

2015 marks 100 years of AACC International members working together to share cereal grain science. The Centennial Committee, with the help of many expert members, is creating activities to celebrate achievements and look to the future of our science. The Scientific Milestones Sub-committee is coordinating a series of summary highlights—each focusing on an important area of cereal grain science. Experts in each area have identified key breakthroughs over the last 100 years, provided brief descriptions of the discoveries, and given examples of how these breakthroughs led to changes in our cereal foods. The experts also provide a few ideas

on where future research may lead us. These brief highlights are meant to provide an overview and cannot be inclusive of the exhaustive research in these areas.

Centennial Scientific Milestones Sub-committee: Lauren Brewer, Rachel Prosocki, and Steven Nelson.

100 Years of Nutrition and AACC International

Julie Miller Jones

1910–1935: The Age of Vitamins and Protein

The 100 year history of AACC International and the history of the science of nutrition started in tandem. When the American Association of Cereal Chemists (now AACC International) was founded in 1915, vitamins had just been discovered (1), and the role of vitamins and other micronutrients in health was just emerging. In fact, the “vitamine theory” was introduced just three years before AACCI’s founding. This theory suggested there were components in foods, beyond proteins, carbohydrates, and fats, called “accessory factors” (2). The name, vitamin (the “e” was subsequently dropped), stems from the fact that they are necessary for life and prevent deficiency diseases (3)—hence the combination of “vital” and “amine.” These compounds were misnamed due to the prevailing view at the time that compounds important for health were derived from amines (4).

During these early years, one of AACCI’s scientific giants, Thomas Burr Osborne, who directed research at the Connecticut Agricultural Experiment Station, was studying proteins and amino acids in foods, including wheat (5) and other grains. His experiments on protein not only showed that various proteins play different roles in supporting life (6), but also led to the critical discovery of many “accessory factors” (7). His studies showed that rats eating casein or glutenin could grow, while those eating gliadin or hordein (limited in lysine) could be maintained but not grow and those eating zein (limited in

tryptophan) lost weight and did not survive without eating additional foods (8).

At the same time, studies were also being conducted at places such as the University of Wisconsin, where S. M. Babcock and his colleagues E. B. Hart, E. V. McCollum, H. Steenbock (9), and G. Humphrey performed experiments in nutrition. Their studies showed that diets constituted of different single grains, either wheat, corn, or oats, each of which had identical amounts of protein, carbohydrate, and fat, gave differing results. After two years on these diets, heifers eating either the wheat or oat diets were sick, and their calves were unhealthy or died, while the cows that ate corn were all healthy, as were their calves (10). This group theorized that yellow color in foods such as corn might be critical for health (11,12). For this work, McCollum and his team were regarded as the discoverers of the first vitamin to be recognized, vitamin A—although their paper was published just three weeks before the T. B. Osborne and L. B. Mendel paper on vitamin A (13).

Osborne and Mendel devoted considerable efforts to studying fat-soluble vitamins and proteins and to advancing the understanding of their role in health, as is shown in their seminal papers (4,14). Osborne’s important role in nutrition science and agricultural biochemistry was recognized in 1928 when he received the inaugural Thomas Burr Osborne Medal. This

1913 Vitamin A became the first recognized vitamin



1940s U.K. and U.S. suggested fortification and enrichment to improve nutrient content of troop diets in WWII

1960s Health benefits of dietary fiber were investigated



1980 First Dietary Guidelines Committee was created to address link between nutrition and chronic diseases

1930s

American Medical Association began debating fortification to improve nutrient content of refined grain foods

1950s



Links between diets high in fat, cholesterol, and saturated fat and coronary heart disease and death were studied

1970

U.S. regulations regarding voluntary nutrition labeling of foods were enacted

gold medal is awarded by AACCI in recognition of important scientific contributions to cereal chemistry and nutrition.

This was a ripe discovery period for the young science of nutrition and for determining the role of grains in the diet. It included the first studies undertaken to assess the effects of high-protein diets, low-carbohydrate and low-fat diets, and variations in the supply of various minerals, as well as the discovery of fat-soluble vitamins, B vitamins, and their structure and function. In many cases vitamins were isolated from food sources and synthesized. The nutritional contribution of whole cereal grains and their outer layers to B vitamins (except B₁₂) and vitamin E in the diet was recognized.

Joseph Goldberger of the U.S. Public Health Service suggested that pellagra, a major cause of death in the Southeastern United States, was caused by poor diet. His feeding trials with prison volunteers who ate a marginal, corn-based diet countered the prevailing view that pellagra was caused by germs. After 2 weeks on the diet, the prisoners complained of headaches and other neurological issues, but it took 5 months for the skin lesions characteristic of pellagra to develop. Although Goldberger proved that a marginal, corn-based diet was the cause of the disease, it took another 20 years to prove that pellagra was caused by a lack of niacin in the diet.

Government nutrition recommendations during this time paralleled some of these scientific discoveries and resulted in the publication of U.S. Department of Agriculture (USDA) guides on nutrition (15): “Food for Young Children” and “How to Select Food.” These guides, like those published today, were based on food groups and household measures. Their focus was “protective foods” and preventing malnutrition, especially in children.

Important contributions to the science of human starvation were made by conscientious objectors (16) who fulfilled their duty to country by volunteering to go on starvation diets.

1935–1950: More Discoveries, the War Years, and Enrichment and Fortification

While USDA food guides suggested that breads and cereals could provide an inexpensive source of nutrients, scientists were starting to question whether refined grains were providing

adequate nutrients, especially for children. In 1936 the American Medical Association (AMA) Council on Foods and Nutrition discussed fortification to increase nutrient content.

In 1940 the British government suggested the fortification of flour and bread with thiamin, but this was not done because other war efforts precluded it. During the same year in the United States, the National Research Council suggested the fortification of flour to meet the need for thiamine created by the physical demands on U.S. troops. Bread became the enrichment vehicle for fortification in the United States as a result of a coalition among the baking and food industries, the U.S. government, and academia.

Also during this time researchers looking at the effects of protein noticed that indigestible materials could impact its usage. This 1941 study contains the first mention of the term “dietary fiber” in animal feeding (17).

In 1943 the USDA “Basic Seven Food Guide,” the first food guide for the entire U.S. population, named breads and cereals as one of the seven food groups. Improving bread through enrichment and other means was a goal. To this end, Clive McCay and his wife, working at Cornell University, developed a bread with improved nutritional qualities imparted through addition of full-fat soy, wheat germ, and dried milk. It was known as the Cornell Bread and was valuable for improving diets during war-time rationing. The U.S. Food and Drug Administration (FDA) also passed legislation (CFR Title 21) for Standards of Identity of Enrichment with thiamine, riboflavin, niacin, and iron in cereal flour, cornmeal, farina, and pasta. While thiamine, riboflavin, and niacin were added to replace nutrients lost during processing, iron was added to compensate for meat shortages due to rationing. The reasoning behind the Standards of Identity was simply to use cereal grains as a carrier for nutrients that needed to reach a large population and be effective in preventing disease. Calcium and vitamin D, which are found in milk, were added to the Standards of Identity as optional ingredients. The Standard of Identity for rice was added in 1958 following the Bataan Study in the Philippines. Fortification of breakfast cereals was developed and standardized in 1973 and included vitamin A.

A significant development in enrichment and fortification occurred with the addition of folic acid to cereal grains. After an

1992 Nutrition Labeling and Education Act mandated nutrition labeling and USDA Food Guide Pyramid was developed



2005 Dietary Guidelines included whole grains in dietary guidance

2013 FDA issued final ruling on gluten-free labeling of foods

AACCI announced standard for whole grain characterization

1990s



AACCI issued a definition for dietary fiber and developed Method 32.05.01 for determining total dietary fiber

1999



AACCI issued a definition for whole grain

2011



USDA MyPlate was released and prominently featured grain-based foods

intensive review period, the final ruling for a new Standard of Identity for folic acid became effective in 2000. The addition of folic acid was used as a means of preventing neural tube defects in infants. The reasoning was strengthened by the fact that the defects develop during the first trimester of pregnancy, before the mother may begin taking supplements.

Further review of guidelines for fortification of cereal grains occurred in the 1990s and continues to the present.

1950–1967: Concerns Shift to Dietary Excess, Fat, Cholesterol, Inadequate Fiber, Chronic Disease, and Celiac Disease

Nutritional concerns began to shift in the latter part of the 20th century from concerns about nutrient adequacy to concerns about nutrient excess and factors in food that may have a negative impact on health. During this time, many new foods were introduced in the marketplace, and diets changed to meet the needs of a growing population of working women. In terms of dietary guidance, the “Basic 7” was simplified to the “Basic 4” in 1958. The guide specified types and amounts of foods and recommended 4 servings of grains/day.

Nutrition discoveries from this period included wheat as a cause of celiac disease, identification of dietary fiber as important to human nutrition, and links between fat in the diet and coronary heart disease. In 1952 Dutch pediatrician Willem Karel Dicke observed that disruption in the availability of staple foods such as bread during World War II improved the clinical condition of some children in his care. He hypothesized that bread might be problematic for his patients (18). This was confirmed when the Allied forces began dropping bread in the Netherlands. Children whose condition had improved began to deteriorate rapidly. His post-war experiments challenged these children with various grains under a strict dietary protocol. Through these experiments he linked celiac disease to the ingestion of wheat proteins.

In 1953 E. H. Hipsley, a researcher at the Australian Department of Health, noted there was a higher incidence of toxemia from September to May, when there was less fresh food (19). He named “dietary fiber” as one of the important missing components, thus relating dietary fiber as important for human health.

The Seven Country Study of Ancel Keys started to focus the attention of the scientific and medical communities on excess fat intake and the rising rates of coronary heart disease (20). His epidemiological studies suggested that diets high in fat, cholesterol, and saturated fat were associated with increased coronary heart disease risk and death rates (21,22).

In the late 1960s physicians Denis Burkitt, Hugh Trowell, Neil Painter, and Alex Walker working in rural Africa proposed the “dietary fiber hypothesis” because diseases common in Westernized countries were rare in rural Africa (23,24). They proposed that diets filled with indigestible plant material, e.g., plant fibers, in rural Africa was one of the reasons for their observation. In 1963 De Groot et al. (25) noted that diets high in oatmeal lowered cholesterol, suggesting that the fiber in oats may be different than some of the fibers from other sources.

1968–1995: Fat Phobia, Fiber Mania, Glycemic Carbohydrates, and Nutrition Labeling

Dietary fiber, dietary inadequacy, and fat phobia were the focus of nutrition research, communication, and product development in the 1970s. There was concern about inadequate diets, as demonstrated by the creation of the U.S. Senate Select Committee on Nutrition and Human Needs (1968–1977), sometimes referred to as the McGovern Committee. Based on their findings, dietary goals for the nation were issued in 1977 (26).

Consumers also began expressing a desire for information about the nutrients in their foods. In 1970, regulations were promulgated regarding nutrition labeling of foods in the United States (27). Labeling was voluntary unless a product was fortified, which was the case for many cereals, or nutritional claims about a product were made. Labeling at this point was akin to the “Wild West” because serving sizes could be made very large or very small to meet specific claims. By the late 1980s the nutrition findings concerning oat bran and its cholesterol-lowering properties had taken the country by storm (28,29). An advertorial about bran fiber and cancer claims that used wording from the National Cancer Institute led to nutrition label reform and regulation of health claims with the passage of the Nutrition Labeling and Education Act in 1990 (30,31).

Concerns about nutrition and chronic disease permeated nutrition thinking during this era. Government concern was shown in 1980 with the creation of the first of the Dietary Guidelines Committee. This committee and the others that met during this timeframe warned against excess fat, saturated fat, cholesterol, salt, and sugar intakes and recommended that consumers “choose a diet with plenty of fruits, vegetables and grains.” One of the later committees during this time period added a guideline concerning food safety.

Bread and carbohydrate foods were placed at the base of the 1992 USDA Food Guide Pyramid (32), and adequate dietary fiber intake was a growing concern. Dietary fiber was also a big topic for AACCI members. Conferences held in the 1980s and 2000 on the definition of dietary fiber and ring test analysis (33) resulted in development of AACCI Approved Method 32.05.01 for determination of total dietary fiber (AOAC Method 985.29). This was the operative method for research and labeling for many years and an important agenda item for AACCI members (34,35). Much research was done linking high fiber intakes to lower risk of many chronic diseases. In addition, dietary fiber studies conducted during this period showed that undigested starch could function as dietary fiber (36,37).

Although there was still a great deal of focus on fat, interest in and concerns about carbohydrate quality grew. In 1981 David Jenkins in his work with diabetics developed a method to assess carbohydrate quality called the glycemic index (38). Controversy over the application of this index outside the research lab and the validity of the numbers in the tables with respect to what is eaten by consumers has plagued the index since its introduction. In response, AACCI established a committee to look at the glycemic index and determined that the concept was valid but that there was too much variability in the measure caused by many different factors to make it ready for use in labeling or other measures.

1996–Present: Whole Grains, Folate Fortification, Gluten-free, Carbohydrate, and Grain Bashing—Oh My!

In 1998 folate fortification became mandatory in the United States. In the ensuing years, folate fortification has reduced neural tube and other birth defects by up to 55% in some of the countries where it has been adopted (39). According to the U.S. Centers for Disease Control and Prevention, this result has made it one of the top 10 public health measures of the last century. Yet, there is still debate about its benefits because folate acid can mask B₁₂ deficiency in the elderly, and free folate may have adverse effects on the population as a whole (40).

In 1999 an AACCI expert committee issued a definition for whole grain (41). The definition was necessitated due to new data suggesting that more whole grains in the diet could reduce the risk of some chronic diseases (42). Other definitions of whole grains are adaptations and refinements of the original AACCI definition, such as the definition issued by HEALTHGRAIN (43).

In 2001 AACCI, together with the International Life Sciences Institute, met and adjusted the original AACCI dietary fiber definition to reflect new scientific findings and the role of resistant starch and short-chain polysaccharides. This definition was adopted by several countries, including Australia and New Zealand. AACCI was very active in providing input for both a dietary fiber definition and methods of measuring it that were approved by Codex in 2009 and later (44–46).

Both the 2005 and 2010 Dietary Guidelines Committees reaffirmed the recommended limitation of fat and saturated fat in the diet and emphasized whole grains by making it a specific guideline, suggesting that consumers make “half their grains whole.” In 2013 these whole grain guidelines were made part of the USDA school lunch regulations regarding the serving of whole grain-rich foods on school menus when offering grain-based items (47). These changes were implemented because in 2005 very few American children consumed the recommended amount of whole grains daily. Data analyses in 2015 should elucidate whether whole grain consumption has improved.

In 2008 data on the incidence of celiac disease completely changed ideas about its prevalence. It went from what was thought to be 1 in 2,500 to 1 in 133 people in the United States (48). Further data suggest that celiac disease is increasing in many countries around the world (49,50). For AACCI this necessitated discussions on what is “gluten-free” and how to measure gluten. Codex Alimentarius and many regulators have adopted a standard of 20 ppm for foods labeled as gluten-free (51,52).

Also during this time AACCI committees worked to characterize whole grain foods to create a fair and equitable playing field for the industry and to help consumers identify whole grain foods. This resulted in a whole grain characterization of 8 g of whole grain/30 g of food (53). This was chosen so that 6 servings (the number of grain servings recommended for most) would reach the minimum level of whole grain (48 g) thought to provide health benefits.

A major concern in recent years has been the rise in obesity, diabetes, and associated chronic diseases. Excess calorie intake from all categories contribute to these diseases. With regard to the bread and cereal category, there is concern about overconsumption of grain-based desserts and snacks. For some there is concern about carbohydrate quality and excessive carbohydrate consumption from all categories, especially sugars and refined carbohydrates. Most data on chronic disease, diabetes, and weight control indicate diets that are balanced among the food groups and that follow food plans such as USDA MyPlate, the DASH diet (Dietary Approaches to Stop Hypertension), and the Mediterranean diet promote beneficial health outcomes (54) and can be adopted successfully for the long term for both weight loss and management (55,56).

2015 and Beyond: Consumers, Industry, and the Roles of AACCI and Government in Nutrition and Health

AACCI has always been an association that utilizes experts from industry, government, and academia to improve public health and help improve the lives of consumers through the development of methods to assess the nutritional content and quality of foods. This involves the application of science to the marketplace and labeling since companies that produce packaged goods impact nutrition in the daily lives of consumers. The industry’s continuous interface with nutrition calls for marketing teams to plan for annual renovations to their business road maps, because the importance of nutrition spans company and government standards. In addition, consumers determine which nutritional food trends are viable businesses within the industry by exercising their purchasing power. Currently, the largest nutritional trends in grain products are whole grain and gluten-free. Looking forward to the future, nutrition will continue to be of utmost importance for companies selling and supplying ingredients for packaged foods.

The FDA provides guidelines and regulations on proper labeling of foods sold within grocery stores. Recently AACCI members, through committees like the Dietary Fiber Methods Committee, have sent written comments to the FDA regarding their proposed changes in nutrition labeling. This is one way that academia, industry, and government can work together to try to ensure that the best science is applied and the fairest rules are enacted.

Over the last few years, the industry has observed whole grain consumption and the gluten-free product market increase. However, barriers still exist within the consumer mindset on whether to eat whole grain and/or gluten-free, including confusion concerning labeling, higher costs, lower quality and flavor, and changes required in food preparation. There is also significant concern among consumers about how food is produced and processed. There is an anti-processing, anti-big agriculture and -big food industry, and anti-science sentiment that must be addressed if the world is to be fed in 2050. AACCI coalitions need to be part of a strategy to do this and must do it with transparency and goals for the greater good.

AACCI members need to be ready to show data supporting the fact that nutritious food can be 1) processed and convenient; 2) the result of big agriculture and the food industry, which will use yield-increasing, sustainable, safe, and nutritionally

advantageous scientific advancements; and 3) fairly described in the marketplace to all. Further, they need to be able to address critics and others about such techniques in open dialogue that not only considers science and economics but also recognizes the fear and distrust that dwell in many sectors.

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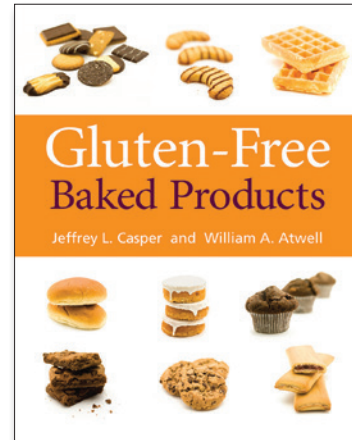
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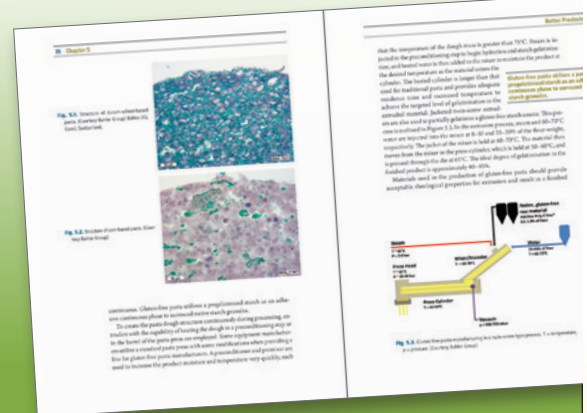
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