expansion and texture. Moreover microscopy and X-ray tomography are viable techniques to elucidate the fine structure of extrusion products, providing information to optimize textural properties of high fiber cereals.

Extrusion cooking improves the nutritional characteristics of ready-to-eat expanded products

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Extrusion cooking is a continuous and versatile process. It is low cost and a very efficient technology in food processing where the raw materials undergo many chemical and structural transformations. Two different by-products from the food process industry, brewer's spent grain (BSG) and red cabbage (RC) were dried to a moisture content of 5–7% and incorporated at a level of 10% into samples containing wheat flour and corn starch. Four different samples were made: wheat flour +BSG (WBSG), corn starch +BSG (CBSG), wheat flour + RC (WRC) and corn starch + RC (CRC). These samples were processed in a Werner and Pfleiderer Continua 37 co-rotating twin-screw extruder with the process conditions as follows: feed rate 25 kg/h, water feed 12%, screw speed of 200 rpm and two barrel temperatures were utilized as 800C at feed entry and 1200C at die exit. Pressure, material temperature and torque were monitored during extrusion runs. The effect of BSG and RC and extrusion cooking on nutritional properties (dietary fibre (DF), total phenolic compounds (TPC) and total antioxidant capacity (TAC)) of final products were studied. BSG and RC significantly ($P < 0.0001$) increased the level of dietary fibre. The results showed that extruded WBSG samples gave higher levels of dietary fibre than samples containing CBSG while WRC displayed lower levels than CRC. Extrusion cooking significantly ($P < 0.001$) increased the level of dietary fibre in samples prepared with BSG probably as a result of forming resistant starch but significantly ($P < 0.001$) decreased the level of dietary fibre in samples containing RC due to the change of insoluble to soluble fibre. Furthermore, extrusion cooking significantly ($P < 0.001$) increased the level of TPC and TAC in samples containing WRC and CRC, which seems a normal consequence of the high temperature, water-stress and wounding. Extrusion cooking did not change the level of TPC and TAC in sample of WBSG while decreased their level in samples of CBSG. This study clearly showed that extrusion cooking could improve the nutritional quality of expanded ready-to-eat products.

The many facets of the molecular interactions and mechanisms involved in carbohydrate recognition and processing by barley alpha-amylase

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Starch mobilisation and seed germination are very important processes in cereals. alpha-Amylases (EC. 3.2.1.1) catalyze hydrolysis of internal 1,4-alpha-glucosidic linkages in starch and related oligo- and polysaccharides. Structures of barley alpha-amylase 1 (AMY1) and its inactive catalytic nucleophile mutant D180A AMY1 in complex with substrate and substrate analogues uncovered two secondary sugar binding sites (SBS1 and SBS2) besides the substrate binding cleft [1,2]. SBS1 on the catalytic domain contains Trp278 and Trp279 stacking onto adjacent ligand sugar rings. SBS2 on in the non-catalytic remote C-terminal domain is also called "a pair of sugar tongs" because the conserved Tyr380 swings to catch the sugar ligand. Surface plasmon resonance showed 7-fold increase in Kd for beta-cyclodextrin binding to the Y380A mutant which also did not accommodate the pseudotetrasaccharide acarbose at SBS2 in the crystal structure [3]. The joint action of barley alpha-amylase SBS1 and SBS2 with the substrate binding cleft in hydrolysis of starch is investigated using a series of double mutants at subsite –6 (Tyr105), SBS1 (Trp278 and Trp279), and SBS2 (Tyr380) showing a role of SBS2 in multiple attack hydrolysis of amylose. SBS1 is far more important in binding and attack on starch granules while SBS2 has stronger oligosaccharide affinity. The dual SBS1 and SBS2 mutants lost ability to adsorb onto barley starch granules. Moreover, the affinity of AMY1 was found to depend on the botanical source, genotype and ratio between amylose and amylopectin of the starch granules. AMY1 showed highest affinity for waxy-type starch and the lowaffinity for high amylose maize starch granules. The affinity to starch granules will be further analysed for surface site mutants using also confocal laser scanning microcopy. Remarkable differences were found between SBS2 in barley alpha-amylase 1 and 2 consituting the minor isozyme and the predominant isozyme in germinating seeds [4]. [1] X. Robert et al., Structure 11, 973 (2003). [2] X. Robert et al., J. Biol. Chem. 280, 32968 (2005). [3] S. Bozonnet et al., FEBS J. 274, 5055 (2007). [4] K.S. Bak-Jensen et al., FEBS J. 274, 2552 (2007). This work was supported by the EU FP5 project CEGLYC (QLK3-CT-2001-00149), the Danish Natural Science Research Council, a Ph.D. stipend from DTU (MMN) and a H.C. Ørsted postdoctoral fellowship from DTU (ESS).

Detection and measurement of green seeds in barley samples using colour imaging and hyperspectral imaging

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Green seeds in barley are often immature and small, as the result of late maturing heads or environmental effects that stop growth and maturation prematurely. These green seeds are often a bright green which makes them visually distinct and identifiable by visual inspection. Environmental effects that prevent the entire field of barley from fully maturing may leave a residual of chlorophyll is all the kernels. These kernels may not appear as 'grass green', yet their colour is darkened and germination vigour reduced. Grass green seeds can be detected and counted using an imaging system based on a flat bed document scanner, thus removing the need for tedious visual inspection. This system has low sensitivity to immature green seeds. A method has been developed using a hyper-spectral system (400–1000 nm) that can directly detect the chlorophyll absorption band around 680 nm. A method has been developed that can segment the green seeds from the healthy seeds, even when there is no clear visual evidence of greenness to the inspector. We are currently developing models to predict the greenness of individual seeds. Green seeds not only reduce the visual quality of malting barley samples, they also reduce malt quality by producing high levels of soluble protein that can lead to unacceptable beer colour and hazes in the final product.

Total phenols and antioxidant capacity of bulgur

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Bulgur is a traditional, pre-gelatinized, and rice-like durum wheat product that is widely consumed in Turkey and Middle East countries. Although the available literature on bulgur is mainly focused on the technological aspects, bulgur as a whole-wheat product deserves particular attention for its potential health improving properties. In the scope of this study, the proximate composition, starch, resistant starch, dietary fiber, total phenolics, and anti-oxidant activity of bulgur were analyzed using five commercial bulgur samples produced by different manufacturers in Turkey. The moisture, protein and ash contents of bulgur samples were found to be in the range of 11,1–13,8%, 9,3–11,1% (in dry matter) and 0,70–1,19%, respectively. The amount of total phenolics of bulgur samples was determined using Folin-ciocalteu method. The amount of phenolics varied between 13,25 and 20,20 mg gallic acid per 100 grams of dry matter in all samples. In addition, total antioxidant activity was determined using ABTS radical scavenging activity method. The hydrophilic antioxidant activity of bulgur samples was found between 216,09 and 308,23 mmol TEAC/100 g dry matter for the samples, while lipophilic activity was between 89,63 and 250,07 mmol TEAC/100 g dry matter. The results indicate that bulgur has significant amount of functional components and therefore, represent the great potential as a healthy whole-wheat product.

An analysis of ICARDA lentil mini core collection for variation in soluble carbohydrates

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The quality of lentils and its consumption in human and animal nutrition is affected by the presence of high quantities of raffinose family of Oligosaccharides (RFO). It is widely believed that lentil consumption can be increased by developing low RFO cultivars. To find natural variation in RFO concentration in lentils we studied the variability in the concentration of lentil seed soluble carbohydrates. ICARDA lentil mini core collection comprising 122 domesticated and 46 wild lentil genotypes were grown in two environments in Saskatchewan, Canada over two years and the concentration of soluble carbohydrates (glucose, sucrose and raffinose family oligosaccharides) was determined. Significant variation in soluble carbohydrates concentration among domesticated and wild genotypes was observed. Glucose concentration of domesticated lentil genotypes ranged from 0.01 – 0.96 mmole /100 g lentil meal, sucrose concentration ranged from 1.32 – 7.79 mmoles /100 g lentil meal and total raffinose family oligosaccharides concentration ranged from 3.75 – 6.06 mmoles/100 g lentil meal respectively. For wild lentil genotypes the concentration of glucose, sucrose and total RFO were 0.08 – 0.91 mmoles/100 g, 0.44 – 4.88 mmoles/100 g and 1.71 – 5.28 mmoles/100 g lentil meal respectively. Variation observed in lentil genotypes in this study may be used in the development of low RFO lentil cultivars in the future.

Structure and properties of Poly (vinyl alcohol)/starch/clay nanocomposite films

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Research on bio-based packaging materials has been stimulated due to environment concerns and scarcity of petroleum-based natural resources. In this study, a series of Poly (vinyl alcohol)(PVOH)/starch/clay nanocomposite films were cast by the solvent method. X-ray diffraction (XRD), mechanical, moisture barrier property studies of the composite films were carried out. The XRD study of the composite structures revealed that well exfoliated clay layers existed in all the nanocomposite films. The addition of nanoclay (6%) improved the barrier properties of the composite films, but caused a significant decrease of elongation at break. With the increase of starch concentration (from 0 to 47%), there was a slight decrease in water vapor permeability and tensile strength. However, elongation at break decreased from 210% to 107%. The effect of various molecular weight of PVOH (provided by the manufacturer) on the properties of nanocomposite films was also explored. Molecular weight of PVOH significantly affected the mechanical properties of the nanocomposite films. With increased molecular weight, the degree of polymerization and viscosity of PVOH, which led to higher elongation and tensile strength. As a summary, nanocomposites based on combinations of PVOH, starch and nanoclay can be used for low cost, commercial-grade biodegradable packaging films because of good mechanical and oxygen barrier properties of PVOH, low cost of starch and the potential of achieving good water vapor barrier properties due to nanoclay.

Storage studies of nutritional qualities of wheat flours as influenced by different processing methods of wheat flours: Antinutritional, biochemical, microbiological attributes

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Cereal Foods World 53:A42

Comparative storage behavior of wheat flours were studied during the three months of May to July. Flour was prepared by grinding wheat grains of the same variety by roller flour milling (FM) and chakki milling (Cki), packed in polypropylene woven bags and stored at ambient temperature and relative humidity at Peshawar. The wheat flour samples were analyzed for different quality parameters in the beginning and at monthly intervals. Proximate composition was determined only in the beginning. Phytic acid contents were determined calorimetrically using 2, 2-bipyridine as a coloring reagent. Phytic acid, contents were found higher in Cki-flour than FM flour and significant differences ($P < 0.01$) were observed between the Phytic acid contents of the two types of flour. The Phytic acid contents of unleavened FM, leavened FM, unleavened Chakki and leavened Chakki bread (chappaties) were 0.3%, 0.24%, 0.44% and 0.26% respectively, A significant decrease of phytate content was noticed in both types of breads (leavened and unleavened) when compared to its corresponding wheat flours. Leavening and cooking in both types of flours resulted in significant ($P < 0.01$) reduction in the phytic acid content of the resultant bread due to a greater percentage of Phytic acid was hydrolyzed. The iron contents found higher in Cki flour (79.65 ppm) than in FM flour (36.56 ppm). The differences were statistically significant ($P < 0.01$). Iron contents during storage intervals did not change significantly. The phosphorus contents of both types of flours are 1804 ppm and 2736 ppm. The storage had non significant effect on phosphorous contents of both flour. Available carbohydrates were higher in FM flour and did not change significantly during storage. Initially the Peroxide Value (POV) of FM flour and Chakki flour were 1.15 and 1.37 meq/Kg respectively. There was no significant difference between two types of flours, but the POV values increased significantly ($P < 0.05$) during the whole storage period due to increase storage temperature and exposure to light and as a result it becomes a cause of rancidity. The pH of two types of flours showed no significant difference. However, the average value decreased from 7.35% to 6.72% during 3 months. Total fungal count increased from 0 to 7.47E+04 in 3 months, however, differences in the two types of flour were non-significant. Protein solubility was higher in FM flour than the Cki flour and storage had no effect on this value. The average value for Gluten content remained almost unchanged for 2 months but decreased significantly in the 3rd month. The storage of wheat flour at ambient conditions is prone to fungal growth and various biochemical changes, and may not be advisable for consumption for longer than one month, specifically in the hot and humid months of summer. Results of both types of flour were comparable and no specific difference in the storage behavior was noted. It is recommended that the wheat flour should be stored at lower temperature with careful consideration given to the moisture content of the storage atmosphere and the type of package used to store the flour. This study also reveals that the effective fermentation (leavening) would increase bioavailability of minerals in whole wheat flour breads.

Characterization of pre-cooked split and whole dry edible pea flours

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Legumes are rich in terms of lipoxygenase, lipase enzymes and anti-nutritional compounds such as trypsin inhibitors. Cooking is applied to legumes in order to enhance shelf life and improve the chemical attributes of legumes. Precooked split and whole edible pea flours can be utilized as alternative ingredients in the food industry. The objectives of this study are i-) to develop and characterize roasted yellow and green pea flour, ii-) to characterize and evaluate the effects of roasting on physical, chemical, nutritional, microbiological and rheological attributes of pea flour. Green and yellow split and whole dry edible peas were used. Hydrothermal treatment was applied as a tool for pre-cooked flour process. Pea samples were soaked in water (60°C) for 30 min. Then soaked peas were roasted at 170°C for 12.5 min. Cooled peas were milled with Fitzmill- at 7200 RPM mill speed and 25 RPM feed screw speed. Moisture, protein, starch, color, RVA, aerobic plate count, mold & yeast and protein dispersibility index experiments were conducted. Roasting process significantly ($P < 0.05$) decreased moisture content and test weight scores of all samples. Roasting process decreased brightness scores of whole peas, whereas slightly increased for split peas. Redness scores for yellow peas did not change significantly, whereas greenness scores decreased significantly ($P < 0.05$) in green peas due to roasting process. Roasting decreased ($P < 0.05$) particle size for whole yellow, whole green and split green pea samples, whereas roasted split yellow peas had similar results with control yellow split pea. Roasting significantly ($P < 0.05$) decreased moisture content of pea samples. Roasting process increased starch content for split green, split yellow and whole yellow pea samples. This phenomenon might be due to resistant starch formation due to hydrothermal treatment. Soaking and roasting gelatinized starch in all pea samples. Roasting decreased ($P < 0.05$) peak viscosity, hot paste viscosity, final viscosity and setback scores. Roasting significantly ($P < 0.05$) reduced aerobic plate count and mold & yeast scores of all pea flour samples. Precooking process showed impact on pea flour quality which can enhance pea flour utilization in food systems.

Microbial bioconversion of fiber present in distillers' grain (DG) to single cell protein

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Enhancement of the Distiller's grain (DG) protein content creates value-addition and positions the animal feed product in a premium market segment. DG has about 7 to 10% fiber on dry basis, which can be converted to single-cell-protein using microbes with cellulolytic activity. In this project, eleven ATCC cultures with known cellulolytic activity and isolates from corn fields, corn stem and stalk were screened for cellulolytic activity and were evaluated for fiber utilization activity at shake flask and 2 L fermentor level. The effect of nitrogen source, phosphorous and optimum pH for successful fiber bioconversion was evaluated. Among the ATCC cultures, Aspergillus oryzae exhibited significant fiber utilization with protein enhancement after four days of incubation. Among the wild isolates, a new culture identified belonging to Bacillus sp. exhibited superior fiber utilization capability and productivity with accompanying protein increase. The presentation will discuss the significant increase in true protein and true soluble protein with concomitant reduction in neutral detergent fiber (NDF) and acid detergent fiber (ADF). Successful outcome of this project will enable a protein enhanced animal feed product.

Rheological properties of wheat flour dough and their relation with bread volume: Creep-recovery and dynamic oscillation measurements

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The rheological properties of seventeen pure European wheat cultivars were analyzed and evaluated in relation to the bread volume. Rheological testing included two empirical rheological methods, farinograph and alveograph, besides more fundamental rheological methods, more specifically creep-recovery and dynamic oscillation measurements. All rheological methods revealed large differences in dough rheological properties among the 17 wheat cultivars. Creep-recovery and dynamic oscillation parameters significantly correlated with protein content, Zeleny sedimentation value and farinograph

water absorption. Creep-recovery and dynamic oscillation parameters were strongly correlated. A non-linear relationship (power; $r^2 > 0.9$) between the maximum creep or recovery strain and the dynamic moduli was found and this at both shear stresses (100 and 250 Pa). Phase angle delta showed a positive relationship with the maximum creep or recovery strain ($r^2 = 0.9$). The dynamic oscillation parameters showed the highest correlations with bread volume. Phase angle delta could explain almost 70% of the variance in bread volume among the wheat cultivars. The dynamic moduli showed an inverse relationship with the bread volume. A non-linear relationship with the bread volume could be established for G' ($r^2 = 0.75$), G" ($r^2 = 0.72$) and |G*| ($r^2 = 0.74$). For the creep-recovery parameters, the highest correlation with bread volume was found for the maximum recovery strain at a shear stress of 250 Pa ($r = 0.79$).

Physical dough tests; why do they work, but not perfect

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2008 Brabender Award

There are two aspects to answering the question about the value for physical dough testing of the extensigraph and alveograph. Firstly which dough parameters are determined by these tests and secondly which physical dough parameters give a good indication of its bread baking performance. Good quality bread must have a high volume and in many countries a fine, regular crumb structure. During mixing a large number of small gas cells are incorporated in the dough of which only a part will form the final dough structure. An important physical mechanism determining the number of gas nuclei that grow out to gas cells is Ostwald ripening, causing the growth of larger gas cells at the cost of smaller ones. Moreover, a regular crumb structure is only obtained if gas cells grow at roughly equal speeds during proofing. Interfacial properties of the gas cells are probably the main factor determining Ostwald ripening during the first part of the fermentation stage. During later stages of dough development bulk rheological properties become of primary importance both with respect to Ostwald ripening and equal growth of gas cells. These are the relative increase in resistance to deformation with increasing deformation of the dough around growing gas cells (extent of strain hardening) and the resistance to deformation. Higher values are beneficial since they help to stop Ostwald ripening and lead to equal growth of gas cells. Coalescence of gas cells due to rupture of the dough film is the main instability mechanism at the end of the proofing stage and during baking. The stability against it is primarily determined by bulk rheological properties as strain hardening and rupture strain. During baking the change in these properties with increasing temperature is expected to be a factor determining the transition from a foam to a sponge structure. Both the extensigraph and alveograph provide information on the required bulk rheological properties. Drawbacks of both instruments are the high applied deformation speeds of the dough compared with those in bread dough during baking. The extensigraph has the added disadvantage that the deformation applied is uniaxial whereas around growing gas cells biaxial deformation is dominant. Moreover, measurements can only be performed at room temperature. In spite of it both instruments provide a good first estimate of baking quality of a dough for standardized conditions. However, for getting a profound understanding of dough properties determining baking quality a combination of better defined physical tests and chemical ones is essential.

Baking quality improvement of flour milled from aged wheat

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Cereal Foods World 53:A43

Two Canada Western Red Spring (CWRS) wheat samples stored for about five years at the North region and the South region of China were analyzed for composition, dough rheological properties and baking quality against a sample of CWRS wheat harvested during the current crop year. The aged wheat from the North region showed good bread-making performance. Longer mixing time, very pale bread crust colour and small loaf volume were identified as the primary deficiencies in the overall quality of bread baked from the flour milled from the aged wheat from the South region. The longer mixing time of the aged wheat sample resulted from longer gluten hydration and development time indicating slow water/gluten penetration and lack of gluten cohesiveness. The pale crust could be due to its extremely low alpha-amylase activity. The small loaf volume might be attributed to its more elastic but less extensible gluten properties, and also the extremely low alpha-amylase activity. From the results, we selected the poor performing sample from the South region to explore possible additive corrections. The aged wheat flour was treated with ascorbic acid, L-cysteine, alpha-amylase and xylanase, and baked against the flour milled from the fresh wheat. The addition of L-cysteine was successful in reducing excessive dough mixing time. Adding alpha-amylase improved proof height and bread crust colour to some extent but not oven spring. The addition of xylanase to the aged wheat flour increased dough extensibility, oven spring and loaf volume more than a similar addition to the fresh wheat flour. By selecting the correct treatment levels it was possible for the aged wheat sample to perform more closely to the fresh wheat sample. As the alpha-amylase activity of the aged wheat from the South region was found to be extremely low, we postulated that the endogenous xylanase activity in the aged wheat might also decrease under the long term storage, especially in the conditions of high temperature and high humidity. Adding xylanase would compensate for the deficiency in the endogenous xylanase activity in the aged wheat. The results from this study can provide flour millers and commercial bakers with valuable information to better understand the baking quality of aged wheat and recommend ways to improve its baking quality.

Genetic and environmental effects on flour pentosan content in relationship to farinograph absorption

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Baking absorption as measured objectively by farinograph absorption is one of the most important breadmaking quality properties of wheat flour. The nature of farinograph absorption, particularly as it relates to flour pentosan content, protein content and starch damage, was studied in the context of genotype and environmental influences. Six adapted genotypes of western Canadian hard spring wheats, were grown in replicated field trials at different locations across the Canadian prairies in two years, providing nine site-years of wheat samples for analysis. In addition to determination of sample properties such as grade, bulk density and thousand kernel weight, following milling to approximately 74% extraction on average, flour was analyzed for numerous quality factors including protein, starch damage, total pentosan content, dough rheological properties and loaf volume. A highly significant genotypic effect was observed for pentosan content, but no significant environmental effect was found in contrast to most breadmaking quality parameters where environment effects were considerable. Total pentosan content was the most important factor explaining farinograph absorption variation, whereas flour protein was not significant. Depending on the quality of samples as reflected by milling grade, correlations between farinograph absorption and various independent variables were as follows: pentosan content ($r = 0.77–0.82$); starch damage ($r = 0.25–0.38$); flour protein ($r = 0.11–0.21$) and thousand kernel weight ($r = 0.34–0.65$). These results warrant special attention by wheat breeders as they indicate that farinograph absorption is amenable to genetic manipulation by screening wheat or flour for total pentosan content using available small-scale tests in early generations.

Impact of temperature and carbon dioxide on the quality of rice

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The impacts of global warming and climate change on rice have featured strongly in both scientific literature and the media. Previous research has generally focused on the impact of climate change on yield with information on rice quality being neglected. Given that grain quality drives the both the global and local marketplace, it is important that some emphasis should also be placed on the affects of climate change on rice grain quality. In this study four rice varieties were grown in four controlled environments: ambient (380 ppm) and elevated (780 ppm) carbon dioxide levels, and during the reproductive stage each carbon dioxide group was further divided into two temperature regimes, 25/19°C or 30/20°C (day/night temperatures). Overall temperature was the dominating climatic feature driving down the amylose content in Wx^b varieties, and the high nitrogen fertilization rate skewed the overall ratio of amylose and amylopectin. Changes in the structure of starch were matched by changes in functional qualities. The viscosity curve parameters of immediate retrogradation and setback decreased with temperature but remained unchanged by the carbon dioxide level. The physical dimensions and weight of the grains remained unchanged with environmental treatment however less chalk was observed in elevated carbon dioxide levels. Overall it is clear that temperatures during the reproductive stage have the dominant affect on rice grain quality and increased carbon dioxide levels do very little to ameliorate those negative effects.

Instant noodles: The impact of processing variables on the quality attributes

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Instant noodles are the fastest growing sector in the noodle industry and have gained popularity amongst western countries due to the convenience of fast preparation, desired flavour and texture. The aim of this study has been to evaluate the quality of instant noodles processed using varying conditions including mixing time (1–5 min), resting time (0–30 min) and the steaming time (2–4 min) as well as the number of folding steps used during the sheeting process (0–4 times). Resting times were investigated at two stages of the process, after the first sheeting through the largest roll gap of the noodle maker and after the final sheeting of the dough sheet. Instant noodle quality attributes assessed include noodle colour measured using the Minolta Chromameter (CR-100) and noodle texture assessed by texture analyser (TA-XT2). The experimental design and statistical evaluation involved response surface methodology (RSM) following second order central composite face centered design (Design Expert version 7.1). It was found that mixing and resting times did not impact noodle colour significantly, however noodle texture (hardness) was significantly and negatively correlated with mixing time. Brightness (Minolta *L** values) of instant noodles was significantly affected by steaming time and the number of folds during the processing. Increasing both steaming time and number of folds resulted in enhanced brightness of the final product. While hardness was not significantly influenced by varying the steaming time or the number of folding steps, steaming time was significantly and positively correlated with the yellowness (Minolta *b** values) of the noodles.

Effects of elevated atmospheric carbon dioxide concentrations on the quantitative protein composition of wheat grain

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Cereal Foods World 53:A44

The concentration of carbon dioxide in ambient air has continuously increased since the beginning of industrialization and is expected to reach 480 - 550 uL/L air from a current value of 385 uL/L by the middle of this century. Studies on wheat have shown that grain yield and starch content increase under carbon dioxide enriched air, whereas thousand kernel weight and total protein content decrease. The aim of the present work was to study the quantitative changes of protein composition in more detail. Winter wheat "Batis" was grown under ambient air (385 uL CO_2/L) and under free-air CO_2 enrichment (FACE, 550 uL/L) and was supplied either with adequate (N+) or reduced (N-) nitrogen fertilizer. Mature kernels were milled into white flour and analyzed for the contents of crude protein, Osborne fractions, single gluten protein types and glutenin macropolymer. The results demonstrated that the increased carbon dioxide concentration induced a significant loss of crude protein and all protein fractions and types except albumins and globulins. These effects were more pronounced in samples supplied with higher amounts of nitrogen fertilizer. Crude protein was reduced by 9% (N-) and 14% (N+), gliadins by 13 and 20%, glutenins by 15 and 15%, and glutenin macropolymer by 16 and 19%, respectively. Within gliadins, omega5- and omega1,2-gliadins were more affected than alfa- and gamma-gliadins, and within glutenins, HMW subunits were more affected than LMW subunits. According to the close relationship between protein content and bread making quality, enriched carbon dioxide concentration will cause a serious impairment of dough and bread quality.

The joint AACC International - ICC methods harmonization project

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Cereal Foods World 53:A44

Analytical chemistry was the basis of the formation of both the American Association of Cereal Chemists (AACC International as it is now named), and the International Association for Cereal Science and Technology (ICC). Both the AACC International and ICC have developed independent compendia of analytical methods for application to cereals and their products, and both associations have rigorous procedures for the approval of new, and of modifications to existing methods. To improve global communication, to avoid duplication of efforts, and to avoid confusion of users of the methods of both organizations, in 2003 the two associations agreed to initialize a harmonization process. At meetings held at AACC International Annual conventions, starting that year, it was decided that nine methods should be standardized. The development of coordinating the methods involved: a) identifying areas of the individual methods where changes were needed that would make the methods acceptable to all cereal laboratories, and b) making suggestions for the possible changes. The methods included ash content by incineration, Falling Number, Gluten Index (mechanical), moisture by air oven, protein content by Kjeldahl, Dumas (combustion) and Near-infrared Spectroscopy methods, wet gluten (mechanical), and the Zeleny Sedimentation test. The paper describes the methods that were addressed, and the main suggestions made for changes. It will also discuss possible methods for incorporation of the harmonized methods into the method compendia of both organizations.

Wheat Bran: By product or bioactive?

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Cereal Foods World 53:A44

Wholegrains have been linked to many health benefits including protection against cancer, cardiovascular disease, diabetes and obesity. Wholegrain wheat and several of its layers including the endosperm, pericarp and aleurone were studied for antioxidant activity and glycemic index lowering effects. High antioxidant activity was found in the bran layers. Since seventy-five percent of the phytonutrients in wholegrain wheat are contained in the bran, further bioassay guided fractionation was employed to identify active constituents. Unsaturated fatty acids oleic (C18:1), linoleic (C18:2) and linolenic (C18:3) acids were the main compounds present in the active fractions of wheat bran with ORAC values of 2424, 5542 and 5220 µmol Trolox equivalents (TE) per gram of extract respectively. This study then investigated eight crude wheat bran extracts from commercial soft, durum and allied wheat varieties for biological activity in antioxidant and enzyme inhibition assays as well as a broader range of *in vitro* assays including anti-inflammatory, anti-cancer, estrogen binding ability, immune function and cholesterol lowering. Wheat bran was found to be a highly nutritious by product of the milling industry with many health benefits resulting from its high antioxidant and other associated benefits. Further studies to investigate more compounds present in wheat bran responsible for this activity is warranted.

Stability to food processing conditions of cross-linked RS-4 type resistant wheat starches

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Cross-linked resistant wheat starch products are commercially produced and available as an ingredient for low glycemic, high fiber, and low caloric foods. These products are produced by reacting wheat starch with a mixture of sodium trimetaphosphate and sodium tripolyphosphate. The food-grade resistant wheat starches belong to RS4 category and chemically classified as phosphated distarch phosphate. Food processing, such as conventional cooking, autoclaving, extrusion, homogenization or pasteurization often involves changes in structural and functional properties of food ingredients and affects final quality of food products. Effects of typical food processing conditions on cross-linked resistant wheat were evaluated for alpha-amylase resistance by AOAC Method 991.43, morphology by scanning electron microscopy, freeze-thaw stability by the amount of water separated after centrifugation, and storage stability by the retrogradation enthalpy using a differential scanning calorimeter (DSC). Cross-linked resistant wheat starches showed excellent stability during conventional cooking, autoclaving, extrusion, dry heating, homogenization or pasteurization. Up to two weeks of extended storage after conventional cooking, the cross-linked resistant wheat starches were shown to be stable as evidenced by the disappearance of major retrogradation peak measured by DSC. In repeated cycles of freezing and thawing after conventional and pressure cooking, cross-linked resistant wheat starches lost not more than 10% of water. Along with health benefits of high dietary fiber, reduced calorie, and controlled glycemic and insulin responses, the process stability of the cross-linked resistant wheat starches provide additional benefits in formulation and final product qualities of numerous leavened and unleavened bakery products, processed foods, confectioneries, and frozen food products.

Effect of heating kernel on viscosity properties of oat flours

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Cereal Foods World 53:A44

The oat (Avena Nuda) kernel was milled into four components such as bran, shorts, bran flour and flour after air-heating at 140°, 155°, 170° and after far-infrared heating at 200°, 220°, 240° respectively. The viscosity properties of bran flour, flour and whole flour (mixing bran flour and flour according natural milling ratio) were investigated. The results showed that, comparing

with no heat-treatment, the pasting temperature of bran flour, flour and whole flour with heating were lower; and the peak viscosity, final viscosity and hold viscosity of all bran flour, flour and whole flour under air-heating (140°,155°), or under far-infrared heating (200°), were higher. The peak viscosity, final viscosity and hold viscosity of all bran flour, flour and whole flour under air-heating (170°) were lower than those under air-heating (140°), similarly under far-infrared heating (220°) were lower than under far-infrared heating (200°). Suitable heating treatments can decrease the pasting temperature and the peak viscosity of the whole flours. Keywords: oat (Avena Nuda), oat flour, heat-treatment, viscosity properties.

Starch Blocklets: A Review

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Cereal Foods World 53:A45

A blocklet model has been proposed by starch scientists in the last 10 years. The starch granule is considered to be largely amylopectin-based blocklets, which range in diameter from 20–500 nm depending on starch botanical type and their location in the granule. Blocklet distribution is continuous throughout the granule. Literature attempts to suggest that a single macromolecular super helix is identical to the unit of blocklet. The constitution of blocklet is also thought to be association or clustering of amylopectin helixes. The more-crystalline blocklets appear as hard objects immersed in a swollen amorphous largely amylose-based matrix. The matrix in which the blocklets are embedded may contain a harder network structure. It is proposed that the harder structure may be due to the presence of a partially crystalline amylose network. Often root B-type starches have larger blocklets than cereal A-type starches. High amylose starches have larger blocklets than waxy starches. Observation of starch blocklets in native starches requires high-resolution method. Atomic force microscopy (AFM) provides direct spatial mapping of surface topography and surface heterogeneity with nanometer resolution (down to 10 nm). AFM and Scanning Electron Microscopy (SEM) experiments were performed for the mainstream native granular food starches, such as waxy maize and potato starches. The ellipsoidal starch blocklets in dominant amount in granules have been visualized. It is evident that starch blocklets are subunits of the native granules. Lots of properties of starch material depend on size and internal structure. Nano-submicron particles already attract interests in food and industries. Starch blocklets, if releasable, would be promising for many new applications.

The color advantage of Chinese white wheat and the analysis of color formation factors

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Cereal Foods World 53:A45

AW white wheat imported from Australia and Jimai 21 white wheat vastly planted in Shandong Province of China were chosen as contrasts to investigate the color advantage of four white wheat cultivars (lines) (Youmai3, Shannong12, Shannong8355, and 62008) and the color formation factors for breeding of high whiteness traits of different wheat genotypes. The results showed that both brightness and yellowness of the four wheat cultivars (lines) were lower than those of AW white wheat, however the appearance color of steamed bread made from 62008 and Shannong12 was better than that of AW white wheat. By adding BPO, the flour color change showed the four wheat cultivars (lines) were smaller than AW white wheat. The analysis of four white wheat cultivars (line) showed that there were low PPO activity and low yellow pigment content for the high-protein content wheat varieties, and high starch content for the low-protein content varieties. Therefore, the wheat cultivars with low PPO activity and yellow pigment content and high protein content would be good for steamed bread and white noodles. The wheat cultivars with low protein content and high starch content could also be good because of their low PPO activity and yellow pigment content. Some special wheat lines with low PPO activity and high yellow pigment content could be chosen to make bright and yellow foods.

Physical and biochemical properties of high amylose – soy protein concentrate extrudates

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Mechanical and microstructural properties of expanded extrudates, prepared from blends of high amylose corn starch and soy protein concentrate, were studied in relation to the biochemical changes in starch. The effects of screw speed (230 and 330 rpm) and soy protein concentrate (SPC) level (0, 5, 10, 15, 20%) on expansion and mechanical properties were determined, and results were compared with a previous study that utilized normal corn starch as the base. Molecular weight changes of the extruded high amylose starch were determined by gel permeation chromatography (GPC). X-ray microtomography scan was used to determine void fraction, average cell size distribution and average cell wall thickness of the extrudates. Extrudate microstructural characteristics were related to the overall expansion and mechanical strength of the extrudates. The expansion of high amylose corn starch alone was lower compared to normal corn starch. However, the addition of SPC did not cause any decrease in expansion ratio. Indeed, the expansion of high amylose corn starch-SPC blend was higher as compared to normal starch-SPC extrudates at 10–20% SPC levels. This suggested that different starches impact the expansion of soy protein-fortified extrudates differently. Results from this study will aid in developing expanded foods with high levels of soy protein and having desired textural properties.

2008 Annual Meeting
Abstracts of Poster Presentations

Abstracts submitted for poster presentations at the 2008 annual meeting in Honolulu, Hawaii, September 21–24. 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.

***In vitro* digestion using small intestinal brushborder saccharidases to determine the glycemic part of non-starch carbohydrates**

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Cereal Foods World 53:A46

Currently in carbohydrate research much emphasis is on carbohydrates (CHO) that give low glycemic responses after administration. Administration of a food with low glycemic CHO or non-glycemic CHO can result in a low glycemic response. According to the recommended classification of the FAO only glycemic CHO are digested and/or absorbed as CHO in the small intestine and thereby deliver CHO for metabolism, while non-glycemic CHO do not. In cases of malnutrition, for instance in malnourished diabetics, it is important that CHO gradually enter the blood stream as CHO and thereby deliver sufficient energy. With the emergence of (new) CHO not occurring regularly in the human diet, it is becoming more difficult to distinguish *in vitro* between glycemic and non-glycemic CHO. The digestion of CHO involves several enzymes of which most are expressed at the small intestinal brushborder. Studying the digestion of CHO *in vitro* using brushborder saccharidases (BBS) can therefore give insights on what part is potentially glycemic. Intestinal acetone powders from rat were extracted and incubated with maltose (MAL), trehalose (TRE), isomaltulose (ISO) and modified cornstarch maltodextrin (Fibersol-2 (F2)) at 37°C. After incubation the glucose was quantified using glucose-oxidase. In a pilot experiment MAL, TRE and ISO were hydrolyzed completely in 48 hrs under the used conditions and could therefore be completely glycemic when the BBS have enough time. The digestion of TRE and ISO was comparable, but more gradual than that of MAL. A lower digestion rate *in vivo* could result in a lower glycemic response of TRE compared to MAL. The glycemic response of ISO could be even lower, considering that each ISO molecule contains 1 glucose molecule, whereas TRE contains 2. F2 was only hydrolyzed for ca. 20%, which suggests that a low glycemic response of F2 would be due to large non-glycemic part and that F2 would therefore not contribute to deliver sufficient energy. In conclusion, by use of BBS the digestion characteristics of different types of CHO can be studied *in vitro*, which could be useful to select slowly but completely digestible CHO which are recommended for an optimal postprandial glucose control and to deliver sufficient energy.

Electrophoretic characterization of starch biosynthesis enzymes from blue maize

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Cereal Foods World 53:A46

Blue maize starch has been scarcely investigated. Some studies have shown that its morphological, structural and functional characteristics are different from those of white maize starch, which may be indicative of differences in their biosynthesis. Maize starch has two principal granule populations, named small and large granules, showing different structural characteristics. The aim of the present study was to carry out the electrophoretic characterization of the starch biosynthesis enzymes present in blue maize. White maize starch was used as a control. Starch granules were isolated and their two populations, large (> 10 µm) and small (1–9 µm) were separated. Starch biosynthesis enzymes were extracted from the granule preparations using diverse buffers and tensoactive agents, and submitted to 2D-PAGE. The electrophoretic pattern of proteins extracted from small and large granules were different. In all samples, the 2D-PAGE showed approximately 5 protein spots of 60 kDa protein (GBSSI) with p*I* range between 5 and 6; this is the predominant enzyme associated to starch granules. However, the 2D-PAGE of large granule proteins indicated a higher expression level than in small granules, a feature observed for both white and blue maize starches. The SBEII protein (90 kDa, pI 5-6) was observed in the electrophoresis gels of large granules of blue maize starch. This protein was found in lower concentration in 2D-PAGE of small granules. The SSSI protein (75 kDa, p*I* 5-6) was also visualized in this gel. Detection of both SBEII and SSSI in the 2D-PAGE of small granules was performed using SYPRO Ruby fluorescence. Comparison of the electrophoretic patterns of proteins extracted from the two granule populations from blue and white maize indicated different biosynthesis, which could explain the different morphological and physicochemical characteristics of both starches and suggests structural differences between large and small granule populations.

Effect of hydrolyzed gluten and microbial transglutaminase treatment on the interaction of myofibrillar protein and the textural and microstructural properties of pork frankfurters

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Cereal Foods World 53:A46

The effect of chymotrypin-hydrolyzed wheat gluten (15 h, degree of hydrolysis = 13.5%) on microbial transglutaminase (MTGase)-mediated interaction of pork myofibrilar protein (MP) was evaluated in dilute NaCl solutions by SDS-PAGE and turbidity (600 nm) measurements. The hydrolyzed gluten (GH) was incorporated into pork frankfurters at 2% level; and the effect of GH and MTGase incubation (0.5 and 6 h) on the frankfurters' textural and microstructural properties were investigated by compression tests and scanning electron microscopy respectively. Substantial myosin cross-linking was evident in the MTGase-treated MP, but this was hindered in the mixed MP/GH. GH addition reduced MP aggregation, decreasing the final optical density at 75°C from 0.3 to 0.2 units in MTGase-free solutions. The inhibitory effect of GH was not reversed when samples contained MTGase. The addition of GH to pork frankfurters significantly ($P < 0.05$) increased the gel hardness and breaking strength when compared with the pork-alone (GH-free) control, presumably resulting from improved emulsification (i.e., contribution of protein-coated fat globules). However, in the presence of MTGase, the gel-strengthening effect of GH was diminished. The GH- and MTGase-dependent textural attributes were corroborated by the frankfurter microstructures, suggesting that GH influenced the overall textural characteristics of MTGase-treated pork frankfurters through complex protein-protein and protein-fat interactions.

Searching Brazilian cookie wheat cultivars

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Cereal Foods World 53:A47

Compared to the large effort spend developing Brazilian bread wheat cultivars, relatively few studies have examined soft wheat cultivars for cookie flour in Brazil. The objective of this study was to identify soft wheat cultivars with improved manufacturing quality for the cookie and cracker industry. 39 and 32 wheat cultivars were produced during 2004 and 2006 crop seasons, and milling quality parameters were determined. The solvent retention capacity test (SRC, AACC 56-11) was used to evaluate functionality for end use applications and to select wheat cultivars for production of flour for cookie and cracker manufacturing. Significant differences in solvent retention capacity were observed among wheat cultivars in two different years. In the year 2004, none of the cultivars were better than the soft check, North American cultivar JUBILEE, for water, sodium carbonate and sucrose SRC. BRS LOURO had lactic acid SRC value similar to JUBILEE, indicating that flour of this cultivar can be used in the cookie industry. The 2006 results indicate none of the cultivars were better than the soft check, North American cultivar HONEY, for lactic acid SRC. However the cultivar BRS ANGICO had water, sodium carbonate and sucrose SRC value similar to HONEY, indicating this cultivar flour can be used for cookie manufacturing. Significant positive correlations between SRC and wheat milling quality parameters were observed in both years of study: SRC water and flour gluten strength, as measured by alveograph W (0.64 and 0.65), alveograph tenacity (0.76 and 0.77), tenacity / dough extensibility ratio (0.63 and 0.66) and farinograph water absorption (0.87 and 0.93); SRC sodium carbonate and tenacity (0.83 and 0.67), tenacity / dough extensibility ratio (0.78 and 0.65) and farinograph water absorption (0.86 and 0.75); SRC latic acid and flour gluten strength (0.73 and 0.64). Soft wheat genotypes with acceptable cookie functionality are available within the domestic wheat Brazilian germplasm. The current challenge is to identify them in a classification system based on alveograph W and farinhograph water absorption.

Non-thermal starch modification using ultra high pressure: Physico-chemical properties of non-thermally acetylated cornstarch

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Cereal Foods World 53:A47

Cornstarch (20%, w/w) was non-thermally acetylated with an acetic anhydride (0 and 12%, w/w) at 0, 100, 200, 300, 400 MPa for 15 min. Conventionally acetylated cornstarch was prepared at 30°C for 60 min. Physicochemical properties, such as swelling power, solubility, moisture sorption isotherms, pasting properties, X-ray diffraction pattern and thermal properties, of non-thermally acetylated cornstarches were determined. Solubility and swelling power of non-thermally acetylated cornstarch revealed higher value than native but lower than conventionally acetylated cornstarch. In both solubility and swelling power, pressure level did not show significant difference. Non-thermally acetylated cornstarches and conventionally acetylated cornstarches showed no significant difference in moisture sorption isotherm compared to native. Non-thermally acetylated cornstarches showed distinctive RVA pasting properties compared to native and conventionally acetylated cornstarches. Pasting temperature decreased with increasing pressure level and reached same value with conventionally acetylated cornstarch. On the other hand, non-thermally acetylated cornstarches showed relatively lower peak viscosity than both native and conventionally acetylated cornstarches. This result suggests that non-thermal acetylation of starch provides different pasting properties compared to conventional acetylation of starch. X-ray diffraction pattern showed no difference in all samples indicating that both conventional and non-thermal acetylations did not affect the crystalline region but only affect amorphous region of starch molecule. On the other hand, DSC thermal characteristics were influenced by both conventional and non-thermal acetylations. Amylopectin melting enthalpy decreased with both non-thermal and conventional acetylation indicating that some double helical structure in amorphous region disintegrated during both non-thermal and conventional acetylation processes. This work showed a potential of ultra high pressure (UHP) processing for new starch modification method and provides the basic and fundamental information of non-thermally acetylated corn starches.

Qualities of dough and bread made from rice with various starch properties

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Cereal Foods World 53:A47

Starch consists of two kinds of glucose polymer, amylose and amylopectin. The amylose content and amylopectin chain length distributions differ among rice cultivars. It is known that these starch properties affect quality of the cooked rice. The objective of this study is to evaluate how the starch properties affect qualities of the breads made with rice flour. Ten rice cultivars with various starch properties, including high, middle, and low amylose contents or amylose extender (ae) were used in this study. Dough was made from mixture of eighty grams of rice flour and twenty grams of wheat gluten (both are 14% moisture basis). Dough volumes, loaf volumes, amylose contents, amylopectin chain lengths distributions, protein contents, and damaged starch contents were measured. The dough development became higher with the decrease of damaged starch content in flour. However, those of *ae* mutants were low in spite of its low damaged starch content. Correlations were not observed among the dough development, amylose content and protein content. Interestingly, the rice with higher ratio of amylopectin short chains (S type) gave higher dough volume development than the rice with lower ratio of short chains (L type). Although there was no correlation among loaf volume, amylose content or protein content, loaf volume was negatively correlated with damaged starch content except *ae* mutants. Bread hardness was positively correlated with amylose content, but not with protein content. The bread hardness was highest with the bread made from the rice with L type amylopectin. These results showed that damaged starch content is one of the most important factors responsible for rice dough and bread qualities, and that amylose contents and amylopectin chains affect bread hardness, but rice protein does not affect dough and loaf properties.

Ecological alternative heat sources to cook maize tortilla

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Maize tortilla is the basic food of daily consumption in Mexico. A main step in the elaboration of maize tortilla is the baking. Tortillas are baked in a continuous oven on a metallic gas. Today, tortillas machines, which consume gas L.P. are used. 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 baking stage of tortillas elaboration process has not had important changes. In this work, tortillas elaborated by the traditional method and cooked in an infrared oven (IR) with different times and cooking temperatures, and in a microwaves (MW) stove with times of 0.0, 1.0 and 24.0 hrs, were tested and compared with cooked tortillas on comal heated with L.P. gas. Quality parameters were determined. Tortillas elaborated with traditional and lR methods were similar and their quality characteristics (color, texture and puffing degree) were very good. Advantages of IR ovens are: capability of penetration and uniform heating, direct energy transfer with high efficiency, clean process without pollution and safety to humans and food products. Base on results we concluded that the IR method is one of the best alternatives for the maize tortilla elaboration.

Resistant starch content of re-made maize tortillas, and their physico-chemical and textural properties

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The maize tortilla is a basic food in the daily diet of the population of Mexico and Central America. Due to its high contained of starch (72%), in Mexico, a high percentage of the population presents problems of health as diabetes and obesity. To diminish the caloric content of this type of food, it is possible to process them and the native starch transforms in resistant starch. In this work, different forms were evaluated to increase the contents of resistant starch in the maize tortillas. The variables and levels tested, were: type of maize, white and yellow; type of process, addition of pericarp and re-processing of tortilla; and temperature of dehydration, 30 and 60°C. The tortillas were produced, characterized, dehydrated and re-processed several times. For all treatments, the content of resistant starch (RS), retrograded resistant starch (RRS), physicochemical and texture properties were determined. The RS and RRS increased from 3.41 to 5.90% and from 1.13 to 2.69% respectively, respect to the re-process number. In some treatments, the water absorption capacity (WAC), moisture content, maximum (MV) and retrogradation viscosity (RV) of the flours, and the tensile and cutting force of tortillas were negatively affected. Tortillas elaborated with white maize presented higher content of RS (5.90%), and RRS (2.36%), than those of yellow maize, and their characteristics were similar to that tortillas prepared by the traditional method. Two types of maize produced tortillas of good quality during the first making process, although the MV and RV were different, showing

the biggest values those tortillas prepared with yellow maize. The flours of both types of maize presented similar WAC (1.84 mL/g), in the first, the second and the third re-process times. The same flours, after transforming them into tortillas, presented the best characteristics. The RS and RRS contents were similar in tortillas from two types of maize. Although all the variables evaluated, affected the RS and RRS contents, the biggest increases were appeared when changed the type of process and the dehydration temperatures, mainly. The re-processes, which involve cooking of mass and dehydration of tortillas, were who provoked the biggest increases of RS and RRS, and the tortillas were obtained with acceptable characteristics for the consumer.

Flour and physical dough properties of some organic Turkish wheat varieties

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Organic agriculture is of particular interest for producing healthy and ecologically friendly food since the application of chemicals, such as synthetic fertilizers and pesticides, in conventional agriculture is a concern for consumers. Since the available literature on technological properties of such products is limited, there is certainly a need for the further research on organic wheat and its products. The objective of this study was to investigate the flour and physical dough properties of three organic wheat varieties ("Bezostaya"-hard red wheat, "Kirik"-hard white wheat and "Gerek"-semi hard white wheat) produced in Turkey in 2006. They were evaluated by their ash, protein and dry & wet gluten contents, sedimentation value, falling number and farinograph & extensigraph values. Ash, protein, wet and dry gluten content values of organic flour samples were 0.52-0.91%, 7.81-12.84%, 13.9-32.4%, and 4.6-11.30%, respectively. Gluten index, sedimentation and delayed sedimentation and falling number values were also found to be in the ranges of 73-91, 11-32 ml, 16-44 ml, and 173-380s, respectively. In addition, farinograph data of all organic flour doughs were 47.2-57.3% for water absorption, 1.00-2.75 min. for mixing time, 1.5-18.5 min. for mixing tolerance, 1-220 B.U. for mixing tolerance index. Furthermore, extensigraph values of "Bezostaya" and "Kirik" organic doughs were 369-485 B.U. for maximum resistance, 13.6-14.5 cm for extensibility, 66-80.5 cm^2 for energy-area, 25.76-35.66 for ratio value. In conclusion, organic "Bezostaya" and "Kirik" wheat varieties were found to be suitable for acceptable quality for bread making, whereas organic "Gerek" wheat variety showed weak quality properties.

Nutrient recovery from dry grind corn process streams using membranes

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The corn dry grind process is the most widely used method for fuel ethanol production in the U.S. In the dry grind industry, concentration of thin stillage nutrients requires evaporation of large amounts of water (4 to 5 L water/L ethanol) since the thin stillage stream is characterized by high water content (90 to 95%). Dewatering and nutrient recovery are major challenges for the dry grind industry. Membrane filtration could lead to improved thin stillage value and reduced energy to concentrate thin stillage. The objective was to determine effectiveness of microfiltration (MF) and ultrafiltration (UF) in nutrient recovery. The study was carried out in two phases: (1) evaluation of MF and UF membranes in recovering nutrients and (2) use of a sequential separation technique to improve nutrient recovery. In the first phase, we investigated a stainless steel MF membrane (0.1 micron pore size). To obtain maximum permeate flux rates, pressure excursions were conducted; as a result, 690 kPa was used throughout the MF experiments. Thin stillage was concentrated from 7.0 to 21.5% solids with a mean permeate flux rate of 75 ± 6 LMH. UF experiments were conducted in batch mode under constant temperature and flow rate conditions. Regenerated cellulose membranes with molecular weight cut offs of 1000, 10,000 and 100,000 kDa were evaluated. Permeate and retentate streams were analyzed for composition. In the second phase, permeate streams from MF were subjected to UF. Removal of solids, protein, fat and fiber may generate a relatively clean permeate that can be concentrated through an evaporator. Cleaner permeate might allow increased water recycling within the dry grind process.

Membrane filtration and heat transfer fouling tendencies of thin stillage in dry grind corn process

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Increased demand of ethanol as a fuel additive has resulted in rapid growth of ethanol production in the U.S. Within the dry grind corn process, approximately 6 to 7 L thin stillage (TS) is produced concomitantly with 1 L ethanol. Dry grind processors recycle 30 to 50% TS in the plant; the remaining 50 to 70% is diverted to evaporators for concentrating into syrup. TS concentration requires evaporation of large amounts of water as well as evaporator maintenance. Evaporator maintenance requires excess evaporator capacity at the facility, increasing capital expenses, requiring plant slow downs and/or shut downs. Fouling of evaporator surfaces depends primarily on concentration and composition of the fluid flowing over the evaporator surface. Membrane technology may provide an efficient means for dewatering and reducing fouling of evaporators by solids removal. We investigated effects of microfiltration (MF) on heat transfer fouling tendencies of TS. A stainless steel MF membrane (0.1 micron pore size) was used to remove solids from TS. To obtain maximum permeate flux rates, pressure excursions were conducted and 690 kPa was used throughout the experiments. The MF process effectively recovered total solids from thin stillage. Thin stillage was concentrated from 7.0 to 22.6% solids with mean permeate flux rates of 150 ± 30 LMH. Permeate and retentate streams were analyzed for composition. Protein and fat contents were increased from 19.2 and 17.6% to 28.0 and 39.8%, respectively. TS ash content was reduced 64% in retentate stream. Retentate with high protein and fat contents could be used as a non ruminant animal feed. Removal of solids, protein, fat and fiber generated a relatively cleaner permeate that was used as an input stream to the fouling probe system and fouling tendencies were measured. An annular fouling probe was used to measure fouling tendencies of TS from a commercial dry grind facility. The probe measured heat transfer rate through its surface, allowing determination of fouling resistance. Fouling resistances of original and microfiltered TS will be quantified and analyzed. Lower fouling rates would allow evaporators to operate longer periods between cleaning and maintenance.

Characterization of barley (*Hordeum vulgare*) with altered carbohydrate composition

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Barley (*Hordeum vulgare*) is used for the production of malt, food and animal feed. In a barley breeding program some lines with interesting carbohydrate profiles were observed. To characterize these lines, barley grains were analyzed for total starch by the AACC approved method 76.13; protein by the combustion AACC method 46-30, and amylose by debranching starch and analyzing using the Size Exclusion-High Performance Liquid Chromatography (SE-HPLC). The beta glucan (beta-glucan) concentration was determined by both the AACC method 32-23 and the Calcofluor methods; total dietary fiber by AACC method 32-07, whilst the crude fat was determined by the Hexane extraction method. The barley lines exhibited significant differences in carbohydrate content and profiles. The total starch concentration ranged from 58%–72%, while amylose varied from 0% (waxy lines), 25.8% (normal) and from 39%–41% for the higher amylose lines. Higher amylose concentration lines showed significant reduction in total starch concentration. Lines with higher percent amylose (41%) also had the lowest percent total starch (58%–59%) compared to the normal lines (72%). Results from both the AACC 32-23 and Calcofluor methods for beta glucan concentration gave similar trends, however values from the latter method were slightly higher but not significantly different from the former method. Differences in percent beta glucan among barley lines were significant and ranged from as low as 6% for the normal, 8% for the waxy lines and 11%–13% for the high amylose lines. Starch amylose had a significant effect on total dietary fiber but not on protein and crude fat. Total dietary fiber values significantly differed among barley lines and ranged from 17.4%–18.2% for higher amylose lines, 13.7%–15.1% for the waxy lines and 11.8% for the normal lines. Barley lines with lower total starch had significantly higher amylose, percent beta glucan and total dietary fiber content. To understand the biochemical reason for the starch profiles, granule proteins were analyzed by SDS-PAGE. Some barley lines with no starch amylose had the Granule bound starch synthase I (GBSSI) polypeptide which was confirmed by immunodetection with GBSSI specific antibodies. Studies are underway to characterize GBSSI gene in these waxy barley lines with no amylose.

Detecting homogeneity of octenyl succinic anhydride modified starch by FT-IR microspectroscopy

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Starch becomes lipophilic after reacted with octenyl succinic anhydride (OSA) and the modified starch is widely used in emulsion and encapsulation applications. The functionality of OSA starch is dependent on the degree of substitution and distribution of OSA group in starch. However, it is a challenge to determine the amount of OSA in individual starch granules. In this work, FT-IR microspectroscopy was used to investigate uniformity of OSA reaction on waxy maize starch granules and detect homogeneity of blends of OSA starch and native waxy maize starch. Starch granules were flatted by a roller and each individual granule was examined by FT-IR microspectroscopy. Spot size of 15 µm by 15 µm was used and single starch granule was examined under a reflection mode for 128 scans. OSA starch granules with degree of substitution (DS) of 0.075, native starch granules, and blends of OSA starch and native starch granules were analyzed by FT-IR. Compared with native starch, OSA modified starch showed a new peak at 1724 cm^{-1} and 1566 cm^{-1} due to the asymmetric stretching vibration of carboxylate $RCOO^{2-}$ from OSA. The ratio of the area under the peak at 1724 cm^{-1} to the area of the complex carbohydrate peak at 1025 cm^{-1} was used to calculate the OSA content. Spectrums of 108 individual OSA starch granules with DS of 0.075 revealed that 99% granules showed carbonyl peak, indicating that most starch granules were reacted with OSA although the OSA content varied. A blend of OSA starch (DS 0.075) and native starch (3:7 w/w) was prepared to match the same DS of starch reacted with 3% OSA. Among the 112 granules examined by FT-IR microspectroscopy, 30% starch granules had carbonyl absorption, whereas other 70% granules did not give the carbonyl peak, suggesting that FT-IR microspectroscopy can be used to detect homogeneity of starch blends containing OSA starch.

Assessment of the effects of soy protein isolates with different protein compositions on gluten thermosetting gelation

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Soy proteins are nutritionally suitable to improve protein quality in wheat based foods and are frequently added to bread. However, interactions between soy proteins and wheat gluten proteins during gelation is still poorly understood. Different sources of soy protein isolates (SPI) were used to investigate the effects of gluten and SPI interactions during hydro-thermal treatments using a gluten quality test for the Rapid Visco Analyser (RVA). Commercial SPI and SPI made under controlled conditions either from commercially defatted flour or from selected Ontario soybean lines (with different subunit composition: Harovinton, A3-null, Multi-null and 11S-null lines) were used in this study. RVA analysis showed that with increasing SPI replacement, the peak viscosity and final viscosity decreased. However, a cooperative effect between soy and gluten proteins during heating for all the samples containing soy protein with gluten compared to gluten alone was observed. Mixed systems containing gluten and SPI with different protein compositions affected the thermosetting gelation differently. The 11S-null SPI seemed to interfere more in the gluten protein gelation, showing behaviour similar to higher SPI replacements. A3 null SPI showed the opposite behaviour, that is, the formation of thermoset protein gels with the highest final viscosity. The results strongly suggest that the soy subunits, in particular the 7S proteins and the A3 subunit of the 11S soy proteins, interfere with the formation of a continuous gluten network. Also, the addition of soy proteins from these new lines could improve the properties for wheat and soy protein mixed systems at certain levels.

Salt-washing process for improved gluten quality

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Vital dry gluten is an important ingredient in bread-making and in many food and feed products. The industrial washing of wheat gluten from flour causes much of the flour lipid to be concentrated in the gluten. This incorporated lipid has deleterious effects on the rheological characteristics, the appearance, the flavor and the odor of the isolated gluten. The inclusion of common salt (sodium chloride, 2% flour basis) in the wash water has the effect of reducing the lipid content of the resulting gluten. Use of other salts can also affect the lipid content and properties of the resulting gluten. In particular, the inclusion of ammonium chloride, at low concentrations (0.5 to 1%), in the dough mixing and washing stages of the gluten preparation, yields a product with improved color and rheological properties. Laboratory- and pilot-scale trials have shown that when such salts are used with a poor-quality flour, the quality of the gluten is much improved over what is prepared without the use of salts. For example, in an Extensigraph method designed specifically for isolated gluten, extensibility improved from 11 cm to 14 cm for gluten, as a result of washing with 0.5% ammonium chloride, compared to water washing. The ammonium-chloride wash process now offers the possibility of producing gluten with better quality, with little added cost or alternation in the processing conditions.

Screening for wheat-grain defects due to alpha-amylase: Sprouting or late-maturity alpha-amylase?

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Wheat grain is unsuitable for milling and baking when alpha-amylase activity is excessive. This enzyme may be present in excess when there is pre-harvest sprouting due to rain. It may also be due to the genetic defect late-maturity alpha-amylase (LMA), which is present in many parent lines. LMA must be eliminated from the progeny of these parents so that the LMA defect is not carried forward into advanced lines. It is thus important for cereal chemists to distinguish between these two reasons, especially when selecting non-LMA genotypes in a breeding program. At the phenotype level, there is the distinction that the alpha-amylase activity of sprouted grain is concentrated in the outer layers, whereas the activity for LMA grain is distributed throughout the endosperm. We used pearling as a basis for removing the outer layers from both types of grain, following up by determining enzymic activity with both the Amylazyme method and immuno-assay. The mean ratios of alpha-amylase activity for pearls versus whole grains were 1.2 for LMA grains and 0.3 for sprouted grains, using either of the two assay methods. This approach thus provides a clear distinction between these two reasons for elevated alpha-amylase activity.

Effect of source on the molecular and rheological characteristics of starches isolated from fruit and cereal growing in Mexico

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Starch is widely used in industries and looking for novel source for isolation of this polysaccharide with new or different physicochemical and functional properties is an actual topic. The effect of the source on the molecular and rheological characteristics of two groups of starches isolated from cereals and fruits growing in Mexico were assessed. Even inside the same botanical group the starch presented different morphological characteristics. Mango starch had an A-type X-ray diffraction pattern similar to that determined in the cereal group. Banana starch presented a C-type pattern. No influence of the botanical group was showed in the temperature and enthalpy of gelatinization, because maize and mango starch presented similar values of those parameters. Similar behavior was showed in the retrogradation study. However, the pasting characteristics were influenced by the botanical group, where barley and maize starch had lower viscosity peak than fruit starches. The dynamic rheological study showed that the loss module value was higher for starches isolated from fruits than those from cereals. In the frequency sweep at 25°C (gel conformation), the reorganization level was different for each starch, indicating that the botanical source plays an important role in this pattern.

Rheological and structural characterization of starches isolated from pigmented maize

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Maize (*Zea mays* L.) is the most domesticated plant of the planet. There are several varieties of pigmented maize with colors such as violet, red, black and blue due to anthocyanins. Very few studies are reported on starch of pigmented varieties, although the food products elaborated with pigmented maize (such as tortilla) have different characteristics than those elaborated with white maize and starch is perhaps the responsible of this behavior. The objective of this study was gain information on some physicochemical, molecular and structural characteristics of starch of pigmented maizes. Starch was isolated from blue and black maize varieties using a wet-milling procedure; white maize was used as control. The amylose content, microscopy analysis, X-ray diffraction pattern, thermal analysis, dynamic rheological and structural characteristics were tested. The amylose content was not different in the three starches studied (23.9–24.8%), pattern that is in agreement with the average gelatinization temperature (69.3–69.5°C). The enthalpy of gelatini-

zation of the pigmented maize starches was higher than white maize, and black maize presented the highest enthalpy value, that is in agreement with the crystallinity level. The black maize had higher moduli values than blue and white starches, and no differences were found in the last samples. The blue maize had the lowest global Mw (4.14 × 108 g/mol) and black maize the highest (5.0 × 108 g/mol). This value is in agreement with the Mw of amylopectin. The Mw of amylose showed different pattern, because white maize presented the highest value (6.94 × 106 g/mol) and black maize the lowest (5.23 × 106 g/mol). The pattern showed in the Mw values is in agreement with RZ value, because black maize presented the highest value (328 nm) and blue maize had the lowest (318 nm). Differences were found between the pigmented maize starches and those might explain the functional characteristics of maize-based products.

The incorporation of Teff (Eragrostis teff) in bread-making technology

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Cereal Foods World 53:A50

Teff is a little-known cereal grain. It is indigenous cereal in Africa and is currently grown in some areas of the Netherlands, the United States and Canada. It has a very high fibre and iron content and an excellent source of essential amino acids, especially lysine, the amino acid that is most often deficient in grain foods. Teff has a high calcium content, and contains high levels of phosphorous, copper, aluminum, barium, and thiamine. The objective of this work was to incorporate Teff in breads and to study its effect on the textural properties of baked bread. Teff flour at levels of 10, 20 and 30% was added to the dough mix and a standard wheat loaf was used as a reference. A number of analyses were conducted using a Farinograph to determine water absorption ability, the rapeseed displacement method to determine loaf volume, a texture analyzer to study texture and shelf life over a period of 6 days and a Hunter Lab Colorimeter to record colours of breads. The results showed that addition of Teff increased the level of water absorption and decreased the loaf volume, increased stability and decreased dough development time at samples containing above 20% Teff flour and increased the degree of softening at 30% Teff. Lightness was negatively affected by the higher level of Teff, while crumb redness and yellowness were positively affected. The textural characteristics revealed increasing of crumb firmness at 20 and 30% Teff addition. Further increase in crumb firmness at 20 and 30% Teff addition was recorded during the each day of storage.

The effect of microbial transglutaminase on soymilk gelation

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Soy protein is a popular food ingredient used throughout the world for its nutritional and functional properties. In most cases soybeans are processed into a range of forms of soybean meals, tofu being the one most generally recognized. Microbial transglutaminase (mTG; EC 2.3.2.13) promotes protein cross-linking reactions through an acyl transferase mechanism. This cross-linking results in the polymerization of protein/peptide molecules with a subsequent increase in molecular mass. The modification of proteins by mTG has been extensively studied and has been shown to be a powerful tool for improving the gelling properties of soy protein. Microbial transglutaminase has been shown to effectively induce soymilk with a certain level of solid content to form filled tofu. The present study was designed to elicit an understanding of the roles of transglutaminase in improving the gelling properties of soybean varieties with poor tofu-making potential. The immediate objectives of this study were to examine the effects of mTG treatment on the molecular weight distribution of soybean protein extracts, the texture characteristics of tofu and the importance of a coagulant selection on the level of response in the cross-linked soymilk. Soymilk prepared from various soybean varieties differing in their protein quality was subjected to mTG treatment before tofu making. Nigari-type salt (magnesium chloride), sulfate-type coagulant (calcium sulfate) and glucono delta-lactone were used as coagulants together with various levels of transglutaminase. Capillary electrophoresis results revealed the effect of mTG on the molecular weight distribution of protein extracts from tofu. Texture profile analysis measurements showed that mTG had a major impact on the hardness of the final product and the extent of that was influenced by the type of coagulant used. The results suggested that there is a potential for incorporating mTG addition within the process of commercial production of various types of tofu. The results are also discussed in relation to the possibility of improving the processability of soybean seeds with low tofu-making potential. Ultimately, this approach may provide novel soy protein-based food ingredients with unique functional characteristics for expanded applications within the world marketplace.

Mixolab characterization of flour quality according to their end use

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The quality of flour is judged on the basis of its end use. Mixolab is a polyvalent dough mixer which is used to determine the rheological and gelatinization properties of flour. A complete characterisation of the flour is possible in a single test. The objective of this study is to determinate the ability of the Mixolab to discriminate samples as a function their end use. For doing so, the profiles of different flours with different end uses are defined according to 6 functional criteria given by the Mixolab (Profiler): water absorption, kneading behaviour, gluten strength, maximum viscosity, amylase activity and retrogradation. Each criterion is noted with an index value ranging between 1 and 9. Each sample is characterized with a Mixolab index composed of the value of the 6 criteria. 5 sample of standard baguette flours, 5 samples of pan bread flour and 5 samples of biscuit flour are analysed on Mixolab (Standard protocol). The minimum and the maximum Mixolab index is (5-46-577; 6-57-688) for pan bread, (5-13-221; 6-34-432) for baguette and (1-16-777; 2-57-888) for biscuit. Regarding only the water absorption index, the baguette and the pan bread type of flour are not different. But the information provided by the entire profile completely discriminate the 3. This study proves that the Profiler tool of the Mixolab system is an efficient quality control tool for the milling and baking industries.

Ergosterol - A screening tool for risk management of mycotoxins in grain

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Mycotoxin occurrence in food and feed and the concerns about possible health effects has become increasingly important. Limits and regulations regarding mycotoxin levels have been established in many countries. It is crucial too keep mycotoxins out of the food handling chain and the key point where this can be done is at grain terminal receiving grain deliveries from farmers. Quality control of incoming grain during the harvest season is a hectic task, usually all quality tests including moisture, protein, foreign matter and kernel damages should be done within 4 – 5 minutes. Presently the only viable alternative for control of mycotoxin levels at such terminals are various test kits but these typically take 10–20 minutes for a complete test. This makes it basically impossible to analyze all incoming grain. There is a need for a rapid screening test that can be used to identify the low and high risk samples so that the toxin tests done can be used as efficiently as possible. Determination of ergosterol is one possibility for such a screening test. Ergosterol is found in the cell walls of fungi and the occurrence of fungi is in turn related to the risk of mycotoxin production. If there are no fungi there is basically very low risk to obtain any mycotoxin production. In Sweden the cooperative Lantmännen has together with FOSS developed a calibration for ergosterol in wheat and barley. The system is used in a risk management system where “risk” samples are further analyzed for toxins by other techniques. The calibration determines the content of ergosterol and Lantmännen have defined limits for direct acceptance, further control or direct rejection of deliveries. The calibration has now been in commercial use during several harvests and results from different crop years will be presented. The use of this calibration has enabled Lantmännen to stop contaminated grain from entering their grain storage systems.

Nutraceutical potential of sorghum bran: Hyaluronidase inhibition

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Hyaluronidases (Hyases) degrade hyaluronan, a glycosaminoglycan found in cartilage and extracellular matrix. Increased Hyase activity causes imbalanced hyaluronan metabolism, increasing cartilage breakdown in inflammatory joint disease, e.g., osteoarthritis (OA). Sorghum bran has high polyphenolic content with anti-oxidant and anti-inflammatory activities. We tested whether extracts of 7 sorghum bran varieties would directly inhibit Hyase. We prepared ethanolic extracts (1:9 wt/vol 50% EtOH) and measured total phenolic, anthocyanin and FRAP (ferric reducing antioxidant power) values. We found a range of potencies for inhibition of Hyase: three varieties had IC50s at 1:5000 total dilution and four had significant, but lesser, activities (25–50% inhibition range) at 1:700 total dilution. Inhibition of Hyase correlated positively with total phenolic and FRAP values, but not with anthocyanin content for each of the 7 varieties. Current management of OA involves decreasing mechanical, inflammatory and oxidative injury while providing substrates to increase cartilage synthesis (e.g., glucosamine and chondroitin). Sorghum bran extracts may provide a complementary nutraceutical approach with high Hyase inhibition, anti-oxidant and anti-inflammatory activities. In summary, Hyase inhibition is a heretofore unrecognized property of sorghum

bran that provides rationale for its development as a nutraceutical/food supplement. USDA-CRA # 58-5430-4-363

Rye bran, blueberry husk and multi-strain probiotics affect the severity of dextran sulfate sodium (DSS) induced colitis

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Ulcerative colitis (UC) is a chronic, relapsing inflammatory disorder of the gastrointestinal tract characterised by cycles of acute inflammation. Its etiology is not known, although some bacterial species are known to be involved, and a diminished capacity to utilize butyric acid by the colonocytes may be another contributing factor. Probiotic bacteria have health-promoting effects for the host when ingested and have shown efficacy in UC. Dietary fiber induces the production of short-chain fatty acids (SCFAs) of which butyrate most effectively protects the intestinal mucosa against injury and promotes mucosal healing. Since some types of dietary fiber give high amounts of butyrate at colonic fermentation, the diet may be a promising form for treatment of UC. The aim of the present study was to elucidate the beneficial effects of a combination of rye bran or blueberry husks with probiotic bacteria on the inflammatory response in a DSS colitis animal model. During fourteen days Sprague-Dawley rats were given either a control diet without any fiber or bacteria, or a test diet containing 8 g/100 g dietary fiber from rye bran or blueberry husk and/or a bacteria mixture containing *Lactobacillus gasseri* DSM 16737, *Lactobacillus crispatus* DSM 16743, *Bifidobacterium infantis* DSM 15158. Throughout the last seven days, 5% DSS were administered to the rats by gastric tube feeding. Colitis severity was assessed using a disease activity index (DAI). The DAI was lower for all test diets on the last day of DSS administration than for the control diet (0.3-1.3 versus 2.8, $P < 0.05$), and the body weight gain was higher in rats fed the test diets, except rye bran alone (0.03-0.13 versus –0.28 g/g feed, $P < 0.05$). The amounts of SCFAs were higher in rats fed rye bran and bacteria mix than those fed the rye bran diet alone (344 versus 153 µmol, $P < 0.01$). Rats fed the blueberry husk diet had higher amounts of butyric acid compared with rats fed the control diet (23 versus 9 µmol, $P < 0.05$). The malondialdehyd levels were lower in all rats fed test diets containing fiber compared with those fed the control diet (8-9 versus 15 nmol/g, $P < 0.05$). Daily administration of dietary fiber and probiotics had an anti-inflammatory effect in the animal model of distal colitis. Our findings may be of interest when developing foods for prevention and treatment of colonic inflammation.

Development of a small-scale durum wheat milling protocol

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Milling quality of durum wheat is an important end-use quality trait, but selection is difficult given the large sample size required and low throughput. The aim of this work was to develop a small-scale milling and purification protocol to enhance selection of durum breeding lines with adequate milling quality. The Crop Development Centre (CDC) protocol utilizes two Brabender Quadrumat Jr. mills, a Retsch sieve shaker and a Chopin purifier. A sample size of 300 g is ideal for the procedure and up to 15 samples can be milled in a day. The final testing for registration of wheat varieties in western Canada is carried out at the Canadian Grain Commission's Grain Research Laboratory (GRL). Accordingly, the CDC protocol must be able to predict semolina yield and semolina quality outcomes of the GRL to be effective. The GRL procedure, which utilizes a three stand Allis-Chalmers mill in conjunction with a laboratory purifier, is more complex, comprising four break passages and five sizing passages. A relatively large sample size is required (minimum of 1 Kg) and throughput is only about 5 samples per day. Compared to the GRL milling procedure, the CDC small-scale procedure gives lower semolina yield and ash content, finer particle size and paler yellow colour. For durum wheat lines with diverse milling and quality attributes, strong correlations were seen between the two milling procedures for semolina yield, colour, yellow pigment content, gluten index, mixograph parameters and spaghetti colour, verifying the effectiveness of the CDC protocol for quality screening of durum wheat lines.

Time progress curves for hydrolytic enzymes on three lignocellulosic substrates

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Generally, production scheme for bioethanol/biomaterials consist of suitable pretreatment of lignocellulosic biomass followed by enzymatic hydrolysis and fermentation. Grinding of lignocellulosic biomass to suitable particle size for better enzymatic conversion is the essential first step in bioethanol production. Three lignocellulosic feedstocks, namely, soybean hulls, wheat straw and wheat bran were ground to particle size < 132 µm in a hammer mill. Enzyme reaction time progress curves were drawn using cellulase from 0 minute to 60 minute and reaction progress was monitored at three substrate level (10 mg/ml, 6 mg/ml and 4 mg/ml) and one enzyme concentration for all the three feedstocks. Higher the substrate concentration higher was the enzyme turnover in terms of sugar release as measured in milimoles per liter (mmol/L). Sugar release increased from 0.6 mmol/L to 2 mmol/L in wheat bran at 10 mg/ml substrate concentration and 0.3 mmol/L to 2 mmol/L for soybean hulls at 6 mg/ml substrate concentration. Similar trends were observed for other substrate concentrations. In wheat straw trends were not very clear. There were periods where sugar release increased to maximum at 1.8 mmol/L at 40 minutes followed by decline to 1.5 mmol/L at 60 minute for 10 mg/ml wheat straw concentration. This study highlighted the hydrolysis response of different feedstocks at different substrate levels. Wheat bran was the preferred substrate followed by soybean hulls and wheat straw showed the maximum resistance to hydrolysis. Similar time progress curves are planned with xylanase, and a combination of cellulase, cellobiase and xylanase.

Mechanical pretreatment of soybean hulls and wheat bran for enhanced enzymatic hydrolysis for bioenergy and biomaterials

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The current rate of grain ethanol production is not sustainable due to the strain it puts on limited natural resources. Lignocellulosic biomass such as soybean hulls and wheat bran are attractive low cost and abundantly available resources to utilize as alternate feedstocks. High temperature and high pressure in the presence of acid or alkali or both is the common pretreatment currently used to modify plant cell wall structure of lignocellulosic biomass for better enzymatic hydrolysis. In the current study alternative mechanical pretreatments like grinding, and extrusion were studied to assess their effect in breaking the lignocellulosic structure and eventually improving the cellulase hydrolysis. Enzyme hydrolysis of the pretreated samples was carried out using cellulase from Trichoderma reesei at 50°C, and pH 5 for 30 minutes. Hammer mill grinding to particle size < 132 mm enhanced available surface and resulted in improved enzyme hydrolysis of wheat bran and soybean hulls. Hydrated soybean hulls and wheat bran were extruded using different die temperatures at various screw speeds. In particular, die temperature and speed combination of 110°C and 220 RPM, and 150°C and 420 RPM enhanced soluble sugar release by two folds compared to enzyme treatment of ground (< 132 mm) wheat bran. The changes in lignocellulosic structure achieved from grinding and extrusion pretreatments were quantified using X-ray diffraction pattern by comparing the maximum intensity during 2-theta scan. Scanning was carried from 2-theta = 10° to 40° at scan rate of 4 degrees/minute using X-ray diffractometer. Lower the intensity higher is the structural modification achieved with particular treatment. Ground wheat bran of particle size <132 mm had maximum intensity of 115 linear counts per second compared to 141 linear counts per second of wheat bran of particle size >132 mm. Wheat bran extruded at 220 RPM and 150°C had the lowest maximum intensity of 104 linear counts per second. Soybean hulls also showed similar X-ray diffraction pattern indicating that pretreatments resulted in reduction of crystallinity in the both wheat bran and soy hulls.

Effect of comminution on lignocellulosic composition, enzymatic hydrolysis and acid-mediated enzymatic hydrolysis of agricultural co-products

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The current rate of grain ethanol production is not sustainable due to the strain it puts on limited natural resources. Lignocellulosic biomass such as soybean hulls, wheat straw and wheat bran are attractive low cost and abundantly available resources to utilize as alternate feedstocks. Generally, production schemes for bioethanol from lignocellulosic biomass consist of suitable pretreatment followed by enzymatic hydrolysis and fermentation. Size reduction of lignocellulosic biomass to desired particle size for better enzymatic conversion is an essential step in bioethanol production. In the present study, hammer mill grinding of three feedstocks: soybean hulls, wheat straw and destarched wheat bran was carried out to investigate how differences in lignocellulosic composition and particle size affect cellulase hydrolysis processes. Enzyme hydrolysis was carried out using cellulase from Trichoderma reesei at 50°C for 3 hours with pH of medium adjusted to 5. Ground fractions were

also subjected to high-pressure dilute sulfuric acid treatment at 125°C, 15 psi for 30 minutes followed by cellulase treatment. Particle size reduction of biomass resulted in altered lignocellulosic composition of feedstocks. For wheat straw, grinding to particle size < 132 microns greatly reduced the lignin content from 20% to almost 5%; also there was reduction in hemicellulose content of the feedstocks at this particle size. Reduction in lignin content considerably increased the effectiveness of enzyme on wheat straw. The reduction in particle size creates more surface area, which benefits enzyme action. Particle size < 132 microns had highest soluble sugar release for all three feedstocks studied. Of the feedstocks studied, wheat straw had highest sugar release followed by soybean hulls and wheat bran respectively. Treatment with dilute sulfuric acid improved porosity by digestion of hemicellulose. Hemicellulose content was reduced to less than 5% in all the three feedstocks on treatment with acid. This additionally enhanced the cellulase action that resulted in two fold increase in sugar in de-starched wheat bran. Similar enhancement was almost 1.5 fold for wheat straw and soybean hulls. This research implies that different deconstruction conditions are necessary for biomass of different composition in order to achieve optimum conversion.

Ferulate trimers and tetramers as arabinoxylan cross-links in corn

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Cereal grain plant cell walls are a major source of dietary fiber. Although hydroxycinnamates are only minor components within the plant cell wall, they strongly influence the physico-chemical properties of the cell wall due to their ability to act as cross-links between polysaccharides. Cross-linking of arabinoxylans influences their gelling properties and probably their solubility. In addition, cross-linking of polysaccharides to lignin (or lignin-like compounds) may partly prevent the polysaccharides from being fermented in the gut. Ferulic acid plays a major role in the formation of radically formed cross-links. Next to ferulate dehydrodimers higher ferulate oligomers have been proposed to be formed in the cell wall. The aim of our studies was to isolate and identify higher ferulate oligomers from corn bran insoluble fiber, a source rich in ferulates. The isolation process included preparation of insoluble fiber, alkaline extraction and several chromatographic procedures such as SEC and RP-HPLC. Identification was achieved by MS and NMR. Seven ferulate trimers and two ferulate tetramers were isolated and fully structurally characterized. Within the trimers, the 8-O-4-linkage seems to play a predominant role being involved in five trimer structures. Next to the 8-O-4-linkage, the 5-5-linkage is an important coupling mode for trimers. The predominant triferulate in maize bran is the 5-5/8-O-4-coupled dehydrotriferulic acid, the 8-O-4/8-O-4- and the 8-8(cyclic)/8-O-4-coupled dehydrotriferulic acids also being dominant within the trimer fraction. The ferulate tetramers were identified as 4-O-8/5-5/8-O-4- and 4-O-8/5-5/8-5(non-cyclic)-dehydrotetraferulic acids, demonstrating the prevalent character of the 8-O-4- and 5-5-linkages within higher ferulate oligomers as well. The results show that ferulate dehydrotrimers and -tetramers now need to be recognized as implicating more diverse modes of cell wall polymers cross-linking.

Development of sorghum bran as an anti-inflammatory nutraceutical

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The anti-inflammatory properties of extracts of four sorghum bran varieties were tested in a topical inflammatory animal model. Ear edema was induced with an application of tetradecanoylphorbol acetate (TPA) dissolved in acetone to the inner and outer surfaces of both ears of male Swiss Webster mice. Acetone and ethanol groups were included as vehicle controls. Extracts of black, sumac, mycogen or white sorghum bran varieties or indomethacin (0.5 mg/ear) were topically applied 30 minutes following TPA treatment. Total phenolic content and ferric reducing antioxidant power (FRAP) values were obtained for extracts (1:4 wt/vol 50% ethanol) of each sorghum bran variety. The application of extracts of black and sumac sorghum bran varieties significantly decreased ear thickness and the weights of ear punches 6 hr after TPA treatment. No effect was observed with mycogen and white sorghum bran varieties. The anti-inflammatory effects of sumac and black sorghum bran varieties were statistically similar to that produced by indomethacin. Anti-inflammatory activities of sorghum bran extracts correlated positively with total phenolic and FRAP values. High anti-inflammatory activities provide further rationale for use of selected sorghum brans in nutraceutical products. (Supported by USDA Grant #5854304363)

Preparation and properties of high oil content starch-oil composites

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Many applications have been developed for aqueous dispersions of jet-cooked starch-oil composites prepared by excess steam jet cooking. Previous formulations have typically contained between 20% and 50% oil by weight based on the weight of starch. In order to expand the range of potential applications, new preparation methods were investigated to increase the oil content to as high as four times the weight of starch. High amylose corn starch was cooked in an excess-steam jet cooker in the presence of oleic acid, and soybean oil was added to form the starch-oil composites. Amylose is removed from solution by forming helical inclusion complexes with the oleic acid, and if the materials are cooled sufficiently quickly the helical inclusion complexes only form small aggregates and shells around the oil droplets, and not a firm gel. Depending on the composition and preparation method, a wide range of stable, high-oil materials from low-viscosity liquids to smooth pastes can be formed. The flow, textural and structural properties of these materials are shown. The materials can be used in a wide range of applications, including spray lubricants, lotions, and for fat delivery in cake mixes.

Crystallization of short chain amylose from debranched waxy corn starch

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The objective of this work was to study crystallization behaviors of short chain amylose during debranching of waxy corn starch and determine the molecular origins of the resistant starch. Waxy corn starch (25% solids, pH 4.0) was heated in a 1L Parr reactor at 115–120°C for 10 min. The cooked starch was cold to 50°C and isoamylase (0.5% based on starch) was added. Debranching was fast at the first hour and complete within 16 h. Gel permeation chromatography (GPC) of totally debranched starch showed a bimodal distribution with two peaks at degree of polymerization (DP) 11 and 30 respectively. Debranched starch was birefringent as observed under a microscope after 4 h. Differential scanning calorimetry (DSC) data revealed a broad endothermic peak ranged from about 40°C to 90°C for samples debranched at 1, 2 and 4 h, and another broad endothermic peak ranged about 90° to 130°C for samples debranched at 16 and 24 h. These results indicated that crystallization took place before debranching was complete and the crystallites became stronger with increase in time. The crystallization of short chain amylose in relation to enzyme digestibility will be discussed, and the information would be useful in better designing starch-based food ingredients for health benefits.

Interrelationship between water activity and speed of deformation on instrumental and sensory characterization of crispness

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A main interests of instrumental characterization of crispness is its correlation to sensorial data. A clear effect was observed of deformation speed on instrumental characterization of crispness and with that its correlation to sensorial data. Toasted rusk roll was used for both instrumental and sensory measurements of crispness. Samples were conditioned at water activity values ranging from 0.3 till 0.8. For the instrumental measurement two deformation speed were used: 0.4 and 40 mm/s. Sensory characterization was carried out by a panel consisting on 8 trained panelists. They were asked to evaluate crispness perception. Analysis of the sound emitted during instrumental measurements was performed by using homemade software implemented in Matlab. The sound parameters analyzed were number of events per unit area of fractured sample, sound total intensity per unit area of fractured sample, maximum intensity, mean pitch, and the fraction of multiple peaks. The measured number of sound events in 1 cm^2 (unit area) of a fresh sample (aw = 0.3) was about 17 times higher for a deformation speed of 0.4 mm/s than for 40 mm/s. On the other hand the sound total intensity per unit area of fractured sample was about 1.3 times higher for 40 mm/s than for 0.4 mm/s. This higher sound intensity is produced by overlap of the sound events at a deformation speed of 40 mm/s. Maximum sound intensity was about 2.3 higher for 40 mm/s than for 0.4 mm/s. The fraction of multiple peaks was about 5 times higher for 40 mm/s than for 0.4 mm/s. The transition of crispy to non crispy behavior as determined by sensory analysis started at an aw of 0.5 and was completed at an aw of about 0.75. For the instrumental measurements this transition depended on the deformation speed during the measurement. This transition started at aw is 0.4 for the low deformation speed and at ~ 0.6 for the high deformation speed and was completed at an aw of 0.6 and 0.75, respectively. This difference in the transition region in aw is likely related to some visco-elastic behavior of the toasted rusk rolls at these aw. So to correlate sensory and instrumental data a proper selection of deformation speed is important.

Effects of extrusion process variables on extractable ginsenosides in wheat-ginseng extrudates

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Effects of extrusion process variables (feed moisture, screw speed, and barrel temperature) on extractable ginsenosides (G, ginseng saponins) in wheat-ginseng extrudates (WGE) produced under different extrusion conditions were investigated. A wheat flour (WF)-ginseng powder (GP) blend (10% GP, w/w) was extruded in a twin-screw extruder (L/D ratio of 25:1) with full factorial combinations of feed moisture (25, 30, and 35%), screw speed (200 and 300 rpm), and zone 5 barrel temperature (110, 120, 130, and 140°C). Samples of WF, GP, WF-GP, and WGE extruded at different conditions were ultrasonically extracted for G. Individual G (Rb1, Rc, Rd, Rg2, and Rg3) were fractionated and identified by RP-HPLC from each sample. The quantities of G (Rb1, Rc, and Rd) extracted from WGE samples extruded at a zone 5 barrel temperature of more than 120°C were significantly higher than those extracted from the control blend, indicating the conversion of malonyl G (Rb1, Rc, and Rd) into G (Rb1, Rc, and Rd, respectively) during extrusion cooking. Neither G Rg2 nor G Rg3 were found in pure WF, GP, nor in the WF-GP blend. Ginsenoside Rg2 was found in all the WGE samples studied. Increasing feed moisture caused a significant decrease in the quantities of G Rg2 in WGE samples. In contrast, increasing screw speed and barrel temperature each led to a significant increase in the quantities of G Rg2 in WGE samples. Ginsenoside Rg3 was present in WGE samples produced under only the following three extrusion conditions: (1) 25% feed moisture, 300 rpm screw speed, and 130°C zone 5 barrel temperature, (2) 25% feed moisture, 300 rpm screw speed, and 140°C zone 5 barrel temperature, and (3) 30% feed moisture, 300 rpm screw speed, and 140°C zone 5 barrel temperature. Thus, the production of new G Rg3 was dependent upon the extrusion process conditions used.

Pasting properties of granular starches exposed to iodine vapor

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In an earlier study we reported the effects on granular swelling and pasting behavior of different starches as a function of iodine content when added at room temperature or at 95°C. In this study we report observations on the differences in the degree of granular swelling and pasting behavior, following exposure of different granular starches to iodine vapor at varying moisture contents (9–25%). Corn and potato starches, and their waxy counterparts, were equilibrated to a_w value of 0.33, 0.75 and 0.97, and then exposed to iodine vapor for 24 h. The absorption spectra of the treated starches were recorded and the starches were analyzed by using the RVA under standard conditions. The K/S maxima increased with increasing moisture content for all starches, as has been previously reported, reflecting increasing mobility of longer segments of polymers with increasing moisture content. Significant differences were also observed in the pasting properties of the four treated starches. Peak and final viscosities of corn starch decreased with the increasing levels of iodine binding. However, with the increasing iodine content, the magnitude of decrease in peak viscosity was greater for potato starch and the decrease in setback was lower, compared to corn starch. Increasing the iodine content of the granular waxy starches also affected their pasting behavior. The effect of iodine absorption on waxy corn starch, as was evident in the case of K/S maxima value, is not reflected in the changes in pasting behavior, while significant differences were observed in the pasting behaviour of waxy potato starch. Comparison of these results with our earlier study, demonstrates that when starch is exposed to iodine vapor granular swelling and pasting properties are different from when iodine is added in solution. These differences are likely a function of the individual granular segments of polymers than bind iodine when equilibrated and exposed to vapor; whereas when iodine is added in solution, all polymers have an equal access to iodine. Further studies will improve our understanding of granular architecture of starch and their relationship to starch functionality.

Morphological, physicochemical and structural characteristics of oxidized barley starch

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Barley (Hordeum vulgare) is one of the major cereal crops and is mainly used in the brewing and malting industries and for animal feeds. Barley still presents an important starch source for food and industrial applications, but in order to increase those application it should be modified. Barley starch was oxidized at different levels and its morphological, physicochemical and structural were determined in order to known the effect of the reagent level. The amylose content in the oxidized starches was higher with the oxidation level due to depolymerization of starch components. However, no evidences of alteration of the morphology and the X-ray diffraction pattern were show, but the crystallinity level increased when the oxidation level rose. The average gelatinization temperature (Tp) of oxidized barley starches showed a slight increase with the oxidation level, but the enthalpy value had an inverse pattern. The retrogradation study showed that in general, the temperatures and enthalpy of the phase transition slightly increased with increasing levels of oxidation. The oxidation decreased the pasting temperature and the peak viscosity of barley starch that might be due to depolymerization of starch components. In the high-performance size-exclusion chromatography (HPSEC) study of the native barley starch, three fractions were obtained, but in the oxidized sample the high-molecular-weight fraction was not presented due to depolymerization of amylopectin. HPSEC chromatograms of isoamylase-debranched evidenced the presence of degradation in the oxidized samples due to longer elution time compared with its parental starch. Oxidation of barley starch might be an alternative to obtain novel starches with specific physicochemical and functional properties and diversify the use of this cereal.

Evaluation of end-use quality in bread wheat using a recombination inbred line population

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Improving the end-use quality of bread wheat is a major target for many breeding programs. This process can be accelerated by using molecular markers tightly linked to the genes controlling the end-use quality. This study was conducted to identify qualitative trait loci (QTL) related to grain quality (grain hardness, kernel weight, and kernel diameter), flour quality (flour protein content, flour yield, and flour paste viscosity), mixing quality (mixing peak time and height, mixing tolerance, and mixing absorption), and baking quality (SDS-SED). A population of 180 recombination inbred lines was generated from a cross between Rio Blanco, a hard white winter cultivar and IDO444, a hard red winter wheat line. Bread-making quality of each line in the population has been evaluated for the seeds sample harvested from two rainfed locations in southern Idaho in 2007. Grain hardness, kernel weight, kernel diameter, and flour yield were significantly correlated between two locations and were then used in marker analysis of this study. Based on multiple regression analysis, three common QTL on chromosomes 1A, 7A, and 7B were significantly associated with grain hardness, kernel weight, and kernel diameter in two locations. In addition, a QTL on 2B was significantly associated with kernel weight and kernel diameter, and a QTL on 4B was significantly associated with kernel diameter in two locations. QTL on chromosomes 1A, 1D, 6A, and 6D were significantly associated with flour yield. Evaluation of QTL for other end-use quality traits is currently in progress.

Modification of extensigraph dough preparation method developed for wheat breeding lines and commercial wheat

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Dough rheological characteristics – resistance to extension and extensibility, are very important wheat flour quality traits for the milling and baking industries, and for new wheat varietal selection in wheat breeding programs. Current available techniques or test methods, such as the AACCI extensigraph standard method or the small-scale TA-XT2 Kieffer method, have some limitations with respect to flour sample size, testing time, water absorption, sample throughput, data interpretation, and results. A modified extensigraph test method utilizing 100 g flour and 2 g salt and adapting 50-g Farinograph optimum water absorption for dough prepared in a 100-g mixer with an orbital speed of 86 rpm was developed to measure dough rheological characteristics. The dough is mixed until it is fully developed. Mix time was much shorter and dough preparation was much easier in the 100-g mixer than that in the 300-g Farinograph. Data generated by the modified method is highly correlated with data obtained by the standard extensigraph method (AACC method 54-10). The correlation coefficients (r) for 93 pairs of each of six extensigraph dough characteristics of 31 different tested wheat samples, grown in Texas, Oklahoma, Kansas, Colorado, Nebraska, South Dakota, and Montana were 0.95 for resistance to extension, 0.93 for maximum resistance to extension,

0.80 for extensibility, 0.93 for ratio of resistance to extension to extensibility, 0.92 for ratio of maximum resistance to extension to extensibility, and 0.81 for the area under the curve. There were also significant correlation coefficients for the data of extensigraph dough characteristics evaluated at each of three tests (30, 60, and 90 min.) between the modified and standard methods. Therefore, the modified extensigraph test method is a useful and valuable alternative for wheat breeding programs, milling and baking industries, crop quality surveys, and wheat quality research due to its smaller flour sample requirement and the reduced time required for dough preparation.

Effects of addition of mushroom fiber on the baking qualities and on the total dietary fiber content of baked products

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Sclerotia of Pleurotus tube-regium contains over 80% total dietary fiber (TDF). It has a high degree of whiteness which makes it a possible source of dietary fiber for addition to food. Due to its low moisture, plain taste, and higher fiber content, the sclerotia of the mushroom can be ground to a fine powder and added to food products without further treatment. Effects of addition of the mushroom powder (MP) on bakery product qualities as well as the effect of baking processes on TDF content of the MP added to the baked products were studied. Three bakery products (bread, cookies and crackers) were used in the experiment. 0%, 5%, 7.5% or 10% (w/w) MP was added to each of the bakery formulations. It was found that the volume of bread significantly decreased and the hardness of bread significantly increased when 7.5% or higher of MP was added. Diameter of cookies and the hardness of cookies significantly decreased when 7.5% or higher of MP was added. For crackers, length, width, thickness and hardness decreased with increasing percentage of MP added. A decrease in moisture was observed for crackers with addition of the MP. Among the products containing 7.5% MP, TDF content of crackers increased after baking, while TDF contents of both bread and cookies decreased after baking. No significant changes in size and texture were found for any of the three studied bakery products with incorporation of 5% (w/w) mushroom powder. Thus, sclerotia of Pleurotus tube-regium could be a possible source of fiber for enrichment of bakery products.

***In vitro* digestibility and physicochemical properties of germinated brown rice**

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Brown rice grains, steeped in an ambient water for 24 h, were germinated at 25°C under 100% relative humidity up to 36 h. During the germination, brown rice samples were collected at regular intervals (6 h, 12 h, 24 h and 36 h) and dried at 40 or 60°C, and *in vitro* digestibility and physicochemical properties of the germinated brown rice were measured. Almost all brown rice grains were geminated within 12 h, after which only sprout length increased. The overall digestibility of the rice samples after cooked increased by germination. Rapid digestible starch (RDS) and slow digestible starch (SDS) contents were increased (24.79→42.57% and 35.97→41.49% respectively), but resistant starch (RS) content was reduced by the germination (39.86→ 15.94%). The estimated glycemic index (GI) value of the cooked rice samples (dried at 60°C), measured by the kinetics of *in vitro* starch hydrolysis, was increased by germination (69.48→83.00). The rice samples dried at 40°C showed higher digestibility after cooking than those dried at 60°C. It indicates that drying process also affects the digestibility. As germination was proceeded, the molecules weight decreased (790,000→320,000 g/mol) indicating that the enzymatic hydrolysis of starch contributed the increase in digestibility. Overall pasting viscosity of the samples (RVA) decreased by germination, and the decrease was specially significant after 12 h. This result suggests that the structural changes of starch in brown rice granules occur more substantially during the growth of the sprout, rather than the initial sprouty period. Hardness of cooked samples was decreased by germination but other texture parameters were not significantly changed. *In vitro* digestibility and physicochemical properties of germinated brown rice could be controlled by germination time and drying temperature. Optimization of germination process for improving nutritional and physicochemical properties should be considered for in future study.

Differences in functional properties of starches between hard and soft wheat genotype

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Gelatinization, pasting and retrogradation properties of starch significantly affect processing, cooking and textural quality as well as shelf life of many wheat-based food products. Amylose content of starch depends mainly on the genetic background of wheat and is largely responsible for variation in functional properties. To explore the differences in gelatinization, pasting and retrogradation properties of starches between wheat classes, we isolated prime starches from wheat genotypes of contrasting classes, including regular and partial-waxy starch endosperm, hard and soft, white and red, and winter and spring wheat, and determined their pasting properties using a micro-visco amylograph, syneresis during storage and hardness of gel. Six partial-waxy wheat genotypes exhibited lower pasting temperature and greater peak viscosity than 12 genotypes of regular starch. In wheat genotypes of regular starch, starch pasting temperatures of four hard white (HW) wheat genotypes ranged from 83.4 to 85.7°C, while those of seven soft white (SW) wheat genotypes ranged from 79.2 to 82.9°C. SW wheat genotypes, with the exception of one SW genotype, were lower in peak viscosity of starch than HW genotypes. Similarly, in genotypes of partial-waxy starch, three SW wheat genotypes exhibited lower pasting temperature (69.2–76.6°C) and smaller peak viscosity (201-236 BU) than three HW wheat genotypes, which had pasting temperature and peak viscosity of 78.0–80.1°C and 246-261 BU, respectively. In both regular and partial-waxy genotypes, hard white wheat exhibited greater peak temperature than hard red wheat genotypes, while differences in peak viscosity between white and red wheat genotypes were inconsistent. Syneresis and hardness of starch gel stored for 7 days at 4°C varied widely among genotypes, but the differences between hard and soft wheat genotypes were not significant. Starches of regular amylose content showed much greater syneresis and hardness of starch gels than partial-waxy starches, which ranged from 1.51 to 7.18% and 15.5 to 23.0 N in the former, and from 0.20 to 0.57% and 12.1 to 15.8 in the latter, respectively.

Extension of the breakage equation for First Break milling of wheat: Characterisation of the mineral composition of wheat stocks by ICP-OES

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In the flour milling process, First Break roller milling is a critical unit operation because the particle size distribution resulting from First Break determines the performance of the rest of the process. Previous work has therefore aimed to predict the particle size distribution of material exiting First Break, based on wheat kernel properties and roller mill operation. However, particles exiting First Break vary not only in size, but also in composition; the outer layers of bran from the wheat kernel tend to stay as large particles, while the starchy endosperm tends to break into smaller particles. Therefore, the current work aims to extend predictions of wheat breakage to include particle composition as well as size. The mineral profiles of wheat components (pericarp, aleurone layer, germ and endosperm) were quantified by mineral analysis using ICP-OES (Inductively Coupled Plasma - Optical Emission Spectrometry). Then, the proportions of these components in size fractions produced on breakage of wheat during First Break roller milling were quantified, based on the mineral profiles of these fractions. The distributions of these components were incorporated mathematically into the breakage equation. The results showed that, under both roll dispositions (Sharp-to-Sharp and Dull-to-Dull), germ and aleurone material tended to distribute across all size ranges evenly, while endosperm was found more in the smaller size fractions, as expected, and pericarp in the larger fractions. The work provides the basis for extending the breakage equation to model particle composition as well as size following First Break roller milling of wheat.

Production of bioethanol from steam flaked sorghum and maize

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The aim was to study the effect of steam flaking on bioethanol production and the effects of this hydrothermal and physical process during liquefaction, saccharification and yeast fermentation. A bifactorial experiment with a level of confidence of $P < 0.05$ was designed to study differences among grains (sorghum and maize) and the effectiveness of steam flaking. Grains were steamed flaked in order to increase starch bioavailability and break down endosperm proteins. The steamed flaked sorghum had significantly higher starch hydrolysis during liquefaction with heat stable alpha amylase compared to the regular kernel. This hydrolyzate contained about 33% more reducing sugars compared to the untreated counterpart. At the end of saccharification the final glucose concentration in steamed flaked sorghum was similar to the concentration obtained in whole maize mashes and 26% higher compared to whole sorghum. Results showed that steam flaking, especially in sorghum, can significantly increase the ethanol yield during yeast fermentation. Therefore, the steam flaking is a physical treatment useful to increase ethanol

production especially in sorghum due to the higher starch bioavailability and the reduction of physical barriers for enzymatic hydrolysis.

Preparation and properties of biodegradable starch-LDHs nanocomposites

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A simple but effective method has been successfully employed to incorporate layered double hydroxides (LDHs) nanoparticles into starch-based materials. This method involved a fast coprecipitation followed by the controlled hydrothermal treatment conditions that completely leached out starch molecules and aged LDHs nuclei at the same time. X-ray diffraction (XRD) and transmission electron microscopy (TEM) analyses showed that the plate-like LDHs crystallites stacked in the rhombohedral structure with a d-spacing of ~7.7 Å. The homogeneously dispersed crystallites were no preferential orientation in acid-modified starch (AMS) matrix, whereas tending to an aggregated morphology in native corn starch (NCS) matrix. Furthermore, the crystallites were in size of 44–60 nm and their thickness were 5–10 nm, corresponding to 5–8 layers per stack. When native and acid-modified corn starch-LDHs nanocomposites were stored at relative humidity (RH, %) = 53 or 97% for two days, the relative B- and VH-type crystallinity were 21–25 and 4–5%, respectively. The introduction of 0–12% LDHs nanoparticles did not restrain recrystallization of starch effectively. The phase separation was more pronounced in the samples of NCS4 (NCS containing 11.66% LDHs) and AMS1 (without LDHs) as observed by light microscopy. The higher concentration of LDHs nanoparticles resulted in more aggregated polymer phases inside the NCS, but not in AMS. The interaction between starch and LDHs nanoparticles was significantly influenced by the molecular weight and structure of starch molecules. The opacity of NCS increased from 40 to 100 × 10-5 AU with 3.31% LDHs addition, but AMS remained the same opacity (~ 40 × 10-5 AU) when LDHs loading was less than 10%. Tensile tests performed on the nanocomposites showed that acid-modified starch-10.47% LDHs nanocomposites (AMS4) display enhanced Young's modulus compared to those of the NCS nanocomposites and neat matrix. Moisture isothermal sorption indicated the incorporation of LDHs nanoparticles did not significantly increase the hydrophilicity of the starch-based materials in this study.

Impact of annealing and heat-moisture treatment on rapidly digestible, slowly digestible and resistant starch levels in native and gelatinized corn, pea and lentil starches

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Impact of annealing (ANN) and heat-moisture treatment (HMT) on rapidly digestible starch (RDS), slowly digestible starch (SDS), resistant starch (RS), and expected glycemic index (eGI) of corn, pea, and lentil starches in their native and gelatinized states were determined. ANN was done for 24 h at 70% moisture at temperatures 10 and 15°C below the onset (T_o) temperature of gelatinization, while HMT was done at 30% moisture at 100 and 120°C for 2 h. The swelling factor (SF), amylose leaching (AML) and gelatinization parameters of the above starches before and after ANN and HMT were determined. SF and AML decreased on ANN and HMT (HMT > ANN). The gelatinization temperatures increased on ANN and HMT (HMT > ANN). However, the gelatinization temperature range decreased on ANN but increased on HMT. Birefringence remained unchanged on ANN but decreased on HMT. The Fourier transform infra red (FT-IR) absorbance ratio of 1047 cm^{-1}/1022 cm^{-1} increased on ANN but decreased on HMT. ANN and HMT increased RDS, RS and eGI levels and decreased SDS levels in granular starches. HMT had a greater impact than ANN on RDS, RS, and SDS levels, whereas a much greater increase in eGI levels was observed on ANN than HMT. In gelatinized starches, ANN and HMT decreased RDS and eGI, but increased SDS and RS levels. These changes were more pronounced on HMT. This study showed that amylopectin structure and interactions formed during ANN and HMT had a significant impact on RDS, SDS, RS and eGI levels of starches.

Identification of bioactive components and utilization for possible hypoglycemic effects from *Oryza sativa* cv. *Heugjinjubyeo*

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From *Oryza sativa* cv. Heugjinjubyeo (OSH), anthocyanins, phenolic acids, flavonoids, alkaloids, sterols, and sugars were identified as bioactive components by an activity-monitored fractionation and isolation method. A human study was then conducted to determine whether supplementation with OSH decreases blood glucose levels. OSH cakes were made at a rice mill according to a specific recipe and then frozen and stored until use. Study participants were recommended by medical doctors at DoBong-Gu Health Center, DoBong-Gu Office. Eleven subjects, 6 women and 5 men, aged 63.0 ± 10.7 yr (±SD), eating 1557.7 ± 374.0 calories/day, with body weights of 68.6 ± 11.4 kg, were included in the study. Medical records were obtained from the DoBong-Gu Health Center. The participants were told to eat one slice of OSH cake (33.3 g) with every meal for 4 weeks. After 4 weeks, blood samples of participants were drawn for biochemical analyses. After intake of OSH cakes (100 g/day for 4 weeks), fasting plasma glucose and postprandial plasma glucose levels decreased by 9.0% (90.5 ± 14.3 to 88.0 ± 12.5) and 9.60% (142.7 ± 40.3 to 128.5 ± 40.5), respectively. HB A1c ranges were not changed by OSH rice supplementation. In conclusion, eating OSH cake might bring down blood glucose levels by means of bioactive components. Further studies are needed to determine possible longer-term effects of OSH on blood glucose control.

Sorghum bran extracts as novel functional food and beverage ingredients for metabolic syndrome market

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The purpose of this research was to formulate novel nutraceutical beverages containing polyphenolic extract from high-tannin sorghum bran (*v.* Early Sumac). The functional beverage formulations also contained ingredients which exhibited complementary attributes for taste, appearance and health. The beverages were appropriate for improving the diets of those with chronic disease states such as inflammatory diseases, metabolic syndrome, pre-diabetes or diabetes. For beverage formulation, sorghum bran was extracted with either 50% aqueous ethanol or hot water. Other ingredients used were white grape juice and hot water extracts of cinnamon and allspice. Total phenolic content of the beverages was assayed by the Folin-Ciocalteu method. Antioxidant potential was estimated by the FRAP (ferric reducing antioxidant potential) method. A series of formulations with different proportions of ingredients ranged in total polyphenolic content from 1.8–3.4 mg of gallic acid equivalents per mL of solution. In an 8-ounce serving, this would provide 400–800 mg of polyphenolics. FRAP values were about 10 mmol of ferrous sulfate equivalents per mL of solution. Functional data relevant to metabolic syndrome and diabetic markets was obtained by testing the ability of the formulated beverage to inhibit fructose-induced glycation of albumin protein *in vitro*. Glycated albumin is an example of the advanced glycation endproducts (AGE proteins) formed when sugar levels are not well regulated in conditions involving insulin resistance. The IC50s (concentration for 50% inhibition) were expressed as dilutions of the beverage formulations. IC50s ranged from 500–750 x dilutions to inhibit advanced glycation endproduct formation *in vitro*. In sensory analysis, beverages were evaluated for overall acceptability, flavor, color, aroma, mouthfeel, and likelihood of purchase using 5- or 9-point structured hedonic scales. In summary, novel beverage compositions containing extracts of Sumac sorghum bran and spices provided high levels of polyphenols, antioxidants, and anti-AGE protein inhibition, enhancing the functional value of white grape juice.

Sweet bread crumb structure evaluation by means of image analysis

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Image analysis (IA) has become a useful tool in the food industry. It has been used to study the shape and microstructure of foods. Bread products and specially their internal characteristics has not been the exception. The IA crumb evaluation has been applied mainly on salty pan bread, measuring the cell size, cell density, the number of pores and its circularity among others. Many of these IA studies have been carried out on salty bread using different software programs that allow a fast and cheap analysis of the samples. However there are not reported studies of this technique applied on sweet bread. The aim of this study was to develop a methodology to evaluate the crumb features of three different commercial kinds of sweet bread using IA techniques. The kinds of sweet bread analyzed were: yeasted sweet bread,

danish bread and "panque". This last kind of bread is similar in structure to a pound cake. The study was divided in two steps. The first one includes the determination of the best scanning resolution to obtain the best images. Once obtained this data, the level of brightness and contrast were chosen. Best results were: 555 dpi resolution, a minimum of 60 and a maximum of 165 for bright and contrast respectively. This data corresponds to the software conditions that gave as a result the best segmentation of the samples. This evaluation was carried out using the program ImageJ. Once these parameters were obtained, 16 samples of each kind of bread were analyzed for their crumb structure (mean cell area and cell density, shape factor and maximum perimeter). In this evaluation the program SigmaScan Pro was used. The effect of using two types of filters (Otsu and manual Threshold) was also evaluated. Results showed that there was not significant difference ($P > 95\%$) when using both filters and yeasted sweet bread and Danish bread presented similar crumb characteristics, having both of them bigger mean cell area, smaller cell density and a smaller perimeter compared to the "panque". This study showed that IA is a useful tool to characterize different kinds of sweet breads.

Modification of sorghum proteins for enhanced functionality

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Sorghum is the third most widely produced crop in the United States (U.S.) and fifth in the world during fiscal year 2006/07(USDA-FAS, 2007). The use of sorghum in foods faces functional and nutritional constraints due, mainly, to the rigidity of the protein bodies. The disruption and modification of these protein bodies can improve protein functionality and increase the use of sorghum in food applications. This study explores various ways to achieve this, including extrusion processing with the simultaneous conjugation of sorghum proteins to sugars. Sorghum flour (SF) and a sorghum flour-dextrose (SFD) blend (2:1 by weight) were processed in a twin-screw extruder at two barrel temperature settings (low or ≤80°C and high or ≤100°C), two extruder screw speeds (165 and 225 rpm) and varying in-barrel moisture contents (MC; 11–37% wet basis). Sorghum proteins from extruded SF and SFD were sequentially extracted with water and sodium dodecyl sulphate (SDS), followed by size exclusion-high performance liquid chromatography (SE-HPLC). SE-HPLC of SDS extracts more efficiently differentiated treatments. The molecular weight distribution of proteins extracted from extruded SF and SFD were higher than those of kafirin monomers. Dextrose increased protein solubility in both water and SDS. Higher MC increased protein solubility, while increasing processing temperature reduced it. Protein solubility was greater at higher screw speeds only at the lower process temperature. In general, lower specific mechanical energy (SME) input during extrusion resulted in higher protein solubility. Confocal scanning laser microscopy (CSLM) micrographs of representative sorghum extrudates showed disruption of the protein matrix during the extrusion process. Making sorghum proteins digestible and available for interactions opens avenues for applications in gluten-free food products. In addition to thermo-mechanical treatments, research is underway on enzymatic and chemical methods of modifying sorghum proteins.

Three-dimensional measurement of bubble size distribution in dough

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A novel technique to recognize bubbles in bread dough and to analyze their size distribution was developed by using Micro-Slicer Image Processing System (MSIPS). MSIPS enabled reconstruction of three-dimensional (3-D) images based on two-dimensional (2-D) cross-sectional images obtained during multi-slicing of a dough sample with a thickness of 1 μm. Samples were taken from the final stage of dough mixing process, which is generally classified into five distinctive stages, and they were frozen in liquid nitrogen before slicing tests. Bubbles in dough samples were identified as defocusing spots in 2-D images acquired by MSIPS due to the difference in focal distance created by vacant spaces. From a frozen dough sample, 250 cross-sectional images were taken from a 500 × 396 × 237 μm portion. Thresholding of the 250 2-D images provided binary images containing 891 circles of equivalent diameters ranging from 1.7 to 34.7 μm with an average of 10.8 μm. A total of 235 bubbles were recognized by reconstructing the circles in the 2-D images into 3-D spheres; and the volume, length of major and minor axes, nucleus, and aspect ratio of each bubble were measured from the 3-D images. Expressly, the measuring method for the equivalent diameters of the spheres corresponding to the bubbles was established, and the equivalent diameters of spheres in the 3-D images were larger than those of circles in the 2-D image. The proposed technique can provide a novel tool to investigate the effect of mixing treatment on size, morphology and distribution of bubbles in bread dough.

Inhibition of aromatase activity by tannins and flavonoids from sorghum bicolor

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Aromatase catalyzes the conversion of testosterone to estradiol and is a target for chemotherapy of breast and prostate cancers. We compared *in vitro* inhibition of human aromatase and porcine alpha-amylase by bran extracts from two sorghum cultivars that have similar phenolic levels but differ in tannin content. Tannin-rich sumac sorghum inhibited alpha-amylase more strongly (IC50 = 1.4 μg/mL) than did black sorghum (IC50 = 11.4 μg/mL), which lacks tannins. Sumac inhibited aromatase activity slightly more than did black sorghum (IC50 = 10.8 μg/mL v. 12.2 μg/mL). Bovine serum albumin (BSA), which binds tannins, reduced inhibition by sumac but not black sorghum in both enzymatic reactions. Sumac tannins, separated from other flavonoids on Sephadex LH-20, inhibited both enzymes but showed reduced inhibition in the presence of BSA. Non-tannin flavonoids from either cultivar had higher IC50 values for both enzymes than the tannins, and BSA had little effect on their inhibition. We conclude that aromatase is inhibited both by non-tannin flavonoids and by the tannins of sorghum. Only non-tannin flavonoids are expected to be bioavailable to prostate or breast tissue. (Supported by USDA Grant # 5854304363

Relationship between bread characteristics and the Mixolab

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End-product quality is always the results of the raw material quality (i.e. flour quality) and the process. We should also pay attention that customer's habits and culture also define the product quality. If one considers standard white pan bread; customers will ask for a good shape, a good flavour, good colour, fine and regular alveols, soft crumb and good shelf life. Considering this pan bread always produced under the same process conditions, flour functionality plays a critical role in the bread formation. The water absorption will be influenced by several components (proteins, starch, damaged starch, and pentosans). Dough mixing characteristics influence the dough matrix creation, air incorporation forming nuclei that will be the base of future alveols. Gluten characteristics and particularly hydrogen bonds between chains and influence dough behaviour during the 1st phase of baking, influencing the volume. Starch quality and possibility to gelatinise (this gelatinisation is limited in dough systems where water is not fully available) and will influence the crumb softness. Amylasic activity, which will influence gas production, bread volume, cell diameter, colour, crumb stickiness. The starch retrogradation will influence the bread shelf life. 50 wheat flour samples with bread volume between 1071 cm^3 and 1999 cm^3, bake absorption between 55.9% and 61.3% and dough scoring between 22 and 97 are analyzed with the Mixolab. Prediction model based on the data given by the mixolab (times, torques and temperatures) have been developed for these 3 parameters. The obtained predicted models show very good performances. 98% of volume predictions, 100% of bake absorption and 98% of dough scoring are inside the reproducibility limits of the standard. The Mixolab permits to determine the bread characteristics on wheat flour samples.

Dietary fiber and its fractions on commercial 'high fiber' breakfast cereal as related to their basic ingredients

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The beneficial effect of dietary fiber consumption in human health has long been recognized. Changes in the daily diet towards increasing consumption of whole grains have been proven their effect on reducing the incidence of cardiovascular diseases and various types of cancers. Most of the ready-to-eat commercial breakfast cereals classified as 'high fiber' cereals are industrially prepared from whole grains as wheat, corn, oats and rice, or their various fractions as wheat germ and cereal bran. The purpose of this research was to establish a relationship in the dietary fiber and its components (soluble and insoluble fractions) from commercial 'high fiber' breakfast cereals, and the dietary fiber (soluble and insoluble fractions) from whole grains, mainly cereals use for their preparation. Nine commercial 'high fiber' breakfast

cereals were selected and four cereals: wheat, corn, oat and rice, wheat germ and wheat bran. A highly consumed corn flake cereal was used as a reference. All samples were analyzed in their chemical composition, dietary fiber contents, soluble (SDF) and insoluble (IDF) according to recommended official methods. Results showed that ready-to-eat commercial 'high fiber' breakfast cereals have significant differences in their dietary fiber contents, and also in their soluble and insoluble dietary fiber fractions. These differences in dietary fiber are associated to the whole grain cereals use in their manufacture.

Wheat gluten influences oil droplet size and mobility in jet-cooked starch-oil composites

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Jet cooked starch-lipid composites have been developed as a technology for suspending micron-size lipid droplets in aqueous cooked starch dispersions. Normally oil droplets are independent and freely mobile in such liquid composites. When wheat flour was used as the starch source, unusual behavior of the cooked dispersion was observed suggesting gluten effects on oil droplet distribution. Wheat gluten was shown to form amorphous networks and condense into dense masses when jet cooked alone, but when combined with wheat starch, the gluten networks were suspended in the dispersion. Soy oil droplets were observed to be embedded in the gluten networks in ternary composites with wheat starch and gluten as well as flour-oil composites, and no freely mobile oil droplets were seen. Association of oil droplets with gluten did not occur when mixed together after cooling jet-cooked dispersions. Wheat gluten reduced the size of soy oil droplets in cornstarch-soy oil composites, entrapped all oil droplets into gluten network fragments, and substantially increased the efficiency of oil encapsulation in drum dried composites. These observations explain the unusual behavior of jet-cooked flour-oil composites and enable the design of liquid and dried cornstarch-lipid composites with higher oil content.

The effect of enzymic activity of wheat flour on its dough characteristics and Barbari bread quality

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Wheat germination increases the enzymic activity and its use at bread production, would affect bread quality. In this research we studied the effect of addition of germinated wheat flour (GWF) to the control flour on the dough and bread characteristics. One of the accessed wheat varieties purchased from local market and was germinated. Different percents of germinated wheat flour (GWF) added to the Barbari bread flour (control flour) till the resulted falling numbers were (150, 200, 250, 300, 350) ± 10 seconds. The control and 5 mixed flours analyzed for maltose value, farinograph and extensograph experiments. Barbari breads baked from them and sensory analysis was done on the produced bread. The results are summarized as follow: 1-Maltose value increased when the percent of GWF increased in the mixed flours and the highest maltose value observed in the GWF which is related to amylolitic activity. 2-All farinograph parameters (except dough softening that increased) decreased by the reduction of flour falling number. This reduction (and increase) was not mainly significant in the flours with adjacent falling numbers but became significant when the difference between falling numbers increased that is the result of proteolitic activity ($P < 0.05$). 3-All the extensograph determined parameters in 3 different fermentation periods (45, 90 and 135 minutes) show direct relation with the flour falling number. It was because of proteolitic activity and the curve didn't draw in the flour with the falling number of 150 seconds for 135 minutes fermentation. 4-The addition of 0.94% GWF to the control flour improved the resulted bread quality but more amounts had undesirable effect on the bread quality. In sensory analysis, the low enzymic activity in the control flour put it in the more inferior place than the bread made of the flour with the falling number of 350 seconds. 5-According to the results of all experiments, the best falling numbers for the production of Barbari breads were 300–350 seconds.

Genetic diversity in chickpea (*Cicer arietinum* L.) for carbohydrate seed quality traits

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Chickpea is a major pulse crop in Canada, which contributes nearly 40% of chickpea global trade with Saskatchewan contributing over 80% of Canada's contribution. The major storage compound in pulses are carbohydrates, the quantity and quality of which can affect physical attributes of grain as well as its utilization in human diets and/or other applications. Mini core subset (211 accessions-defined as unimproved genotypes or landraces) defines or represents the smallest size (1%-developed by the cluster analysis method) of the entire ICRISAT's chickpea accessions (16,991). This mini core, reported to retain 70% of alleles and capturing most of the useful variation of the entire chickpea collection has been developed at ICRISAT, Hyderabad, India. The objective of this study was to analyse the genetic diversity in/and the relationship among selected grain quality traits of chickpea mini core. This will in the short-term assist in identifying potential parental lines to be used directly in the chickpea breeding program and in the long-term, selected accessions can be used to study the biosynthesis and regulation of grain carbohydrates in chickpea. Starch, amylose, protein, seed color, seed size and thousand seed weight were determined by AACC Method 76-13, High Performance and Size Exclusion Chromatography, AACC combustion method, Hunter Lab machine, digital vernier caliper and electronic seed counter, respectively. These chickpea collections belonged to the two cultivated and market classes; desi and kabuli. Desi total starch (TS), ranged from 42.0% (Ethiopia) to 61.0% (Myanmar) with mean of 51.5 ± 3.6%. TS of kabuli ranged from 41.3% (Russia) to 59.0% (Chile) with mean of 50 ± 3.7%. In both types, accessions having extreme starch contents had average protein contents of 22–25%. Amylose concentration ranged from 22% (Iran) to 30% (Ethiopia) in desis and 24% (Canada) to 30% (Russia) in kabulis with means of 27.6% and 27.5%, respectively. Shannon-Weaver diversity indices for seed color, shape, seed size, TSW, protein, starch and amylose were respectively 0.19, 0.18, 0.19, 0.19, 0.18 and 0.18. We will present detailed analysis, distribution and range of starch, amylose, protein, seed color, seed size, and thousand seed weight traits of this mini core. Keywords: Chickpea, desi, kabuli, genetic diversity, starch, amylose, minicore.

The relative merits of instrumental and sensory evaluation of rice

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Evaluation of rice is an important process to ensure the quality of current and new varieties. Rice quality evaluation is often undertaken using a sensory panel and this technique is useful in predicting the acceptability of rice based products. However, sensory analysis using trained panels is expensive and time consuming and is only suitable for small sample numbers. Alternative instrumental methods have been investigated by numerous researchers in various types of evaluations in an attempt to replace trained sensory panels. This paper discusses the relative merits of instrumental techniques and sensory panels in the evaluation of the changes that occur in rice quality during storage.

Phenolic acids profile and antioxidant capacity of selected Canadian and Egyptian barley cultivars and their pearling fractions

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There is a growing demand for functional food ingredients that offer therapeutic and disease-prevention properties. In this respect, barley would be a potential candidate due to its high content of bioactive compounds such as beta-glucan and phenolic compounds. In the current study, selected Canadian and Egyptian barley cultivars and their pearling fractions were investigated in terms of phenolic acids composition and antioxidant capacity against DPPH radical, ABTS radical cation and human LDL oxidation *in vitro*. Seven phenolic acids including caffeic, para-coumaric, ferulic, para-hydroxybenzoic, protocatechuic, syringic and vanillic were separated and quantified in barley samples using HPLC and DAD detector. Ferulic and para-coumaric were the primary acids in all the cultivars and fractions accounting for 43–97% and 2–55% of the total phenolic acids, respectively. This broad range demonstrates significant variations among cultivars and pearling fractions. Barley cultivars also significantly varied in antioxidant properties with hull-less barley exhibiting the greatest capacity. Among pearling fractions, the outer layers fractions had the highest scavenging capacity toward ABTS and DPPH radicals whereas the endosperm fractions had the least antioxidant capacity. The outer layers fractions also exhibited relatively high inhibitory effects toward LDL oxidation. The hull fractions obtained from hulled barley cultivars showed high levels of phenolic acids and antioxidant capacity. These

results suggest that barley outer layers and hull fractions would be good sources of natural antioxidants.

Characterization of flour proteins derived from waxy wheat lines

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Six waxy wheat lines utilized in this study are relatively new. Preliminary work in our group has shown that six newly developed hard waxy wheat flours have different rheological properties compared to normal hard wheat flours. The objective of this work is to investigate the molecular structure of protein in hard waxy wheat flours and relate the information to their rheological properties. Flours were examined for % gluten index by gluten washing method using Glutomatic 2200™. The data indicated that % gluten index was lower in waxy wheat lines compared to the non-waxy varieties. Additionally there were differences in % gluten index among waxy wheat flours. Flour proteins were analyzed using reverse-phase HPLC following sequential extraction of gliadins and glutenins. Gliadins were extracted using 50% 1-proponal, while glutenins were extracted using 50% propanol + 2% BME. The results indicated differences in the levels of omega-5, omega-1, 2 and gamma-gliadins in waxy wheat flours as compared to non-waxy wheat flours. Glutenin composition indicated the absence of some high molecular weight subunits in some waxy wheat flours. The data from RP-HPLC along with additional characterization of proteins using lab-on-a-chip electrophoresis will help explain the differences in observed properties of waxy wheat proteins. Additionally, it will give novel insights into the variation in protein composition among newly developed way wheat lines and between waxy wheat lines and normal hard wheat flours.

Evaluation of ohmic heating processing factors used to obtain corn tortilla

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Corn tortilla, a food product highly consumed in Mexico, is prepared by a traditional cooking process called nixtamalization (alkaline cooking). However, nixtamalization has some disadvantages such as long processing time and pollution effluents. Ohmic heating, which uses an electrical current to heat materials, is an alternative heating method for food products, capable of reducing process time and effluents. The objective of this work was to determine whether ohmic heating could be used as an alternative to nixtamalization and to determine the important factors affecting the process. Dry corn kernels were milled and the resulting powder was cooked in an ohmic heating cell. A 2^5 factorial design was run in duplicate. Factors were applied voltage (80–110 V), temperature (90 and 110°C), moisture content (50 and 70%), particle size (0.5 and 0.8 mesh) and lime content (0 and 0.5%). The responses measured were dough yield, adhesion, texture, and tortilla moisture content. Results showed that moisture content, temperature, applied voltage and lime content had significant effects ($P \leq 0.05$) only on tortilla moisture content and texture. Particle size did not have a significant effect on any of the responses. The factors primary interactions had a significant effect on dough yield. Some factor combinations were adequate for obtaining tortilla with good quality. It was concluded that ohmic heating has a great potential to be used in the production of corn tortilla.

Milling quality, rheological properties and bread volumes of near-isogenic wheat lines with contrasting grain textures

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Two near-isogenic lines (NIL-1 and NIL-2) of the common wheat cv. Enesco, which differ only in their grain hardness characteristic, were grown at two locations according to a randomised block design with three replications, and compared for their agronomic traits, milling quality, rheological properties and bread volume. Wild-type alleles *Pina-D1a* and *Pinb-D1a* coding for puroindoline proteins, which are responsible for the soft texture (SKCS value = 36 ± 4) in NIL-1, were found to increase flour yield and alveograph extensibility L compared to hard NIL-2 (SKCS value = 69 ± 5) containing null allele *Pina-D1b* coupled with *Pinb-D1a*. On the contrary, water absorption, alveograph parameters P and W, farinograph peak time and stability were low in NIL-1 compared to NIL-2. However, no significant differences were observed in bread volumes between the two NILs analysed. Variation in 1,000-kernel weight due to environmental effects was found to affect kernel hardness in both NILs. The amount of puroindoline proteins on starch granules was found to be a major factor affecting wheat grain end-use quality.

Nutrient retention of vitamins and minerals in cooked whole grains

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Recipe calculations are used in many applications, such as food consumption surveys and food service, to estimate the nutrient content of multi-ingredient foods when analytical data are not available. When using uncooked foods as ingredients in recipes, retention factors are needed to account for loss of nutrients in cooking. Samples of amaranth, quinoa, and spelt were analyzed to provide nutrient values for these whole grains. The analytical nutrient data for both the uncooked and cooked forms of these grains, in conjunction with food weights before and after cooking, provided the opportunity to calculate nutrient retention factors for the vitamins and minerals. 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. Standardized cooking procedures based on package directions were developed for each type of grain. Uncooked and cooked samples for each composite along with appropriate control and reference materials were shipped to analytical laboratories. Composites were analyzed for proximates, ten minerals, six vitamins, and other components using validated methods as part of USDA's National Food and Nutrient Analysis Program. The nutrient data are presented in the USDA National Nutrient Database for Standard Reference at http//:www.ars.usda.gov/nutrientdata. Percent true retentions were calculated via the USDA Nutrient Data Bank System for each of the cereals using the following algorithm: percent true retention = (nutrient content per g of cooked food * g of cooked food) / (nutrient content per g of raw food * g of food before cooking) * 100. This method accounts for the loss or gain of moisture from food that occurs during preparation and cooking. Retention of iron, magnesium, phosphorus, copper and manganese ranged from a low of 85% in quinoa to 100% in spelt. Selenium had 100% retention in all three grains. Retention of vitamins was more variable, ranging from a low of 45% for riboflavin in amaranth to 100% for niacin and vitamin B_6 in spelt. This research provides retention factors that can be used to calculate nutrient content when uncooked grains are used as ingredients in recipe calculations or when there are no nutrient values available for other cooked whole grains such as wheat berries.

Folates content and the dough rising ability of baker's yeast obtained at medium involving p-aminobenzoic acid (PABA)

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The aim was determined the effect of the addition of p-aminobenzoic acid to a culture medium on the capacity of *Saccharomyces cerevisiae* yeast to accumulate folates and the attempt of using that yeast biomass in the bakery industy. Experiments were conducted with a diploid strain of bakery yeast *Saccharomyces cerevisiae* 2200 (Pure Cultures Collection of the Department of Biotechnology and Microbiology, Warsaw University of Life Science). The experimental media was molasses medium (10 Blg). Molasses culture media without PABA were used as a control. Folates were determined by the HPLC method using a Phenomenex Synergi UU Hydro RP-80-A column (250 × 4.6 mm; 2U micron), a UV–HP 35900 interface detector, and a HP-1046A programmable fluorescence detector. The content of total folates in the biomass of *S. cerevisiae* -2200 cultured in the control medium reached 1632 microng/100 g d.m. PABA addition at concentrations of 1 to 25 microng/ml to the experimental medium resulted in a significantly higher content of folates. The cell biomass of yeast obtained from the control and experimental media was characterized by the presence of two forms of folates, namely THF and 5-CH3-THF. In each case, the prevalence of methylated tetrahydrofolate was observed (72 to 89% of the total folates estimated). The rising activity of yeast obtained at control medium (without PABA) measured up Polish Norms. PABA addition at concentrations of 1 to 25 microng/ml to the experimental medium resulted in a significantly higher time of dough fermentation by the yeast biomass. The rising activity of that biomass was too low and did not accord to Polish Norms. The biomass obtained from the molasses medium containing PABA could be use to preparation of yeast extract, and after used as a supplement of folates in human diet.

Factors affecting waxy wheat flour dough rheology

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Six waxy wheat flours gave different dough rheological properties compared to normal wheat flours. Protein content and composition were analyzed to understand the differences between these flours. An optimum dough development was not achieved if the water absorption was calculated and used based on protein content. Water content had to be adjusted for some waxy wheat flours in order to develop an optimum dough compared to a normal wheat flour. A model of wheat gluten and starch mixture was designed to understand if difference in waxy wheat starch and normal wheat starch contribute the flour dough rheology. A blend of starch from normal wheat (Karl) (7.3 g, db) and a commercial vital wheat gluten (1.8 g, db) at ~66% absorption failed to develop a dough, but the same wheat gluten developed a dough with waxy wheat starch (NX03Y2114 and NWX02Y2459). At a lower water content (~51%), the blend of normal wheat starch and wheat gluten developed a dough and gave a mixogram curve but the blend of waxy wheat starches and wheat gluten did not form a dough. Waxy wheat starches (NX03Y2114 and NWX02Y2459) absorbed 106%, 119% water (w/w) respectively whereas normal wheat starch (Karl) gained 98%, indicating that waxy starch absorbs more water than normal starch. These results suggest that the difference in water absorption between waxy wheat starch and normal wheat starch may affect the water distribution between starch and wheat gluten, which in turn affects the hydration and gluten development.

Spelt wheat (*Triticum spelta*) as a source of phenolic and folate compounds

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Spelt wheat (*Triticum spelta*) is an old crop, genetically related to common wheat (*Triticum vulgare*). It was widely cultivated in ancient times, throughout the Near East and Europe. Because the modern varieties of common wheat were easier to thresh than spelt (which have kernels in husks), they replaced this crop in the beginning of 20th century and spelt production dramatically declined. Recently, interest in use of spelt is systematically increasing, mainly among persons who are looking for alternative foods, especially for organic grains from certified ecological production. Actually spelt is grown primarily in Europe (e.g. Germany, Switzerland Austria, Belgium, Slovenia, Czech, Poland), also in U.S. and Canada. Seven winter spelt varieties (*Ceralio, Schwabenkorn, Frankenkorn, Holstenkorn, Schwabenspelz, Ostro, Oberkulmer Rotkorn*), three spring spelt culture lineages (*UWM-010, UWM-011, UWM-012*) and two common polish wheat varieties as a standards (*Korweta* and *Torka*) were used in the study. All samples were derived from certified ecological production located in north-east part of Poland and harvested in 2007. Before analyses spelt grain was dehusked in special dehulling machine ("Gerbgang"). Phenolics from defatted grain samples were extracted at room temperature using 80% methanol. Total phenolic compounds (TPC) was determined with the Folin-Ciocalteu reagent (Merck) with ferulic acid as a standard. The content of TPC in spelt grain ranged from 0.60 to 0.71 mg/g d.b. for winter varieties and from 0.69 to 0.77 mg/g d.b. for spring culture lineages. Common wheat varieties *Korweta* and *Torka* showed lower level of TPC, 0.61 mg/g d.b. and 0.55 mg/g d.b., respectively. Most of spelt grain varieties were characterized by significantly higher level of TPC than grain of common wheat standards. Moreover, content of TPC depends on variety of spelt wheat; the highest values were obtained for grain of spring spelt culture lineages *UWM-11* and *UWM-10* and winter spelt varieties *Ceralio, Ostro* and *Oberkulmer Rotkorn*. Folates were measured using a tri-enzyme extraction and were separated by high-performance liquid chromatography after clean-up using SAX spe. cartridges. The results showed that the content of folates derivatives in the spelt grain depends on the nature of variety.

Evaluation of isolated emmer and einkorn starches

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Emmer and einkorn were one of the earliest domesticated forms of wheat. Today they are only seldom cultivated. To increase the variety of raw materials old crops are now rediscovered and analysed for potential uses in food processing. To characterise isolated emmer and einkorn starch the main components and the functional properties were analysed. Starch was isolated from emmer and einkorn in pilot scale by using the tabeling method. The amylose (Megazyme testkit), protein (Kjeldahl) and fat (Soxleth) content of the starch was measured. The functional properties water binding capacity, swelling power, solubility and transmittance (spectrophotometer) of the starch and the freeze-thaw stability (freezing starch gels at –7°C overnight, thawing at 30°C for 2 h, four cycles), viscosity (Brabender viscograph) and hardness (Texture Analyser TA-XT2i®) of emmer and einkorn starch gels were analysed. The amylose content was higher in einkorn starch than in emmer starch. The protein and fat content of emmer starch was lower, suggesting that the cleaning and isolation process was more successful than in einkorn starch. Isolated emmer starch showed a higher solubility, a higher water binding capacity but a lower swelling power compared to einkorn starch. The freeze-thaw stability of einkorn starch was higher as shown by lower syneresis values. The peak viscosity, viscosity at 30 and 95°C and the setback profile of einkorn starch was higher than that of emmer starch. The transmittance of the einkorn starch gel decreased faster than that of the emmer starch gel during 5 days. The hardness of the emmer starch gel was higher at the first day than that of the einkorn starch gel. The increase of the hardness during one week storage at 4°C was higher in the einkorn starch gel.

Affect of flaxseed particle size on dough rheology

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Flaxseed has been widely accepted as an ingredient in breads. The level of flaxseed addition to breads and bakery products has been investigated extensively; however, limited research on the impact of particle size on dough quality has been reported. Thus, the objective of this research was to determine the effect of milled flaxseed particle size on hard red spring wheat dough rheological properties. Flaxseed (Omega) was ground using an Urschel type mill and then separated on a Roto-Tap device according to mesh size. The particle sizes separated were grouped into the following based on retention on the appropriate sieve: 850 µm (20 mesh), 600 µm (30 mesh), 425 µm (40 mesh) and <425 µm (60 mesh). A milled sample containing all particles (i.e. non sieved) was also used as a treatment. The milled flaxseed or separated particles were then added to flour at a 15% level. Mixograph, farinograph, extensigraph and mixolab were used to evaluate the rheological properties of the dough. Farinograph water absorption (FWA) increased with decreasing flaxseed particle size until the <425 µm particle. At this particle size, the FWA was 63.7% whereas the control flour (without flaxseed) had FWA of 63%. The flour containing 425 µm flaxseed had the highest FWA of 67% followed by 600 µm and then the 850 µm. The peak time (PT) of 6.5 min was observed in the dough containing <425 µm flaxseed. The PT of the control dough was 7.5 min whereas values (8.3–11.5 min) increased with increasing flaxseed particle size. Flaxseed particle size had little influence on dough stability; however, all values were about 50% of control dough stability. Mixing tolerance index (MTI) and dough stability demonstrated that the control flour was of good quality. Except for <425 µm flaxseed, the addition of flaxseed particles of smaller size increased the MTI and combined with dough stability resulted in flours of poor to fair quality. Extensibility increased with decreasing flaxseed particles in the dough. However, the values were still significantly lower than the control. In general, particle size of the flaxseed did affect the traditional bread rheological properties. The <425 µm flaxseed appears to be the least intrusive in regards to affecting dough properties.

Development of gluten-free cracker snacks using pulse flours and fractions

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The world snack food market was valued at US$66 billion in 2003 and is estimated to reach US$278 billion by 2010 with baked goods accounting for about 22% of the market. About 1% of North Americans are suffering from gluten intolerance and there is an opportunity to develop gluten-free cracker snacks for the celiac market. Present statistics show that this market has grown by 27% since 2001 and this pace of growth is also projected to continue until at least 2010. The objective of the study was to develop gluten-free cracker snacks utilizing various pulse flours and fractions to promote the anti-allergenic and health-enhancing natures of the pulses. Eight commercially available pulse fractions were evaluated in a model cracker formulation, i.e. chickpea flour, green and red lentil flours, dry pea flour, pinto bean flour, navy bean flour, pea protein isolate and pea fiber isolate. The resulting gluten-free crackers exhibited lighter color, good flavor and crisp texture. Similarity in characteristics between pea starch and other pulse fractions benefited the formulation of cracker snacks. Prototype cracker products were evaluated for textural and sensory characteristics. Textural profiles of the crackers determined using an Instron showed a wide range of peak forces from 8.7N

for navy bean to 16.7N for chickpea. The first break distance attributes of crackers were from 0.46 mm for green lentil to 0.65 mm for pea fiber. Overall acceptability of the sensory test showed that 51% of response was within the "liking" range in a hedonic scale. The overall acceptability may have been heavily influenced by product flavor (correlation coefficient of 0.82). Because of the unique characteristics of the gluten-free formula and properties of pulse fractions, the quality parameters of regular (wheat flour) crackers were not applicable for evaluating the gluten-free crackers. The selected cracker formulations were tested in a commercial production-scale trial at a local bakery. A consumer sensory evaluation panel tested consumer acceptability of the cracker snacks and the results will be presented.

Properties and health benefits of a novel resistant starch

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Resistant starch (RS) is known for its use to prevent hyper- and hypo-glycemic responses of diabetic patients and for intervention of diabetes and obesity. A novel RS was developed by complexing high-amylose cornstarch VII (HA7) with fatty acids (FA). The HA7-FA complex contained up to 72% RS when analyzed using AOAC Method 991.43 for total dietary fibers. The objective of this study was to understand the properties and health benefits of this novel RS for applications in health food products. Scanning electron microscopic (SEM) images showed that the HA7-FA complex had granular structures similar to the control native starch. X-ray diffractograms confirmed the presence of a starch-lipid complex. The HA7-FA complex had a higher onset gelatinization temperature and lower swelling power and solubility than the control native starch. RS residues were collected after the starch was digested with thermostable alpha-amylase at 100°C. SEM images of the RS residues of the HA7-FA complex showed granular structures. Human feeding studies of the RS product were conducted with twenty healthy male subjects ingesting bread made from the RS. The RS bread was made by substituting 75% of the bread flour with the HA7-FA complex and wheat gluten to give the same proportions of starch and protein contents as the control bread. Blood samples were collected every 15 min from 15 min before ingestion to 2 h after ingestion of the control and RS bread. The total plasma glucose response and the total plasma insulin response of the human subjects fed with RS bread were reduced by 51% and 58%, respectively, comparing with those fed with the control bread. In conclusion, the HA7-FA complex contained up to 72% RS, and this starch could be baked into bread. When fed to human, there were more than 50% reductions in glucose and insulin responses.

Investigation of folic acid stability in fortified instant noodles by use of HPLC

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A simple, rapid procedure, using high performance liquid chromatography (HPLC), that efficiently measures folic acid in fortified instant fried noodles, has been developed. Separation of folic acid was performed on a reversed-phase LiChrospher C18 column (125 mm × 4.6 mm, 5 µm particle size) in a single run with a binary gradient elution of mobile phase consisting of 0.1% acetic acid (solvent A) and acetonitrile (solvent B). The separation was achieved within 15 minutes with a flow rate of 1.0 mL/min and the detection performed at 280 nm. The analytical curve produced a linear response in the range of 0.065-1.2 mg/L with a regression coefficient $R^2 > 0.999$. Excellent results were also obtained for different analytical figures of merit including accuracy and precision. Sample preparation involved homogenized in 0.1M phosphate buffer solution for 1 h (pH 8.5) prior to enzymatic extraction with alpha-amylase for 1 h at 65°C (pH 7.0). Results indicated that folic acid was relatively stable producing recoveries of 99 to 103% during the four main stages of instant fried noodle manufacturing (dough crumbs, cut sheets, steaming and frying). However, upon cooking the instant noodles, folic acid showed considerable losses of 30 to 40% possibly due to chemical degradation and leaching.

On the storage period of stone-milled buckwheat flour: Changes in flavor, scent and texture

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The noodle made of buckwheat flour is one of the Japanese traditional foods, and is preferred to be fresh in its flavor, scent and texture. The objective of this study was to test how the storage period of stone-milled buckwheat flour affects the flavor and texture. The sensory evaluation and instrumental analyses were made in a set of stone-milled buckwheat flour stored for 0, 7, and 14 days at 25° in craft-bags. The moisture content decreased with the longer stored periods. In the sensory evaluation of flavor, the stored samples showed high scores in the bitterness and the astringency when compared with the non-stored sample ($n = 6$, $P < 0.05$, Students' t-test). In the instrumental analyses using the taste sensors, some of the sensor outputs were significantly different with different storage periods ($n = 6$, $P < 0.05$, Students' t-test), being consistent with the result of the sensory evaluation. In the sensory evaluation of scent, the score decreased with the longer stored periods. In the sensory evaluation of texture, the score of the hardness and the smoothness changed with the storage. In the instrumental analyses using the texture analyzer, the stretch decreased with the longer stored periods. Since the Rapid Visco analysis showed an increase of the max viscosity with the longer stored periods, it was suggested that degradation of the starch during the storage cause the texture change. The present study showed that a long period of the storage can change the flavor, scent, and texture of stone-milled buckwheat flour, and that the instrumental analyses we utilized can be valid for the quantitative evaluations of such changes.

Effects of superheated steam processing on the functional properties of oat bran and flour

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A typical processing method for oats includes steam conditioning followed by kiln drying. The process aims at inactivation of enzymes to prevent rancidity, elimination of any microbial contamination, and development of a desirable flavour. However, the kiln drying is difficult to control and not energy efficient. Processing with superheated steam (SS) is potentially an alternative method to stabilize oats. SS also known as dry steam is the water vapour which has been overheated to a temperature above the saturation (boiling) point at a given pressure. SS can be used to dry wet materials due to its ability to absorb moisture as long as the SS temperature stays above the saturation (condensation) point for water. High heat transfer capability of SS makes it suitable for rapid heating and processing. Also, the replacement of air with SS eliminates oxygen from the surrounding of the processed product stopping any potential danger of oxidation. The objectives of this work were to process two oat cultivars (HiFi and Furlong) with SS and evaluate the functional properties of bran and flour samples derived from the processed groats. SS at velocity of 1 m/s and temperature of 110, 120, or 130°C was used in the study. The control groats were steam-conditioned and kilned. The SS-treated groats were slightly softer (SKCS) and exhibited a greater groat width than the control groats as determined by image analysis and SEM. The processed groats were roller milled into bran and flour. The milling recovery and yields of bran and flour were not affected the SS treatments. The particle size and colour were determined using a Mastersizer 2000 and CR-410 Minolta, respectively. The particles of bran fractions obtained from the SS-treated groats were slightly bigger than those from the control groats. The SS bran and flour samples were significantly brighter than those derived from the control groats. Bran samples obtained from groats treated with SS at 120°C and 130°C exhibited a greater solubility of beta-glucans than the control and SS-heated at 110°C. The SS flour and bran samples exhibited a higher critical viscosity that the control samples. This study demonstrated that the functional properties of oat flour and bran obtained from groats processed with SS were similar or better to those obtained via the conventional process.

Impact of wheat bran dry fractionation on the *in vitro* bioaccessibility of folates, phenolic acids and antioxidant potential of bran-rich breads as compared with white bread

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In western countries, most of wheat-based foods are produced from refined endosperm from which the outer layers are excluded. These grain tissues, which are eliminated in the bran fraction and mostly used for animal feeding, contain however most of the micronutrients, fibres, and antioxidant compounds of the wheat grain, that could contribute greatly to increase the nutritional quality of human foods if included in flours or used as food ingredients. Wheat bran is a complex material composed of several tissues. Most of the interesting compounds are located in the aleurone layer, but their availability can be limited by the surrounding complex cell wall fibres. New dry-fractionation processes were tested in order to improve the nutritional potential of bran. Ultra-fine grinding was used to drastically decrease the bran particles size to facilitate the separation of bran tissues and increase the breakage of aleurone cell walls to make the aleurone cell compounds more bio-accessible. As the heat generated during bran grinding can damage

bioactive compounds, cryogenic grinding was also used to prepare ultra-fine bran fractions, to evaluate the impact of processing conditions on the preservation of bioactive compounds. Ultra-fine bran was submitted to electrostatic separation, to obtain fractions exhibiting different compositions (rich in cell walls or rich in intracellular material). The different fractions obtained by these dry-fractionation processes were used to produce bran-rich breads. Raw fractions and breads were then tested for their antioxidant capacity using TEAC tests (trolox equivalent antioxidant capacity), and the bioavailability of the phenolic compounds and folates of bran-rich breads and control white breads was assessed using a dynamic gastro-intestinal model (TIM). Thus, the effects of bran particles size and grinding process on the nutritional quality of breads were studied, and the nutritional interest of fractions produced by electrostatic separation was evaluated. This work allowed to assess the impact of bran dry fractionation processes on the preservation of some nutritionally interesting compounds and on the bioavailability of these compounds.

Use of image analysis to study the germination of seeds of blue corn (Zea mays)

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Currently approved germination tests are reliable but require considerable time from the analysts. Image analysis has been used previously to detect accurately the germination phases. Blue corn can be use to elaborate the Mexican corn beer known as tesgüino, however, its germination process must be studied. The objective of this work was to introduce image analysis as a novel technique to study the blue corn germination phases. For this study the germination conditions included a 24 h steeping time, a ratio of 200 ml of water / 100 g of grain and a 96 h germination time at 25°C. Under these conditions, 94% of the grains germinated. Images were recorded at different germination stages to evaluate the area and the Feret's diameter (the greatest distance possible between two extreme points along the boundary of a region) of the corn seed. The moisture content, area and Feret's diameter of the seed increased continuously with the germination time reaching final values of 43%, 1.8 cm^2 and 2.21 cm respectively. Traditionally, the ends of the first and second phases of imbibition are indicated by the times of occurrence of the first and second inflection points of the time course of seed area. When the time course data of water uptake and image analysis parameters were plotted together, similar inflection points in the graphs were obtained indicating the end of phase I after 24 h and of phase II after 96 h. These results indicate that Feret's diameter could be used as a new image analysis parameter (in addition to seed area) to monitor some stages of the corn germination process such as imbibition and radicle emergence.

Studies of retrogradation in pigmented corn tortillas

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Tortillas represent the main source of carbohydrates in the Mexican diet. Traditionally, tortillas are elaborated with white corn, although the blue corn is also used. Recently, the interest of blue tortillas has been increased for the anthocyanins content and their possible nutraceutical effects. Starch is the main component of tortillas. The starch retrogradation is the most important aspect that determines the shelf-life of tortillas. Until today, there are not studies at molecular level on the retrogradation in the pigmented corn tortilla. The aim of the present work was to examine the retrogradation of blue tortillas. Blue (BT) and white tortillas (WT, control) were elaborated by traditional process and stored at 4ºC up to 168 h. Differential Scanning Calorimetry (DSC) and Infrared (IR) Spectroscopy was used to verify the retrogradation phenomenon. DSC shows that both tortillas had two endotherms, corresponding to the first one between 50 and 56°C with a melting enthalpy between 0.75 y 1 J/g. a second endothermic transition was observed between 105 and 123°C with a melting enthalpy between 2 and 6 J/g. The enthalpy was used to calculate the retrogradation percentage (%R). WT presented higher %R (46–70%) than BT (58–64%). The short-range order measured with IR spectroscopy show an increased in the absorbance ratio 1022/1045 cm^{-1} with the storage time. The increase in the absorbance ratio for WT was higher and faster than BT. This pattern agreed with DSC results. These results demonstrate that the retrogradation was higher in WT, which can influence in the starch digestibility.

Sensory color acceptability of corn tortilla in the Mexican market and its relation to analytical measurements of L*, a* and b*

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In this study, ten samples of corn tortilla available in the Mexican market were collected from different sources, including home made (H1, H2, and H3), a small-scaled commercial (S1, S2, S3, and S4), a large-scaled commercial (L1), and experimental (E1 and E2). Following a balanced incomplete block design, 300 Mexican consumers evaluated color acceptability of these ten tortilla samples using a 9-point hedonic scale. Color of these samples was also measured using a Minolta portable spectrophotometer (Model CM 508d) and expressed as L*, a*, and b*. Differences in sensory color acceptability and analytical measurements of the ten tortilla samples were analyzed using ANOVA. Mean sensory color acceptability ratings were plotted against mean L*, a*, and b* values in order to identify possible relationships. ANOVA showed differences in sensory color acceptability and analytical measurements among samples. All home-made samples (H1, H2, and H3), two small-scaled commercial samples (S2, S3), and the experimental sample (E2) obtained high sensory acceptability ratings (a mean of 6.19). Mean values of L*, a*, and b* for these samples were 70.01, 1.63, and 23.66 respectively. No clear correlation of L*, a*, and b* with color acceptability was observed. With this information it is likely that sensory color acceptability may be influenced by other sensory attributes related to other observable attributes of the samples such as visual appearance and surface characteristics.

Barriers and opportunities related to whole grain foods in Minnesota school foodservice

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The purpose of this research was to identify barriers and opportunities associated with the introduction of whole grain foods into school cafeterias. The primary objective was to elicit input from school foodservice personnel (SFP) regarding their experiences in ordering, purchasing, preparing, and serving whole grain foods in the school environment. Data were collected through four focus groups consisting of 36 foodservice directors and/or managers from urban, suburban, and rural school districts in Minnesota. Focus groups were held during the 2007 Minnesota School Nutrition Association's (MSNA) annual conference in Rochester, MN. Transcripts of the interviews were coded independently by two coders and differences were reconciled. Data were analyzed using a frequency and intensity of response format. Participants had difficulty in defining what constitutes a whole grain product. The current definition for whole grain was viewed as ambiguous and difficult to use. Standards for ordering whole grains were also seen as problematic. The responses indicated a need for greater uniformity in specifications used for ordering and purchasing of whole grain foods in school foodservice. There was also a perceived difference in service and quality from the vendors depending on the size and location of the schools. Finally, there was a clearly expressed need for increased communication between school food service and the food industry and to set policy and regulatory guidelines regarding a universal definition of whole grain foods. The goal should be to remove confusion regarding whole grain definitions and standards when ordering and serving whole grain products in school foodservice.

Effects of pearling level on physical, compositional, and cooking properties of selected Western Canadian barley varieties

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Interest in incorporating barley into the diet of North American consumers is increasing considerably due to the reported health benefits associated with barley. The most common method for processing barley for food use is pearling which involves the gradual removal of the outer layers of the kernel including the hull by abrasive action. Limited information exists about the effect of pearling level on the physical, compositional, and cooking properties of barley, especially hulless barley varieties. In this study, ten genotypes of Western Canadian barley differing in hull and starch characteristics were pearled to three differing levels (5%, 10% and 25%) with a Satake grain testing mill. Multivariate analysis was performed to determine differences among genotypes and among different pearling levels. Genotypes with high amylose or low amylose (waxy) starch were found to be higher in protein and

beta-glucan contents than genotypes with normal starch. In addition, high amylose genotypes were harder as determined by the single kernel characterization system (SKCS) and had firmer instrumental cooked texture as determined by the texture analyzer (TA-XT2 Plus). As pearling level increased, both starch content and lightness (L*) increased. In contrast, a decrease in protein, arabinoxylans, and free phenolic acids was observed with increasing pearling levels. Small differences in beta-glucan were observed as the degree of pearling increased Differences in the sensory characteristics of the cooked pearled barley were also observed by a trained sensory panel.

Non-thermal starch modification using ultra high pressure: Physicochemical properties of non-thermally cross-linked cornstarch

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Corn starch (20%, w/w) was cross-linked with a phosphorus oxychloride ($POCl_3$; 0 and 0.1%, w/w) at 100, 200, 300, 400 MPa for 15 min. Conventionally cross-linked cornstarch was prepared with a $POCl_3$ (0.1%, w/w) at 45°C for 120 min. Physicochemical properties of non-thermally and conventionally cross-linked cornstarches, including swelling power, solubility, crystallinity (X-ray diffractometer), thermal (DSC) and pasting properties (RVA) were determined. Swelling power and solubility of both non-thermally and conventionally cross-linked cornstarches were relatively lower than native cornstarch. Pressure level did not greatly affect the solubility and swelling power of non-thermally cross-linked conrstarches. X-ray diffraction patterns and relative crystallinity were not significantly affected by both conventional and non-thermal cross-linking. DSC thermal characteristics of both non-thermally and conventionally cross-linked cornstarches were slightly changed. Amylopectin melting enthalpy and conclusion temperature of all cross-linked cornstarches were higher than native cornstarch indicating that double helical structure of amylopectin influenced by cross-linking reaction. However, pressure level did not influence the DSC thermal characteristics. Both non-thermal and conventional cross-linking greatly affected the RVA pasting properties of cornstarch, such as increase of pasting temperature and decrease of peak viscosity compared to native starch. Although pressure level did not show significant difference, non-thermally cross-linked cornstarch showed similar pasting properties compared to conventionally cross-linked corn starch. This result suggests that in case of cross-linking using a $POCl_3$, both non-thermal and conventional methods reveal similar physicochemical properties and non-thermal cross-linking with $POCl_3$ can reduce the reaction time from 120 min to 15 min. This work showed the potential and possibility of non-thermal starch modification and provides the basic and scientific information on the physicochemical properties of non-thermally cross-linked corn starches using UHP.

Partial substitution of wheat flour with corn processing by-products and its effect on cookie baking performance

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Daily consumption of dietary fiber of the world population is below the adequate intakes (30–38 g/day in the United States; 32–45 g/day in the Netherlands). Failure to meet these recommendations is in part due to the low fiber content of popular foods. The objective of this study was to determine the maximum substitution level of wheat flour (WF) by fine (FF) or coarse (CF) fiber, or germ-rich fraction (GF) in cookies manufacturing using the AACC Method 10-50D's formula. Water adsorption and optimum mixing time for the control and composite flours (5, 10, 15, 20, 25 or 30% substitution) were determined with the National Mixograph. Cookie dough for each formulation was prepared and baked individually. Cookies width (W), thickness (T), spread factor (W/T), appearance, and hardness were recorded. The best baking performance was observed with the GF inclusion; even the 30% substitution level was equal to the control. The composite flours made of 15% FF-85% WF, and 25% CF-75% WF performed similar to the control. It is possible to include this type of by-products in cookies manufacturing without affecting cookie quality, assuring higher dietary fiber intake.

Physicochemical properties of fiber rich fractions from hull-less barley: Influence of particle size reduction and thermal treatments

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The objective of this study was to investigate the physicochemical properties of barley fiber rich fractions (FRF) relevant to their technological and physiological functionalities. FRF with variable particle size were obtained by roller milling and pin milling of two hull-less barley genotypes with variable starch characteristics (high amylose and waxy). Furthermore, the FRF were hydrated, autoclaved, and freeze dried. Particle size distribution of FRF was measured by laser diffraction analysis using Mastersizer 2000. The coarse FRF preparations ($d_{0.5}$ = 260–280 μm) were further reduced by roller milling or pin milling resulting in particles with $d_{0.5}$ = 138–146 μm and $d_{0.5}$ = 106–109 μm, respectively. The particle reduction had a substantial effect on porosity and hydration properties of the FRF. The total beta-glucan content of FRF preparations was ~19% (w/w, db) for waxy barley and ~14.5% (w/w, db) for high amylose barley, whereas total arabinoxylans was ~7.5% in both preparations. Water solubility of beta-glucan and arabinoxylans increased with reducing particle size and increasing extraction temperature for both FRF preparations. Moreover, the hydrothermal treatment greatly improved the extractability of beta-glucan and arabinoxylans. The viscosity of aqueous slurries of FRF increased as the particle size of the FRF preparations decreased. The FRF from high amylose barley developed distinctly higher viscosities at 45°C than at 25°C, whereas no clear effect of temperature on viscosity profiles of waxy barley FRF was observed. The hydrothermal treatment of FRF caused a substantial increase of the slurry viscosity for both FRF preparations. Changes of the wet particle size upon suspension of the FRF in water as affected by temperature and thermal treatments were also measured. Initially, the size of FRF particles increased sharply followed by a decrease thereafter. Heat treated FRF demonstrated less particle reduction compared to the raw samples. The increase of temperature brought about a greater reduction of particle size in all cases. This study showed that the physicochemical properties of FRF can be changed/controlled by physical and/or thermal treatments.

Changes in amino acid and protein contents of wheat during milling and steamed bread making

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Both hard and soft wheat varieties were used in this study to investigate the changes of amino acid and protein during milling and steamed bread making. The results showed that losses in amino acid content occurred during milling. The loss of threonine was the highest at 18.0% which was followed by proline at 15.5%, methionine at 15.1%, and histidine at 15.1%. The losses of tyrosine and lysine were at the lowest, which were 8.1% and 9.7%, respectively. Losses in amino acid content were also found during steamed bread making. The highest loss was observed with alanine at 17.1% followed by tyrosine at 12.5%. Leucine exhibited the lowest loss at 4.3%. The mean protein contents of wheat, flour, and steamed bread prepared from the materials tested were 15.3%, 14.3%, and 14.3%, respectively. This indicated that protein content decreased during milling, but no significant change was observed during steamed bread making. Amino acid score (AAS) of lysine in wheat, flour, and steamed bread were 45.4, 41.0, and 38.2, respectively. The variation trend of protein and amino acid was similar in the two hard and soft wheat varieties.

Crystalline structure of enzyme-resistant maize *ae*-mutant starch

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GEMS-0067 maize *ae*-line starches had substantially larger enzyme-resistant starch contents (37.3–43.4%) than existing inbred *ae*-line starches isolated from H99*ae*, OH43*ae*, B84*ae*, and B89*ae* (10.6–14.1%). The *ae*-mutant starches showed similarity between their resistance to acid hydrolysis and to enzyme hydrolysis. The objective of this study was to understand the crystalline structures of these *ae*-mutant starches by analyzing the structures of the remaining starch after acid hydrolysis. The starch granules were hydrolyzed using sulfuric acid (15.3%, v/v) at 38°C for up to 102 days. The rates of the acid hydrolysis of these *ae* starches were faster in early days and slowed down after 21 days of acid hydrolysis. After 102 days of acid hydrolysis, GEMS-0067 *ae*-line starches had 37.4–39.5% acid-resistant starches, which were larger than the existing inbred *ae*-line starches (18.3–26.7%). Average chain lengths of all the remaining starches ranged between DP 23.7 and 28.0. The starches remaining after 102 days of acid hydrolysis had higher onset (80.1–95.0°C), peak (113.1–122.3°C), and conclusion (136.5–147.5°C) gelatinization temperatures than the native *ae*-mutant starches (64.5–65.8, 76.9–98.4, and 100.5–130.0°C, respectively). The enthalpy changes increased from 11.7–17.4 J/g to 19.8–32.7 J/g after 102 days of acid-hydrolysis. Scanning electron micrographs showed that the remaining starches contained mostly rod/filamentous granules and shells of spherical granules. These results indicated that the starches remained after 102 days of acid hydrolysis were highly crystalline and were concentrated in the rod/filamentous granules and at the periphery of the spherical granules. The

crystalline structures of the remaining starches were improved after acid-hydrolysis at 38°C, which was evident by the increase in the gelatinization temperature and the enthalpy change. The weight percentages of the *ae* starches remaining after 102 days of acid hydrolysis were positively correlated with remaining enzyme-resistant starch with a coefficient of 0.96. The results obtained from this study confirmed that the crystalline structures in the *ae*-mutant starches were responsible for the enzyme-resistance of those starches.

Effect of composition of wheat gluten HMW-GS on extrudate properties

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High moisture textured wheat gluten is a kind of meat analog processed by high-moisture extrusion technology. It can be used as food material for a product of high protein and high fiber content. The wheat gluten with different compositions of high-molecular-weight glutenin subunits (HMW-GS) from wheat varieties were prepared by water-washing method and were extruded by a DSE-25 twin-screw extruder (Brabender, Germany) under the optimal processing parameters. The extrudate properties were investigated with texture analyzer and chemical methods. The results indicated that significant difference was found in the extrudate properties among the glutens with different HMW-GS composition. When subunit 1 was at Glu-A1 and subunit pair 2+12 or 5+10 was at Glu-D1, the properties of extrudate with subunit pair 7+9 at Glu-B1 were better than those with 7+8. When subunit 1 was at Glu-A1 and 7+8 or 7+9 was at Glu-B1, the properties of extrudate with subunit pair 5+10 at Glu-D1 were better than those with 2+12. The gluten with subunit pair 7+9 at Glu-B1 or subunit pair 5+10 at Glu-D1 had good extrudate properties under high-moisture extrusion condition. The compositions of high-molecular-weight glutenin subunits (HMW-GS) of wheat gluten may be effected on the extrudate properties. Keywords: wheat, gluten, HMW-GS, extrusion, textured protein.

Micro-baking of waxy wheat and triticale breads analyzed by C-cell

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The term 'waxy' refers to amylose free starch and, depending on the number of waxy null alleles carried (partial, waxy and wild types), waxy wheat lines will have different amylose/amylopectin ratios. This may ultimately influence the quality of end-use products such as breads and noodles. Triticale has one third fewer loci coding for gluten proteins, resulting in poor bread making and this can be improved by introducing the 'D' genome of wheat. Translocations of 1A.1D and 1R.1D were developed to introduce the Glu-D1a and Glu-D1d alleles into triticale to improve the bread making performance. Two sets of waxy (Svevo-durum; N11-bread wheat) and three sets of triticale lines (GDS7, Trim, and Rhino) were used for the investigation. The main aim was to evaluate the bread making performance of waxy flour alone and in a 50% flour blend as well as different triticale translocation lines. Micro baking (10 g flour) was performed and C-cell images were used to analyze the loaf characteristics. Loaf volume was highest with 100% waxy wheat flour and was not improved by 50% blending with commercial bread wheat flour. However, dark color and poor appearance with large bubbles was observed with 100% waxy flour which is unacceptable to consumers. High loaf volume was observed with 1A.1D 5+10 translocation lines in all the triticale sets, indicating that translocation of Glu-1 d allele with HMW-GS 5+10 is beneficial in terms of improving the bread making quality.

Evaluation of the cake quality of flours with Mixolab

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Cakes are defined as being aerated, chemically leavened bakery products. The main parameters of cake quality are volume, firmness, color and weight loss. The cake quality is affected by several factors like quality and level of ingredients used, most generally flour. Mixolab is a new instrument that has the capabilities to measure physical dough properties like dough strength and stability and also to measure the pasting properties of starch on actual dough. The aim of this study was to test the possibility of using Mixolab to predict the cake baking quality of different wheat flours. Ten different commercial flours obtained from different milling companies were used. Mixolab data were compared with some flour quality characteristics (Zeleny sedimentation and falling number values, damaged starch contents, Alveoconsistograph values). Correlation coefficients were calculated between the cake quality characteristics and Mixolab parameters as well as the cake quality characteristics and the other flour characteristics. Cake samples are baked according to a standard white layer cake recipe (100% flour, 100% sugar, 12% non-fat dry milk, 9% egg white powder, 3% salt, 5% baking powder and 90% water, all percentages were given in flour weight basis). The cake quality was evaluated in terms of volume index and hardness (TAPlus, Lloyd Ins., UK) values. Hardness values and volume index of the cake samples were in the range of 0.094–0.143 kgf and 34.3–38.7 mm, respectively. There were no significant correlations between Zeleny sedimentation value and the cake quality characteristics. Falling number value was only correlated with the cake hardness ($P < 0.05$) and damaged starch content was only correlated with the cake volume index ($P < 0.10$). None of the Alveoconsistograph characteristics were significantly correlated with the cake hardness and volume index values. Therefore, Zeleny sedimentation, falling number, damaged starch and Alveoconsistograph tests do not seem to be useful to predict the cake quality of the flour samples. There were significant correlations between volume index and most of the Mixolab characteristics (C2, C3, C4 and C5). C5 was also significantly correlated with cake hardness value. The flour samples which gave lower cake volumes had higher C2, C3, C4 and C5 values and the samples with higher cake hardness values had higher C5 values. The results showed that Mixolab could be used to predict the cake making quality of flour samples.

Isolation of yeasts from a mother dough of the Italian sweet bread, Panettone and analysis on the anti-mold factor and the chromosome karyotypes for the yeasts

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Panettone is the traditional sweet and sour bread in northern Italy. Though recently the bread starter is commercially prepared for bakeries, originally the mother dough has been preserved in a cycling renewal for more than sixty years at each individual home as the traditional baking method. The predominant micro-organisms are yeasts and lactobacilli. Those micro-organisms are presumed to be originated from natural resources such as fruits, vegetables and so on. In this study, we isolated yeasts from the Panettone mother dough which has been preserved for about 150 years at a bakery in Fecchio near Firenze. 9 different yeasts were isolated from the dough with YPD and MRS mediums. CHEF analysis showed that those strains are all *Candida holmii* which is the typical strain predominant for the Panettone. Since the chromosome karyotypes of the 9 strains are similar, it is presumed that those are mutants derived from a single ancestor. As an additional study on Panettone yeasts, the result of CHEF analysis for several strains and the properties of anti-mold factor excreted by a Panettone yeast will be reported in this presentation.

Dissolution of glutenin macropolymer into water from soft-wheat-flour by electrical treatment with weak direct current causing increase of batter viscosity

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Effect of direct electric current on functional properties of batter made from soft-wheat flour was studied to establish a new processing method for food. Soft-wheat batter was treated with direct current (30 mA) and was separated into anode side and cathode side from the middle. Each of the anode side and the cathode side samples was mixed for five minute manually. The batter viscosity was measured with a rotation viscometer before and after the manual mixing. The viscosity of anode side sample increased with increasing electric-treating period after the mixing. To elucidate the cause of the change, the treated batter was lyophilized and extracted with water. The amount of extracted protein detected by the Bradford method increased with increasing period of the electric treatment. The sodium dodecyl sulfate gel electrophoresis showed the increase of protein bands attributed to glutenin macropolymer (GMP) in the extracted fraction, simultaneously. These results indicate that the part of GMP become water soluble. The protein dissolution after electro-treatment was also confirmed by confocal laser scanning microscopic observation. The extracted protein may have good chance to interact with each other and make up extensive protein network which cause increase of batter viscosity. The phenomena will contribute better dough formation.

The effect of cropping systems on starch structure, chemistry, and functionality in developing sorghum kernels

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Starch, the largest component of cereal grains, consists of two types of polymer. These polymers are deposited into granules by amyloplast organelles as amylose, a near linear molecule and amylopectin, a highly branched molecule. The objective of this study was to determine if sorghum grown under an irrigated cropping system displayed different starch characteristics, such as granule size distribution and amylopectin structure, than samples grown under a dry-land cropping system. A commercially available sorghum hybrid was grown in an irrigated and a dry-land plot at the Ashland Bottoms Research Farm in 2006; upon reaching the mid-bloom stage in maturity approximately 200 heads were tagged in each plot. Samples were regularly collected beginning seven days after anthesis (DAA) until harvest. The samples were then decorticated and the starch was isolated. The granule size distribution, analyzed by laser diffraction sizing, showed a significant shift as the sorghum kernel developed. The volume percent for the A-type granules ranged from 54.9% to 6.6% in the 28 DAA and 7 DAA samples. Amylose concentrations, measured by Concanavalin A precipitation, ranged from 23.5% to 29.3%. Peak gelatinization temperatures, measured by Differential Scanning Calorimetry, ranged from 71.8°C to 75.4°C. Fluorophore-Assisted Capillary Electrophoresis (FACE) was performed to provide details on the amylopectin chain length distribution and its relationship to starch functionality. The cropping systems and maturity of the sorghum affect the structure and functionality of starch as well as provide some insight into possible new end-uses.

Enzymatic synthesis of defined chain-length oligosaccharides and quantitative detection of the products by an HPSEC-ELSD method

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Phosphorylase-a (EC 2.4.1.1; 1,4-alpha-D-glucan:phosphate alpha-D-glucosyltransferase) catalyzes a reversible phosphorylytic reaction from alpha-1,4 glucan in the presence of inorganic phosphate, and linear alpha-1,4 glucan can be synthesized when glucose 1-phosphate (G-1-P) is in excess. To obtain defined elongated chain length, reaction mixtures containing 25 mM G-1-P, 100 mM Na-citrate buffer (pH 7.0), phosphorylase-a (2 U ml^{-1}), and 80 μM primers (either maltopentaose, maltohexaose or maltoheptaose) were incubated at 37°C and controlled for 1, 2, 4, 6, 8, 16 and 24 hr. Phosphorylase-a was eliminated by filtration (14000 × g for 10 min) using Microcon YM-30 to recover products which were purified by Sephadex G-25, using Bio-spin disposable chromatography column. Degree of polymerization (DP) of oligosaccharide (OS) products was detected by an HPSEC-ELSD method (high performance size exclusion chromatography coupled with evaporative light scattering detector). An Asahipak GS-320 HQ multi-mode column (300 × 7.6 mm) and an Asahipak GS-2G 7B guard column (Shodex, Japan) were used in the system where the temperature settings for elution and detector nebulizer were 30°C and 80°C, respectively. The mobile phase was isocratic solvent (water/methanol, 70/30) with flow rate of 0.6 ml/min. Commercial pullulan and maltodextrin were used as calibration standards. Results showed a parallel correlation between the length of primers and maximal DP of OS products, where maltopentaose, maltohexaose, and maltoheptaose resulted in maximal DP of 73, 79 and 82, respectively, showing that the reaction seemed to be independently on the length of primers. In addition, biphasic synthesis was observed that DP grew rapidly during the first 6 hours and slowly afterward until 24 hours when the G-1-P almost exhausted. This study demonstrates a method where defined chain length of OS is able to synthesize *in vitro* and monitored by HPSEC equipped with ELSD.

Ethanol production from wet and dry fractionation processes

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In the U.S., the dry grind process constitutes 82% of the production capacity for fuel ethanol. One third of corn in conventional dry grind ends up as distillers dried grains with solubles (DDGS). An increase in conventional dry grind ethanol production has led to an increase in DDGS produced. Due to high fiber content, DDGS is used as a food ingredient for ruminants. Wet and dry fractionation methods have been developed to recover germ and pericarp fiber prior to fermentation. These fractionation methods result in salable coproducts and decrease the quantity of nonfermentables in the fermenter. As compared to the conventional dry grind process, removal of germ and pericarp fiber results in reduced DDGS. Wet and dry fractionation processes were compared using high oil, high extractable starch, waxy and high fermentable hybrids. Ethanol concentration profiles were recorded. Germ oil and residual starch were analyzed. Pericarp fiber was analyzed for residual starch content. The wet fractionation process had the highest final ethanol concentrations (15.7% v/v) compared to dry fractionation (15.0% v/v). Germ and pericarp yields were 7.44 and 6.31% for wet fractionation and 8.51 and 6.59% for dry fractionation, respectively. Germ obtained from wet fractionation had higher oil content (34.0% db) compared to the dry fractionation method (10.8% db). Residual starch content in the germ fraction was 16.0% for wet fractionation and 44.1% for dry fractionation. Compared to dry fractionation process, wet fractionation process results in with cleaner germ (less residual starch) and higher ethanol yields.

Physical and morphological characterization of the cornstarch particles produced by ultra-fine pulverizations with a ball mill

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Dry-milling of cornstarch particles employing ultra-fine pulverization for 0.5–6.0 hours resulted in the almost consistent particle distribution patterns, regardless of grinding time with the mean particle diameters of 13.6–14.2? due to the tendency of finer particles to unite together as shown in the SEM micrographs. In the mean time, ratios of the damaged starch have gradually increased from 8.13% (0 hour, control) to 82.41% (6 hours) by ultra-fine pulverization treatments. The amounts of amylase to in the cornstarch were not affected by ultra-fine pulverization. Ultra-fine pulverization of the cornstarch have brought about the decreasing peak intensities in the X-ray diffraction patterns, notably after 1.5 hours of operations and have shown the typical V patterns of the corn starch. With the passage of ultra-fine pulverization time, the enthalpy values in the Differential Scanning Calorimeter (DSC) thermograms have decreased, thus losing graphical peaks in relation with the starts of gelatinization in 6 hours of treatments. In the results of the Rapid Visco Analyzer (RVA) tests, the clear points of in peak viscosity along with hold viscosity, and final viscosity values of the untreated cornstarch samples have gradually lowered with the passage of time during ultra-fine pulverization operations. Consequently, cornstarch powder that have been treated with 6 hours of ultra-fine pulverization was possessed with a flat line without point of inflection and with almost consistent viscosity, RVU values throughout the heating/cooling procedures in the RVA profile. Removal of the static electrical charge that may dwell on surface of the minute starch particles to reduce intimacy of each other that leads to agglomeration during and/or after ultra-fine pulverization and to develop the use of the product are further research scopes to be continued.

Comparison of the corn starch particles as obtained from dry- and wet pulverization methods

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Some quality characteristics of the corn starch minute particles as obtained from different fine-grinding methods, i.e., wet- and dry-grinding using ultra-sonic homogenizer and ultra fine pulverizer, each were evaluated. The widespread agglomerations of the pulverized particles in which smaller particles adhere to the larger ones were observed from the microstructure of dry-pulverized corn starch particles, possibly due to the electrostatic forces accumulated on the surface of the minute particles during ball milling. No noticeable size distribution pattern and/or morphological changes in the microstructure of corn starch particles were introduced through wet grinding methods. In contrast, dry pulverization caused more or less increases in the minute starch particles sized less than 10?. Water binding capacities of the pulverized corn starches were noted to increase up to 96.9% (2.3 times) and 246.8% (8.4 times) for wet- and dry pulverization, respectively, from 41.3% of the original corn starch. Dry-pulverization also caused increases in swelling capacity, solubility, and light transmittance characteristics of the starch particles according to grinding times while wet pulverization did no noticeable changes. However, a sharp increase in the Hunter colorimetric lightness 'L' value of the starch particle was obtained from wet pulverization while the effects from the dry pulverization were almost negligible. *In vitro* digestabilities of the pulverized starches were recorded as 16.4–21.9% and 37.9–95.9% for wet- and dry pulverization, respectively.

Granular reaction patterns within chemically modified wheat starch A-type granules

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This work probed granular reaction patterns of wheat starch A-type granules derivatized with either a propylene oxide analog (POA), sodium trimetaphosphate (STMP), or phosphorus oxychloride (POCl3), with each reaction evaluated at 3 reagent addition levels. Reaction patterns within modified granules were viewed by reflectance confocal laser scanning microscopy. Channels within granules facilitated passage of reagent to into the inner regions of the granule and into the granule matrix in a manner that was distinctive for each specific reagent. For POCl3 reactions, reagent entered the granule through channels, but react quickly at channel surfaces without significant lateral penetration of reagent from channels into the granule matrix. As POCl3 reagent levels increased, reaction progressed deeper into channels toward the granule interior until it eventually reached the hilum at high levels of derivatization. For STMP-starch derivatives, reaction for the lowest level of reagent addition occurred primarily within channels, though reagent did appear to also reach the granule hilum. With increasing levels of STMP, reagent was observed to flow laterally from channels into the granule matrix, causing channel boundaries to become less visible and distinct as reaction progressed further into the granule matrix. For POA derivatives, channels effectively facilitated reagent access into the hilum region. Reagent was observed to readily penetrate the granule matrix through channels (laterally) and from the hilum outward (toward the granule exterior), producing the most homogeneous granular reaction patterns of all reagents tested (for highest POA levels, channel structures were no longer visualized due to the homogeneity of reaction within the granule matrix). These results suggest that the ability of reagent to diffuse into the granule matrix was in the order: POA>STMP>POCl3.

Physical properties of starch from gamma-irradiated grain amaranth

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Gamma irradiation has been employed to protect foods from infestation and microbial contamination during storage for a long time, the effects of gamma irradiation on foods have drawn wide attention due to food safety. Starch is a main composition in foods, the effects of gamma irradiation on starch have been studied in corn, maize, rice, wheat, but no report has been done on amaranth starch. The objective of this work was to determine the effects of gamma irradiation on physical properties of amaranth starch. Physical properties of starches isolated from three cultivars of gamma-irradiated grain amaranth (Cr049, Hy030 and TibetY) with different amylose content were characterized by viscoamylography using a Rapid Visco Analyzer (RVA), differential scanning calorimetry (DSC), and dynamic rheometer. Results showed that amylose content was 5.3% (Cr049), 6.0% (Hy030) and 10.3% (TibetY), respectively. Pasting properties including peak viscosity (PV), hot pasting viscosity (HPV), breakdown viscosity (BD), cool pasting viscosity (CPV) and setback viscosity (SB) decreased continuously with increase of irradiation dosage (control, 2 kGy, 4 kGy, 6 kGy, 8 kGy, 10 kGy). But there were only slight changes in thermal properties with different irradiation dosage.

Selenium biofortification of wheat

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Selenium (Se) biofortification of wheat is receiving greater attention in South Dakota owing to the availability of high Se soils and a growing demand for high Se wheat. A 3-year (N = 504) study revealed the relative contributions of growing year, location and cultivar to Se variability. Fractionation of the kernel by scarification, pearling and conventional milling, showed predictable distribution of the element within the mill fractions. The concentration gradient from the outer kernel inward of the grain was significantly different from all other elements studied with the exception of sulfur. Approximately 65% of the grain Se partitioned with the flour proving that flour from 0.5 to 1.9 ppm Se wheat contributed significantly to Se in the food supply relative to levels normally seen in wheat (0.5 ppm). A level of 1 ppm in the grain has been reported to be a good starting-point for the cereal industry. While cultivar was a secondary factor in Se variability, next to growing location, strong correlations were noted between protein content and Se as well as protein content and selenomethionine (Se-Met). Approximately 45% of the total Se existed as Se-Met as measured by ICP/MS. Supra-high Se soils have been identified in select Kennebec and Selby locations to study sustained high Se wheat (10–18 ppm) production under the influence of various agronomic factors (rainfall, temperature, soil type, acidity, timing and dose of fertilization, etc). Predictive modeling is being pursued to permit reliable estimation of grain Se uptake. We will also report on the role of high-Se wheat protein isolates and concentrates in enhancing baking functionality in lean dough formulations.

Characterization of slowly digested starch of waxy/amylose-extender double-mutant rice

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Properties of glycemic and insulinemic response to dietary starch are directly related to the rate of starch digestion. A *waxy* (*wx*) starch defective in amylose is a good material for the analysis of the amylopectin property that greatly contributes to the properties of starch. The starch of a double mutant of *wx* and *amylose-extender* (*ae*), genetically defective in the starch branching enzyme IIb function, was used to evaluate the effects of mutation on the crystalline structure and the physical properties of starch. The distribution of elongated chains in amylopectin in the *wx/ae* mutant was determined by a fluorophore-assisted carbohydrate electrophoresis method. X-ray diffraction analysis revealed that the crystalline structure of the *wx/ae* starch had changed from A type to B type. Differential scanning calorimeter analysis showed that the *wx/ae* starch started gelatinization at 78.1°C, which is higher than for the wild type and *wx* starches (60.3°C and 60.6°C). The raw *wx/ae* starch was almost indigestible by rats. Rats fed cooked *wx/ae* starch showed a slowly increasing a blood glucose level and had lower blood glucose levels than rats fed cooked *wx* starch or wild-type starch. Furthermore, *wx/ae* starch bound more easily with amylases in *in vitro* experiments. Both the slow increase in blood glucose level and the binding property with amylases were likely due to the elongated chains in *wx/ae* amylopectin. Genetic modification of starch may allow for the production of a slowly digested starch that could be used in new functional human diet.

Influences of amylopectin structure, shear stress, and urea on the rheological properties of starch

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Understanding the basis for the changes of starch rheological properties during gelatinization is critical since these changes are responsible for the unique characteristics of starch-containing products. The objective of this study was to investigate the influences of amylopectin structure, urea, and shear stress on the rheological properties of corn starch during gelatinization. Six experimental waxy corn mutant lines, HSyn996w *wxwx*, HSyn99 *wxwx*, HSyn99 *duwx*, HSyn73w *wxwx*, HSyn73 *wxwx*, and HSyn73 *duwx*, were used. Both *duwx* mutants had a greater proportion of B1 chains and a smaller proportion of B3+ chains than the *wxwx* mutants. The rheological properties of starch under different shear stresses and concentrations of aqueous urea solution during heating were performed by a dynamic rheometer. At a small shear stress, the G′ and G″ of *duwx* mutants during heating were higher than that of other mutants. The G'_{max} and G''_{max} of starch decreased as the shear stress increased. The effect of shear stress on the rheological properties of starch during gelatinization was more pronounced for *duwx* mutants and HSyn73 mutants. The G'_{max} and G''_{max} of *duwx* mutants increased significantly but those of other mutants decreased slightly with increasing urea concentration from 0% to 15%. When the urea concentration was further increased from 15% to 20%, G'_{max} and G''_{max} of all mutants decreased significantly. The results suggest that entanglement of amylopectin B3+ chains and hydrogen binding of amylopectin B1 chains played dominant roles in maintaining the granule integrity during gelatinization under urea solution and shear force, respectively.

Tailoring micronutrient assemblies to design food products of improved nutritional benefits

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Micronutrients such as antioxidants and polyunsaturated fatty acids of the omega-3 series (w-3 PUFA) have numerous health benefits. However their chemical unstability is often an obstacle to insure their nutritional benefits until their consumption and release in the gastro-intestinal tract. A polyphasic matrice is currently explored in our laboratory to ensure the nutritional benefits of dietary antioxidant and w-3 fatty acids. Firstly in the lipid phase (composed of triglycerids and w-3 fatty acids), antioxidants were added to

ensure the nutritional benefits of dietary w-3 fatty acids and secondly an innovative strategy was developed to incorporate antioxidants and protect their nutritional properties in the aqueous phase. The conception and the building of protective assembly of hydrocolloids (starch in particular) that incorporates antioxidant is studied by X rays diffraction, differential scanning calorimetry and NMR.

Vital wheat gluten characterization thanks to Infraneo and Mixolab

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Vital wheat gluten is one of the most popular improvers in bakery industries. In spite of this industrial interest, instrumental methods to analyze physicochemical properties and rheological behaviour of this product are pretty rare. The objective of this study is double: to develop near-infrared calibrations on Infraneo (Chopin's NIR analyzer) in order to measure in few second proteins and moisture content, and to develop a Mixolab protocol that evaluates the rheological behaviour of different vital wheat gluten. 48 vital wheat gluten samples with moisture content between 2.8% and 7.3% and proteins between 70.9% and 82.3% are used for near-infrared calibration development. The obtained calibrations show very good performances (R2 = 0.95 and SECV = 0.57 for proteins, R2 = 0.96 and SECV = 0.16 for moisture content). 6 vital wheat gluten samples, with different baking qualities, are used for rheological study. The developed protocol (200 rpm, 75 g of gluten, 120% of hydration) is strongly repeatable (difference between 2 repetitions is lower than 5%) and discriminates clearly the 6 tested samples. Mixolab and Infraneo combination are providing a fast and complete scoring of vital wheat gluten samples.

The EU-FRESHBAKE European project: Innovation in bake off technology

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This project aims at taking benefit of refrigeration to improve the availability for the consumer of fresh bread with enhanced nutritional and organoleptic quality. It concerns the BAKE OFF TECHNOLOGY (BOT), which consists in producing bread from industrial refrigerated or frozen or non frozen bakery goods and to retail them in downtown baking shops or to make them available in supermarkets for domestic baking. This project is aiming at improving the quality (nutrition, organoleptic) of breads made in the industry. It also aims at improving the industrial practice versus energy consumption. For this purpose, three indexes on quality, nutrition and energy demand of the process have been designed. The quality index takes into account selected parameters like texture, crust crumb ration, staling. The nutrition index accommodates selected nutrients. The energy index evaluates the energy demand and the energy efficiency of the process. Experiments have been carried out to assess the impact of selected processes on these indexes. A comparison between conventional and frozen part baked bread shows that the energy demand of frozen part baked is almost four times the one of conventional. An Energy efficiency index has been designed; such an index should be carefully designed. Indeed, some process may be efficient in term of yield but can be les interesting in term of energy demand by kg of product. Concerning the quality index, it has been observed that part baked bread exhibited a slower kinetic of staling even though the firmness of the bread is different between both products. Website: http://eu-freshbake.eu/eufreshbake/index.php. This study has been carried out with financial support from the Commission of the European Communities, FP6, Thematic Area "Food quality and safety", FOOD-2006-36302 EU-FRESH BAKE. It does not necessarily reflect its views and in no way anticipates the Commission's future policy in this area.

Bread baking, energy and industrial practice - toward a better practice and innovative processes in the frame of the EU-FRESHBAKE European research project

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This paper presents preliminary results obtained within the European project "EU-FRESHBAKE" on the energy demand of the baking process. Baking is one of the most energy demanding process among other thermal treatments. An average value of 4 MJ/kg of bread is demanded by the process. Furthermore, only 10 to 20% of this energy is finally attracted by the bread as such. There is thus an urgent need to improve the existing practice and to develop innovative processes that are less energy demanding. If the bread is frozen, the overall energy demand increases. A summary of key results obtained from an experimental work done on small scale (bakery size) equipments is presented and commented. Results show that depending on the oven technology, different efficiency can be observed. The refrigeration step is less energy demanding. Nevertheless, the energy needed to freeze bread can be small in comparison to the overall energy demand. A comparison between selected processes of the bake off technology is presented: conventional, frozen part baked, …. An introduction to the guide of good practice that will be issued in Oct. 2009 is then presented. A focus is done on the case of frozen part baked bread which is one the preferred technology among the BAKE OFF TECHNOLOGIES (BOT).

Evaluation of antioxidant capacity and aroma quality of purple berry flour and bread

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Purple berry flours and bread products, produced from anthocyanin-containing grains, such as purple wheat may be beneficial to human health due to their phenolic profiles. Purple berry flour bread (PBFB) was evaluated for antioxidant capacity and aroma quality. PBFB 1 and PBFB 2 were made from purple berry flour PBF 1 and PBF 2, respectively. The 2,2-diphenyl-1-picryhydrazyl free radical (DPPH•) scavenging activity, total phenolic content (TPC), oxygen radical absorbance capacity (ORAC), and total anthocyanin content (TAC) of PBF 1 and PBF 2 were also investigated. 100% whole wheat bread (WWB) and enriched white bread (EWB) were used as controls. DPPH• scavenging activity at 60 min was 32.20–34.06% and 47.58–47.66% for the control and PBFB, respectively, and 58.39–62.94% for PBF extracts (10-fold dilution). The TPC ranged from 515 to 1005 mg/kg, 1111 to 1178 mg/kg, and 11528 to 13618 mg/kg for the control, PBFB and PBF, respectively. The corresponding ORAC values were 8.88–10.64 g/kg, 11.31–12.09 g/kg, and 130.77–145.15 g/kg, respectively. TACs were 69–78 mg/kg and 3188–3363 mg/kg for PBFB and PBF extracts, respectively. TAC was not detectable in WWB and EWB. Similar aroma quality was found between the control and PBFB bread products by using the electronic nose when the controls were used as good criteria for predicting good or poor scores of PBFB products. WWB had high antioxidant capacity compared to EWB control because whole wheat flour contains bran whereas enriched white wheat flour was devoid of wheat bran. Our previous work indicates that the bran contains higher antioxidant capacity than the flour obtained during wheat milling. Our present results show that PBFB products have higher antioxidant capacity in comparison with WWB control. The high antioxidant capacity and good aroma quality for PBFB products are an advantageous in expanding the applications of antho-grains. PBF had significantly high antioxidant capacity, however only 10% proportion of flour (PBF) was used in bread (PBFB) production. The other ingredients in PBFB diluted the contribution of PBF to antioxidant capacity of bread.

Granule ghost structure of sweet potato starch as affected by heating time and temperature

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Starch granule ghost, the surface of the granule remains as remnant after gelatinization under light shear, has been proved to affect the paste or gel functionality. The objective of this study was to investigate the effect of heating time (50, 70, 90 min) and temperature (85, 100°) on the granule ghost structure of starch. Sweet potato starches with high amylose content were used, and the yield and amylose content of starch ghosts were measured. The swelling power and pasting profile were significantly different among starch samples. The yield of starch ghost was affected by heating temperature. However, there was no significant difference in the yield of starch ghost prepared at different heating time. The amylose content of starch ghost prepared at 85° was higher than that of ghost prepared at 100°. The amylose

content of starch ghost decreased as the heating time increased from 50 to 90 min. The effect was more pronounced at higher heating temperature. In conclusion, changes on the yield and amylose content of starch ghost at different heating time and temperature might result in altering the functional properties of starch paste or gel.

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 bother age groups, while 45% Moringa leaf snacks were the least accepted.

Effects of different drying processes on quality of sweet potato stick

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Drying process has significant effects to produce sweet potato sticks. Oven drying and microwave drying methods were used to study effects of temperatures and time on sweet potato stick. Sweet potato sticks were extrude as 30X20X100 mm and dried at 50, 65, 70, 75 degree celsius for 12, 24, 36,48 hours. Results showed temperature and time had significant effects on the quality of sweet potato stick. Temperature 65 degree celsius and 36 hours were optimum temperature and time for drying sweet potato sticks. With higher temperature, sweet potato stick will be burnt with bad quality. The final product moisture content around 14% could lead to good quality and longer shelf life of sweet potato stick. Over drying process need longer drying time than microwave method. However, it is difficult to drive moisture out to use microwave process at the beginning of drying sweet potato stick. The results indicated both oven and microwave process had to be used in the drying process of sweet potato stick to lead a better quality of products.

Methods of dry fractionation to produce barley fractions varying in protein and/or beta-glucan contents

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On average, barley contains 64% starch, 11% protein, and 5% beta-glucan. The remaining 20% includes moisture, fiber, ash and other minor components. Among them, protein and beta-glucan are of higher values. Dry fractionation has been the primary and low cost means to enrich protein and other nutrients in cereal grains. In this study, two barley genotypes (hulled and hulless) were sequentially pearled for 1 to 6 cycles, each with 8% removal. The 6 pearled kernels plus the whole kernel were subjected to one of the two milling methods (impact and abrasive), followed by sieving with a series of U.S. standard sieves. The objective was to determine 1) factors affecting efficiency of nutrient shifts, 2) which method (single or a combination) was best for separating barley into fractions with the highest variations in protein, beta-glucan or both among them. Results show that genotype, milling method and particle size all had significant effects on contents of protein and beta-glucan in sieved fractions, while the cycle of pearling significantly affected protein but not glucan content. Furthermore, abrasive milling produced sieved fractions with much higher variation in protein content than impact milling, but the opposite effect was observed for shifting beta-glucan content. When the recovery rate was taken into consideration, pearling was more effective than the method of milling and sieving in producing fractions with high protein content, but for beta-glucan the later method was better. Among sieved fractions, for beta-glucan, the lowest content was about 7% of the whole kernel value, whereas the highest level was about 280%; for protein, the lowest content was about 45% and the highest was about 145%. Therefore, dry fractionation offers a method of choice for separating barley into fractions with varying levels of proteins and/or glucan, but selection of a specific one is needed for achieving maximum shifts of a particular nutrient.

Individual and interactional effects of major viscosity-contributive components on pasting properties of oat flours with differing beta-glucan concentrations

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Understanding the role of oat components, especially that of beta-glucan, on viscosity will help further develop oat-based food products with desirable health benefits and sensory quality. Seven experimental oat lines with high (6.2–7.2%), medium (5.5–5.9%) and low beta-glucan (4.4–5.3%) concentrations were evaluated for contributions of beta-glucan, starch, and their interactions, to the pasting properties of oat flours by using a Rapid Visco Analyzer. The viscosities were measured under four different conditions: 1) autolysis (sodium buffer used for dispersion), 2) inhibition (silver nitrate solution used for dispersion), 3) enzymatic hydrolysis of beta-glucan by added lichenase, and 4) enzymatic hydrolysis of starch by added amylase. The correlation ($r = 0.8289$, $P < 0.05$) between beta-glucan concentration and peak viscosity (PV) after amylolysis demonstrated the important contribution of beta-glucan to viscosity. The decrease of PV after removal of beta-glucan was weakly correlated with beta-glucan concentration in oat lines ($r = 0.7303$, $P = 0.0624$), confirming the contribution of beta-glucan to pasting. The correlation of PV with beta-glucan concentration was greater under inhibition conditions ($r = 0.8108$, $P = 0.027$) than under conditions of autolysis ($r = 0.7883$, $P = 0.035$), confirming that natural beta-glucan-degrading enzymes are active under autolysis conditions causing beta-glucan degradation. The data also reflect the contribution of beta-glucan to water retention. A lack of correlation between starch concentration and PV observed under all experimental conditions might be explained by underlying structural differences in the amylose and amylopectin components and their behavior under these conditions. The sum of PV after amylolysis and enzymatic removal of beta-glucan was much less than the PV obtained under autolysis conditions, suggesting considerable contribution to PV from beta-glucan and starch interactions.

Evaluation of the effects of *Jatropha curcas* L. flours on the quality of cookies

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The *Jatropha curcas* L. flour has an important value nutritional for the bread products. The aim of the present work was to characterize the dough texture, adhesiveness and extensibility of cookies fortified with *Jatropha curcas* L. flour. A proximal analysis was developed. After that dough was prepared with Wheat Flour (WF) fortified with various levels of *Jatropha curcas* L. flour (2.5, 5, 7.5,10 and 12.5%). Later the rheological analyses (TPA, adhesiveness and extensibility) were performed by using a TA.XT2i texture analyzer (Stable MicroSystems Ltd, Surrey, UK) in a compression mode. The chemical composition of the flour was 6.5% protein for WF and 25% protein for *J. curcas* flour. The cookie fortified with 10% of had 24.6% protein content as compared to 6.4% in the regular product, which agreed with other results reported in the literature. The addition of 10 and 12.5% protein content 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 10 and 12.5% of *J. curcas* flour. The presence of *Jatropha curcas* L. flour produced an excellent firmness and consistency of the cookies and an increase in its cohesiveness, which favours the production of a high-quality product. Using flour *J. curcas* fortified cookies to give a protein intake and nutrition.

Development of starch granules and expression of starch synthesis genes in triticale endosperm

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Triticale is a new and marginal crop with high yield potential in western Canada. We investigated morphological characterizations of starch granules during amyloplast development in triticale endosperm and further studied differential expressions of starch synthesis genes, such as granule-bound starch synthase (GBSS), starch synthase (SS), starch-branching enzyme (SBE) and starch-debranching enzyme (DBE), at different developmental stages of triticale starch granules. We found that triticale mainly formed the double-disk structure during starch granule development and mainly have A-type starch granules in maturity. We applied the real-time PCR to analyze expression profiles of starch synthesis genes during amyloplast development in triticale endosperm. The GBSS-I transcripts on average were expressed over 1,000 times more than GBSS-II transcripts. The expression of SS-I and SS-III genes exhibited the similar patterns, whereas the SS-II gene was significantly down-regulated after 18 DPA (days post anthesis). The SBE-I gene was gradually up-regulated and its transcripts significantly increased about 15 times from 6 DPA to mature. The SBE-IIa and SBE-IIb genes were expressed in the similar profiles at all developmental stages. The expression level of Iso-1 (one type of DBE genes) on average was lower than SS-1 and SBE-IIa genes, and similar to SS-III and SBE-IIb genes, but higher than GBSS-I and GBSS-II genes.

Elucidation of fermentation effect on rice noodles using combined dynamic viscoelasticity and thermal analyses

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Natural fermentation is applied widely in Asia to improve the rice noodle texture. In south China, the polished rice is immersed in water and statically fermented for 3–6 days without a starter, and then washed and wet-milled. The subsequent processes are the same as those for extruded rice noodles (nonfermented), except that rice grains of nonfermented noodles are soaked for around 3 hours. To elucidate the effects of fermentation on rice noodle texture, combined rheological and thermal analyses of the rice flour and starch gels with the same concentration as industrial noodles were performed in this study. A 100 g portion of polished Indica rice (Zhongzao 22, apparent amylose content of 20.6%) was immersed in 200 mL distilled water and naturally fermented at 25°C for 144 h. Another portion of 100 g rice, soaked at 25°C for 4 h, was used as control. After fermentation or soaking, the grains were washed, wet-milled and freeze dried. A portion of the flours was purified by removing protein and lipid. A flour or starch suspension (38% w/w) was prepared. Dynamic temperature ramp sweep test of the suspension was conducted by a strain-controlled rheometer, operated with parallel-plate geometry, 25 mm of diameter, 2.0 mm of gap, 1.0% of strain. Temperature program: 60°C to 95°C at a heating rate of 1.0°C/min, kept at 95°C for 10 min, 95°C to 4°C at a cooling rate of 3°C/min, kept at 4°C for 2 hr. The thermal properties of samples were examined by differential scanning calorimetry (DSC). The sample concentration and heating program are the same as the above. Dynamic viscoelasticity in a temperature ramp sweep test showed the starch granules of fermented sample swelled more and resistant to breakdown than those of nonfermented one. DSC revealed that the gelatinization temperature of fermented rice flour shifted to a lower temperature. The partial impairment of amorphous region of starch granule structure may release the internal stress during swelling. The decreased protein content by fermentation played also a role on the modified rheological and thermal properties of fermented rice flour. The fermented rice flour formed gel earlier with a well-formed gel structure, but displayed slower retrogradation during aging.

The influence of adding *chia* flour and vita-gluten on the technological quality and shelf life of bread loaves

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The current trend in nutrition indicates the importance of incorporating into the diet essential fatty acids and dietary fiber; the seed of chia fulfills these conditions. Chia (Salvia hispanica L.) is a seed native to middle America characterized by a high alpha linolenic acid content (w3 = 61 g/100 g lipids) and high protein content (21.6 g/100 g chia, d.w.b.), and thus its addition to bread is currently being studied. The objective of the present work was to study the addition of chia flour in combination with vita-gluten (3-0.6, 17-0.6, 3-3.4, 17-3.4, 0-2, 20-2, 10-0, 10-4, 10-2%), to wheat flour and determine the influence on the technological quality and shelf life of bread loaves. The loaves were produced by the direct dough method, using a 22 complete factorial design, and the respective mathematical models were obtained and the response surfaces for each variable evaluated. Volume, moisture content, compression force and color were studied during the shelf life of 1, 4 and 7 days of storage. The response surfaces showed that the specific volume did not present significant variation up to 10% of chia flour content. With respect to moisture content, the values remained practically constant during storage, increasing with increasing concentration of chia flour, from 17 to 20%. High levels of chia flour decreased the hue angle values (H*), and the values for L* showed the same tendency. Nevertheless the color of the loaves did not change during storage. The compression force was affected by the addition of chia flour and vita-gluten, the best responses and crumb texture quality of the loaves being obtained with lower chia flour and vita-gluten contents. The results showed that the substitution of up to 10% of the wheat flour with chia flour presented acceptable technological characteristics in the elaboration of bread loaves.

Cross-linking of proteins by transglutaminase in raw and pre-cooked navy bean flour

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Transglutaminase (TG) is used in the food industry to improve properties of products through cross-linking of proteins. Studies about the impact of TG on viscosity, gelation, and resistance to extension of several food matrixes have been published. However, the use of this enzyme to improve physical properties of common bean flours has not been reported. For this reason, the objectives of this project were 1) improve the viscosity of common bean flour solutions by protein cross-linking, and 2) compare the effect of TG in the relative rate of protein cross-linking on pre-cooked and raw navy bean flour. Dry navy beans (Seahawk cultivar) were used to prepare raw and pre-cooked bean flours. Bean flour and a commercial TG preparation were dissolved in deionized distilled water. Samples were incubated at 49°C for 3 hours and fractions collected at different times. Protein cross-linking was analyzed by SDS-PAGE. Viscosity and storage modulus were measured with a controlled stress rheometer. The apparent viscosities were measured at shear rates from 1 to 100 Hz at 27°C. An oscillatory dynamic test was conducted to investigate the linear viscoelastic region using a strain sweep (0.1–10% gamma). The elastic modulus was plotted versus % gamma. From the plot a value of strain (in the linear viscoelastic region) was selected to conduct a frequency sweep experiment at constant strain for frequencies from 0.1 to 100 Hz. The results showed that viscosity of all types of bean flours treated with TG increased over time. However, raw bean flour treated with TG showed the highest increase in viscosity. The electrophoresis analysis indicated that protein cross-linking occurred when precooked and raw bean flours were treated with TG. However, raw bean flour showed higher relative rate of protein cross-linking than the other flours. The electrophoresis results also showed that it is necessary to add 10 times as much enzyme to pre-cooked bean flour compared to raw bean flour, to obtained similar rates of protein cross-linking. The big increase in viscosity and the large fading of the protein residues bands in the electrophoresis analysis may be indicators that proteins present in raw bean flour appeared to be a better substrate for TG.

Visualization of internal structure of a kernel of wheat by excitation-emission matrix imaging

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Excitation-emission matrix (EEM) has been reported to be useful for identification of constituents. It was considered that specific structure or constituent distribution of food materials, which would be significant information for food evaluation, could be visualized by combining EEM measurement and imaging technique. The first objective of this study was to develop a novel visualization method for internal structure or constituent distribution inside food utilizing EEM measurement and imaging technique. The second objective was to apply the method for a kernel of wheat and investigate the difference among varieties from the point of view of internal structure. Three-Dimensional Spectral Imaging System (3D-SIS), which is

composed of a spectral illuminator, spectral imager and rotating microtome for the observation of the sample surface at any depth, was developed. An EEM at any point of the sample can be measured using 3D-SIS because auto fluorescence images of the sample surface at any excitation and emission wavelength at any depth can be acquired. EEM measurement domestic, domestic, soft and hard types of grains was carried out using 3D-SIS in the excitation wavelength range of 350 to 670 nm and the emission range of 400 to 720 nm at 10 nm intervals. Total 561 auto fluorescence images were acquired for one surface. By assigning different colors to each pixel of the surface image with a correspondence to its EEM pattern, the difference in EEM pattern at the sample surface was visualized. In addition, three-dimensional image of the internal structure was developed by accumulating the surface visualization images with a volume rendering method. In the image of a kernel of wheat, pericarp seed coat layer, aleurone layer and endosperm were assigned different color, which indicated distribution of constituents such as starch and protein and its content were ununiform and different, respectively. The 3D structure of a kernel of wheat was visualised by means of reconstruction from captured images of stained sequential sections. The method developed in this study was considered to be useful not only for comparison among varieties of a kernel of wheat but also for evaluation of various food materials.

Effects of solvents and heating rates on RVA profiles and their relationships with solvent retention capacity of various types of flours

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Rapid Visco Analyzer (RVA) has been widely used to measure the viscosity profiles of starches and flours for screening, quality control and product specifications, and the solvent retention capacity (SRC) used to characterize specific components of soft wheat flour for predicting a flour's baking performance. However, these tests have not yet been fully explored for their suitability with gluten-free (GF) products. Two hard wheat flours (HWF1, untreated; HWF2, containing malt), 1 soft wheat (SWF), 1 durum wheat semolina (DWS) and 2 commercial GF bread mixtures (GFM1; GFM2) were subjected to RVA testing. A defined temperature profile (50-95°C, 95°C held for 5 min, 95-50°C) was applied to the studied slurries, stirring at 160 rpm and recording the viscosity as a function of temperature and time. To investigate how the heating and cooling rates can affect the pasting properties of the flours, different temperature rates (1.5, 3.0, 6.0, 12°C/min) were applied to the slurries. Role of alpha-amylase activity in controlling RVA profiles was considered by incorporating $AgNO_3$ as an enzyme inhibitor. In addition to water, ethanol and lactic acid solutions were used to obtain RVA pasting properties not only of starch but also of proteins. The 6 samples were also evaluated for their SRC properties. Statistical analyses between RVA indices and SRC properties were conducted. Significant correlations ($P < 0.05$) were found among the SRC properties, including those of GF samples. Interesting relationships were also found between SRC and RVA parameters, suggesting that these two tests could be used not only singly as standard methods, but could also be modified or combined in order to produce quality profiles for different materials such as GF products.

Structure-function relationship mediated by individual bread improver components in the Australian rapid dough process

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Bread improvers enhance a range of dough processing and end product quality attributes in commercial white pan bread manufacture. A precise knowledge of their function is required in order to optimise performance and avoid unnecessary dosage which conveys a significant associated cost. This study aimed to examine the variation in response of individual bread improver components and the relationship to dough structure. A commercial bakers' flour and various gluten-protein modifying bread improvers (oxidants, reductants, enzymes and emulsifiers) were used individually in the Australian rapid dough process. All other variables such as flour protein, starch damage, degree of dough development and proofing height were controlled or normalized. The individual action of each improver over a wide usage rate range was measured objectively and compared in terms of their effect on final product quality attributes which was related to differences in dough microstructure. An optimised baking procedure and lean formulation were first devised and repeatability determined in order to create a baseline reference with which to reliably compare the effect of added improvers. Dough protein modification arising from improver addition during dough mixing was measured by monitoring the change in the distribution of protein fractions (glutenin, gliadin, soluble protein and amino acids) with SE-HPLC and was linked to differences in baking quality and associated structural modification. A structural-functional relationship was observed between dough structure and final product quality attributes with the addition of individual bread improver components.

Effect of ozone treatment on common stored grain molds and fungi

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Stored grain products, such as corn, can harbor multiple microorganisms, including fungi such as Aspergillus species that produce toxins harmful to both humans and animals. In previous studies, we have demonstrated that ozone-treatment can significantly reduce the level of viable microorganisms on the surface of corn. Ozone is a high energy form of elemental oxygen that slowly decomposes to diatomic oxygen accordingly: O3 ? 3/2 O2, ?H = –145 kJ/mol. Ozone is a strong oxidizing agent, which is used in a growing number of industrial applications to control harmful microbes and volatiles. The ultimate goal of this project is to develop a continuous-flow grain treatment system that will kill the microorganisms on the grain surface with ozone. To achieve this goal, a better understanding of the properties of ozone are needed, especially with respect to the half-life of ozone and time/concentration criteria to kill the microbes on corn. This project is part of a larger effort to develop a semi-continuous treatment system that will produce concentrations of ozone at levels high enough to control and/or eradicate all possible microbial growth. The focus of this project is to determine the concentration-time product (CTP) of ozone required to eliminate various levels of microbial growth on grain kernels for a broad range of operating conditions. These conditions include monitoring the effect of varying air speed, temperature and relative humidity on ozone gas half life time. Establishing the half life concentration of the ozone being generated in our lab will help us determine the stability of ozone in high airflow situations. To examine the effect of ozone on surface microbes, samples of freshly-harvested and stored corn were treated with ozone for a maximum of 60 minutes at a maximum ozone concentration of 1900 ppm. Microbial counts on the corn samples before and after ozone treatment were determine by washing 30 grams of corn in 100 ml of 0.05% Triton X-100 and dilution plating the wash onto potato dextrose agar medium and maltose salts medium. The results determined that the concentrations of all microorganisms significantly decreased or were completely absent after the corn samples were treated with ozone.

Effect of microbial transglutaminase on gluten proteins of hard, soft and durum wheat

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Microbial transglutaminase (TGM) protein-glutamine gamma-glutamyl-transferase (E.C. 2.3.2.13), catalyzes acyl transfer reactions, introducing covalent crosslinking between L-lysine and L-glutamine residues. Cross-linking takes place through the formation of inter- or intramolecular epsilon-(gamma-glutamyl)-lysine isopeptidic bonds. The use of this enzyme has been proposed as improver of dough, increasing its strength. The objective of the study was to know which fraction of the proteins in wheat flour from hard, soft and durum wheats participate in the crosslinking reactions produced by TGM, with the objective of optimizing its use. Three different concentrations of the TGM enzyme (0, 5 and 10 U/g flour) were tested. Moisture, protein and dry gluten contents were determined as well as rheological measurements were done with the farinograph. The proteins of dougs of each treatment were extracted and analyzed by SE-HPLC and RP-HPLC. Soluble polymeric protein, gliadins, albumins and globulins were quantified as well as gliadins subclasses and glutenin subunits. The Dumas method was used to determine the insoluble polymeric protein. It was observed that the insoluble polymeric protein increased significantly. Moreover, the omega-gliadins and the reduced high molecular weight glutenin subunits (HMWGS) decreased significantly in the soluble fraction of the wheat dough of soft and hard wheats, with a greater impact on dough of soft wheat. Significant differences were not observed in durum wheat protein fractions. The effect of this enzyme depends on the dose and type of wheat, producing an increase of insoluble protein content, which derives in a potential application as improver for wheat dough.

Investigation on the wheat kernel damages caused by the field molds and their influence on the wheat quality

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The presence of contamination in wheat samples with field molds of fuzarium spp. genera was investigated and the isolated toxins were identified. The kernels of three wheat varieties were classified into three fractions on the basis of sensoric, mycologycal and toxicological analyses as follows: sound, "little fuzarious", and "much fuzarious" kernels. Qualative and quantitative analyses were performed by thin layer chromathography (TLC) according to AOAC methods. The content of ochratoxin varied from 16,00 µg/kg in the "little fusarious" fractions to 30,00 µg/kg in the "much fusarious" fractions, while the zearalenone content varied from 190,00 µg/kg to 320 µg/kg in the respecive fractions. The size of the contaminated kernels has decreased compared with the sound ones: those which have passed through the sieve size of 2,0 mm have increased for 2–3 times. Kernels contaminated with fuzarium spp. produced flour with increased ash content, and its amount in the "little fusarious" fractions was grater from 7,8% to 13% comparing with the sound kernels, while at the "much fusarious" fractions it ranged from 47,8% to 60,8%, depending on the variety. Sedimentation value has decreased for 64–72% in the "much fusarious" fractions. Wet gluten content at the "little fusarious" fractions has decreased from 1,0–2,5% comparing with the sound kernels, and from 2,5–5,5% in the "much fusarious" fractions. The opposite was registered for protein content. It ranged from 12,9–14,3 (% db) going from the sound to the "much fusarious" fractions. Hagberg falling number varied from 145–415 (s) from the sound to the "much fusarious" fractions.

Effect of storage time and temperature on frozen bread dough proteins

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Gluten proteins play a key role in the final texture and structure of bread by forming a network from the dough kneading which lines the inside of gas cells stabilized by baking step. Freezing might affect this network by decreasing available water content and by causing physical damages due to ice crystals. This work investigates the effect of freezing conditions of bread dough on the aggregation of gluten proteins. Bread dough was stored different durations (15, 30 and 60 days) at three temperatures (–18°C, –24°C and –80°C). After dough freeze-drying, proteins were extracted with phosphate sodium 0.05M (pH 6.9) buffer with SDS (2%). Proteins of fresh dough were also extracted as a control. Protein extracts were studied in size exclusion chromatography. Recovered protein fractions were studied in sodium dodecyl sulfate polyacrylamide gel electrophoresis (SDS-PAGE) under reducing conditions. Results help to understand the impact of freezing and storage on the gluten proteins. Such a methodology might then be applied to evaluate impact of additives on the bread doughs formulation improvement, to make doughs more tolerant toward freezing.

Evaluation of milling quality in oats

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The hull, retained at maturity and harvest in covered oats, may contribute up to 30% of the dry weight of the complete kernel. Commercially, hull removal is usually achieved using impact dehulling. Ease of dehulling is rapidly gaining attention as a selection parameter in milling oat cultivars because it is related to losses in the milling process. Varieties which give higher mill yields are preferred by the industry. Using samples with known variation in milling quality, we have compared data from a variable speed impact dehuller (3600, 2500 and 1600 rpm) with data collected from a Codema dehuller, a non-impact apparatus used by breeders for small scale dehulling of samples. Based on the % remaining undehulled after a single pass through, results indicated that discrimination between varieties was best achieved with the 2500 rpm impact dehulling. For breeders, it would be advantageous to be able to evaluate ease of dehulling on very small samples, even individual kernels, so that selection for this trait could start early in the breeding process. Thus, we have modified a roller-type, single-seed oat dehuller with an electronic sensor to determine the force/energy required to remove the hull of individual oat kernels. The highest correlation observed was between the roller-type dehuller and the Codema (r^2 = 0.92). With the variable speed dehuller at the discriminatory speed of 2500 rpm, correlation was lower, but still significant (r^2 = 0.60). These results suggest that more than one parameter contributes to the ease of dehulling trait.

Extractability and characterization of pearl millet (*Pennisetum glaucum*) proteins from Algerian cultivars

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Pearl millet (*Pennisetum glaucum*) is the most drought resistant grain in commercial production. Unlike maize and wheat, it is well adapted to arid conditions. Because only very little information is available on characteristics of Algerian pearl millet cultivars in general and on their proteins in particular, the following study was performed. Eleven pearl millet cultivars of various colour and shape were sampled from the Algerian Sahara, eight are traditionally known as local varieties, and three are known as imported seeds, but all are cultivated in Algeria. The studied cultivars were characterized by wide variability in protein contents. Compared to local lines, with the exception of a genotype from Tamanrasset, the introduced varieties were lower in protein content. The albumin, globulin, prolamin and glutelin protein fractions were extracted. Prolamins were the major protein fraction in the eleven cultivars. The portion of storage proteins in the total proteins varied widely. The amino acid composition of pearl millet cultivars consisted of 40% essential amino acids. The combination of SDS-PAGE, HPSEC and RP-HPLC showed that better protein extractability was obtained using reducing agent. The characterization of pearl millet proteins is essential to unleash pearl millet's capacity to be the cornerstone of food security in Africa as well as in many developing countries. These findings show that it is possible to use the protein fraction characteristics of several cultivars to give directions for selecting the most suitable pearl millet varieties for specific food processing.
Keywords: Pennisetum glaucum, cultivars, protein, protein extraction, pepsin, digestibility.

Rheological behavior of defatted maize germ-wheat flour blends

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Exploring unconventional foods having good nutritional profile is the dire need of time due to the increasing demand for cheap dietary recourses, particularly in countries facing food scarcity and for the people with low-income. Defatted maize germ (DMG) with nutrient dense composition is one of the examples of unconventional food sources which, is currently destined as animal feed. Defatted maize germ was grinded in to flour and sieved to remove the course fibrous materials. DMG flour was blended by partially replacing wheat flour at 5, 10, 15, 20 and 25% levels with DMG flour. Water absorption, dough development time and dough stability drawn from farinogram made on Brabender Farinograph depicted that DMG flour level in blends has a significant ($P < 0.05$) influence on all these parameters. Water absorption and dough development time increased while dough stability decreased with the increased augmentation level of DMG flour. Farinographic water absorption increased from 61.04% to 86.63% while an increase in dough development time was 4.73% to 7.08% with 25% of DMG addition level. Apparent viscosity was more at higher level of DMG fortification in flour blends and same trend was obtained at all suspension levels of 5, 10, 15 and 20 percent of flour in distilled water. The force-deformation curve was recorded for doughs prepared at 60% water level from different flour blends by SMS Texture Analyzer. The control dough had a hardness value of 7.56 N, which increased significantly to 84.6N, when the DMG flour level increased up to 25%. The stickiness also increased significantly from –0.372 N to –4.610 N when the DMG level was 25% in the dough. It is evident from the results that the increased water absorption may result in increased yield of the finished product and less gluten thus, it may be successfully incorporated in products where extensibility of finished product (i.e. cookies) is not needed.

The effect of water stress on carbohydrate metabolism in rice anthers

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Water stress during male gametophyte development significantly reduces grain set in rice. In this study we analyzed some of the molecular processes that occur during water stress to further our understanding of carbohydrate

metabolism in stressed rice anthers. Rice plants were exposed to three consecutive days of water stress (-0.5 MPa) induced by PEG. Anthers were collected from the treated and control plants and distinguished as tetrad, microspore and vacuolated microspore stages by light microscopy. Sucrose, glucose and fructose contents were found to be significantly increased when anthers from stressed plants were compared to the control. Glucose and fructose were significantly increased at all stages while sucrose was significantly higher at the tetrad and microspore stages only. qRT-PCR analyses showed that cell wall acid invertase (OsCIN4) was significantly down-regulated at the vacuolated microspore stage compared to the control, while sucrose transporter (OsSUT5) and monosaccharide transporter (OsMST7) were both significantly up-regulated at the microspore and vacuolated microspore stages. Fructokinase (OsFKI) expression was not significantly different while hexokinase (OsHXK3) was significantly down-regulated at the vacuolated microspore stage only. Spatial distribution of these genes was detected by hybridisation with anti-sense labelled probes. Strong expression of OsCIN4 and OsSUT5 was detected within the anther locule at the young microspore, tapetum and middle layer. Hybridisation with OsMST7 showed it was mainly located within the young microspore and the tapetal cells. Overall, water deficit-induced accumulation of sugars was shown to be correlated with repressed expression of OsCIN4, OsHXK3 and with up-regulation of OsSUT5 and OsMST7. This is the first report of up-regulation of sucrose and monosaccharide transporter genes in drought-stressed rice. Understanding the regulation of expression of these genes in rice could help identify drought-resistant germplasm for future breeding programmes and thereby improve grain yields in rice growing regions prone to drought stress.

Spectral evaluation of anti-staling enzymes

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Staling of bread is a collective name for all the deteriorating changes occurring in bread during storage. The most important changes examined in this study were the increase in firmness of the bread crumb due to retrogradation of starch, changes in the gluten phase and loss of water. Staling of bread has been studied by a number of experimental methods including differential scanning calorimetry (DSC), Ultrasound measurements (US), X-ray diffraction (X-RAY) and nuclear magnetic resonance (NMR) and the textural changes has been measured by Texture Analyzer. In this study the aim was at finding a sensitive spectroscopic method capable of measuring the textural changes (staling) happening during storage of bread for up to 21 days by the use of spectroscopy. The application of Fourier transform-infrared spectroscopy (FT-IR) and Near Infrared spectroscopy (NIR) in combination with chemometrics were investigated on whole wheat bread with or without added anti-staling enzymes (Novamyl® or BAN®). For this purpose 180 bread samples, with or without added enzymes, were measured (TA, NIR and FT-IR) with decreasing intensity up to 23 days after baking. The results showed that FT-IR spectroscopy combined with chemometrics was a suitable method to predict the degree of staling, whereas NIR spectroscopy was able to differentiate between the enzyme treatments and to predict the degree of staling. The results are interpreted in great detail and while the FT-IR results could be directly related to starch retrogradation the NIR results were of more holistic nature.

Azodicarbonamide: Update on reaction products from its use as a dough conditioner

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Azodicarbonamide (ADA) has been used commercially as a flour-maturing agent and dough conditioner since 1962. Code of Federal Regulations (CFR) 21 Parts 136.110, 137.105, 137.200 and 172.806 regulate ADA and limit its use to not more than 0.0045% (45 ppm) by weight of flour. Initial studies on ADA highlighted its excellent stability in dry flours, its ability to improve dough handling and overall bread quality. These studies also established ADA's quantitative reduction to biurea during dough conditioning and found ADA treated breads had no pharmacological and toxicological effects. Then in 1997 Canas et al. reported that concentrations of ethyl carbamate, an animal carcinogen, increased in breads prepared with between 20–45 mg/kg of ADA. More recently, in 2004 and 2005, a number of researchers have established a clear link between the use of ADA and the presence of another suspected animal carcinogen, semicarbazide in bread. Results showed a direct, linear correlation between the amount of ADA (5–45 ppm) added to flour and the semicarbazide concentrations determined in bread (30–400 ppb). Therefore, unlike ethyl carbamate formation, there is no threshold ADA concentration below which semicarbazide is not formed. An important part of our semicarbazide research was the analysis of a limited number of commercial breads. Semicarbazide residues were detected in products with and without ADA listed as an ingredient. Because no other sources of semicarbazide contamination in bread have been identified or proposed, such residues clearly establish the use of ADA. Based on 21 CFR 101.4(a)(1) ADA use must be declared in the statement of ingredients. In addition to unlabeled products, the survey also identified a small number of products which contained high levels of semicarbazide (> 600 ppb). These elevated semicarbazide residues are indicative of the addition of ADA concentrations in excess of the 45 ppm regulatory limit.

The change of physicochemistry of 4 Japonica rice cultivars on milling ratio

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Traditionally, millers standardize only whiteness of rice when they mill for cooked rice. So there is no consideration about nutrients loss and texture of rice, and over-milling is done with frequency. This study examined how the nutrients and texture change due to the milling ratio, and would help that millers find the proper ratio balancing between whiteness and other physicochemical properties. Four korean japonica rices well known as good taste were milled with 0.8% mass ratio interval from 92% to 89.6% to brown rice. The amounts of protein and lipid decreased according to the fall in milling ratio of white rice to brown rice, but the whiteness - L value tested by spectrophotometer increased. RVA viscosity was analyzed using powder of milled rice. Peak viscosities and breakdown viscosities increased slightly according to the fall in milling ratio. Texture analysis were studied with cooked rice. TA (texture analyzer) tested hardness and stickiness of cooked rice. Stickiness of cooked rice increased according to the decrease of milling ratio, but hardness decreased. The above results show that overall properties of stickiness or glutinosity grow strong according to the decrease of protein and lipid content induced by increase of milling ratio, but hardness decreases.

Survey on the heavy metal contents of agricultural products

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This survey was conducted to estimate the contents of heavy metals in agricultural products such as rice, corn, soybean, redbean, sweet potato, potato, Chinese cabbage, spinach, welsh onion and radish available on Korean markets. The concentrations of Lead (Pb), Cadmium (Cd), Arsenic (As) and Mercury (Hg) were measured in 421 samples using mercury analyzer or ICP-MS. The survey was applied to 10 agricultural items and was carried out for 7 months, from April to October in 2007. The average levels of Pb were 0.021 for rice, 0.020 for corn, 0.028 for soybean, 0.034 for redbean, 0.025 for sweet potato, 0.021 for potato, 0.019 for Chinese cabbage, 0.031 for spinach, 0.021 for welsh onion and 0.011 ?/? for radish, of Cd were 0.021 for rice, 0.002 for corn, 0.020 for soybean, 0.006 for redbean, 0.008 for sweet potato, 0.011 for potato, 0.007 for Chinese cabbage, 0.035 for spinach, 0.006 for Welsh onion and 0.006 ?/? for radish, of As were 0.103 for rice, 0.005 for corn, 0.007 for soybean, 0.005 for redbean, 0.005 for sweet potato, 0.004 for potato, 0.007 for Chinese cabbage, 0.015 for spinach, 0.009 for Welsh onion and 0.006 ?/? for radish, of Hg were 2.3 for rice, 0.2 for corn, 0.6 for soybean, 1.4 for redbean, 0.1 for sweet potato, 0.3 for potato, 0.5 Chinese cabbage, 2.1 for spinach, 0.5 for Welsh onion and 0.2 ?/? for radish. The weekly intakes of Pb, Cd and Hg from 10 agricultural products were 2.6, 8.7 and 1.2% respectively, as compared with the Provisional Tolerable Weekly Intake (PTWI) established by Joint FAO/WHO Expert Committee for food safety evaluation.

Extraction of starch from wheat flour by alkaline solution

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Cereal Foods World 53:A71

Separation of starch from wheat flour with high purity is very important for the analysis of starch such as amylose and amylopectin determination by size exclusion HPLC (SE-HPLC). A procedure that extracts starch from flour by ethanol precipitation after dissolving flour in KOH and urea solution was researched to improve extraction and analysis of wheat flour starch at micro scale, comparing with conventional dimethyl sulfoxide procedure. Isolated starches were characterized by SE-HPLC that separated starch molecules into high and low molecular weight amylopectin (AP) peaks and an amylose (AM) peak. Higher refractive index signal and larger peak areas of SE-HPLC were shown by starch extracted from flour that was defatted by refluxing in methanol than ethanol. When compared with conventional dimethyl sulfoxide procedure, KOH and urea procedure extracted starch with higher purity that was evidenced by significantly lower protein, arabinose, xylose, and mannose

contents and SE-HPLC of the starch extract showed the larger peak areas of amylopectin and amylose. Stability of starch was affected by pH adjustment during storage after dissolving in KOH and urea and SE-HPLC indicated that starch stored at pH 9 showed less degradation than pH 7, specifically for non-waxy type. A significant negative correlation was shown between SE-HPLC peak areas of high molecular weight AP and AM among 14 wheat flours. Concurrently, AM peak and high molecular weight AP peak areas had significant correlations with flour peak viscosity measured by RVA, predominantly due to the variation among waxy and non-waxy wheats. The KOH and urea procedure offers advantage of extraction of starch with higher purity over a conventional procedure and could contribute to characterization of flour starches by analytical methods such as SE-HPLC and subsequent research on their associations with flour quality.

Size exclusion HPLC of protein using a micro-bore column for evaluation of bread-making quality of hard spring wheat flours

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Cereal Foods World 53:A72

Variations in quantity and quality of wheat flour protein have significant associations with flour quality characteristics and development of rapid analytical method to analyze molecular weight distributions of flour protein is highly expected to enhance characterization of protein for flour quality evaluation specifically when sample set is large. The objective of this experiment was to investigate if employment of a micro-bore column (MBC) (300 × 4.5 mm i.d.) could improve analysis of unreduced proteins in flour by size exclusion HPCL (SE-HPLC) and subsequent evaluation of flour quality. Total protein was extracted with sonication from 33 hard spring wheat flours and separated by SE-HPLC with measurement of absorbance at 214 nm. MBC separated proteins in 10 min at a flow rate of 0.5 mL/min and in 8 min at 0.7 mL/min, while a regular column (300 × 7.8 mm i.d.) took 30 min at a flow rate of 0.5 mL/min. Flour protein content showed significant ($P < 0.001$) correlation coefficients (r) of 0.82, 0.91, and 0.57 with total absorbance areas (AA) using the regular column and MBC at flow rates of 0.5 and 0.7 ml/min, respectively. Bread loaf volume also showed higher r values with total AA using the MBC at a flow rate of 0.5 mL/min (r = 0.73) versus the regular column (r = 0.61). Correlation analysis was also performed between flour quality characteristics and AA values over SE-HPLC retention time, and AA values from MBC at a flow rate of 0.5 mL/min showed a higher or similar range of r values with quality characteristics when compared with the regular column. Molecular weight distribution of flour protein could be analyzed more rapidly by SE-HPLC at 0.5 mL/min when using a MBC, and r values indicate that it could enhance determination of protein functionality for flour quality evaluation as well as decreased consumption of organic solvents.

Influence of ascorbic acid, pyruvate and pH on color stability of 3-deoxyanthocyanins

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Cereal Foods World 53:A72

The rare 3-deoxyanthocyanins from sorghum are relatively stable compared to other anthocyanins, but their degradation by food additives like ascorbic acid limits their potential utilization as natural food colorants. The objective of this study was to determine the effectiveness of pyruvic acid on improving stability of sorghum 3-deoxyanthocyanin (3DX) stability against ascorbic acid bleaching at different pH levels relative to commercial anthocyanin pigments. The stability of six 3DX standards, crude sorghum pigment extract and red cabbage was measured at pH 2.0, 3.2 and 5.0 in the presence of pyruvic acid (50:1 molar ratio). Samples were incubated at 37°C with pyruvic acid for 5 days to synthesize the pyruvate adducts. Their ascorbic acid (500 ppm) degradation was investigated by incubating at 27°C, in the presence of oxygen and fluorescent light for 21 days. HPLC-DAD/MS analysis confirmed the formation of the 3-deoxypyrano adducts at approximately 11 – 47% conversion rate. Generally, ascorbic acid degraded the standards at pH 2.0, 3.2 and 5.0 by an average of 12%, 35% and 40%, respectively. However, ascorbic acid caused a dramatic increase in color intensity of 5-methoxyapigeninidin and 5,7-dimethoxyluteolinidin at pH 5.0 (20% and 91.4%, respectively). On average, pyruvic acid significantly improved the stability of the standards to ascorbic acid degradation by 30%, 10% and 45% at pH 2.0, 3.2 and 5.0, respectively, after 21 days. Ascorbic acid caused color degradation of crude sorghum and red cabbage pigments by 18% and 60%, respectively, at pH 2.0. Color intensity of sorghum increased in presence of ascorbic acid by 15% and 7% at pH 3.2 and 5.0, respectively, while red cabbage was degraded by 70% and 20% at pH 3.2 and 5.0, respectively. Pyruvate did not improve the color stability of crude sorghum against ascorbic acid degradation at pH 2.0, compared to 30% improvement for red cabbage pigment. The higher the pH the better were stability of both crude sorghum extract and 3DX standards to ascorbic acid bleaching. These observations are important in putative application of the 3-deoxyanthocyanins in coloring low acid foods.

Flour properties in relation to acid requirements for the processing of long shelf-life noodles

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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). Results of our previous study have shown that the requirements of organic acid to low the pH of boiled noodles depend on the wheat types and flour refinement. Wheat samples of commercial cargoes, which are used for the making of white salt noodles, were examined for the requirements of organic acid that were decided by titration with lactic acid. It was found that the acid requirement for Australia Standard White wheat was significantly ($P < 0.0001$) higher than that Japanese predominant domestic wheat. Japanese domestic wheat cultivars "Chikugo-Izumi" were grown with six environmental conditions, and flours were prepared from them with an extraction rate of 60%. The growing condition and environment will affect the mineral content of wheat flour, such as phosphorous, magnesium, calcium and potassium. The ash and phosphorous of flour were correlated significantly with the requirement of acid (R2 of 0.75 and 0.96, respectively). However, the amount of potassium was not significantly correlated to the requirement of acid (R2 of 0.30). The results indicated that flour milled from wheat grown under the condition of heavy fertilizer application or lodging has higher acid requirement when used for the processing boiled noodle. The flour mineral contents, in turn, will impact the acid requirements for noodle processing. This study also suggested that less acid is required to adjust pH of long life noodles by using low ash flours milled from selected wheat classes.

Effects of infestation of *Rhyzopertha dominica* (F.) on sorghum endosperm: A laser scanning confocal microscopy and differential scanning calorimetery study

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Infestations of *Rhyzopertha dominica* (F.), the lesser grain borer, can cause loss of biomass and decrease grain quality through feeding damage or contamination with insect fragments and uric acid. *R. dominica* can change dough properties of wheat and negatively affect bread quality. However, few published studies have described the effects of feeding damage by *R. dominica* on sorghum. A previous study showed that *R. dominica* readily attacked sorghum kernels, and the resulting feeding damage affected the kafirin content and flour pasting properties. In this study, we investigated the physical structure of infested sorghum endosperm using laser scanning confocal microscopy (LSCM) and analyzed thermal properties using differential scanning calorimetery (DSC). The LSCM of roughly ground sorghum flour revealed that infested sorghum endosperm had a weakened or a loose protein matrix with unattached protein bodies and starch granules, compared to undamaged sorghum flour which contained a tight protein matrix covering protein bodies and starch granules. DSC thermograms showed significantly lower onset temperatures (71.0–71.5°C) for infested endosperm compared with uninfested endosperm (73.2°C). Peak temperatures decreased gradually from 77.5°C (undamaged endosperm) to 74.9°C as the damage increased with an increasing number (10, 20, 40, and 80) of adult *R. dominica* introduced in each of the sample jars containing ca. 175 g of sorghum. Gelatinization endotherm area and delta H were lower for undamaged endosperm (19.8 mJ and 4.5 J/g, respectively) when compared with the endosperm from the samples most heavily infested with *R. dominica* (35.4 mJ and 8.0 J/g, respectively). These results may be due to increased starch granule exposure in the infested endosperm.

Isoflavone content of germinated soybeans (BRS 258) as a function of germination time and temperature

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The consumption of soybeans and soybean products has increased considerably in the last few years, due to the functional properties accounted to the presence of bioactive compounds, such as isoflavones, of which the most important forms are genistein and daidzein that, at determined concentrations, bring health benefits to consumers. The objective of this work was to evaluate the isoflavone content of whole and germinated soybeans of the cultivar BRS 258, developed by the genetic improvement program of Embrapa-Brazil. Germination was carried out in a germination chamber, with

paper, and at the end of the time and temperatures of the experiment the samples were frozen at –30°C, and then freeze-dried. Isoflavone determinations were made through high performance liquid chromatography (HPLC). The effects of the variations in germination time and temperature were analyzed using the Response Surface Methodology (RSM), with a 2^2 central composite rotational design. The independent variables studied were: germination time (12, 21, 42, 63 and 72 h) and germination temperature (18, 20, 25, 30, 32°C). The total isoflavone content of the non-germinated freeze-dried soybean flour was 222.37 mg/100 g, of which 25.4 mg/100 g (11.42%) was of the aglycones daizein and genistein. Even though the total isoflavone content decreased to 215.94 mg/100 g increasing germination time, with the combination 63 h at 30°C being the one that presented a significant increment of up to 64.47 mg/100 g (29.85%) in these bioactive aglycones. It can be concluded that soybean germination conditions modified isoflavone total content and forms, especially daizein and genistein, which can bring beneficial biological effects to human health.

Characteristics and sorting of white corn contaminated with mycotoxins

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Near infrared reflectance spectra (500-1700 nm) were analyzed to determine if they could be used to identify single whole white corn kernels contaminated with aflatoxin and fumonisin. Kernels used for the study were obtained from grain lots harvested in 2006 from commercial fields in Southern Texas. Kernels were visually examined and grouped into four symptom categories: asymptomatic, showing 25% to 50% discoloration, over 75% discoloration, and discolored BGYF kernels. Friable kernels and fragments were not included in this study as they are usually removed by existing cleaning equipment at grain elevators. After spectra acquisition, Aflatoxin B1 or total fumonisins (B1, B2, and B3) were measured with a fluorometer after extracts were purified with immunoaffinity columns. The aflatoxin or fumonisin level of each five-kernel group then was assigned to each individual kernel from that group. Kernels were analyzed in groups instead of individually to reduce cost and analysis time. Discriminate analysis was used to select the optimal pair of wavelengths to identify kernels containing mycotoxins. It was found that using the wavelength pair of 500 nm and 1200 nm, approximately 87% and 93% of kernels having high levels of aflatoxin (>100 ppb) and high levels of fumonisin (>40 ppm), respectively, were correctly classified. Additionally, approximately 96% of the kernels having low levels of aflatoxin (<10 ppb) and fumonisn (<2 ppm) were correctly classified as uncontaminated. A commercial sorting machine (Satake DE) was set up to sort corn using light at 500 and 1200 nm and reject 4% to 9% of the incoming corn. 10 kg samples of corn were used in all sorting experiments. Incoming mycotoxin levels in three lots of corn used in these sorting experiments ranged from 23 to 150 ppb aflatoxin and 0.4 to 0.6 ppm fumonisin. In one pass through the sorter, aflatoxin was reduced 19–75% (average 45%) and fumonisin was reduced an average of 60%. Two passes through the sorter reduced aflatoxin by 88%, and below 20 ppb in each of the three lots of corn. It was found that some kernels of white corn with minor symptoms of discoloration could have very high contamination levels of aflatoxin without exhibiting external BGYF. Thus, two passes through the sorter were required to reduce aflatoxin below the regulatory limit of 20 ppb.

High-speed, low-cost image based sorter for grains

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Cereal Foods World 53:A73

A high-speed, low-cost, image based sorting device was developed to detect small defects and blemishes on grains and separate damaged/discolored kernels from good kernels. The device directly combines a complementary metal–oxide–semiconductor (CMOS) color image sensor with a field programmable gate array (FPGA) which is programmed to executes the image processing in real time without the need of a computer. The spatial resolution of the system is approximately 16 pixels/mm. The system includes three image sensor/FPGA combinations placed around the perimeter of a single file stream of kernels so that the entire surface of each kernel can be inspected. The kernels are fed using a vibratory feeder and singulate as they slide down a chute. They are imaged immediately after dropping off the end of the chute. Kernels are diverted by activating an air valve. The system has a throughput rate of approximately 75 kernels/s per channel. This throughput rate corresponds to an inspection rate of approximately 8 kg/hr of wheat and 40 Kg/hr of popcorn. The system was initially developed to separate red wheat from white wheat and remove popcorn having blue-eye damage. Blue-eye damage is indicated by a small blue discoloration in the germ of a popcorn kernel. Testing of the system resulted in accuracies of 94% for red and white wheat separation and 85% accuracy for removing popcorn with blue-eye damage. The sorter should find uses for removing other defects found in grain such as insect damaged grain, scab damaged wheat, and bunted wheat. Parts for the system cost less than $2000 so it may be economical to run several systems in parallel to keep up with processing plant rates.

NIRS method for precise identification of Fusarium damaged wheat kernels

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Cereal Foods World 53:A73

Development of scab resistant wheat varieties may be enhanced by non-destructive evaluation of kernels for *Fusarium* damaged kernels (FDKs) and deoxynivalenol (DON) levels. *Fusarium* infection generally affects kernel appearance, but insect damage and other fungi can cause similar symptoms. Also, some kernels may have high DON levels but appear asymptomatic. We are developing technology to correctly identify FDKs using an automated single-kernel NIR (SKNIR) system. A calibration developed to select sound kernels from scabby kernels had an accuracy of more than 99%, but the fraction sorted as FDKs contain kernels which are not totally scabby or sound ("grey kernels"). Comparison of NIR spectra of sound and FDKs (both tombstones and grey kernels) showed distinguishable NIR absorption patterns at 960-985, 1110-1180, 1210-1230 and 1310-1350 nm wavebands. These differences may be due to changes in food (carbohydrates and proteins) reserves and/or DON levels. Additional research is ongoing to determine DON levels of grey kernels and to assess the accuracy of sorting FDKs. We are also developing a calibration to estimate DON levels of single wheat kernels. Kernels from artificially inoculated and control wheat spikes were used for the collection of spectra in order to get a concentration gradient of DON for calibration and validation samples. Analysis of single kernel DON by wet chemical methods will also yield additional information regarding the changes in DON kevels in kernels above and below the point of infection. The findings of these studies will be helpful to develop a rapid and automated single kernel evaluation technology to correctly identify sound and FDKs in wheat samples and/or to sort wheat kernels based on DON level. This will facilitate quick evaluation of a large number of breeding lines for scab resistance to identify better scab resistant varieties or parent materials for crossing. Further this technique may be extended as a cost-effective and environmentally friendly technique for analysis of DON in wheat samples for grading commercial grain lots by replacing the time consuming and expensive methods that use various other chemicals for extraction of DON. This technique may also be extended to other grains such as barley.

Nordic flour network – experiences from a centralized network system covering flour mills located in several countries

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Cereal Foods World 53:A73

NIR has been around for many years in the flour industry, but has for most flour mills never reached the level of use that it has the potential to do. Main limitations has been instrumental technology used and the skills required to develop accurate calibrations. By using stable scanning monochromator NIR instruments and advanced calibration techniques such as PLS or ANN using large databases these obstacles can be removed. If instruments are operated in a network the resources required for calibration development can be centralized and local operators can concentrate on other quality assurance tasks. In Sweden, Norway & Denmark individual flour mills cooperate in such a network – the Nordic Flour Network. Experiences from this network will be presented with regards to differencies between instruments, instrument standardization, long term stability of instruments and overall accuracy of the common calibration for all flour types produced by the 18 member mills. Ring tests of reference methods have been carried out between the mills and these results will be presented. Special attention has been focused on accuracy of the ash determination.

Ethanol production waste as rubber composite filler: Examining the pyrolysis of dried distillers grains and other dry milling byproducts as potential rubber reinforcement materials

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The current push for corn-based ethanol is creating a large surplus of affordable byproducts that can potentially serve as filler material for rubber composites. Biomaterial fillers can help replace carbon black and reduce dependence on petroleum. This research examines the reinforcement behavior of various ethanol dry milling byproducts after undergoing pyrolysis to

increase the carbon content. Ethanol byproducts were pyrolyzed and ground with a planetary ball mill, then blended with carboxylated styrene-butadiene, freeze-dried, and compression molded. The rubber composites were then rheologically tested to determine their reinforcement properties.

Protein and starch changes during wheat tortilla processing

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Constant increases in wheat tortilla consumption in the U.S. require research tailored to understand tortilla processing and ingredient functionality. Important factors influencing final tortilla quality are wheat proteins and starch. Understanding changes that occur in the gluten network and starch during tortilla processing are useful to determine flour properties for tortilla production. In this study, changes in protein structure and starch composition during laboratory scale tortilla making were investigated. Samples were collected before and after dough proofing, and at multiple time points during processing: immediately after hot-pressing; during baking; and at days 0, 2 and 7 after baking. Samples were lyophilized, ground, sieved and protein extractions were analyzed by size exclusion high performance liquid chromatography (SE-HPLC) analysis. Chromatograms derived from monomeric and soluble polymeric proteins revealed an increase in molecular weight during mixing, indicating the formation of large protein polymers as dough is formed. Subsequently, the extractability of monomeric and soluble polymeric proteins decreased gradually, as dough was transformed into tortillas by hot-pressing and baking. This was supported by a decrease in the total peak area and by an increase in insoluble polymeric protein (% IPP). Relevant changes in the size distribution were observed by decreases in high molecular weight and increases in lower molecular weight proteins. No differences were observed in protein extractability and SE-HPLC chromatograms in tortilla samples collected at days 0, 2 and 7, indicating that changes in protein structure occurred during mixing and baking only. A second extraction procedure using a reducing agent was performed to analyze the insoluble polymeric proteins in the residual pellets. SE-HPLC chromatograms revealed a gradual increase in the total area. Dough had the least amount of proteins, whereas fully baked tortillas revealed the most level of protein. Following polymeric protein extraction, the protein content in the pellet was determined. No differences in protein content were detected throughout samples at this stage. Soluble starch was quantified on defatted samples and composition was determined using gel permeation chromatography. Results indicated an increase in soluble starch during processing.

Beta-glucan rich beverages with fresh taste

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Cereal Foods World 53:A74

Exploitation of heart healthy ingredient, cereal beta-glucan in beverage applications is an attractive opportunity for producers of functional drinks. However, the use of beta-glucan rich fractions in beverage production includes several technological and quality challenges, e.g. viscosity of the drink, stability of beta-glucan molecules during processing and storage, and flavour and flavour stability of the drink. It is very well-known that regardless of the proven functionality of the product the consumers are not willing to sacrifice the palatable and fresh taste. Extraction of beta-glucan from beta-glucan rich bran fractions is an economical way to produce a functional basis for beverage industry. However, the grainy taste of beta-glucan extracts from oats or barley can often be too dominating and furthermore, oat lipids may cause off-taste into the beverage. The aim of this work was to overcome these challenges and to produce fresh-tasting beverage. This was done by optimizing the extraction process of beta-glucans from barley or oat bran fractions in order to minimize the dissolution of lipids and proteins. Furthermore the taste of the extract was modified with yeast fermentation in specific conditions. The resulting extract was clear, fresh, tasteless basis for functional drinks, smoothies and yoghurts including physiologically effective amounts of beta-glucans with stable molecular weight. It was shown to have positive properties such as regulating effect on satiety and low GI.

Taste acceptability of corn tortilla and its relation to crude fat content

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Cereal Foods World 53:A74

In this study, ten samples of corn tortilla representing a broad spectrum of taste perception available in Mexico were collected from different sources, including home made (H1, H2, and H3), a small-scaled commercial (S1, S2, S3, and S4), a large-scaled commercial (L1), and experimental (E1 and E2). Following a balanced incomplete block design, 300 Mexican consumers evaluated taste acceptability of these ten tortilla samples using a 9-point hedonic scale (1 = dislike extremely, 5 = neither like nor dislike, 9 = like extremely). Differences in taste acceptability and analytical crude fat content of these ten tortilla samples were analyzed using ANOVA. A scatter plot involving taste acceptability ratings and crude fat content was analyzed using Pearson correlation coefficient to determine any possible relationship between sensory and analytical data. Both consumer and analytical data showed differences among ten samples. High taste acceptability ratings (6.5 points average) were observed for the two home-made samples (H1 and H2) and two small-scaled commercial (H1 and H2) samples. Mean crude fat content on these samples was 2.88%. A Pearson correlation coefficient of 0.5823 indicated somewhat weak correlation between sensory and analytical data. This weak correlation indicated that taste acceptability is influenced by a combination with other factors such as aroma when consumers tested the samples.

Freeze storage of bread - and the effects on the staling behaviour

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The aim of the study was to investigate for how long time breads containing high water absorbing additives could be stored without any major quality changes; how much the bread changes during the freeze storage and if the changes are time dependent. The freezing process and especially the freezing rate are important factors for the outcome of bread quality after freeze storage. In the study, breads containing a special heat-, time-, and pressure treated barley flour or a pre-gelatinised waxy barley starch were slowly frozen and stored at –20°C for up to 2 years of time. A normal white wheat bread was used as control sample. Analyses were preformed on non-frozen samples and on freeze stored samples after 6 months, and after 2 years of storage. During the analyses the samples were stored at room temperature for up to 7 days. The breads were analysed with regard to; water content, retrograded amylopectin, firmness and springiness, day 1, 3 and 7. It was seen that the additives had different effects on staling when comparing the non freeze stored breads with the freeze stored breads. Previous studies have shown that the water content decreases during freeze storage, which also was the case for the reference samples. The water content in the bread samples containing waxy barley starch did not decrease until the samples had been stored for over 6 months, and for samples containing heat-treated barley flour it could be seen that the freeze-storage time did not influence the water content. For all three recipes, the amounts of retrograded amylopectin increased with time and to higher extents when comparing the three storage conditions with the following storage time used for analysing. All the non-frozen samples had similar firmness values, which increased for each measuring day. The firmness also increased for all samples between non-frozen and frozen conditions day 1. Additionally, the reference samples and the samples containing waxy barley starch had an increase in firmness between samples stored for 6 months and for 2 years while for the samples containing heat-treated barley flour the increase was less notable.

Determination of antioxidant capacity of wild rice using the ORAC assay

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The study was aimed at evaluating the antioxidant activities of mixed, processed and raw wild rice. To extract antioxidant compounds from wild rice, aqueous acetone was used. The antioxidant activities of wild rice extracts were evaluated by using oxygen radical absorbance capacity (ORAC) assay. Compared to the white rice control, the results showed that all the wild rice samples (mixed, processed and raw) had much higher ORAC values which indicated higher antioxidant capacities. Among raw wild rice samples, Canadian lake wild rice had the highest ORAC value which reached 6064 µmol/100 g, whereas the ORAC values of other raw samples were above 4000 µmol/100 g. The mixed wild rice had a relatively low ORAC value of 2284 µmol/100 g due to the blending with white rice. Processing had a significant effect on the antioxidant level of wild rice. Quick-cooking wild rice prepared by soaking in water, cooking and drying had a significant reduction in antioxidant activity. But the scarified product exhibited a high ORAC value of 5799 µmol/100 g which is even higher than the average ORAC value of raw wild rice. It is likely that scarification, a process of scratching the surface of wild rice, enhanced the antioxidant capacity of wild rice.

Segmental mobility of polymers in heat-moisture treated normal and waxy potato starch granules

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Cereal Foods World 53:A75

Heat moisture treatment (HMT) of starches is a physical modification that involves treatment of starch granules at low moisture content at a temperature above the glass transition temperature (Tg) and below the gelatinization temperature. The objective of the present study was to understand the effect of hydrothermal treatment on segmental mobility of polymers in normal and waxy potato starches by using iodine vapor as a tool. Potato (PS) and waxy potato starch (WPS), both B-type crystalline starches, were used in this study. The starches were HMT at 100°C for 16 h at 30% moisture. HMT and control starches were then equilibrated over different saturated salt solutions to final water activity (a_w) values of 0.33, 0.75 and 0.97. Equilibrated starches were then exposed to iodine vapor for 24 h and analyzed for moisture content, absorption spectra and crystallinity by using an X-Ray. As expected, the HMT treatment altered the X-ray pattern of both potato starches from B-type to A+B type, with the formation of V-type. The intensity of iodine absorption by treated and control samples were reflected in the K/S maxima values of the different starches. In general waxy potato starch had lower K/S values than normal potato starches at corresponding water activities, except at 0.33 a_w where they both had similar K/S values before HMT. HMT significantly affected K/S values depending on the a_w level and the type of starch (waxy or normal). Before HMT, at higher moisture contents (a_w 0.97 and 0.75), iodine binding by linear polymer segments reduced the diffraction intensity and disrupted the crystalline order within PS, which agree with our previous results. The same observation with iodine was obtained after HMT. Based on these results it is evident that the segmental mobility of granules is affected differently following HMT.

Understanding the effect of gums, polyols and processing conditions on tortilla cellularity

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Cellularity of a product plays an important role in consumer acceptance. Non-destructive x-ray microtomography was used in this study to understand the effect of ingredient and processing strategies on tortilla cellularity. Tortillas were prepared using the modified Bello et al (1991) method. Xanthan gum, carboxymethylcellulose (CMC), glycerol and propylene glycol were added individually and in combination to tortillas. To understand the effect of processing conditions on tortilla cellularity, 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). A high-resolution (<5 µm) microtomograph (Skyscan 1172, Aartselaar, Belgium) was used for structural characterization of tortilla samples. Images were recorded in the range 0–180° and angular projections used to generate 2-D cross-sectional images. Software was used to reconstruct a 3-D object from multiple 2-D images. A set of 2-D images for the entire tortilla sample was obtained and analyzed to quantify cell size distribution, average cell wall thickness, area, perimeter, shape factor and diameter of each cell using image analysis software. A higher baking temperature of 450°F led to the formation of larger air cells and greater air cell density with reduced cell wall thickness. Cell density increased with higher tortilla cooling time. As expected, more cooling time allowed moisture to escape which gave a shrunken air cell wall. Higher dough resting time of 20 min resulted in smaller air cells, lower cell density and higher cell thickness. Addition of both gums and polyols reduced air cell size but cell thickness remained the same. Understanding the effect of ingredient and processing strategies on tortilla cellularity will provide useful knowledge to the baking industry.

Comparison of methods for monitoring liquefaction for use in the dry-grind ethanol industry

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This study was performed to compare methods for measuring dextrose equivalent (DE) or sugars for samples obtained during or after liquefaction in the dry-grind ethanol process. Four methods based on Fehling reagents (Luff-Schoorl) (Lane et al. 1923), Di-Nitro-Salicyclic (DNS) reagents (Sumner and Sisler, 1944), High pressure liquid chromatography (HPLC), and Near-Infrared Spectroscopy were compared. The Luff-Schoorl and DNS methods are chemical tests based on the reducing properties of sugars, while the HPLC measures the actual sugar concentration in solution. Near-Infrared spectroscopy calibration is a secondary method for the measurement of dextrose equivalent and requires a primary reference method for building the calibration. In this study, the method by Lane et al. (1923) was used as the reference method for measuring dextrose equivalent for developing the NIR calibration. Liquefaction was performed on five yellow dent corn varieties with 4 enzymes doses (25, 50, 100 and 200 µL) of Liquozyme SC (Novozymes, Franklinton, NC) using a completely randomized experimental design with repeated measure in triplicate. The slurry was prepared by adding water to 50 g of ground corn to obtain 25% dry solids content. Slurry was liquefied in a water bath at 90°C with constant agitation for 2 hr. Samples were drawn at time intervals of 1 and 2 hours from the start of the liquefaction process. Samples were tested using all four methods and results were compared. The DE values determined using Lane et al. (1923) method varied from 6 to 24%. Sugar concentration as measured by the DNS method varied from 25 to 97 g/L. With HPLC, total soluble sugar as calculated by adding all the sugars (glucose, maltose and higher polymer of glucose) varied from 15 to 19% w/v. It was found that effect of independent variables (enzyme doses and time) on dependent variables (DE or sugar measurement) from each of the tests were significant at alpha = 0.05 level of Type 1 error.

Stress relaxation behavior of wheat flour dough as a function of water content and extruded cranberry bean flour addition

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The objectives of this study were to characterize the stress relaxation behavior of wheat flour dough as affected by the water content and extruded cranberry bean flour. Beans have been noted specifically for their ability to lower blood cholesterol, glucose, and homocysteine levels and to elevate dietary fiber and blood antioxidant levels. Cran berry flour addition improves the protein content and nutritional quality of the foods by improving the fiber, nondigestible starches, vitamins, and minerals contents. Stress relaxation technique would provide valuable information on the dough behavior under various processing conditions like flattening, sheeting and rolling. The study was conducted by varying the a) water content (50–60%), b) raw cranberry bean flour and c) extruded cranberry bean flour, at 10, 20 and 30% levels using a texture analyzer (TA-XT2$_i$) under 10% strain levels. The stress relaxation decaying constants k_1 (initial decay rate) and k_2 (asymptotic value of the normalized force) were obtained by linearising and plotting 'relaxation time' against '$F_0t/[F_0-F(t)]$'. The constants $1/k1 \rightarrow 0$ relates to elastic solid and $1/k_2 \rightarrow 1$ indicates for a liquid. An increase in water content in the dough decreased the k_1 values and increased the initial compressive strength. Both k_1 and k_2 constants were significantly affected by the addition of raw and extruded Cranberry flour addition. The extent of stress relaxation (ESR) constant calculated from the force recorded after 1 min from the peak, increased from 25.36 to 28.13% when the raw bean flour addition from 10 to 30% respectively, on the other hand the same increased from 31.07 to 37.58% for extruded bean flour. Similar increasing trends were also observed for peak force of dough for raw as well as extruded bean flour added doughs. These findings would help in predicting the behavior of dough under various processing conditions and consequently on the final product quality (cookie) including texture and consumer acceptability.

Rheological characterization of extruded cranberry bean flour dispersions

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The rheological characterization of extruded cranberry flour (ECBF) dispersions will be helpful in designing the new porridge type liquid foods. The concentration, temperature and shear rate are important factors that govern the viscosity of liquid foods. The objectives of this research were to characterize the rheological behavior of ECBF dispersions at different concentrations (10–30% solids) and temperatures (20–60°C). The study was conducted using a Haake rheometer (VT 550) with concentric cylinder geometry by varying the shear rate from 0 to 300 s^{-1} and fitting to rheological models. The apparent viscosity decreased with increasing shear rate, indicating the shear thinning behavior or pseudo plastic behavior of ECBF flour dispersions. The app. viscosity decreased from 1.47 to 0.32 Pa s when the shear rate increased from 25 to 300 s^{-1} for 30% dispersion. When the ECBF concentration increased from 10 to 30% in the dispersions: a) the power law constant-consistency index (K) increased from 0.0073 to 7.593 Pa s, while the flow behavior index (n) reduced from 0.862 to 0.489 b) The Herschel-Bulkley consistency index (K) increased from 0.022 to 5.762 Pa s and flow behavior index (n) decreased from 0.978 to 0.528 and c) The yield stress values increased from 0.1301 to 6.525 Pa s. The temperature had a

significant effect on the viscosity and it increased from 0.05 to 0.154 Pa s at 100 s^{-1} when the temperature increased from 20 to 60°C. These findings would help in understanding the concentration-temperature-viscosity relationships and their interrelationships with the mouth feel characteristics of porridge type liquid foods.

Composition and characteristics of oil extracted from flaxseed-added corn tortilla

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Cereal Foods World 53:A76

Flaxseed has recently gained attention as a functional food. The effect of adding flaxseed (10, 15, and 20%) to tortillas was evaluated. In this research the physicochemical characteristics and free fatty acid content of oil extracted from flaxseed-added corn tortilla were determined. The corn/flaxseed tortilla was prepared by mixing nixtamalised corn flour (NCF) and flaxseed flour, followed by addition of water to form masa. Tortillas were baked on a hot griddle for 1 min per side at an approximate temperature of 250 ± 5°C. All samples were frozen in liquid nitrogen, freeze-dried, ground and analyzed for moisture fat, protein, ash and fiber according to AOAC and AACC methods. In this study, oil was extracted with ethyl ether (Soxhlet method). The crude oil was assayed by means of AOAC and AOCS methods for saponification (SV), peroxide (PV) values and free fatty acidity (FFA). The results showed: the lipid (4.27%) and protein content (9.10%) of control sample was statistically lower ($P \leq 0.01$) than tortillas added with flaxseed resulted. The SV was 95.37 (mg KOH/g oil) in tortilla added with 10% of flaxseed and increased to 100 (mg KOH/g oil) for the 20% flaxseed treatment. PV tended to increase ($P < 0.05$) when flaxseed flour was added at 10, 15 and 20%. In the present study, tortillas exhibited a high amount of total unsaturated fatty acids, 26.32–30.08% (oleic acid). Therefore, flaxseed-added corn tortilla could represent a valuable staple in improving the nutritional value of original food product.

Dietary fiber and other minor components in 4 varieties of Andean native crop quinoa (*Chenopodium quinoa*)

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Cereal Foods World 53:A76

The content of dietary fiber in common cereals, like wheat, rye and oat, is well known. However, there exists very little information about the dietary fiber in native Andean crops, like quinoa (*Chenopodium quinoa*). This crop is very nutritive and well adapted in the Andean region. The aim of this study was to evaluate 4 varieties of quinoa grains as sources of dietary fiber and other minor components. The varieties of quinoa studied were very high in dietary fiber, specially the insoluble fiber being its content between 11.99 and 16.09%. The content of soluble dietary fiber in quinoa was between 1.41 and 2.82%. The total dietary fiber content in quinoa varieties was between 13.57 and 17.94%. In the methanolic extracts of the grains the content of total phenolic compounds was determined according to the Folin-Ciocalteau procedure and the radical scavenging capacity by DPPH method. The content of total phenolic compounds in four quinoa varieties was between 1.42 and 1.97 mg of gallic acid/g of dry basis. The radical scavenging capacity of the studied varieties was 665.79-1225.82 micromol trolox/g of dry basis. There was a correlation between the content of total phenolic compounds and the antioxidant capacity. The quinoa can be considered as good source of dietary fiber and compounds with radical scavenging capacity.

Determination of radical scavenging capacity and total phenolic compounds of Andean cereals: quinoa (*Chenopodium quinoa*), kañiwa (*Chenopodium pallidicaule*) and kiwicha (*Amaranthus caudatus*)

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The Andean cereals have a very high nutritional value and are consumed widely in Peru, Bolivia and Ecuador. However there exists very few information on their bioactive compounds. The colored varieties are potential sources of phenolic substances and other antioxidant compounds. The extraction of the hydrophilic and lipophilic compounds of the Andean cereals was carried out. Kañiwa (*Chenopodium pallidicaule* Cupi variety) had the highest content of both compounds, followed by Quinua (*Chenopodium quinoa* brown ecotype) and finally the Kiwicha (*Amaranthus caudatus* black ecotype). The content of total phenolic compounds was determined with the Folin-Ciocalteau procedure in fifteen varieties of Quinua. The one with the highest content was the variety PIQ031046 with 139,94 mg gallic acid /100 g. In eleven samples of Kañiwa, the variety Leghepito had the highest content of phenolic compounds, with 85,71 mg gallic acid /100 g. Out of six samples of Kiwicha, the variety A00254 with 30,41 mg gallic acid /100 g had the highest content of phenolic compounds. Finally, the radical scavenging capacity was measured with the DPPH-method in the hydrophilic phase. In the fifteen samples of Quinua, the variety PIQ031046 (2400,55 µg Trolox/g) had the highest capacity. Out of eleven samples of Kañiwa, the variety with the highest scavenging capacity was the Puka kañiwa with 1509,80 µg Trolox/g; and in six samples of Kiwicha, the variety A0011 had the highest scavenging capacity with a content of 660,37 µg Trolox/g. All these Andean cereals can be considered as good sources of natural antioxidants, as the phenolic compounds.

Preparation of Korean-type dried noodles from a blend of rehmannia (jihwang) powder and wheat flour

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Noodles are a traditional food product made from wheat and are favored by consumers for their convenience, ease in handling and cooking, storage properties, and nutritional qualities. Recently, there has been interest in developing composite flour noodles, wherein wheat flour is mixed with other starch or dietary fiber-based materials, and natural ingredients with functional properties. Rehmannia (*Rehmannia glutinosa*; also known as Chinese foxglove or Jiwhang in Korea) belongs to the Scrophulariaceae family, is one of the most widely used medicinal herbs in Oriental medicine, especially as a hematopoietic or tonic, and has a high potential for use as a new food ingredient. In this study, Korean-type dried noodles were prepared with composite flours containing various amounts of wheat flour and freeze-dried rehmannia powder. The physicochemical properties of the composite flours and noodle properties were evaluated. Gelatinization temperature of the composite flours increased linearly, while peak viscosity decreased logarithmically, with increases in the rehmannia powder content. Water absorption, determined by both farinograph and cooking tests, decreased linearly with increases in the rehmannia powder content. Swelling index also decreased, while cooking loss and turbidity of cooking water increased progressively, with increasing rehmannia powder content. In terms of turbidity of cooking water, rehmannia noodles with rehmannia powder content of up to 4% (w/w composite flour) were comparable to control wheat flour noodles. Sensory evaluation tests also indicated a similar result in that rehmannia noodles with rehmannia powder content of up to 4% (w/w) were more acceptable than or comparable to the control wheat flour noodles.

Resistant starch levels in exotic corn crosses and impact on starch gelatinization characteristics

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Resistant starch (RS), a type of dietary fiber, has gained importance as a food ingredient because of its health benefits, including functioning as a pre-biotic, reducing gastrointestinal (GI) pH, and decreasing GI transit time. Previous research showed starches containing up to 10% RS maintained most functional characteristics in starch food systems including spaghetti and tortillas. Functional properties included water absorption, cooking loss, firmness and cohesiveness. However, there is little information regarding the effects of RS on starch gelatinization properties, particularly when RS levels are greater than 10%. In this study, eighteen exotic corn lines were bred from twelve parents having wide ranges of amylose concentrations to create progeny varying in RS and with potential differences in gelatinization properties. The RS was evaluated by the Megazyme Resistant Starch kit with values for the parent lines ranging from 18 to 52%, and the exotic crosses ranging from 16 to 35%. Starches were evaluated by Differential Scanning Calorimetry (DSC), scanning from 25° to 180°C to determine gelatinization characteristics and then storing for 7 days at 4°C to enhance retrogradation before rescanning by DSC. The lines with the greatest amount of amylose yielded the highest RS levels and percentages of retrogradation by DSC. DSC gelatinization curves for all exotic starches differed from the curve obtained from typical, commercially-available corn starch, with all curves having multiple peaks suggesting variance in amylopectin structure and chain length. Differences in DSC curves were reflected in differences of RS percentage.

Design of a color reference pattern for the selection of new varieties of chickpea in the Northwest of Mexico

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Chickpea is a well recognized source of vegetable protein, specially in underdeveloped areas of the world. Mexican chickpea are highly priced in the international market due to their desired quality. The Northwest part of Mexico, specially Sonora and Sinaloa, are also recognized for the quality of chickpea, where a high percentage of the annual production is placed in the international market. Among the various characteristics of high-quality chickpea, color is one of the most important, since it influences both: the selection of new improved varieties at the experimental research stations, and also the price at the international market. The purpose of this study was to develop a color reference pattern for chickpea, in an attempt to help for a better selection at the experimental station, and also for commercialization of chickpea produced in the Northwest part of Mexico. Ten chickpea samples were selected for this study: seven were chickpea varieties and three were advanced lines, under improved selection programs. Samples were measured by reflectometer, AGTRON (Md. M300A) and Hunter Lab. Apparatus. Sensory evaluation analyses were conducted using a ranking test, where a trained panel of 12 judges ranked chickpea samples in their preference of color. Statistical analyses of variance showed a significantly high correlation between objective and subjective methodologies of color determination. A color reference pattern was developed, where the spectrum goes from the whiter chickpeas (lighter color) to the intense yellow or brown (darker color). The color reference pattern is currently being used at the experimental station level, for the selection of new improved varieties of chickpea.

Video recording of school meals - whole grain eating behavior

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More than 29 million children participate in the National School Lunch Program (NSLP). Recent plate waste studies indicate that whole grain products are accepted as well as their refined counterparts. Sensory tests conducted with elementary school children suggest that products containing relatively high levels of whole grain are liked as well as products containing the lowest level of whole grain ingredients. To further investigate children's eating behaviors of whole grain products, cafeteria lunches were video recorded in a local school district. Approximately 50 children were taped ~10 times eating a variety of grain foods including whole grain products served in a typical elementary school lunch. Focus groups (n~30) were used to collect in-depth examination of students' response to product introduction. DVD analysis used a modified Dyadic Interaction Nomenclature for Eating (DINE) developed by Stark et al (1995) to investigate eating patterns and behaviors of whole grain products. Results indicate that at higher grade levels children decrease the number of food items selected and time spent eating. As compared to fruits and vegetables, desserts made with grains, such as cookies and cakes, are consistently taken and consumed by all grades when served. Although the frequency of bites and sips vary among children, general eating patterns can be categorized as "typical", "nibblers", "segmenters", and "cyclic" eaters. This baseline data provides a foundation for further exploring the use and acceptability of foods in school meals at the elementary level. This information can be helpful in facilitating product development and introduction of school foods, such as whole grains with children in an interactive and realistic cafeteria environment.

Metabolic and satiating properties of whole grain rye and wheat kernels and their influence on energy intake at a following meal

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Cereal Foods World 53:A77

Wheat and rye are the major cereals for bread making in Europe. Previous studies have shown that whole grain rye breads induce low insulinaemic responses regardless of their glycaemic response. In contrast, there appears to be but modest differences in between glycaemia and insulinaemia to whole grain wheat products. The cause for the lower insulin demand of rye is not known, nor the potential effects on metabolic properties, including effects on appetite regulation. It is therefore of relevance to study the metabolic and satiating properties of rye products compared to those of wheat products. The purpose of the present study was to evaluate the metabolic differences between whole grain wheat and whole grain rye kernels with respect to effects on glycaemia, insulin economy, subjective satiety and voluntary food intake at a subsequent lunch. 10 healthy subjects participated in an acute meal study and were served the test products in randomised order as breakfast approximately once a week. The test products consisted of freshly boiled wheat and rye kernels. White wheat bread (WWB) was used as a reference meal. All meals contributed with 50 g of available carbohydrates. After 270 min an ad libitum lunch buffé was served. Blood glucose, serum insulin and subjective rating of satiety were measured in the post-prandial phase (0–270 min) and the energy intake at lunch was recorded. The rye and wheat kernels both induced significantly ($P < 0.05$) lower glycaemic indices (GI) and insulin indices (II) (GI = 73 and 68, II = 59 and 63) than WWB. Subjective sense of fullness (AUC 0-270 min) was significantly higher for the rye kernels compared to WWB and the test subjects consumed significantly less energy at lunch following the rye kernels than after WWB. In conclusion, despite similar glycaemic and insulinaemic responses, rye kernels, in contrast to wheat kernels, have favourable satiating properties compared to white wheat bread. This publication is financially supported by Funcfood; an interdisciplinary PhD program in functional food sciences at Lund University, Sweden and the European Commission in the Communities 6th Framework Programme, Project HEALTHGRAIN (FOOD-CT-2005-514008). It reflects the author's views and the Community is not liable for any use that may be made of the information contained in this publication.

Bioethanol production from decorticated sorghum fermented with *Saccharomyces cerevisiae* or *Zymomonas mobilis*

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Sorghum is an attractive alternative for bioethanol production because of its comparatively lower cost in international markets and drought resistance. However, sorghum ethanol conversions are lower than maize mainly due to a tougher protein matrix that lowers and delays starch conversion into fermentable carbohydrates. Practically all biorefineries use yeast to ferment sugars. The main limitation of yeast is that is not osmotolerant. *Zymomonas mobilis* is being viewed as an alternative to yeast due to its high osmotolerance and capacity to ferment mashes with higher sugar concentrations. The aim of this research was to compare the fermenting efficiency of *Saccharomyces cerevisiae* and *Zymomonas mobilis* in mashes obtained for decorticated sorghum adjusted to 13 or 20° Plato. Preliminary results indicate that *Zymomonas mobilis* was capable of fermenting 20° Plato decorticated sorghum mashes and therefore increase the use of the fermentation reactors. *Zymomonas mobilis* did not utilize free amino nitrogen and produced less biomass compared to *Saccharomyces cerevisiae*. The kinetics of fermentable sugar utilization and ethanol yield during fermentation of 13 or 20° Plato mashes will be presented.

Consumption of graham snacks with varying whole wheat flour content in after-school snack programs

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Cereal Foods World 53:A77

According to the 2005 Dietary Guidelines for Americans, children should consume at least 3 daily servings of whole grains. Actual intake is about one serving of whole grains per day for this population. After-school snack programs in elementary schools provide an excellent venue for nutrition intervention. However, there is a lack of whole grain snacks in the marketplace that provide about one serving of whole grain (16 g) flour content. To date, no studies have been conducted to assess the acceptability of whole grain products in after-school snack programs between 5 g and 16 g of whole grain flour content. This study examined children's acceptability of graham snacks made with 5 g, 8 g, 12 g, and 16 g whole grain flour per serving through the use of plate waste, taste tests and group interviews. Subjects included 100 elementary school children (grades K-6) participating in after-school snack programs. Over 8 weeks, children were offered graham snacks in random order containing 5, 8, 12, and 16 g of whole wheat flour per 30 g serving. Plate waste was used to measure graham snack consumption, as children placed their unfinished snacks in a waste receptacle and subsequent waste was measured after each session. At week 9, a subgroup of children participated in taste tests and group interviews. During the taste tests, children rated the four different snacks for overall liking using a 9-point hedonic scale with word description. The group interviews provided input about their perceptions for product quality and suggestions for

improvement. Consumption for the 5, 8, 12, and 16 g graham snacks was 80%, 76%, 79%, and 80%, respectively. There was no difference for the taste tests ratings among the snacks. Group interviews indicated little difference in liking and recommendations to improve the various products. This study suggests that these well-liked snacks can contribute to a significant dietary source of whole grain when offered through after-school snack programs.

A thermostable resistant starch-containing preparation from solvent-dispersed and partially debranched common corn starch

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Cereal Foods World 53:A78

Thermostable resistant starch (RS) has been previously generated in our laboratory from solvent-dispersed maize starches. The objective of this study was to characterize the thermostable resistant starch-containing preparation from dispersed and partially debranched common corn starch (CCS). CCS was dispersed in 0.5N NaOH and then precipitated with 80% ethanol. The precipitate was rehydrated at either 1 or 2% concentration in the presence of variable levels of isoamylase (0, 10, or 20 U/g starch) for 16 hours at room temperature. After rehydration and centrifugation, precipitates were collected, and the starch yield was calculated. The proportion of RS in the precipitates was determined by AACC method 32-40. Thermostability was evaluated by subjecting samples to a 30 min boiling treatment in buffer prior to adding alpha-amylase for RS determination. The sample rehydrated at 2% concentration with 20U isoamylase gave the highest starch yield (48%) and the highest proportion of RS. For this sample, the proportion of RS decreased (from 35 to 19%) as particle size decreased, but the proportion of the thermostable RS (14%) was independent of particle size. By size exclusion chromatography (SEC), the molecular composition of this sample indicated substantial, but not complete, debranching from the isoamylase treatment during rehydration. This sample was completely debranched prior to determining the chain length profile by high performance size exclusion chromatography (HPSEC). HPSEC chromatograms showed that the longer chains from amylopectin were preferentially coprecipitated. Compared with samples prepared under other conditions, there were an increased proportion of linear amylose chains. The thermostability of the RS in the sample appears to be related to this unique molecular composition produced on rehydration.

Effect of ozonated flour on bread quality

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Cereal Foods World 53:A78

Ozone is a tri-atomic molecule (O3), and is a powerful oxidant with an oxidation reduction potential of 2.07 V. The use of ozone in the food industry has been limited mainly to shelf life extension of commodities. Recently, there has been renewed interest in ozone and its application in food processing. This project was aimed at studying the effect of ozonated flour on bread quality. Ozone generator model number CDO-8000 was used to ozonate commercial flour, at 1500 ppm for 40 minutes. The ozonated flour was added to commercial flour at 10%, 20%, and 30% (w/w) levels, which were compared with the control flour that was not ozonated. Moisture content, Farinograph, and Rapid viscoanalyzer (RVA) measurements were made according to AACC Methods 44-15-A, 54-21, and 76-21, respectively. Texture analysis and modified extensigraph measurements were made using the Texture analyzer (TA-XT2 texture analyzer). The C-cell-digital imaging instrument was used to compare bread structure and quality. Results showed that ozonated flour added at the 10% level produced bread with the highest specific loaf volume and increased bread firmness. RVA results showed that peak value, breakdown value, final viscosity, and setback values increased with increasing amounts of ozonated flour added to the commercial flour. C-Cell data showed that the 10% ozonated flour produced bread with the least number of holes and the finest cell structure than the bread produced with higher levels of ozonated flour.

Development of a functional cake with partial substitution of wheat flour by toasted whole soy flour and of starch by fructooligosaccharides

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Cereal Foods World 53:A78

Soy and fructooligosaccharides (FOS) are ingredients with functional properties, as they contain isoflavones and fibers, respectively; and their demand in the food market is continuously growing. The objective of this work was the development of a functional cake, substituting part of the wheat flour by toasted whole soy flour (SF), and part of the starch by FOS, resulting in a product with higher nutritional value and functional properties. The cakes were produced using a pound cake formulation, following a 2^2 complete factorial design, with the independent variables SF (0, 3, 10, 17, 20%) and FOS (0, 1, 3, 5, 6%). Specific volume and color (luminosity-L*, hue-h* and chroma-C*) data were obtained on the first day of storage and compression force and moisture were determined during shelf life, on the first, fourth and seventh day of storage. The analyses (Tukey's test with a 95% level of significance) showed that the ingredients SF and FOS had no effect on cake specific volume (average value of 2.36, std.dev 0.05 mL/g). Higher SF contents (20%) resulted in cakes with lower L* (58.57 std.dev 0.81) and h* (71.17 std.dev 0.23) values and a higher C* (29.71 std.dev 0.30) value. The addition of 5% FOS and 3% SF contributed to a reduced hardness of the crumb, of 5.41 std.dev 0.41 N, and a higher moisture content on the seventh day, of 23.34 std.dev 0.46%. The results showed that the incorporation of soy flour (20%) and fructooligosaccharides (6%) in cake formulation is technologically viable, resulting in a product with a higher fiber content and better nutritional value and functional properties than the conventional formula.

Effect of food biopolymers on enzymatic hydrolysis of potato amylopectin

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Cereal Foods World 53:A78

The rate and extent of starch digestion by enzymes notably influence glycaemic response. The process of enzymatic starch hydrolysis is affected by starch properties such as granule structure, crystal type, molecular structure, and retrogradation, and by the interaction between starch and other components which limit the access of the enzyme. Potato amylopectin contains a small portion of phosphate groups. The phosphate groups make potato amylopectin slightly anionic. The interaction of anionic potato amylopectin with cationic biopolymers could provide the possibility to modulate the access of enzyme. The objective of this study was to examine how the presence of other food biopolymers such as gelatin and chitosan modifies the digestibility of starches in mixed systems using a quartz crystal microbalance with dissipation monitoring (QCMD). A base layer was formed on the crystal chip by a 0.6 mg/ml poly-L-lysine (PLL) solution in sodium acetate buffer. A 0.6 mg/ml suspension of potato amylopectin was allowed to flow onto the PLL layer to immobilize, followed by a 0.3 mg/ml gelatin or chitosan solution flow. When gelatin and chitosan solution was added onto immobilized potato amylopectin, the layers were built up with the shrinkage. The hydrolysis reaction was initiated by adding 0.01 unit/ml alpha-amylase solution onto the hydrated layers of potato amylopectin and cationic biopolymers. The process of enzymatic hydrolysis was directly monitored by QCMD and the initial hydrolysis rate from curve fittings was compared between amylopectin-biopolymer layers and control without biopolymers. The deposition of gelatin and chitosan on potato amylopectin suppressed the enzymatic hydrolysis of amylopectin. The results suggest that these cationic food biopolymers could be barrier materials for the enzymatic hydrolysis of potato amylopectin.

Breadmaking with zein-starch dough

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Cereal Foods World 53:A78

Mixtures of maize prolamins (zein) and starch form a cohesive, extensible, viscoelastic dough when mixed above zein's glass transition temperature (Tg), e.g. at 35–40°C. Although this phenomenon has long been known, it has not yet been successfully used for gluten-free breadmaking. We found that by adding hydroxypropyl methylcellulose (HPMC) to zein-starch dough, good bread (specific volume 3.2 mL/g) with soft crumb and regular crumb grain resembling wheat bread, as well as specialities like soft pretzels could be produced. Laser scanning confocal microscopy (LSCM) of zein-starch dough with HPMC revealed fine protein strands resembling a well-developed gluten network. Cooling zein-starch dough below its Tg (≈29°C) rendered these strands glassy and consequently highly susceptible to mechanical impact. Once shattered, the zein consisted largely of very small pieces (<10 μm), which were too small to reaggregate upon remixing above Tg. Mixing conditions were found to be another critical factor, in so far as gentle mixing, allowing glass transition of the zein particles and network development was required.

Development of screening method for genetically modified soybean; plasmid based quantitative-competitive PCR

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Cereal Foods World 53:A79

The commercialization of genetically modified (GM) crops and foods derived from GM crops has been spreading rapidly across the world. With the expansion of GM crop production, consumers have demanded appropriate information for foods derived from GM crops. To enable consumers to make informed choices, labeling systems for GM foods have been implemented in some countries or communities. In this study, we developed a novel type of quantitative competitive-polymerase chain reaction (QC-PCR) system for the detection and quantification of the Roundup Ready® soybean (RRS). This system was designed based on the advantage of a fully validated real-time PCR method used for the quantification of RRS in Japan. A plasmid was constructed as a competitor plasmid for the detection and quantification of GM soy, RRS. The plasmid contained construct specific sequence of RRS and the taxon specific sequence of *lectin1* (*Le1*), and both had 21 bp oligonucleotide insertion in the sequences. The plasmid DNA was used as a reference molecule instead of ground seeds, which enabled us to adjust the copy number of targeted DNA sequences precisely and stably. The present study described the development of the method compared with the data obtained by the real-time PCR method. The results demonstrated that the novel plasmid based QC-PCR (PQC-PCR) method could be a simple and feasible alternative to real-time PCR method used for the quantification of GMO contents.

Digestible, structural and rheological properties of starches modified by amylosucrase

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Cereal Foods World 53:A79

Amylosucrase (AS) from *Neisseria polysaccharea* (E.C. 2.4.1.4) uses sucrose to synthesize alpha-(1→4)-glucan, releasing fructose. This enzyme elongates glucose units at non-reducing ends of external chains on the acceptors. AS was used on waxy rice, normal rice, waxy corn, normal corn, waxy potato and normal potato starches to prepare slowly digestible starch (SDS). Starch suspension (2%) was boiled and incubated at 30°C for 40 hr with AS and 100 mM sucrose. The AS-treated starches produced similar amounts of resistant starch (RS) and decreased rapidly digestible starch (RDS) and increased SDS contents compared with control. The SDS contents of waxy starches were increased by around 25% after the AS treatment, while around 8% for normal starches. Especially, AS-treated waxy corn starch showed the highest SDS content (30.2%). The elongated side chains of AS-treated starches were confirmed by HPAEC-PAD. The number of short side chains (≤DP 20) decreased, whereas long side chains (>DP 20) increased. Also, the molecular weights of starches determined by HPSEC-MALLS-RI, initial Mw of starches were 2.53–9.59 × 10^7 g/mol and increased by 4.81–13.79 × 10^7 g/mol after the modification by amylosucrase. The X-ray diffraction patterns of AS-treated starches were B-type, and the relative crystallinities of AS-treated starches were higher than those of control starches. The mechanical spectra of raw and AS-treated starches at different concentrations were measured. The value of storage (G′) and loss (G″) moduli increased with starch concentration (2, 4, 6%, w/w). The G′ values for 6% raw starches were equivalent to the value for 2% AS-treated starches. The moduli for the gel of AS-treated starches were much larger than those of raw starches, indicating that the gel strengths of starches increased by amylosucrase treatment. Conclusively, the AS treatment led to the increase in slowly digestible property and the changes in structural and rheological properties. This effect was greater when using waxy starch as an acceptor of amylosucrase compared with normal starch.

Effect of defatted maize germ flour addition on the quality attributes of wheat bread

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Cereal Foods World 53:A79

Defatted maize (*Zea mays* L.) germ cake, a by-product of the corn oil industry, is rich in protein content, dietary fiber and minerals. Presently, the defatted maize germ (DMG) is mainly used for animal feed. The objective of this study was to assess the feasibility of using this nutrient-rich food ingredient in bread by substituting wheat flour with 5–20% DMG flour. Breads prepared with wheat-DMG flour blends were analyzed for loaf volume, density, Hunter color values, instrumental texture, and selected sensory attributes. Our results showed that loaf volumes decreased significantly, from 318.8 mL to 216.3 mL, as the DMG flour level was increased from 0 to 20%; whereas, bread density increased significantly at all four DMG flour levels. The bread made with 100% wheat flour (control) was lighter in color, as shown by higher Hunter "L" values than those made with added DMG flour. A similar trend was observed for chroma and hue angle values, which were significantly higher in treatment breads. The bread slice firmness, measured by SMS Texture Analyzer (TA-XT 2*i*), was significantly higher for breads containing DMG flours, 61.58 N in 20% DMG bread as compared to 32.84 N for the control bread. In general, minimal or no differences were observed for the sensory attributes of crumb color, cells uniformity, aroma, firmness, mouthfeel, and off flavor in breads with up to 15% DMG flour. However, most of the sensory attributes were impacted negatively with 20% DMG flour addition. Based on the findings of this study, it is concluded that bread with acceptable quality attributes could be made with up to 15% DMG flour.

Dried flour-oil composites for lipid delivery in low-fat cake mixes

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Cereal Foods World 53:A79

The aim of this study was to prepare and evaluate flour-oil composites for lipid delivery as a dry ingredient in cake mixes at different levels of fat. Four excess steam jet-cooked composites containing wheat flour and varied amounts of canola oil (30 to 55%) were drum dried and used as a replacement for fat and part of the flour in low-fat cake mix formulations. Cakes were baked using the mixes and compared to those prepared with same amount of canola oil added as a source of fat. Specific gravity and viscosity of cake batters were measured. The cakes were analyzed for crumb grain using digital scans of the cake crumb; color by LabscanXe Hunter colorimeter; texture using the TA Texture analyzer with ½ inch acrylic probe (TA 10); and water activity using Aqua Lab water activity meter, model series 3. The effects of storage were determined by evaluating cakes stored at 0, 1, 4, and 7 days. Cakes made with the composites were softer as they required significantly less force than those made with equivalent canola oil and had more spring as measured by the texture analyzer. Similar differences in texture were observed with cakes stored for a week. With storage the cake lost their softness and spring. The cakes made with composites retained their softness and moisture better than control cakes made with equivalent flour and oil. The crumb grain and color were not significantly affected by the use of composites as source of fat in the cakes. The composites have great potential for use as an ingredient in baking industry for delivery of lipids for bake mixes.

The effects of glycosidic treatment on the levels and allergenic properties of the major peanut allergens Ara h 1 and Ara h 2

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Cereal Foods World 53:A79

Allergen proteins in cereals and nuts function as storage proteins and possess similar general characteristics. The peanut allergen Ara h 2 belongs to the prolamin superfamily, together with the allergens in rice, wheat, barley and rye. The prolamins are characterized by low molecular weight, stabilization by disulfide bonds, resistance to proteolysis and heat. The peanut allergen Ara h 1 belongs to the cupin superfamily, with a slightly different secondary structure and an ability to form aggregates. Ara h 1 and Ara h 2 are glycoproteins. The objective of this study was to alter the levels and reduce the allergenic properties of these peanut allergens by cleaving their glyco-portion through enzymatic treatment. The Crude Peanut Extract (CPE) of raw, unshelled and unsalted U.S. Virginia peanuts was first obtained by defatting the kernels (100 g) with acetone (250 mL) and then with diethyl ether (5 × 250 mL). The proteins were then extracted in aqueous solution (300 mL of 0.1M ammonium bicarbonate, pH 8.0), and centrifuged for 20,200 g at 4°C for 80 min (2x). The supernatant was lyophilized and used as CPE for all further studies. The CPE was suspended in acetate buffer (pH 4.0) and incubated at 37°C with the enzyme at 0 h, 1 h, 2 h and 3 h. The reactions were stopped using ethanol. The changes in the proteins were observed using Reversed Phase-HPLC and SDS-PAGE. RP-HPLC indicated a change in areas of certain peaks by as much as 100% and SDS-PAGE confirmed that the monomeric form of Ara h 1 (63.5 kDa) and the Ara h 2 (17 kDa) doublet decreased with enzymatic incubation, with Ara h 2 showing less degradation. Immunoblots using chicken anti-Ara h 1 and Ara h 2 as primary antibodies revealed that the binding of Ara h 1 to the antibodies decreased immediately

after enzymatic treatment whereas Ara h 2 binding decreased only after incubation for 2 h and 3 h. Glycosidic treatment appears to reduce the levels of these allergens. Further study is on the way to test if this translates into a decrease in allergenicity of peanut proteins. Understanding the behavior of peanut allergens can lead to comprehension of the behavior of other allergens with the same molecular features.

Characterization of the functional properties of carob germ proteins

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Cereal Foods World 53:A80

Carob, Ceratonia siliqua, is a leguminous shrub native to the Mediterranean region where its seeds and pods have been used for thousands of years as a food thickener and sweetener. In current times, carob is used for the production of locust bean gum, chocolate substitutes, and molasses. As part of the industrial processing of carob seeds, the germ is separated from the seed, milled and sold as carob germ flour. In 1935 proteins from the carob germ were identified as having gluten-like properties. Although some biochemical characterization of carob germ proteins and their functionality has been carried out, relatively little has been done when compared to proteins such as gluten. The objectives of this project were to characterize carob germ proteins under conditions typically used for gluten and evaluate their baking performance as a gluten free alternative to wheat bread. To accomplish this, carob germ proteins were separated into soluble proteins and insoluble proteins using an SDS phosphate buffer without a reducing agent. The SDS soluble proteins (SP) constituted almost 96% of the proteins and the insoluble proteins (IP) only 4%. Of the SP, roughly 65% were polymers or small oligomers with the remaining 35% monomeric proteins. IP were essentially all large polymeric proteins. Reduction of the SP and IP after extraction revealed that the majority of the polymeric proteins were disulfide-linked. Mixing in a farinograph in the presence of different solvents was done to determine which types of bonds are important in carob dough formation. DTT was found to destroy the mixing curve, demonstrating the importance of disulfide bonds during carob mixing. Bread baked from carob dough had loaf volume and crumb structure similar to those of wheat breads, and a specific volume of ~3 mL/g. In conclusion, carob germ proteins have similar functionality as gluten and are capable of forming a wheat-like dough and bread.

Preparation and properties of citrate waxy rice starch

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Cereal Foods World 53:A80

Citric acid is nutritionally harmless as a substance for derivatization, and citrate starch has been reported to have high freeze-thaw-stability. In this study, the optimum condition for the production of citrate starch with maximal content of resistant starch from waxy rice starch was established, and its physicochemical properties were investigated. A three-factor, five-level central composite design was used, and the optimum condition for citrate waxy rice starch was at 150°C, 6 hr and 0.4 g of citric acid /g starch. Morphological characteristics were investigated using optical microscopy and SEM. The destruction of granule structure was observed in citrate starches, and the starches lost their birefringence. Crystallinities of citrate starches were measured using X-ray diffractometry, and citrate starches had no crystalline region compared to native starch with distinct A-type pattern. Citrate starches showed no endothermic peak by DSC, pointing that gelatinization of citrate starches did not occur. Also, citrate starches showed very low swelling factors compared to native starch. FT-IR spectra displayed C=O bending stretching of citrate starches, indicating the formation of cross-linking by esterification. Chain length distributions were analyzed using HPAEC-PAD. The number of short chain ($\leq$DP20) increased and the number of long chains ($\geq$DP20) decreased. Results showed that the optimum condition for production of citrate waxy rice starch was established, and citrate starch had decreased crystallinities, imperfect granular shape and decreased chain length.

Effects of kernel composition and starch structure on ethanol yield produced from dry-grind corn

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Cereal Foods World 53:A80

Objectives of this study were to understand how the composition of kernels (i.e., starch, protein, and lipid contents) and the starch structure of dry-grind corn affected the enzyme hydrolysis of starch and the ethanol yield during yeast fermentation. Four lines of corn, designated, 05GEM06031, 06GEM01778, 05GEM02989, and 05GEM06000 with 70.7%, 68.9%, 75.2% and 69.7% starch contents (w/w, dry basis), respectively, were developed and produced by the USDA-ARS GEM project and were used for the study. The corn samples were dry ground, and slurries (20% dry substance) were heated to gelatinize the starch, hydrolyzed using *B. licheniformis* alpha-amylase and *A. niger* glucoamylase, and fermented using Ethanol Red dry yeast for 72 h. The ethanol yields from the dry-grind corn lines were 36.2%, 34.6%, 38.0%, and 34.3% (w/w, dry basis), respectively. The efficiencies of ethanol production, calculated on the basis of the starch contents of corn samples, were 90.3%, 88.4%, 89.1%, and 86.8%, respectively. The ethanol yield was related to the starch content and the protein content, with the correlation coefficient of 0.90 and 0.88, respectively. The efficiencies of ethanol production were correlated (correlation coefficient 0.81) to the average branch chain-lengths of the amylopectins of the four corn lines (DP*17.9, DP19.3, DP19.6, and DP 20.2, respectively) and were also correlated to the onset gelatinization temperatures of the starches with a correlation coefficient of 0.65. The residual starch remaining in the distiller's dry grain (DDG) had the peak molecular weight of DP 85, which was attributed to the amylose-lipid complex. *DP-degree of polymerization.

3-D microstructural characterization of food foams

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Cereal Foods World 53:A80

Microstructure and texture have strong impacts on the consumer acceptance of solid and semi-solid food foams such as baked goods, extruded snacks, aerated dairy and fat products. Food products have mixture of textures created through several different processes, process conditions, and product formulations. Characterizing the structure of these products through non-invasive means is useful for understanding the effects of spatial distribution of particles and air in commercial products. This study is aimed at highlighting the use of high-resolution X-ray microtomography (XMT) to quantify the microstructure of different commercial aerated food products. Samples were scanned using Skyscan1072 X-ray microtomograph (Skyscan, Belgium) consists of an X-ray tube operating at 100 kV and 96 μA, an X-ray detector, and a CCD-camera to obtain images from 200 rotation steps in 0–180° range. The scanning process was controlled by a software package, which also allows microtomographical reconstruction using a filtered back-projection algorithm. 2-D cross-sectional images were generated using angular projections, and 3-D objects were reconstructed from multiple 2-D images and sliced virtually for quantitative analysis. The internal structures were visualized by 3D rendering, by 2D slices, or projections following arbitrary directions. SigmaScan Pro 4.0 was utilized for quantitative analysis of reconstructed 2D cross-sectional images. A wide range of products, i.e. cakes, breads, puffed cereals, regular and fat free whipped toppings, whipped butter, marshmallows, crunch bars, malt balls, meal replacement bars, aerated chocolates, and layered waffles, were scanned for analysis. Void volume fraction, which is the best single indicator of how much air is included in a product, ranged between 0.22 to 0.50. XMT scans also provided spatial distribution of micro components such as suspended particles in the product matrix, as well as the size, shape, networking/connectivity, and distribution of various phases. Quantification of such structural features obtained at micrometer scale will open new opportunities for engineering analysis and understanding relationships between composition, processing, and cellular structure formation mechanisms.

Location, location, location! How protein quality attributes of two wheat varieties respond in the same environment

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Cereal Foods World 53:A80

Wheat and wheat flour are marketed on the basis of protein content and quality, both of which are affected by environment. This study's objective was to determine whether two wheat varieties responded to environment in a consistent manner across locations and whether variable responses were sufficient to result in significantly different protein composition and processing quality between varieties of the same wheat class. Two hard red spring wheat varieties were grown in replicated field trials in six locations across the wheat growing area of western Canada. Farinograph absorption differed ($P < 0.001$) between the two varieties and varied across growing locations ($P < 0.001$), but showed no consistent response of variety to location ($P < 0.05$). The two varieties exhibited differing dough strength, as indicated by farinograph stability. One variety was relatively stable across environments with a range of 8.5 min between high and low stability values, while the other exhibited farinograph stability that varied by more than 30 minutes between the highest and lowest value. The percentage of unextractable polymeric protein (UPP) was significantly different ($P < 0.05$) between varieties and

varied significantly across growing locations, but followed the same trends across locations. In contrast, the quantity of polymeric protein extracted with dilute acetic acid using sonication (AS) and measured by flow field-flow fractionation was not significantly different between varieties but was significantly affected by growing location. While there was a strong relationship between UPP and AS (r = 0.85), their relationship with dough strength was relatively weak, accounting for at best 25% of the variation among samples. The sponge-and-dough bread loaf volumes of the two varieties were significantly different, and there were differences across growing locations, however there was no variety × location interaction. Loaf volume did not exhibit a significant relationship with any of the dough strength or protein composition variables for either variety, but was affected by water absorption. In general, protein composition and processing quality of the two varieties followed similar trends across growing location.

The relationship between color and carotenoid/phenolic acid content during grain development of hard red and white wheat

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Cereal Foods World 53:A81

Grain of two Canadian wheat cultivars: Snowbird (hard white spring) and AC Barrie (hard red spring) was studied at different developmental stages with respect to grain color, carotenoid pigments and phenolic acids. Grain samples were collected at one week intervals for six weeks past anthesis at two locations. Samples were either air-dried or freeze-dried. Grain color was evaluated visually and also instrumentally using the CIE L*, a*, b* color scale. Grain color of each cultivar varied significantly depending on the type of drying and on the grain development stage. The color of the air-dried early harvested grain (one to three weeks) changed significantly from green to light brown. The freeze-dried grain samples retained their original color and shape. Total carotenoid pigments were determined using a spectrophotometric method and were expressed as lutein equivalents. Grain samples collected one week past anthesis contained about six times more lutein equivalents on a constant weight basis compared to mature grain samples collected at six weeks past anthesis. Carotenoid pigment content of both cultivars was strongly influenced by environmental conditions especially at early developmental stages, however, the environmental effect was more pronounced in Snowbird. The phenolic acid content of the grain was assessed using RP-HPLC. AC Barrie contained two- to three-fold higher amounts (on a constant weight basis) of ferulic and p-coumaric acid in the early stages of development compared to mature grain. Significant differences in the amount of ferulic, p-coumaric, sinapic, syringic and vanillic acid were observed between samples from different growing locations. The environmental effect was more pronounced in the first week past anthesis compared to the mature grain. Grain color at different developmental stages was related to the presence and quantity of carotenoids and phenolic acids.

The effect of carotenoids and phenolics on grain color and end-product quality of Canadian hard red and white wheat

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Consumers are demanding high quality baked products that are nutritionally wholesome and do not compromise on product appearance. The aim of this study was to determine the influence of grain color of hard red spring wheat (cultivar, AC Barrie) and hard white spring wheat (cultivar, Snowbird) on the color and the quality of whole wheat bread and tortilla. The color of grain, whole wheat bread and tortilla were measured instrumentally by the Minolta spectrophotometer using the CIE L*, a*, b* color scale. The L*, a* and b* values for the red and white wheat grain varied significantly with different growing environments. The visually darker kernel of AC Barrie had lower L* value, higher a* value and lower b* value, compared to that of Snowbird. The AC Barrie grain also contained significantly higher amounts of ferulic and vanillic acid compared to Snowbird as determined by RP-HPLC. Significantly higher amounts of total carotenoid pigment and total phenolics were present in the red wheat compared to the white wheat as measured by UV-spectrophotometer. There was no significant difference in the whole wheat loaf volume between the red and white cultivars at either location. However, loaf crumb derived from Snowbird was significantly lighter (L*) and more yellow (b*) compared to the crumb color from AC Barrie. Tortillas baked from the whole wheat flour of red and white wheats did not differ significantly in quality as evaluated by thickness, rollability and the puncture test. Tortillas made from Snowbird were much lighter and more yellow in color than AC Barrie. The quantity of ferulic acid, total phenolics, and total carotenoids present in the grain were highly and negatively correlated (r = –0.71 to –0.89) with the L*- and b*-color values of the grain, whole wheat bread and tortilla.

Analysis of pesticide residues in rice using acetonitrile extraction and detection by GC-MS/MS chromatograph

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This study was carried out to monitor the pesticide residues in rice, which were selected 63 samples of Korean special products. Also, a multi-residue screening method for simultaneous analysis of 204 pesticides using gas/liquid chromatography was developed. The method contains the acetonitrile extraction followed by a solid phase extraction clean-up step prior to the final determination by GC/triple quadrouple mass spectrometry (GC-MS/MS) and HPLC/PDA. Thus, in the developed GC-MS/MS acquisition method, a total of 197 different multiple reactions monitoring (MRM) transition were monitored in one set of experimental conditions. To evaluate performance of the method, validation experiments were carried out on rice. The recovery of spiked samples was in the ranged of 61.75%-121.81%, respectively. The residual pesticides were detected in 6 samples corresponding to 9.5%, but they were detected less than Korean MRLs (Maximum Residue Limits). One kind of pesticide detected in samples was isoprothiolane. No residual pesticides were detected in 57 samples.

Freeze-thaw stability of cross-linked and hydroxypropylated waxy and non-waxy rice starches

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Starch has been incorporated in many frozen foods either as main material or additive. Thus, evaluating the stability of starch gel when submitted to freezing and thawing is of great interest in order to guarantee the quality of the product. Generally chemical modification is usually carried out to overcome the unstable properties of starch and to improve its physical properties. Many starches were chemically modified and their physicochemical properties were reported. However, limited information is available on freeze-thaw stability of cross-modified starches. In this study, freeze-thaw stability of cross-linked (CL), hydroxypropylated (HP), and cross-modified (CL after HP, HP after CL) waxy and non-waxy rice starches were investigated. HP and CL were carried out using propylene oxide (2–12%) and POCl3 (0.005–0.06%), respectively. Cross-linking and hydroxyl propylation increase the freeze-thaw stability of both waxy and non-waxy rice starches. In case of waxy rice starch, hydroxypropylation showed higher stability than cross-linking. Degree of hydroxypropylation did not greatly affect the freeze-thaw stability except 12% hydroxypropylation. Cross-modified waxy rice starch revealed the synergistic effect resulting in the highest stability than single modified (CL or HP) waxy rice starches. For non-waxy rice starch, hydroxypropylated starches showed relatively higher freeze-thaw stability than cross-linked starches. On the other hand, degree of cross-linking greatly affected the stability compared to degree of hydroxypropylation. In case of cross-linked and then hydroxypropylated non-waxy rice starches, cross-linked starch with 0.02% of POCl3 showed higher stability than cross-linked starch with 0.005% POCl3. However, in case of hydroxypropylated and then cross-linked non-waxy rice starches, hydroxypropylated starch with 12% propylene oxide showed higher stability than hydroxypropylated starch with 2% propylene oxide. These results indicate that cross-modification had synergistic effect on freeze thaw stability of starch compared to single modification. Moreover, the order of modification greatly influenced the freeze-thaw stability of cross-modified starch.

An analysis of varietal and environmental effects on soluble carbohydrates in lentil seeds *Lens culinaris* Medikus subsp. *culinaris*

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Lentil is an important source of proteins and complex carbohydrates in human diet. The presence of high concentrations of raffinose family oligosaccharides in lentils is considered antinutritional and reduces its quality for human consumption. Developing lentil genotypes with reduced RFO is desired. In order to devise a suitable strategy for lentil quality improvement we investigated the variability, heritability and the effects of environmental conditions on the concentration and composition of lentil seed soluble carbohydrates as a first step. The concentration of glucose, sucrose and raffinose family oligosaccharides of selected lentil cultivars grown in different environments in Saskatchewan, Canada were measured and the composition

of RFO was determined. Differences in the glucose, sucrose and RFO content of lentil cultivars were significant. Environmental conditions also significantly affected lentil cultivars seed soluble carbohydrates. Glucose concentration of lentil cultivars ranged from 0.10–0.32 mmole /100 g lentil meal, sucrose concentration ranged from 3.57–4.90 mmoles /100 g lentil meal and total raffinose family oligosaccharides concentration ranged from 4.50–5.47 mmoles/100 g lentil meal. A significant positive correlation between glucose and RFO concentration and between sucrose and RFO concentration in lentil cultivars was found. A non significant negative correlation between glucose and sucrose concentration was also observed. Composition studies of soluble carbohydrates by high performance size exclusion chromatography (HP-SEC) showed stachyose as the major component of raffinose family oligosaccharides in all lentil cultivars. Stachyose, raffinose and verbascose concentrations of the total RFO ranged from 48.6–53%, 39.1–44.6%, and 4.4–10.5% respectively. Any change in ranking of individual RFO under different environmental conditions was not observed. The heritability (broad sense) of sucrose and raffinose family oligosaccharides estimated from the variance components was 0.89 and 0.85 respectively.

Influence of pinto bean (*Phaseolus vulgaris* L.) flour and modified food starch on some physical properties of sugar-snap cookies

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Common beans (*Phaseolus vulgaris* L.) are a traditional food in the human diet and are rich in dietary fiber, protein, vitamins, and essential minerals such as iron, zinc, and calcium. Pinto bean flour addition to the sugar-snap cookie was chosen due to its familiar use in many food products: refried beans, soups, salads, and chilies, and are globally well known. In addition, functional food and nutraceutical industries are increasingly promoting the value-added products with better nutrition profiles and health-promoting properties. The objective of this experiment was to study the effects of pinto bean flour and modified food starch on some physical characteristics of sugar-snap cookies. Two separate experimental sets were conducted: 1) different levels of pinto bean flour (control, 10%, 20%, and 30% flour basis) were added into the sugar snap cookies formulation, 2) one percent (flour basis) of Baka-Snak® food starch-modified from National Starch was incorporated into experimental set 1. Initially, the dough characteristics were observed. The higher the pinto bean flour content, the tougher the dough was. Modified starch addition made the dough fluffier, softer, and smoother, as to compare to the ones without modified starch counterparts. The dough compressibility values were slightly increased with increasing levels of pinto bean flour for both with and without the addition of modified starch. Cookies' physical characteristics on color, texture, height, and spreadability (diameter) were further examined. The color L-values (lightness) were increased with increasing level of pinto bean flour in the formulation. The addition of modified starch also increased the L-values in all levels ($P < 0.05$). The cookie's breaking strength was also increased in the higher level of added pinto bean flour cookies. In the absence of modified starch, the average height of six cookies was found to be 5.57, 5.76, 6.64, and 6.65 cm for control, 10%, 20% and 30%, respectively. The same trend happened to the height of six cookies with added modified starch: 5.62, 5.82, 6.68, and 6.71 cm. However, the average values of six cookies diameter were generally decreased with pinto bean flour addition, and increased with modified starch addition. In conclusion, Baka-Snak® modified food starch improves the quality of sugar-snap cookies with partially added pinto bean flour in terms of more lightness, less breakage, and increasing height and spreadability, which are desirable characteristics in cookies.

Three dimensional analysis of internal structure on white bread and correlation with permeability

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The analysis of the three dimensional structure of white bread is very important in point of the bread quality and also important on the analysis of mass and heat transfer during baking. In this work, the white bread was sliced every 30 micrometers, and the image information was obtained by taking a picture of the sections with the CCD camera. The pictures were made three-dimensional visualization with the image processing software, and were made to the structure model. Moreover, the internal structures of white bread were analyzed by using the X-ray computerized tomography scanning visualization. On the other hand, vapor and air mixture gas was compulsorily permeated through the white bread crumb on various temperatures to obtain permeability. Using these results, the correlation of the three-dimensional internal structure model and the permeability of white bread was examined.

Xylanase and bran in bread dough formulations: Effects and interactions on dough aeration during mixing, expansion during proving and baked loaf volume and quality

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In aerated foods such as bread, bran particles have adverse effects on the aerated structure. Xylanases may be able to alleviate this and improve bread properties by breaking down arabinoxylan molecules in bran into functional forms that are beneficial to breadmaking. This gives the possibility of producing healthy bread that remains palatable to consumers. The objective of the current work was to identify the interactions between bran, xylanases and the gas phase of dough at each stage of the breadmaking process. The effects of two brans differing in particle size, and of two xylanases of fungal and bacterial origin, on gas phase behaviour during dough mixing, proving and baking were investigated. Bran increased the gas content of doughs during mixing, with coarse bran particles increasing gas content more than fine bran particles. The xylanases had no effect on aeration during mixing. The expansion capacity of doughs was quantified using the Dynamic Dough Density (DDD) technique. Bran particles decreased the expansion capacity of doughs during proving, with fine particles giving a greater decrease. Both xylanases increased expansion capacity during proving. For bran-free doughs the two xylanases gave the same level of increase, but for bran-enriched doughs, bacterial xylanase gave a greater increase than fungal xylanase. This indicates that the bacterial xylanase was interacting with the bran more effectively than the fungal xylanase. For the bran-enriched doughs, the decrease in expansion capacity indicated by the DDD test was reflected in the baked loaves. However, the difference in xylanase performance during proving did not translate into measurable differences during baking; the two xylanases performed similarly in baked loaves. This indicates that the DDD test was not a good indicator of the effect of these ingredients on final baked loaves, implying that much of their effect occurs during baking.

Essential minerals in various rice varieties of Sabah Malaysia and their role in providing recommended daily allowance (RDA) for minerals

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Rice is the staple food and diet for the people of South East Asia. This study aims to compare the mineral contents of various indigenous rice varieties grown and consumed by the local peoples in Sabah Malaysia. Both husked and dehusked form of rice varieties were selected in this work. The samples were prepared by digesting with concentrated nitric acid before determining the mineral contents using Atomic Absorption Spectrophotometer (AAS). The result shows significant difference ($P < 0.05$) of mineral content in rice of different forms and mineral contents varies among the rice varieties. For husked samples, the range for concentration of various minerals expressed as mg/100 g were Na (6.65 - 15.70), K (263.33 - 438.33), Ca (5.07 - 10.77), Mg (2.37 - 3.60), Fe (3.32 - 5.85), Cu (0.22 - 0.47) and Zn (2.52 - 3.42). On the other hand, the dehusked samples showed a lower range of mineral contents. The range of concentration expressed in mg/100 g were 4.63 - 6.53 for Na, 223.33 - 310.00 for K, 1.10 - 2.12 for Ca, 1.35 - 2.82 for Mg, 1.52 - 3.30 for Fe, 0.20 - 0.42 for Cu and 2.22 - 2.95 for Zn. However, the magnesium concentration is found lower than those reported in the literature. Iron, copper and zinc reach 29% of the RDA which contributed significantly for daily intake while macro elements in these rice samples did not contribute significantly. Therefore, peoples are urged to consume a wide variety of food to obtain sufficient nutrients and not only depending on rice consumption alone.

Understanding molecular mobility in amorphous sugars using vanillin, a novel triplet probe

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In amorphous solid foods, shelf-life is influenced by modes of molecular mobility which influence the kinetics of physical and chemical processes. Changes in molecular mobility are thus important in defining the shelf-life and quality of amorphous solid foods, pharmaceuticals, and other biomaterials. Predictions of stability must consider matrix mobility above and below Tg (the glass transition temperature); measurement of molecular mobility in amorphous solids over time scales ranging from $< 10^{-9}$ ns to $> 10^{8}$ s at temperatures above and below Tg requires specialized methods. Phosphorescence spectroscopy is a sensitive, site-specific method that can be used to detect molecular mobility in the environment of a probe embedded within an amorphous matrix. Due to the long lifetime of the excited triplet state, phosphorescence responds to molecular events in the ms to s timescale.

This research investigated how the steady-state and time-resolved emission and intensity of phosphorescence from vanillin (4-hydroxy-3-methoxy benzaldehyde), a commonly used flavor compound, can be used to probe molecular mobility when dispersed within amorphous pure sucrose films. Phosphorescence emission spectra and time-resolved intensity decays, measured in sucrose as a function of temperature in the presence and absence of oxygen, were strongly modulated by matrix molecular mobility. Temperature had a large effect on vanillin phosphorescence intensity and lifetime both in the glass and in the melt. Time-resolved phosphorescence intensity decays from vanillin were multiexponential both below and above the glass transition temperature, indicating that the pure (single component) amorphous matrix was dynamically heterogeneous on the molecular level. These data show that vanillin is a promising probe to measure molecular mobility and dynamic heterogeneity in amorphous solid foods, indicating how an intrinsic component like a flavor compound can be used to report on the molecular mobility in foods.

Analysis of SDS-insoluble proteins with thiol groups in wheat doughs by flow cytometry

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1.5% SDS-insoluble proteins play an important role in bread making process. Changes in the amount of 1.5% SDS-insoluble protein fraction and insoluble protein particles with thiol groups during dough processing were investigated. Insoluble protein particles with thiol groups were stained with thiol-reactive fluorescent dye and analyzed by flow cytometry (FCM) without dissolving or extracting them. During dough mixing, insoluble protein fraction decreased rapidly before peak mixing time, and almost disappeared after peak mixing time. The amount of insoluble protein particles with thiol groups increased during the initial mixing stage, reached the maximum amount before peak mixing time and then decreased. FCM analysis indicated that the amount and size of insoluble protein particles with thiol groups were decreasing simultaneously. During dough resting, insoluble protein fraction appeared and the amount of insoluble protein particles with thiol groups increased again. FCM analysis demonstrated that the levels of thiol groups were associated with solubility of proteins during dough mixing and resting. These results suggest that FCM analysis will reveal the effect of redox status of wheat proteins on bread making property. FCM can contribute to evaluation of the native states of wheat proteins in combination with fluorescent dyes and antibodies specific for the target protein. This technique is a novel and useful analysis tool for the field of cereal chemistry.

Effect of endosperm mutation on cell wall polysaccharides content and grain texture in barley

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Cereal Foods World 53:A83

Our previous study revealed that endosperm cell wall polysaccharides were related to grain hardness in barley. In this study we analyzed the effect of mutation in endosperm character (waxy, high amylose, fractured starch granule, high lysine and beta-glucanless) on cell wall polysaccharides and grain texture using near-isogenic lines (NILs). The NILs for waxy (*wax*), high amylose (*amo1*), fractured starch granule (*fra*) and high lysine (*lys1*) showed significantly higher beta-glucan and arabinoxylan contents and harder grain texture than their recurrent parent line 'Shikoku Hadaka 84'. The NIL with *lys1* had highly vitreous and hard grain texture. The NILs with *lys5h* and double mutation of *wax* and *amo1* contained much higher beta-glucan and arabinoxylan and had much harder grain texture than the recurrent parent. Structural analysis with scanning electron microscope revealed these NILs had markedly thick endosperm cell walls. On the other hand the NIL with undesignated gene of high lysine in mutant line 'Riso M56' showed lower beta-glucan and arabinoxylan contents and had softer grain texture. The NIL for beta-glucanless which had thin endosperm cell walls showed much softer and friable grain texture.

Starch Characterization of *Phaseolus lunatus vulgaris* var Jamapa, *Lens culinaris* and *Vicia faba*

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Now that legumes are of particular interest for the diet, which legume will have a greater impact in the dietary prevention of diabetes and hyperlipidemia. The aim of this investigation was to study the effects of debranching time, storage time, and storage temperature on production of slowly digestible starch. *Phaseolus lunatus vulgaris* var. Jamapa, *Lens culinaris* and *Vicia faba* starches were hydrolyzed by 4 g pullulanase per 100 g of starch for various times (4, 8, 12, 16 and 24 h) and the variously debranched products were stored at 24°C for 3 days. Longer times for debranching resulted in maximum formation of starch that is relatively more resistant to digestion. Holding at 24°C produced a starch that is relatively more resistant to digestion. Holding at 1°C produced the smallest amount hydrolized. At 30 min the digestibility of *Phaseolus lunatus vulgaris*, *Lens culinaris* and *Vicia faba* starches decreased.

Evaluation of the impact of location and cultivar on North Dakota dry edible pea quality

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Cereal Foods World 53:A83

Physical, chemical and cooking attributes of dry edible pea cultivars grown in the State of North Dakota indicated variability in our previous research. The objective of this study is to evaluate the impact of location and cultivars on physical, chemical and cooking attributes of dry pea cultivars (n = 109) grown in Carrington, Minot, Bowman, Williston, Crary and Garrison. Dry peas were milled with a Perten grinder. Test weight, 1000 kernel weight, moisture, particle size, color scores, protein, ash and total starch contents were determined. Cooking properties were determined with rapid visco analyzer. Cooking tests of whole peas were conducted with Mattson Cooker equipment. Physical attributes of dry pea cultivars indicated variability in terms of location and cultivar. Cultivars collected from Crary location had the highest 1000 kernel weight scores (227.3 g) whereas, samples from Minot had the lowest score (170.8). In terms of chemical attributes we observed differences based on location ($P < 0.05$) and cultivar ($P < 0.05$). Cultivars collected from Minot had the highest protein content (% 27), whereas Crary samples had the lowest (% 22.8). DS Admiral cultivar from Crary had the highest starch content (% 55.5) with % 22.8 protein, whereas Minuet cultivar from Bowman had the highest protein content (% 30) with % 48.3 starch. Protein and starch attributes were negatively correlated (r = –0.35). We observed the impact of location ($P < 0.05$) and cultivar ($P < 0.05$) on RVA data. Non-soak cooking tests indicated variability in terms of location ($P < 0.05$) and cultivar ($P < 0.05$), whereas we did not observe significant impact on location with soak-cooking test. In conclusion results indicated that location and cultivar had significant impact on dry edible pea quality, which will be used in assisting breeders develop new cultivars.

Effect of nitrogen fertilization on physical dough properties and baking quality of three experimental lines of wheat (*Triticum aestivum* L.) of the northwestern of Mexico

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Four schemes of nitrogen fertilization (Nd) were applied to three experimental lines of wheat (EL), evaluating their effect on protein content, some physical properties of the dough and baking performance. Nitrogen fertilization treatments were Nd1 (0-0-0), Nd2 (50-50-50), Nd3 (150-0-0) and Nd4 (100-100-100); the numbers in parenthesis indicates kg of urea/ha applied at preplanting, first and second auxiliary irrigation, respectively. The amount of total protein was higher in the EL-3 (13.22%), whereas EL-1 showed the smaller amount (11.01%). Physical dough tests were carried out with the texture analyzer TA-XT2. The extensibility (Ext) of dough with Nd3 was similar to the control (Nd1), independently of the EL, however, the maximum resistance (Rmax) was observed when this Nd was applied to LE1 and 3. On the other hand, between the split application of urea to all EL, Nd2 resulted in dough with the highest Rmax. The split urea application also favored the baking quality of the EL tested. It appears that dough with a well balanced gluten determined the baking quality of the EL.

Dough strength: A measurement of quality in wheat flours

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The proteins are the most important components of the flour of wheat by the capacity that they have to form a viscoelastic dough when they are mixed with

water. The rheological tests are some of the tests to predict functionality of wheat flours. They must like objective study the physical properties of the gluten formed by the action of the kneaded one. In programs of genetic improvement of wheat, besides of evaluating the agronomic characteristics of wheat is necessary to evaluate the potential of wheat flours to determine its end-use. In this work 12 flours of experimental wheat were evaluated. Rheological measurements were made with the National Mixograph and the Texture Analyzer TA-XT2 with the Kieffer extensibility rig. The relative amounts of mono- and polymeric proteins were determined by SE-HPLC extracts obtained with buffer-SDS. The bread was prepared according to the direct method and loaf volume was determined by rapeseed displacement. Significant differences in protein composition of flours, dough strength (g) and extensibility (mm) of the obtained dough of different flours were observed.

Evaluating sorghum formulations for a gluten-free beer

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The National Institutes of Health reports that 1% of the United States population suffers from celiac disease, an immune reaction to gluten proteins found in wheat, rye, and barley. There is a limited market of gluten-free products for celiac patients to consume. One product frequently demanded by persons with celiac disease is gluten-free beer. Current beers on the market meet the gluten free requirement for celiac patients, however, these beers do not meet the sensory characteristics demanded by the general population. The objective of this study was to produce a gluten-free beer that would be acceptable to both persons with celiac disease and the general population. Sorghum syrup formulations were used to create several different gluten-free beers to evaluate ingredient functionality of sorghum syrup, adjuncts, yeast, and hops in gluten-free beer. The different formulas were compared against each other and current gluten-free beers on the market. The sorghum syrup beers differ from the current beers on the market by utilizing sorghum syrup which is the only grain used in these formulations. The beers were brewed, fermented, and bottle-conditioned. Each beer was evaluated throughout the process. Physical and chemical tests were used to evaluate the beer include Brix, color, specific gravity, viscosity, and pH measurements were taken. A sensory panel evaluated the beers on flavor, color, mouth feel and overall acceptability. The experimental beers had a Brix measurement that ranged from 5.0 to 6.2 compared to the commercial beers which averaged 6.1. Color ranged from 3-5°SRM for the experimental beers, and 7 to 8°SRM for the commercial beers. The specific gravity showed decreasing trend for all experimental beers (3.0% decrease). The commercial beers had an average pH of 4.61 and the experimental beers average pH was 4.81.

Granular starch hydrolysis kinetics for the enzymatic dry grind process

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Enzymatic dry grind is a corn fractionation process that separates the endosperm fraction from germ and fiber using granular starch hydrolyzing enzyme (GSHE). GSHE hydrolyzes unliquefied starch at temperatures below gelatinization (60°C), allowing separation of germ and fiber by density difference. Granular starch hydrolysis kinetics is complicated by substrate heterogeneity and combined activities of alpha-amylase and glucoamylase during hydrolysis. Using the 3,5-dinitrosalicylic acid (DNS) assay for reducing sugars, hydrolysis progress was monitored in dry grind corn mash (25% dry solids) treated with GSHE at enzyme levels from 0.01 to 0.8% v/w (mash). Comparison of the DNS assay with HPLC results ($r = 0.99$) indicated glucose formation dominated overall kinetics. Hydrolysis progress consisted of a presteady state phase (<15 min), resulting from concomitant product formation upon binding of the enzymes ("burst" kinetics) and hydrolysis of soluble starch (8 g/L) initially in the mash. The subsequent steady state phase (>15 min) was fitted using a two parametric regression model (root mean square deviation of 1.4 to 4.0 g/L), which improved on previously proposed empirical models (root mean square deviation of 4.6 to 16 g/L) by using an exponential time function. Initial hydrolysis rates derived from this modified equation were dependent on enzyme concentrations (E_o), analogous to the Michaelis-Menten expression for heterogeneous phase reactions except they were functions of $E_o^{0.5}$. Initial rates decreased linearly ($P < 0.05$) with the geometric mean diameter of the ground corn. The semiempirical model proposed for granular starch hydrolysis could facilitate optimization of process parameters for the enzymatic dry grind process.

***Jatropha curcas* L. flour addition to wheat flour tortillas and their effects textural properties**

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Texture is a property of major importance in the evaluation of baked products. The objective of this investigation was to study the effects of added *Jatropha curcas* L. flour into wheat flour tortillas on protein content and tortilla rheology. Total protein content according AOAC (1995); tortilla extensibility 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%) were evaluated. The tortillas made with the hot-press method. The extensibility of wheat flour tortillas showed that, increasing the *J. curcas* flour percentage from 0% to 20%, the dough were less extensible, the best mixture was 10% J. curcas wheat flour tortillas. Stretchability measurements were repeatable and are an important textural property of wheat flour tortillas *J. curcas* flour. This indicates that the tortillas of the blends are still strong and elastic. However, when the amount of Jatropha flour was increased up to 20%, the tortillas flour became very strong. The hardness increased particularly in samples prepared with 20% of Jatropha flour. The presence proteins produced a increased in the firmness and consistency of the dough and an decreased its cohesiveness, which favours the production of a high-quality product. The content of protein was 24.5% and 11% of fat in wheat flour tortillas with 10% of *J. curcas* flour.

Nutrients and anti-nutrients of lentils (*Lens culinaris*) as affected by variety, cooking and dehulling

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Cooking whole or split lentils (*Lens culinaris*) in boiling water is the most common method used to obtain a palatable product with improved nutritional value. Lentils are also processed into dehulled and split forms for human consumption in soups, stews, salads, meat extenders, and gluten-free diets. Although studies have been carried out on the chemical composition of raw lentils, little information is available on the composition of processed (cooked and dehulled) lentils. This project was undertaken to investigate the effect of variety, cooking and dehulling on nutrients and anti-nutrients in lentils. Eight lentil varieties were evaluated in this study. Analysis of variance showed that variety, cooking and dehulling had a significant effect on chemical composition of lentils. Cooking significantly increased insoluble dietary fiber (IDF), total dietary fiber (TDF) and verbascose content in lentlis whereas soluble dietary fiber (SDF), sucrose, TIA, phytic acid, raffinose and stachyose content were reduced. Phytic acid, stachyose and verbascose content were significantly increased by dehulling but SDF, IDF, TDF, TIA, sucrose and raffinose content were decreased.

Effect of processing conditions on tofu characteristics

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Tofu is a soybean (*Glycine max*) protein gel-like product and its physical properties such as yield, texture and color determine the quality of tofu. Factors including solids in soymilk, concentration of coagulant, stirring speed and time, and temperature of coagulation influence tofu quality. The effect of these factors on tofu characteristics was investigated using response surface methodology (RSM). It was found that concentration of coagulant and the ratio of bean to water were the most significant factors affecting tofu yield, textural properties (hardness, fracturability, adhesiveness, gumminess, springiness and chewiness) and color (L*, a* and b* value), followed by stirring time, temperature of coagulation and stirring speed. Models for predicting tofu characteristics were developed as functions of processing factors (solids in soymilk, concentration of coagulant, stirring speed and time, and temperature of coagulation).

Effects of endosperm hardness, protease and urea on GSH process for ethanol production

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During fermentation yeast growth requires nitrogen that can originate from ammonia ions, urea, amino acids and/or small peptides. Proteases can

hydrolyze proteins into free amino nitrogen (FAN). Granular starch hydrolyzing enzymes (GSHE) convert starch to fermentable sugars at temperatures lower than starch gelatinization temperatures. Compared to high temperature hydrolysis using conventional enzymes, GSHE can reduce energy requirements and simplify the dry grind process. In the GSH process (dry grind process using GSHE), enzymes digest solid phase starch; whereas, in the conventional process, enzymes digest soluble starch. More pores, exposed starch granules and rough surface produced from soft endosperm will create more surface area, which will benefit solid phase hydrolysis used in the GSH process. The effects of protease, urea, endosperm hardness and GSHE levels were evaluated. Whole corn, soft endosperm and hard endosperm were processed using the GSH process at two GSHE levels (0.1 and 0.4 mL/100 g flour) and four treatments of protease and urea addition. Soft and hard endosperm material were obtained by grinding and sifting flaking grits from pilot plant dry milling; classifications were confirmed using scanning electron microscopy. Ethanol and glucose profiles during 72 hr of simultaneous starch hydrolysis and fermentation were determined using an HPLC. Compared to controls (no urea and protease addition), urea addition increased final ethanol concentrations of soft (66 and 33% at 0.1 and 0.4 mL GSHE, respectively) and hard endosperm fermentation (17 and 62% at 0.1 and 0.4 mL GSHE, respectively) but had no effect on final ethanol concentrations of corn fermentations. Protease addition had more effect in increasing final ethanol concentration than urea. For same dry solids, soft endosperm fermentations resulted in higher final ethanol concentrations (17.7% v/v) than whole corn (16.4% v/v) or hard endosperm (15.9% v/v). With increased GSHE level, final ethanol concentrations of all four treatments increased 15 to 22%.

Bioactive compounds of soybean affected by thermal treatments and ultra-fine milling

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The bioactive compounds of selected domestic soybean varieties (soybean KS 1 and black soybean TN 6), which contained high amounts of dietary fiber and isoflavones, were investigated before and after germination and thermal treatments (moist- and dry-heating). The germinated and thermal treated soybeans were further milled to produce ultrafine-milled whole soybean paste with the mean particle sizes of 3–20 μm by using a planetary ball mill. Germinating and thermal treatments slightly increased the total isoflavon contents and significantly increased the aglycons in soybeans. The significant decreases in the ether extracted crude fat contents and increases in the insoluble dietary fiber contents of ultrafine-milled whole soybean pastes were attributed to the formation of lipid-fiber complex during milling process. DPPH scavenging capacity was decreased for ultrafine-milled whole soybean pastes but increased in ultrafine-milled whole black soybean pastes. The alycone contents of isoflavones were significantly increased in the ultrfine-milled whole soybean pastes. But, the total isoflavone contents were decreased after ultrafine milling. The germination, thermal treatment and ultrafine milling process may improve the bioavailability of bioactive compounds in soybeans so that the ultrafine-milled whole soy pastes will have great potentials for developing the functional foods made with whole soybeans.

Effect of urea on the physicochemical properties of cross-linked starch

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The radioactive substances are egested by the patient who has the nuclear medicine inspection, resulting in the radiation pollution. Therefore, the collection of dejection especially the massive urine from those patients is necessary. Native starch possesses the water-binding capacity and could be used to collect the urine. However, the physicochemical properties of starch are affected by the urea. The object of this research was to study the effect of urea on the physicochemical properties of cross-linked starch. Commercial corn and potato starches were used. Starch with different degree of cross-linking was prepared and the water-binding capacity, pasting profiles, and microstructure of cross-linked starch were measured. Water-binding capacity of cross-linked starch in aqueous urea solution was higher than that of native starch. Water-binding capacity of cross-linked starch increased with the degree of cross-linking and the concentration of urea. Effect of urea on the starch water-binding capacity was more pronounced on cross-linked potato starch. The scanning electron micrographs showed that there was no obvious difference in morphology between cross-linked and native corn starch granules, but the cross-linked potato starch granules had different appearance and size as compared with native one. In conclusion, the water-binding capacity of starch in aqueous urea solution could be modified by cross-linking. Thus, the cross-linked starch could be a novel material for collecting the urine with radioactive substances.

How dough mixing properties affect bread-making performance

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Flours from 58 wheat samples from Western and Eastern Canada were analyzed for their composition, dough rheological properties and bread baking quality. For test bread baking, flour samples were mixed using a National Pin Mixer and mixing curves generated using P2M software. Seven parameters from the mixing curve were defined: peak time (PT), hydration time (HY), development time (DT), peak height (PH), bandwidth at peak (BW), area of curve (A) and slope of gluten development period (S). The correlations between the mixing parameters and flour protein/wet gluten content, dough rheological properties and baking performance were compared and discussed. Strong positive correlations were found between PH and protein content (PC, R = 0.91), and PH and wet gluten (WG, R = 0.84). Correlations between S and PC (R = 0.83), S and WG (R = 0.81) were also observed. No significant correlations between the mixing parameters PT, HY, DT, BW, A and the farinograph parameters or baking performance were found. Interestingly, a strong positive correlation between S and loaf volume (LV, R = 0.85) was obtained. The correlations between PH and PC/WG, and S and PC/WG indicated that the amount of power used for gluten network development is largely dependent on either protein content or the wet gluten content of flour. The correlation between S and LV indicated that loaf volume tested using the National Pin Mixer is not only positively correlated to either protein content or wet gluten content of flour but also correlated to the rate of gluten network development. The faster the gluten network developed the larger the loaf volume. Knowledge of how dough mixing properties affect bread-making performance can provide wheat breeders, flour millers and commercial bakers with important information so that they can better understand the mechanism of gluten formation and improve bread and flour quality with respect to various wheat classes, varieties and crop conditions in the future.

The affect of low-amylose starch properties on tortilla quality

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Cereal Foods World 53:A85

The largest component of wheat flour is starch, and properties of the starch affect wheat flour tortilla quality. Flour from seven genotypes of wheat grown at three separate North Dakota locations as well as commercial flour samples were analyzed for their starch properties and tortilla quality. Genotypes studied were Alsen, Glenn, Lolo, NDSW 0481, Parshall, Penewawa, and Reeder. All are hard spring wheat genotypes, and NDSW 0481 has low-amylose starch. Starch was isolated from the flour samples, and the physicochemical properties were correlated with tortilla quality. Tortillas made with the low-amylose flour had unique handling and storage properties, which related to the starch composition of the flour. These tortillas were very moist and sticky after baking and very elastic and extensible on the day of production. Low-amylose flours likely absorb more water as indicated by their high farinograph absorptions. During storage the low-amylose tortillas became more leathery, less extensible, and the force needed to stretch the tortillas increased greatly. The physical characteristics of these tortillas were also affected by the starch properties. The low-amylose tortillas tended to be thin, with a larger diameter, and they had a lower specific volume than the other tortillas. The color of the low-amylose tortillas tended to be more yellow than the other tortillas. The yellowness of the low-amylose tortillas was evident from visual comparisons. These results demonstrate that NDSW 0481 flour has potential to improve tortilla quality if it is blended with flour from other spring wheat varieties.

Leavening and temperature effect on tortilla physical properties

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Tortillas are the second most popular bread type in America, according to results of the 2002 State of the Tortilla Industry Survey. Having cornered 32% of the sales for the U.S. bread market, tortillas trail white bread by only 2%. Challenges in meeting consumer demands for new and lower fat tortillas have included negative effects on the machine-ability and quality of the products. Four treatments and control tortillas were processed at a commercial scale facility. The treatments included: 1) 0.3% leavening and 315°F, 2) 0.3% leavening and 390°F, 3) 1.2% leavening and 315°F, and 4) 1.2% leavening and 390°F. Physical properties of tortillas included strength, roll-ability and blister scores. The tortillas for all treatments were stronger and more extensible than the control group. On average, the treatments produced tortillas with 32% higher force and 26% longer distances before they ruptured. After 4 days of storage at about 25°C, tortillas from all treatments including the control had

roll-ability scores of 5 on a scale of 1–5 with 5 meaning no cracks or breakage. Treatment 1 had 87% less blister spots than the control treatment which represented a lower temperature group. Treatments 3 and 4 had approximately the same amount of blistering as the control group but treatment 2 had 65% more blisters. The transparency of tortillas from treatment 1 was about twice that of the other treatments. Common food service industry practice of warming tortillas in a steam cabinet often promotes surface stickiness, but no surface stickiness was observed after 1 hour with saturated steam at 100°C. Properties of tortillas stored for up to one month will be discussed.

Ultrastructural characterization of the effect of high temperature on the development of starchy endosperm in wheat

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The effect of high temperature on starchy endosperm was investigated in developing wheat (Triticum aestivum L. cv. Butte 86) grain produced under a moderate (24/17°C, day/night) or high temperature regimen (37/28°C, day/night) imposed from anthesis to maturity. Comparison of ultrastructural changes across developmental time courses under the two temperature regimens revealed that high temperature shortened, but did not substantially alter, the starchy endosperm developmental program. The starchy endosperm in grain grown under the 37/28°C regimen was ultrastructurally similar at 14 dpa to that of grain grown under the 24/17°C regimen at 40 dpa. Despite this shortening of the developmental program, the sequence of events – increases in number and size of A- and B-type starch granules, appearance and increase in the protein matrix, and the resultant densely packed endosperm cells – was similar under both temperature regimens. However, starch granule populations were altered under the 37/28°C regimen; the number of B-type starch granules decreased relative to the A-type starch granules. In addition, the A-type starch granules showed, late in development, pitting that might be due to enhanced action of starch degradative enzymes.

Investigating the effect of dough prepartion using hot water and pre-geleatinized starch on tortilla quality

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One of the traditional ways to make “Lao Bing”, a Chinese tortilla-like flatbread, is to mix dough in which one-half of the added water is heated up to 60–800C. The product is preferred due to its softness, but the reason for this increased softness is unknown. Our hypothesis is that addition of hot water gelatinizes part of the starch, which could hold more moisture, and hence increase the softness. The objective of this study was to determine if pre-gelatinized (pre-g) starch could improve tortilla quality. A complete randomized block design was applied. Tortillas were made using a commercial tortilla flour with the addition of 0%, 10%, 20%, and 30% pre-g starch. To examine the effects of hot water on tortilla quality, tortillas were prepared using the commercial flour and 50% of the total water at 75°C. Samples were kept in plastic ziplock bags at room temperature immediately after cooling. Rollability test was conducted on day 1, 7 and 14 of storage and samples were rated on a 1–5 scale with 5 as best. Stretchability (maximum force (MF) and distance) was analyzed on day 0, 1, 7, and 14 after baking using a Texture Analyzer (TA-XT2, Texture Technology Corp., Scarsdale, NY). At least 6 replicates were tested for rollability and 12 were tested for stretchability. The control had the lowest rollability compared to the others at all timepoints. At day 14, the rollability of the 30% pre-g was 3.85, which was 1.71 times of that of the control. MF of all the samples was about the same at day 0 and increased during storage. However, the 30% pre-g had the lowest rate of increase. On day 14, the control had the highest MF, which was 1.5 time of that of the 30% pre-g. The results indicated that pre-gelatinized starch could improve tortilla quality. Increasing water temperature could easily gelatinize starch and hence improving tortilla quality with minimal cost. This method would largely benefit the commercial tortilla producer.

The pH dependence of the rheology of wheat protein isolate suspensions

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Linear and non-linear rheological properties of wheat protein isolate (WPI) suspensions were investigated as a function of concentration and pH. Linear dynamic viscoelastic properties for WPI were strongly dependent on concentration and pH. The higher the concentration, the stronger the viscoelasticity of the WPI would be. In the pH range of 4.0 – 7.0, higher pH resulted in the stronger viscoelasticity. WPI suspensions exhibited viscoelastic fluid behavior at lower concentration and/or lower pH. However, at high concentration and high pH, WPI 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 WPI was in evidence. The non-linear shear viscoelastic properties of WPI were also found to depend on concentration and pH. Viscosities of WPI displayed shear-thinning behavior, and fits by a power law constitutive model. Our results indicate that the WPI structure in suspension changes over a small concentration and pH range, which suggest that WPI 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.

Ethanol production from field-sprouted sorghum

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The objective of this research was to investigate the fermentation performance of field-sprouted grain sorghum in ethanol production. Five field-sprouted sorghum varieties from South-Central Texas, which received abnormally high rainfall during harvest, were used in this study. Enzyme activities, microstructure, flour pasting properties, and thermal properties of field-sprouted grain sorghum were analyzed using Megazyme ceralpha method, scanning electron microscopy (SEM), rapid visco analyzer (RVA) and Brabender visco-amylo-graph, and differential scanning calorimeter (DSC). Single kernel characterization system (SCKS) was used to measure sorghum hardness. The effect of germination on conversion of grain sorghum to ethanol was determined using laboratory ethanol fermentation procedure. The results showed that ethanol fermentation time for field-sprouted sorghum was about half of that for non-germinated sorghum. Ethanol yield and fermentation efficiency increased as kernel hardness decreased. The results from RVA and Megazyme ceralpha method test had the similar results on enzyme activity. There was strong liner relationship between ethanol yield and peak viscosity. The results confirmed that using germinated/sprouted grain sorghum for ethanol production could shorten the fermentation time without decreasing the ethanol yield and efficiency. Keywords: ethanol, sorghum, germination, sprout, kernel hardness.

Contribution of lipids to flour and dough properties and Mantou-making quality of wheat flour

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Wheat flours from three wheat varieties, Karl (American Hard Wheat with strong gluten), Jagger (American Hard Wheat with weak gluten) and Zimai 12 (Chinese Soft Wheat with weak gluten), and their defatted counterparts, obtained after lipids were extracted by chloroform, were used to investigate the effect of lipids on physicochemical properties and Mantou-making quality of wheat flour. Mantou is steamed bread. Microstructure and thermal properties of these samples were measured by scanning electron microscopy (SEM) and differential scanning calorimeter (DSC) respectively. The defatted flours had more single starch granules and higher gelatinization enthalpies than the normal flour samples. Rheological properties were determined by Farinograph, Rapid Visco Analyzer and Mixolab. In contrast to the normal wheat flour, defatted flour had a higher water absorption, longer pasting peak time, higher peak and hold viscosities, but lower setback and breakdown. Characteristics of the first two stages of Mixolab, dough development and protein reduction, did not show differences except for water absorption. A distinct variation during the other three stages, starch gelatinization, amylasic activity and starch gelling were observed. It showed that defatted flour had a higher maximum consistency during starch gelatinization, a lower amylasic activity and a higher consistency value as dough temperature was lowered. C-CELL technology and Texture Analyzer were used to test internal grain and texture of Mantou. It showed that the volume of Mantou made from defatted flour did not change, but the crumb grain was poorer, showing bigger cell diameter, less cell number and thicker cell wall compared to those made from non-defatted samples. Results of Texture Analyzer tests showed that Mantou made from defatted flours of two weak gluten wheat had higher hardness and resilience than that made from non-defatted samples but this was not found for the strong gluten wheat. Keywords: lipids, defatted flour, physicochemical properties, Mantou making quality, wheat.

Functionality of waxy wheat flour protein

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Waxy wheat flours have been reported to have lower quality than normal wheat flours with respect to dough properties and baking performance. These

functional properties are mainly determined by gluten protein. This study was made with the objective of characterizing the proteins of a set of waxy wheat flours and relating this to functionality. Functionality was measured by Mixolab and protein composition was analyzed by size exclusion high performance liquid chromatograph (SE-HPLC). It was found that the proportion of polymeric protein in the waxy wheat flours was lower than normally found. Mixolab measurements were used to determine dough rheological properties as affected by protein of waxy wheat samples. Mixolab results showed the differences in water absorption, dough formation time, dough stability, and dough elasticity between a set of waxy wheat flours. The combination of Mixolab to describe functionality and SE-HPLC for characterizing protein was useful for investigating waxy wheat varieties. Keywords: waxy wheat flour, gluten protein, protein functionality, protein composition, SE-HPLC, Mixolab.

In vitro phase II enzyme inducer and antiproliferation activity of sorghum 3-deoxyanthocyanins

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Epidemiological studies show a correlation between consumption of sorghum and decreased occurrence of certain cancer, especially oesophageal and colon cancer. The main pigments in sorghum, 3-deoxyanthocyanins have unique chemical and biochemical characteristics compared with their anthocyanin analogues. The objective of this study was to determine chemopreventive and anti-carcinogenic potential of sorghum 3-deoxyanthocyanins. *In vitro* cell culture study was used to determine capacities of sorghum 3-deoxyanthocyanins to induce quinone reductase (QR, a known phase II enzyme) in Hepa 1c1c7 (murine hepatoma) cells, and inhibit HT-29 (human colon adenocarcinoma) cell proliferation. Crude black sorghum (TX430) extract showed 2.93 times QR inducer activity at the concentration of 100 µg/mL; in comparison, red cabbage anthocyanins showed a maximum inducer activity of 2.10 times at 200 µg/mL. At the concentration of 200 µg/mL, TX430 and red cabbage extracts showed 62.6% and 12.5% inhibition of HT-29 cell proliferation, respectively. Among the pure 3-deoxyanthocyanidins, the highest QR inducer activity was observed in 5,7-dimethoxylated forms of apigeninidin and luteolinidin (1.97 and 3.0 times, respectively). For 5-methoxyapigeninidin and 7-methoxyapigeninidin the maximum inducer activity was 1.74 and 2.03 times, respectively. Apigeninidin and luteolinidin did not show any inducer activity at tested concentrations. For cell proliferation assay, dimethoxyapigeninidin showed 95.4% inhibition of HT-29 cell growth at 20 µM whereas dimethoxyluteolinidin showed 92.5% inhibition at 100 µM. At 100 µM, non-methoxylated deoxyanthocyanidins showed 38.1%–71.2% inhibition of HT-29 cell proliferation while mono-methoxylated deoxyanthocyanidins inhibited HT-29 cell growth at 63.1%–83.1%. These results show that 3-deoxyanthocyanins in sorghum may have both strong protective effects against carcinogenesis, and inhibition of cancer cell proliferation. Methoxylation appears to improve their activity.

Physical and molecular properties of total and resistant starches from corn with different doses of mutant amylose-extender and floury-1 alleles for use in Hispanic food products

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Corn types with different numbers of mutant amylose-extender (*ae*) and floury-1 (*fl1*) alleles: #1, *aeaeae*; #2, *fl1fl1fl1*; #3 *aeaefl1*; and #4 *fl1fl1ae* were developed for use in making Hispanic food products with high resistant starch content. Starches from these corn types were evaluated for pasting properties with a Rapid ViscoAnalyser (RVA) and for thermal properties with a Differential Scanning Calorimeter. #1 had a low peak viscosity (PV) caused by incomplete gelatinization, whereas #3 had the greatest PV and breakdown. Starches #2, #3 and #4 had pasting temperatures of 78–81°C. #2 had the lowest onset temperature and greatest enthalpy. #3 and #1 had similar onset and peak temperatures, both higher than those of #2 and #4. The gel strength of the starch cooked by RVA then stored at 4°C for 10 days (retrograded) was evaluated by using a Texture Analyzer. The #1 gel appeared watery and had the lowest strength of 30 g. The #3 gel, although exhibiting syneresis, had greater gel strength (286–305 g) than #2 and #4 (194–209 g). Resistant starches (RS) in the original starches were: #1, 54.6%; #2, 1.1%; #3, 5.1%; #4, 1.9%. The structures of the original starches, of the RS in the original starch (RS-O) and of the retrograded starch (RS-R), were evaluated by using size-exclusion chromatography. The chain-length distribution of amylopectin was analyzed by fluorophore-assisted carbohydrate electrophoresis. Starch #1 had greater % amylose than the other starches. RS-O of all starches had a lower % amylopectin and a higher % low-molecular weight (MW) amylose than in their original starches. The RS-R from all starches had no amylopectin or high-MW amylose; however, the low-MW amylose (fractions 34-47) of RS-R from #2, #3, and #4 had strong blue values, with a different maximum absorbance wavelength than that of #1. The bigger chain lengths (DP 35-60) were greater in #1 and #3 than in #2 and #4, and the smaller chain lengths (DP 10-20) were greater in #2 and #4 than in #1 and #3. In general, #3 starch inherited some pasting, thermal and structural characteristics from both #1 and #2, but was distinctly different from #4. The appropriate dosage of *ae* with *fl1* will be further pursued to optimize structure-function relationships in food applications.

Rice-shaped extruded kernels: Grains for Hope

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Rice-shaped extruded kernels were developed to address nutritional deficiencies in developing countries and utilize sorghum which is a dominant crop in Africa but has been limited in food applications due to its poor digestibility and protein functionality. Also, as these extruded kernels were pre-cooked, it was expected to shorten the cooking time. Grains for Hope "rice" kernels were made with blends of corn and wheat flour, sorghum and wheat flour, or rice flour alone using a pilot-scale twin screw extruder. Each blend was fortified with an enrichment blend including vitamin A and C, folic acid, and iron. Extrusion conditions were controlled to obtain optimized product quality depending on the properties of these blends. Cooking quality test was conducted to determine cooking loss and water absorption. Texture profile analysis (TPA) and color measurements were conducted using TA-XT2 and Minolta colorimeter, respectively, and the results were correlated with descriptive analysis (DA) data. Retention of vitamins after processing was also evaluated. Extruded kernels with corn and wheat flour were high in yellowness and greenness. Kernels with sorghum and wheat flour showed highest cooking loss (13.4%) and water absorption (124.4%). Mean separation by least significant difference (Fisher) indicated that extruded kernels with sorghum and wheat flour were significantly different ($P < 0.05$) from the other samples for both TPA and DA results. Instrumentally measured adhesiveness with TA-XT2 was highly correlated to 6 of the 8 texture sensory attributes. One serving size of final product (150 g) provided up to 69.8%, 24.4%, 84.4%, and 96.9% of RDI of vitamin A, vitamin C, folic acid, and iron, respectively. After extrusion processing, the retention % of vitamin A was about 44% or less, however retention % of vitamin C was lower at 42% or less.

Effect of enzymatic tempering of wheat kernels on milling and baking performance

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The effect of cell-wall degrading enzymes added to the temper water was studied for their effect on wheat milling performance and flour quality. An enzyme cocktail consisting of equal amount of cellulase, xylanase, and pectinase and five independent variables (enzyme concentration, incubation time, incubation temperature, tempered wheat moisture content, and tempering water pH) were manipulated in a response surface methodology (RSM) central composite design. A single pure variety of hard red winter wheat was tempered under defined conditions and milled on a Ross experimental laboratory mill. The data showed that some but not all of the treatment combinations affected the flour yield from the break rolls more than that from the reduction rolls. However, a maximum for flour yield were not found in the range of parameters studied. While the treatments did not affect the optimum water absorption for the bread making, enzyme treated flours produced dough exhibiting shorter mixing times, and slack and sticky textures compared with controls. Regardless of the differences in mixing times, the specific loaf volumes were not significantly different ($P < 0.05$) for the treatments. For crumb firmness and bread staling rate, bread baked with the flour milled from enzyme treated wheat was comparable to the control after 1 day of storage but became firmer during storage up to 5 days.

Factors affect graham dough development

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Biscuit dough development is affected by ingredients in the formula such as flour type, sugar, fat, and water, as well as process conditions such as water temperature and mixing time. More and more products are being produced with whole grain in recent years due to the health benefits associated with whole grain flour (graham flour). However, the addition of whole grain to

dough affects its development due to the interference of bran particles and increased level of pentosan and damaged starch in graham flour. The objective of this study is to investigate the effect of various factors, such as sugar types, amount of sugar pre-dissolved in water, enzymes, and processing conditions such as water temperature and mixing time on the development of dough containing 30% graham flour. The dough development was observed with Farinograph using a commercial graham cracker formula and mixing procedure. The results indicated that sugar type affected the dough development. Glucose and fructose shortened the development time and increased dough firmness. Increasing the amount of pre dissolved sugar in formula water seemed to develop the dough faster. Dough with graham flour required longer mixing time compared to white wheat flour dough. Increasing water temperature and addition of xylanase improved dough development. These results may help to adjust the whole grain dough development, based on the specific need of the product.

Determination and analysis of tricin and total anthocyanin in different colored wheats

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Tricin (5,7,4′-trihydroxy 3′,5′-dimethoxy flavone) was found to be the dominant flavone pigment in wheat. A specific Ultra Performance Liquid Chromatography-mass Spectrometry was developed for the determination of tricin using positive electrospray tandem mass spectrometry (ESI--MS/MS). Multiple reaction monitoring transitions at 329.4 > 299.3 was selected for the quantification of tricin in wheat grain. Tricin and total anthocyanin contents of the wheat grain were analyzed for Black Wheat 76 (black epidermis), VICTO (white epidermis) and their twenty-two Sib-lines of hybridized offsprings with different color. The results showed that the tricin contents in wheat were regulated by inheritance, and those in Sib-lines of hybridized offspring had the significant difference with different genotypes. There was significant difference in total anthocyanin content between the black wheat and the VICTO white wheat in parents and their twenty-two Sib-lines of hybridized offspring. The results of the correlation analysis showed that the correlation between the total anthocyanin content and tricin was significant. The tricin content was higher in deeper colored wheat grains.

Gelation and physicochemical properties of whey protein-citrus fiber gels

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Heat-induced gelation of whey proteins has been extensively studied. With the increased demand for dietary fiber intake, combining whey proteins with non-gelling polysaccharide such as citrus fiber (CF) is an attractive method to develop new products with desired textures. Our objectives were to investigate the gelation of whey protein isolate (WPI) with CF and characterize physicochemical properties of the resulting gel. CF of different particle sizes (<30, 100, 300 meshes; Fiberstar, Inc.,) were used. CF and WPI were mixed with CF mass percentages of 10%, 20%, 30%, 40%, 50% and 60% in CF/WPI mixtures; water content was adjusted to 80% of total mass. The mixture was heated in a water bath at 100°C for 30 min to form the gel. Gelation characteristics were studied in situ using DSC and dynamic rheometer. Water retention property of the gel was measured as the function of time. The gel strength was measured by uniaxial compression test, and microstructure using confocal laser microscopy. Effect of salt addition was identified in terms of gelation properties. Our results showed that water holding capacity of the gel decreased with CF particle size due to the destruction of the citrus fiber, and increased with CF concentration due to its expandability. Owing to the diluting effect of non-gelling CF, increasing CF concentration lowered gel elastic modulus (G′) and gel firmness. DSC results showed that gelation temperature and energy needed to from a gel increased with CF concentration, which indicates that CF hinders the formation of WPI gel network. However, gel strength increased significantly with addition of Ca2+ due to the salt bridging effect. Therefore, it is possible to obtain stable WPI gels with CF addition, which may, in addition to improving dietary fiber intake, result in novel food textures. Results showed that CF addition and pH exhibited significant effects on rheological and physicochemical properties of the mixtures, which can be related to three primary aspects: (1) existence and relative strength of polysaccharides-polysaccharides (PS-PS), polysaccha-ride-protein and protein-protein interactions; (2) cationic, non-gelling properties of CF; and (3) thickening (high viscosity) and water holding properties of CF.

Rheological and stability of citrus fiber added O/W emulsions

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Highly expanded citrus fiber can be used to enhance the fiber content of foods. Whey proteins are employed for their high nutritional value and emulsifying properties. Polysaccharides may be added along with proteins to improve texture and stability of food emulsions. Our objective was to investigate the rheological and physicochemical properties of citrus fiber (CF)-whey protein isolate (WPI) system as an emulsifier for oil-in-water (O/W) emulsions. Emulsion rheological properties of the emulsions were investigated using a dynamic rheometer. Other properties characterized were: droplet size distribution, surface charge, creaming index, and microstructure. All the tests were at pH 7 or pH 4 adjusted using 1M NaOH or HCL. Viscosity of emulsion increased with the increased concentration of CF. Bridging and depletion flocculation were observed from microstructure and particle diameter. CF concentration has no effect on droplet size at pH 7 due to the electrostatic repulsion between negatively charged WPI and CF molecules; however, it had a significant effect at pH 4 owning to the positive charge of WPI below its isoelectric point (~5.2), which attracted CF molecules resulting in rapid creaming. Results indicate that CF can be incorporated along with WPI to stabilize food emulsions, which may exhibit novel properties at certain end-use conditions.

Potential moisture redistribution in wheat flour after milling

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Wheat flour is a living material. The physical, chemical, and biochemical reactions of wheat kernel continue after milling. It has been reported that the viscosity of diluted wheat flour solution changes with time after milling. Such change may affect the properties of gluten and starch polymers and therefore the end use. The objective of this study was to observe the possible moisture migration between the starch and gluten components of the flour, and the effects of environmental humidity and temperature. Commercial wheat starch and vital wheat gluten isotherms were measured with a Dynamic Vapor Sorption Analyzer (DVS), under various temperatures. The results showed that at the same humidity, wheat starch absorbed more moisture than vital wheat gluten. At 25°C and 65% relative humidity, wheat starch contains more than 15% moisture while gluten has less than 10%. This indicates that the moisture may migrate between flour components, such as, from gluten to starch after milling. With the increase of temperature, both starch and gluten lose moisture under the same humidity, gluten losing more than starch. This moisture lost did not recover when temperature returned back to 25°C. Therefore, in addition to the moisture migration, the starch and gluten polymer structure may be further modified if these components experience a temperature change between milling and end use. This study was conducted with commercial purified starch and vital wheat gluten. The purification process may change or modify the structure and therefore the properties of these polymers, especially the gluten. The results observed in this study need further investigation with flour (native starch and gluten).

Effect of phenolic compounds on the pasting and gel textural properties and *in vitro* enzymatic digestibility of potato and rice starches

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Phenolic compounds are major antioxidants in foods and have a great contribution to sensory, textural and nutritional quality, and ultimately to the benefit of human health. But their influence on functional and color properties of starch as well as on enzymatic hydrolysis has not been well studied. Rapid Visco Analyzer (RVA) and texture profile analysis were employed on rice and potato starches in the presence of catechin, naringin, rutin, gallic acid and proanthocyanidins. Additionally, a viscoamylometric method using RVA was used to detect the effect of phenolic compounds on the extent of enzymatic hydrolysis by porcine pancreatic alpha-amylase. Addition of phenolic compounds could either increase or decrease the peak viscosity (PV), depending on both the type of starch and the phenolic compounds. For example, Gallic acid increased PV of rice by 35 RVU but decreased that of potato by 67 RVU. Rutin increased PV of both rice and potato by 32 RVU and 22 RVU, respectively. All phenolic compounds increased hot paste viscosity of potato (greatest by proanthocyanidins) but decreased that of rice (greatest by catechin). Gallic acid decreased the cold paste viscosity of both rice and potato starches 31 RVU and 64 RVU, respectively. Rutin increased the hardness and adhesiveness of gels of both starches whereas other phenolic compounds either decreased or maintained them. Addition of all phenolic compounds altered the color characteristics of the starches. Catechin and

proanthocyanidins imparted redness the starch gels of both rice and potato whereas rutin imparted more yellowness. Gallic acid and proanthocyanidins completely inhibited enzymatic hydrolysis by porcine pancreatic alpha-amylase on rice and potato starches. Catechin facilitated the enzymatic hydrolysis for both rice and potato starches whereas naringin and rutin facilitated it for potato starch. This study may provide a basis for the use of phenolic compounds as ingredients for functional foods to meet quality requirements.

Underlying mechanism for waxy rice flours having different pasting properties

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The underlying mechanism for three rice varieties having different flour pasting properties was examined. Those three waxy rice varieties, Yangfunuo, Suyunuo, and Guanglingxiangnuo, gave different pasting properties at 10% solids as determined by a Rapid Visco-Analyzer (RVA). Yangfunuo flour (YF) exhibited the highest pasting temperature and highest peak viscosity, whereas Suyunuo flour (SF) had the lowest peak viscosity, and Guanglingxiangnuo four (GF) showed the lowest pasting temperature. The differences in flour pasting viscosity were narrowed when 0.5 mM AgNO3 solution was used instead of water, suggesting that amylase activity may contribute to the low pasting viscosity of GF and SF. To understand how starch is contributed to the flour pasting properties, pure starch was isolated from each flour. The peak viscosity of isolated Suyunuo starch (SS) was the lowest, whereas Yangfunuo starch (YS) and Guanglingxiangnuo starch (GS) had similar peak viscosity. The pasting temperature of YS was the highest, while GS and SS were similar. Starch pasting curves were not significantly altered when 0.5 mM AgNO3 was used instead of water. A microscope equipped with a hot-stage was used to determine morphology changes of the rice flours and isolated starches during heating. The start swelling temperatures of the isolated starches were in the following order: YS (71.8°C) > GS (62.4°C)>SS (61.3°C). Chain length distribution of debranched starches determined by gel permeation chromatography (GPC) revealed that YS had a larger proportion of short chains as compared to GS and SS.

Whole grain wheat flour functionality assessed by alveograph analysis

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Commercial whole grain wheat flours have been marketed recently with reduced particle size. These flours exhibit poor food processing performance in baked goods, especially in cookie, cracker and cereal production, due to fine grinding of the whole grain to particle sizes ≤150 microns, resulting in starch damage. Commercial stabilization used to extend storage stability is commonly performed, and can result in starch gelatinization. Therefore, the functionality of the flours is compromised, having a big effect in dough machinability and cookie spread, for example (Haynes et al., 2007). The need to assess whole grain wheat flour functionality with a predictive tool is thus existent. Alveograph analysis was chosen because it is a widespread rheological test used in the milling industry, which has been found to correlate to dough fermentation and early stages of baking (Faridi and Faubion, 1990) of low-extraction wheat flours. A modified version of the AACCI 54-30 method was developed by Chopin Technologies (Algeldeh et al., 2008) in which the mixing times and % hydration were modified to achieve bubble inflation of whole grain wheat flours. Commercially-available whole grain wheat flours of different sources of wheat and varying particle sizes were analyzed, resulting in a range of alveograph parameters (P, L and W). Future work includes correlating these measurements to predictive tests such as solvent retention capacity and sedimentation tests, which would give an enhanced profile of whole grain wheat flour functionality, as well as flour performance during commercial production of baked goods.

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