The 2009 AACC International Annual Meeting Focuses on Cutting-Edge Science and Its Application

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In this paper, I have the honor of reporting to you on the 2009 AACC Intl. Annual Meeting. Let me begin by saluting the authors who presented in Baltimore, MD, U.S.A., from September 13 to September 16, 2009. Their combined efforts advance and ultimately evolve AACC Intl.'s 7 key scientific initiatives.

I am proud to report to you that the AACC Intl. Annual Meeting has been revitalized thanks to the efforts of its board of directors and countless volunteers. Participants in the 2009 annual meeting felt this and they were inspired. The promise of our future and the global advancement of grain science are bright indeed. But our mission can only be realized through the continuous collaboration of our scientists around the world. How we fare as a professional society depends on what we do as volunteers today. I am happy to assist new or returning volunteers in any way I can, as are the members of our board of directors.

I would like to also take this opportunity to recognize the six students who competed in our first Best Student Research Paper Competition: Sean Finnie, Stephanie Moriartey, Sindhu Nair, Moustafa Saad, Catrin Tyl, and Liyi Yang. This was the second round of judging for these students, chosen from an initial pool of presentations. The hallways in Baltimore were full of praise for your scientific contributions and your ability to present; you raised the bar for future AACC Intl. presenters. Thank you!

Below are some of the annual meeting highlights per scientific initiative. Additionally, many of the 2009 authors have graciously agreed to record their work so that it can be further disseminated through the Cereal Science Knowledge Database (www.aaccnet.org/CerScienceKnowledgeDB). Be sure to watch for announcements as these are updated and posted.

Health & Nutrition

This year was very special as the HEALTHGRAIN EU Integrated Project Team presented four years of research regarding the scientific basis for increasing the intake of protective grain components and reduced risk of metabolic syndrome-related diseases. Results presented included: bioactivity diversity screen of European grains, novel milling fractionation, enzymatic processing and cereal fermentations, food factors important for metabolic merits, and consumer perceptions of health claims related to cereal foods. Moving forward, there is a need for international collaboration to establish the characteristics of foods high in fiber and the bioactives from whole grains that contribute to consumer preference, and to evaluate the success of gradual introduction and increased consumption.

Other areas of focus within the health and nutrition initiative were: health claims and the use of dietary fibers in cereal products, the effects of dietary fiber from cereals on gut health, and potential physiological effects of cereal bioactives. The amount of scientific evidence that is needed to substantiate health claims was discussed, in addition to the governmental perspective on what is needed to avoid misleading consumers. The use of randomized controlled trials and healthy subjects to substantiate health claims were debated. In terms of gut health, gut-enhancing effects of cereals are known, but most of the data are from isolated cereal fibers. Work to examine dietary stressors to the intestinal epithelium is ongoing since the condition and integrity of the epithelium is considered key to health and survival. More work is needed to find out how foods that are high in fiber and bioactives from whole grains deliver health benefits.

Mirko Bunzel, the Young Scientist Research Awardee (1), reviewed two studies investigating how ferulate oligomers might modulate the physiological properties of cereal fibers. In the first study, the influence of feruloylation on cell wall degradability by human fecal microbiota was tested. Shifting cell wall concentrations of total ferulates from 1.5 to 15.8 mg/g and diferulates from 0.8 to 2.6 mg/g did not alter the release of carbohydrates or the overall degradation of cell walls. The results indicate that low to moderate levels of ferulates and diferulates do not interfere with hydrolysis of nonlignified cell walls by human gut microbiota. In the second study, arabinoxylans were cross-linked through ferulate oligomers and the cross-linking effect on postprandial blood glucose levels was determined. It was demonstrated that arabinoxylan gels blunt the blood glucose maximum and shift this maximum to later time points after feeding. Long-term feeding studies are required to support these promising data.

Every human society has developed its own ways of knowing food and health relationships as matters of survival and sustainability. Emerging scholarship asks professional scientists to develop skills in cross-cultural engagement (CCE). CCE prepares scientists to respectfully access foreign ways of producing knowledge of food and health that lie outside the orthodoxy of their professional training. Participants in Baltimore heard the theories of classic Chinese medicine and experienced the world views described by indigenous healers. Shifting cultural perspective allows for knowledge otherwise incomprehensible to become more empathetically understood; it allows the presuppositions and paradigms of scientific thinking to become more visible and can ultimately lead to broader and more innovative forms of scientific inquiry.

Food Safety & Regulatory

Due to recent food safety issues within the United States and abroad, there is increased scrutiny on the safety of our food supply. The emphasis on food security, food safety, and recalls has led to a rapid increase in the number and types of audits that are required. As we respond to these requirements, we are faced with the challenge of maintaining food safety and retaining con-

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sumer confidence while effectively managing overall costs and complexity. In order to fully understand and determine security requirements for the food and beverage supply chain, leaders from various perspectives and disciplines addressed third-party audits and hazard analysis and critical control points (HACCP) management systems vs. the industry's changing environment. As a result, AACC Intl. has established a task force to work toward a consensus best practice for the food and beverage industry.

Biotechnology & Sustainability

Our 2009 keynote speech, given by H. S. Muralidhara, addressed the importance of recycle/reuse opportunities for water in the food- and bio-processing industries to promote sustainable development. Water availability is arguably the most pressing resource in the world. America's largest aquifer, the Ogallala, is being depleted at a rate of 12 billion cubic meters per year. The Ogallala stretches from Texas to South Dakota and irrigates approximately one-fifth of U.S. farmland. There are also several food-manufacturing plants among the aquifer, and the water stress could have, major impact on many of these operations. The food-processing industry uses an enormous amount of water. With the advent of biofuels, the water balancing act is absolutely essential. Membrane technology should be explored further to mitigate this water problem.

Rice sustainability was also discussed in Baltimore. Rice feeds nearly half of the world's population and is responsible for more than 20% of calories consumed. Growing rice and its processing, distribution, and preparation have significant impacts on the environment, and even small improvements can make an important difference. Hybrid rice is improving sustainability. Hybrid rice worldwide typically shows an average 20 to 30% yield advantage over pureline cultivars with equal or less fertilizer input (14). Additionally, increased resistance to disease and insect pressure lessens the need for costly fungicide and insecticide applications, reducing the pesticide load on the environment. Organic rice is also showing real agronomic potential.

Biofuels from plants, plant by-products, and in particular maize are becoming more significant energy resources. The use of grain as feedstock for ethanol has raised issues. The next generation of biofuels will likely be derived from lignocellulosic resources. Collection, transportation, and storage; enzyme effectiveness; thermochemical versus biochemical processes; and greenhouse gas emission reduction requirements for advanced biofuels were among the topics addressed in Baltimore.

Cereal & Polymer Chemistry

There was a lot of discussion in Baltimore about grain foods as rich sources of potential bioactive components. Whether whole grains, dietary fiber, or low molecular weight bioactive components (partially attached to fibers) elicit health benefits has not been fully elucidated in part because the grain materials are not well defined. It also remains unknown how results from in vitro measurements of grain components and their effects on antioxidant and cell culture tests translate into effects on human health. There is little information about the breakdown and release of grain components through enzymatic action as they pass through the digestive tract. A lack of methods validation continues to be a source of confusion; additional work is needed.

The molecular origins of starch properties were discussed during the Alsberg-French-Schoch Memorial Award lectureship given this year by Mike Gidley (4). There is an opportunity to describe and model starch structure in ways that would not be possible for chemically more complex polymers. The resulting information provides baseline knowledge from which the behavior of the complex polymer architectures found in granules and processed forms of starch can be extrapolated. This information may be applied to current scientific challenges, such as identifying the factors responsible for granule integrity and the control of starch digestibility.

Nonwheat proteins and ingredient systems for gluten replacement received significant attention in Baltimore. Gluten is a unique relative to proteins found in closely related plant species, but the functionality of gluten in baked bread is not unique. Moreover, cereal scientists are finding new ways to improve the functionality of nonwheat cereal proteins. For example, prolamins from maize (zeins) are known to form viscoelastic, extensible, and cohesive dough when mixed with starch and water above the glass transition temperature (Tg, ~28°C) (5,11). The incorporation of HMW subunits from wheat into rye proteins, zeins, or kafirins considerably improves the gel protein (GMP) content and the bread-making performance. The formation of high molecular mass aggregates by cross-linking rye proteins with transglutaminase leads to comparable results. Hydrocolloids, modified starches, emulsifiers, and gluten-free proteins can also be combined to replace gluten functionality in bread making. Reliable and sensitive methods to evaluate risks of dietary proteins in ingredients and processed foods are needed for celiac patients. Additionally, pharmaceutical therapy (available by prescription) to treat inadvertent gluten exposure is needed. For food manufacturers, there is currently no AACC Intl. approved method for quantifying trace gluten concentrations (less than 20 ppm) in foods.

The Thomas Burr Osborne Medal lecture, presented by this year's winner Jan Delcour (2), emphasized progress in our basic understanding of cereal starches, proteins, and nonstarch polysaccharides over the past two decades. A major element of progress has been in enzyme systems of microbial origin that modify specific cereal constituents. These enzymes have been used to unravel the role of cereal constituents in food applications. Particular focus was on the arabinoxylan system, the insights gained on its functionality by use of xylanases, the concept of xylanase inhibitors, and the conversion of arabinoxylan to health promoting constituents. Basic (structure and function) cereal-based research leads to application-based research, which then results in commercialization.

Structure and function studies continue to generate breakthrough results in grain science. For example, size distribution data is being used to understand the mechanisms of starch biosynthesis, digestion, and degradation. There was also a debut of milling studies on a soft durum wheat created through traditional cytological (non-GMO) means. Additionally, a benchtop baking method for chemically leavened crackers was presented during the Applied Research Award lecture presented by last year's awardees Harry Levine and Louse Slade (6).

Quality & Analytical Methods

The Edith A. Christensen Award lecture, given by Jon DeVries (3), addressed dietary fiber methodology. From a nutritional perspective, dietary fiber is unique in that benefits relate to resistance to digestion. Serious research on dietary fiber in the 1950s to 1970s resulted in a definition by Trowell et al. in 1976 (13), for methods 32-05.01, 32-06.01, 32-07.01, 32-20.01, 32-21.01, and

32-25.01, to match that definition. Scientific advances in the subsequent two decades resulted in the conclusion that additional components, such as resistant starch and nondigestible oligosaccharides, are on a physiological basis included validly in the Trowell definition, therefore AACC Intl. Approved Methods of Analysis 32-28.01, 32-31.01, 32-32.01, 32-33.01, 32-40.01, and 32-41.01 for these components have also been validated. Recently, the CODEX Committee on Nutrition and Foods for Special Dietary Uses has produced a single, concise, clarifying definition of dietary fiber that reflects the scientific findings of the past five plus decades. AACC Intl. scientists are collaborating on the validation of an all-inclusive method commensurate with this definition; more than a dozen laboratories have submitted data as part of the effort.

Other topics of interest included work on starch-antioxidants interaction as a means to improve the nutritional quality of food, applications of small-angle scattering techniques in the structural characterization of resistant starches, and a novel approach in the determination of estimated glycemic response. The 2009 Applied Research Award lecture, presented by Barry McCleary (7), focused on applying basic research in developing analytical solutions.

Characterizing the size and molecular weight distributions of starch continues to be an area of debate. Improvements in human and animal nutritional needs, and industrial applications, such as manufacturing paper, require structure-property relations for starch, especially the distributions of size and of molecular weight of the fully dissolved starch molecules. Examples are emerging as to how these distributions have major effects on cooking and other properties. However, it is likely that there are no reliable data on these distributions for native starch. Characterizing the structure is complex because one of the two types of starch in grains, amylopectin, is hyperbranched and of very high molecular weight. Size separation techniques (size-exclusion chromatography, field-flow fractionation) with multiple detection provide (in principle) powerful tools for obtaining data that are sensitive to amylopectin structure. However, reliable application of these methods is bedeviled by two problems: 1) not all the starch may be dissolved, and 2) shear scission may occur during separation.

Ingredients & Cost of Goods Sold

This year, the role of grain-based ingredients in reducing childhood obesity was presented. Childhood obesity is a multi-factorial disease with severe implications for the future health and well being of school-aged children. Grain ingredients and foods contribute calories, macronutrients and fiber, various vitamins and minerals, along with numerous bioactive components. The grain industry can work together to focus on approaches that gradually introduce grain foods with additional health attributes that help prevent excess weight gain in young children. Consumer behavioral techniques and product development approaches were addressed within the context of the child's current environment. Each of these disciplines is instrumental in exploring potential opportunities for developing grain-based foods that assist in the prevention of excess body weight gain in children. There is agreement that improving school nutrition will encourage long-term consumption of whole grain and nutrient-dense foods by forming preferences at a young age. Significant granting opportunities exist in the areas of improving school nutrition and preventing childhood obesity. There is an opportunity to market responsibly to children through school food service. In addition, the school cafeteria is an ideal and low-risk environment for testing new and improved foods. Ultimately, experiences in school food service are leading to a model that can be applied to additional food sectors and population segments.

Pulses as nutritional and functional ingredients were also discussed. Pulses are nutritionally beneficial food sources that are high in fiber and protein, and low in fat. They can be used as whole seeds, ground to flours, or fractionated into protein, starch, and fiber streams. New, healthy ingredients are constantly being sought for use in innovative food products. Pulses may be used as ingredients in many products and provide nutritional, functional, and environmental advantages for foods.

Other topics dealt with moving toward healthier foods with novel ingredients or ingredient systems. For example, whole grain, soft wheat flour tortillas; kafirin microparticles; pasta made with nontraditional ingredients; brewer's spent grain proteins and their hydrolysates; naked barley; and saltiness enhancement by inhomogeneous spatial distribution of salt.

Engineering & Processing

Dough structure and rheology continues to be a fascinating area of study. In particular, X-ray microtomography was used to study the microstructure of proofing dough and baking bread to compare the stability of wheat flours of varying strength throughout the proofing and baking process, and to understand the interrelationship between protein quality, biaxial rheological properties, and microstructure. Three-dimensional analysis of dough samples indicated that the void fractions increased dramatically over the proof time from 31.7% for the unproofed dough (0 min) to 63.2% and 72.7% for the under-proofed and optimally proofed doughs, respectively. Oven spring caused further expansion in the baked loaves which increased average void fraction to 84.4%. Understanding the factors affecting gas cell stability during the bread-making process is important in creating distinct structural and textural characteristics (9).

Another study (10) used ultrasound technology to evaluate dough properties. Ultrasound is particularly sensitive to the presence of bubbles contained within the dough's viscoelastic matrix, so measurements of ultrasonic velocity and attenuation over a wide range of frequencies have allowed us to identify three distinct regions that are associated with the mechanical response of the dough matrix and its bubbles. New information on dough properties can be derived from ultrasonic measurements at low frequencies, where the properties of the dough as a whole (matrix and bubbles) are investigated. Ultrasound is a low strain technique, but ultrasonic measurements of doughs made from flours with a range of bread-making quality correlate well with parameters acquired from conventional large strain techniques, such as the alveograph and farinograph. Ultrasound techniques can also be combined with large strain techniques. By subjecting samples of dough to uniaxial compression and monitoring their relaxation with ultrasound, markedly different behavior is evident in air-mixed doughs compared to those mixed under vacuum. Therefore, bubbles appear to substantially affect the short-time relaxation behavior of air-mixed dough samples.

The impact of redox agents on sugar-snap cookie quality was addressed. Reducing agents significantly decreased dough setting, while the opposite was true for oxidants. This resulted in smaller (83.7 to 84.9 mm) or larger (87.8 to 88.3 mm) diameters respectively than those of the control cookies (87.3 mm). This was related to more pronounced entanglement and subsequent cross-linking when reducing agents were used to modify the gluten, and less pronounced entanglement and cross-linking when-

ever oxidants were added. Furthermore, more cross-linking led to reduced collapse. Microfocus computer tomography, a technique based on differences in X-ray absorption between pores and cookie material, clearly showed that modifying the gluten largely influences the internal cookie structure (8).

The potential of glycolipids from lecithins in bread making in comparison to classical surfactants and two synthetic glycolipids was also presented. The most important glycolipid classes in commercial lecithins, such as soybean, rapeseed, or sunflower, were found to be sterol glucosides, acylated sterol glucosides, cerebrosides, and digalactosyl diacylglycerides. These classes were isolated and characterized for their techno-functional properties by micro-scale baking and extension tests (10 g of flour). The baking tests revealed the excellent baking potential of all isolated glycolipid classes, with clearly better or equal baking activities than commercial surfactants. The synthetic monogalactosyl monoglyceride and the isolated digalactosyl diglycerides showed the highest bread volume increases. Furthermore, the glycolipid classes influenced the crumb structure significantly by improving the crumb softness and grain. Interestingly, all glycolipid classes showed no significant antistaling effect, except the synthetic monogalactosyl monoglyceride with a considerably weaker effect than the commercial surfactants used for this purpose. A direct effect on the overall rheological behavior of the dough was only found for the commercial surfactants. However, the rheological effect seen on Glutomatic-obtained gluten revealed that the surfactants could be divided into two main groups. One group, acylated and nonacylated sterol glucosides, only had a significant influence on the resistance to extension of the gluten and the other group, this being all other glycolipid classes and the reference compounds, only had a significant influence on the extensibility of the gluten. Results indicate that in wheat dough, glycolipids seem to have an impact on the dough liquor rather than on the gluten-starch-matrix, with different modes of action (12).

Finally, the promotion of health and wellness through food consumption is a powerful driver for ingredient and food product manufacturers. The many healthful components found in grains and grain legumes (many in underutilized, lower value process streams) represent a very rich resource that can be fashioned into value-added components that address consumer needs for nutrition, diet, and a healthy lifestyle. To achieve this goal in a predictive manner, cereal scientists need two things: good understanding of the basic physical and chemical mechanisms of interactions between food components so that this knowledge can be used to drive process strategies that will maximize nutritional benefits; and process technologies that minimize degradation of the component of interest or provide innovative means for successful incorporation of these higher value components from the grain industry into food products. The impact of nanotechnology, microwave and radio frequency energy, extrusion, and other process technologies were discussed in Baltimore. More work is needed to understand the effect of current production, handling, processing, and delivery systems on the characteristics of foods that are high in fiber and bioactives from whole grains.

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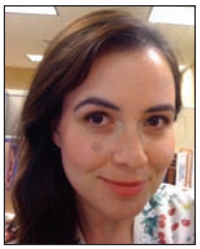
References

1. Bunzel, M. Potential influence of ferulate oligomers on physiological effects of cereal dietary fibers. Cereal Foods World Annual Meeting Abstracts Online Supplement. Published online at www.aaccnet.org/cerealfoodsworld/openarticles/2009/CFW-54-4-suppl.pdf.
2. Delcour, J. Basic insights in cereal constituents as a basis for progress in cereal-based biotechnological processes. Cereal Foods World Annual Meeting Abstracts Online Supplement. Published online at www.aaccnet.org/cerealfoodsworld/openarticles/2009/CFW-54-4-suppl.pdf.
3. DeVries, J. Dietary fiber methodology: AACC Intl. approved methods commensurate with dietary fiber research and the CODEX definition. Cereal Foods World Annual Meeting Abstracts Online Supplement. Published online at www.aaccnet.org/cerealfoodsworld/openarticles/2009/CFW-54-4-suppl.pdf.
4. Gidley, M. Probing the molecular origins of starch properties: Methods and models. Cereal Foods World Annual Meeting Abstracts Online Supplement. Published online at www.aaccnet.org/cerealfoodsworld/openarticles/2009/CFW-54-4-suppl.pdf.
5. Hamaker, B. R., Mejia, C. D., Goodall, M. A., and Bugusu, B. A. Texture and cereal protein functionality. Cereal Foods World Annual Meeting Abstracts Online Supplement. Published online at www.aaccnet.org/cerealfoodsworld/openarticles/2009/CFW-54-4-suppl.pdf
6. Levine, H., and Slade, L. Development of a benchtop baking method for chemically leavened crackers. Cereal Foods World Annual Meeting Abstracts Online Supplement. Published online at www.aaccnet.org/cerealfoodsworld/openarticles/2009/CFW-54-4-suppl.pdf.
7. McCleary, B. Applying basic research in developing analytical solutions. Cereal Foods World Annual Meeting Abstracts Online Supplement. Published online at www.aaccnet.org/cerealfoodsworld/openarticles/2009/CFW-54-4-suppl.pdf.
8. Pareyt, B., Brijs, K., and Delcour, J. A. The impact of redox agents on sugar-snap cookie quality. Cereal Foods World Annual Meeting Abstracts Online Supplement. Published online at www.aaccnet.org/cerealfoodsworld/openarticles/2009/CFW-54-4-suppl.pdf.
9. Pickett, M., and Dogan, H. Study of gas cells during proofing and baking using biaxial rheology and X-ray microtomography. Cereal Foods World Annual Meeting Abstracts Online Supplement. Published online at www.aaccnet.org/cerealfoodsworld/openarticles/2009/CFW-54-4-suppl.pdf
10. Scanlon, M. G., Page, J. H., Fan, Y., Kiefte, A., and Mehta, K. L. Combining low frequency ultrasound with large strain techniques to evaluate the properties of wheat flour doughs. Cereal Foods World Annual Meeting Abstracts Online Supplement. Published online at www.aaccnet.org/cerealfoodsworld/openarticles/2009/CFW-54-4-suppl.pdf.
11. Schober, T., and Bean, S. R. Potential of prolamins from maize and sorghum to form gluten-like structures in wheat-free bread. Cereal Foods World Annual Meeting Abstracts Online Supplement. Published online at www.aaccnet.org/cerealfoodsworld/openarticles/2009/CFW-54-4-suppl.pdf. Cereal Foods World Annual Meeting Abstracts Online Supplement. Published online at www.aaccnet.org/cerealfoodsworld/openarticles/2009/CFW-54-4-suppl.pdf.
12. Selmair, P. L., and Koehler, P. Influence of glycolipids on the technological properties of wheat dough. Cereal Foods World Annual Meeting Abstracts Online Supplement. Published online at www.aaccnet.org/cerealfoodsworld/openarticles/2009/CFW-54-4-suppl.pdf.
13. Trowell, H. C. *Definition of Dietary Fiber*. Lancet:503, 1974.
14. Wilson, M. A consumer packaged goods company perspective on rice sustainability. Cereal Foods World Annual Meeting Abstracts Online Supplement. Published online at www.aaccnet.org/cerealfoodsworld/openarticles/2009/CFW-54-4-suppl.pdf.



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