

A Century of Food Science



Institute of Food Technologists

This book was the product of the Research Report Task Force,
including

Roy G. Arnold
Robert E. Berry
Ellen Bradley
Walter L. Clark
Al. S. Clausi
Arnold E. Denton
Charles Feldberg
F. Jack Francis
Daniel Fung
Marianne Gillette
Dennis Heldman
Richard Lechowich
Gilbert Leveille
David Lineback
Daryl Lund
Laszlo P. Somogyi

Special thanks to three IFT members who wrote special articles
about their acquaintences and experiences:

Al Clausi
John Powers
Jack Francis

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Food science is a somewhat odd amalgam of scientific disciplines, including basic sciences, “soft” science, culinary arts and its outgrowths, chemistry, biology, economics, agronomics, microbiology, and engineering. There are others, but “food science” is the common theme that turns traditional foods into a variety of specialty products and makes them tasty, safe, available, and convenient. Food supply and security are sometimes prominent in the roster, and other disciplines take their place from time to time. It is rare that food science teaches something truly new—but the “devil is in the details,” and food science takes knowledge to a supremely practical use.

Between the early 1900s and the present, food science and its cousins have provided Americans with the safest food supply the world has ever known, as well as the most plentiful and the least expensive. The other developed countries of the world have also been provided with the same kind of food supply. The underdeveloped and developing countries of the world have an improving food situation, and the information gained during the long race toward food security for developing countries has been extremely helpful to developed countries as well. Issues have diverted from strictly “food issues” to issues of preference such as organic foods and naturally derived foods, with distinctly economic overtones.

Dividing the century roughly into five parts, we can see certain trends within these time periods that are somewhat defined by issues that are external to food. But these issues help define food issues, and cannot be ignored.

Getting Enough Food (1900–1929)

The first period is that of an emerging nation, and covers the era surrounding World War I. Food was essential to fighting that war, and methods of preserving food so that it could free troops from foraging for food meant a major difference in winning it. The United States was developing its food systems, and three important issues emerged: preserving food to break the ties of seasonality, dealing with the concerns about economic and toxic adulteration, and building an agronomic system that could provide food not only to Americans but also to other countries. The beginnings of our great companies were clear during the early part of the 20th century, and the American sweet tooth was evident.

Innovation in Getting By (1929–1945)

The second period was clearly dominated by the Great Depression and World War II. During this time of chaos, companies were built and fortunes waxed and waned. Some of the themes that would be seen later in the century have their roots during this time. Americans developed a desire for the good life: more meat, dairy foods, and sweets. But the discipline of the war years brought out a Yankee determination to do a little more than “make do.” Many of the beginnings of reduced-fat foods were found in kitchens that added oatmeal and bread crumbs to the ground beef for meatloaf, or mayonnaise or applesauce to cake recipes. Fats were scarce because of the war effort, and other ingredients were substituted. Imported ingredients including gum arabic, tapioca starches, cocoa, bananas, imported cheese, and

others were often unavailable because of interruptions in shipping. Sometimes there were no harvests. Sugar was in short supply, and nearly all foods were rationed for a short time in the United States, and for a longer time in Europe.

Convenience and New Products (1945–1965)

The third period was a time of some extravagance; there were stirrings of nutritional concerns, and a great deal of emphasis on convenience. More women joined the workforce, so that one-dish meals and casserole mixes gained popularity. Companies and supermarket chains vied for more new products, and sometimes technology couldn't keep up with the new product mania. There were new product failures, competition was fierce, and products left the marketplace quickly. Food scientists, especially formulators, were in demand. Marketers voiced opinions that "nutrition wouldn't sell." Price was considered very important, and indeed appeared to be correlated closely with the success of new products.

Nutrition and Food Safety (1965–1980)

During this era of transition, Americans looked for more government assistance, formed consumer groups, and tried to better understand the consumer's role in the food sector. FDA and USDA tried to more tightly control food quality and content. Probably the defining event of this era was the White House Conference in December 1969. The changing emphasis on nutrition and good food for all consumers, following the Fair Practices Labeling Act, opened the door for nutrition labeling, changes in product standards, and a general adjustment in the thinking about what was good food and what was not.

Changing Styles of Food Consumption (1980–2000)

As American preferences for food became increasingly global, the kinds of food that were preferred also became more international. Consumers were interested in seasonal foods all year round, so that imported foods became the norm. As Americans bought food in fresher forms, the concept of a safe food supply with its cornerstone of commercially sterile products changed. New testing methods identified foodborne organisms that would have been missed (or blamed on "flu") a short time before. The food sector moved to provide both safer and fresher foods, using a panoply of new processing techniques, new agricultural methods, and faster testing. More ethnic foods widened the supply of foods and required broader sources for new products. Two new concepts entered the "food science" mix: nutraceuticals and biotechnology. These two subjects will continue to dominate food-based discussions for at least the first decade of the new millennium.

Past is Prologue (2000 and beyond)

As the millennium begins without computer or economic meltdown, we estimate that those new processes now being developed will continue to develop. New product development will change as more of the food dollar is spent in ways not associated with present food channels. But it is unlikely that the steak dinner-in-a-pill will emerge. Consumers still like to eat, although they will do so in more modest, circumspect ways. As knowledge about the relationship between food choices and health continues to emerge, eating patterns will modify to meet the specifications for longer, useful lives. In the United States, total food consumption will not change appreciably, but the balance between food variety will shift.

Food science will continue to play a vital role in the food industry. For instance, it would be hard to find a more American food than apple pie, right? (Humor us, and agree!) But apple pies require a modicum of food science to deliver the variety that Americans demand of this classic. How does apple pie get on the table, and where is the table?

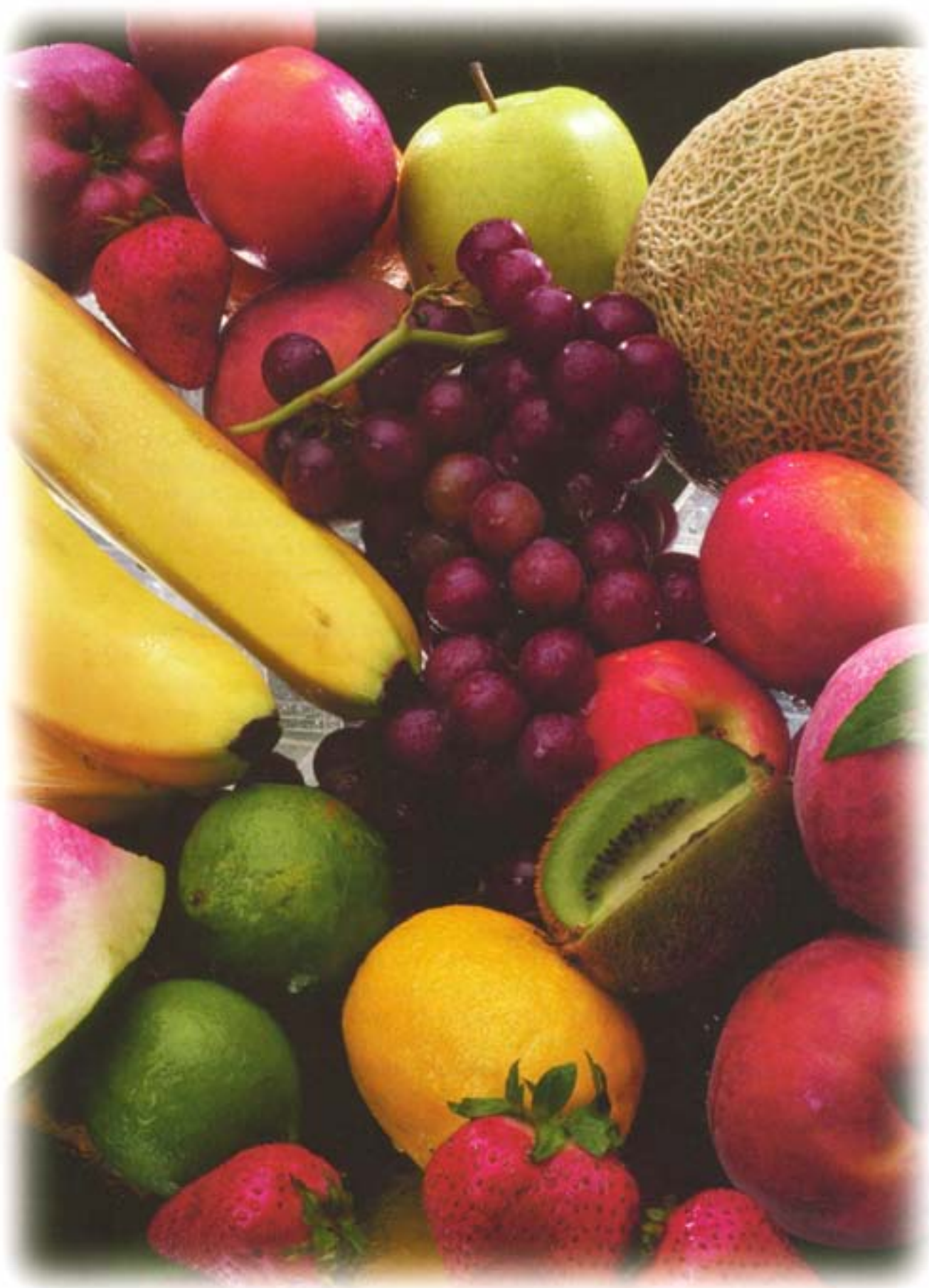
If the table is at home, and the occasion is Sunday dinner, if the food preparer has the time, knowledge, and inclination, apple pie may be a deep-dish version, with rolled-out crust filled with freshly peeled apples, sugar, and cinnamon, and may be topped with whipped cream, ice cream, or a chunk of sharp Cheddar. The crust may be made from vegetable shortening, lard, butter, or a fat substitute; the wheat flour may or may not be pastry flour, depending on the wheat crop that year.

The apples may be Jonathons or Greenings-bred for apple pies, or Granny Smiths, imported from Australia. The filling may have come from a can, and contained a modified starch to thicken the juice while speeding heat penetration, to retain the texture of the apple. Or the filling may be made with pre-cut, pre-peeled apples that were treated with a minimum amount of heat to retard bacterial growth. The sugar could be granulated, invert, high-fructose corn syrup, or a high-intensity sweetener. The cinnamon will probably have been treated with a disinfectant, or be an oleoresin, plated on sugar or encapsulated, to reduce the danger of bacterial contamination. The topping may or may not contain dairy product, and may have been frozen for some months; the ice cream may be selected from varying amounts of fat, overrun, sugar content; and the vanilla may have come from one of several sources, or be synthesized. The cheese may have been produced with bioengineered rennet, or reduced fat.

The whole pie may have been from the bakery or the frozen food cabinet, and could have been a single or double crust, filled with custard, topped with Streusel. It could have been a pie, cobbler, fried pie, tart, torte, or strudel. Food safety concerns at the manufacturer will probably prevent anyone at the table from eating a product that will cause illness, sensory evaluation has optimized some portion of the formula, and it's quite likely that some portion of that dessert has been manufactured through an ISO system to guarantee continued quality. If there's a label on any of the components of the pie, the nutritional content has been evaluated, and the tests that provided the information were done by methods developed during the last few decades. There is a system in place to identify any component found not to meet FDA or USDA regulations, so that it can be easily recalled if necessary.

So, why does the industry need food science? To provide and identify the full range of products that consumers want; to process the products safely; to identify preferences of consumers and improve the final product in ways the consumer may not articulate, but will accept enthusiastically; to keep prices within affordable market values; to ensure shipping and provide protective packaging that is appropriate; to handle the waste materials resulting from preparation; and to improve and identify the nutritive content of the product and fit that nutritive content to human needs. And to make a profit, lest we forget.

Food science occurs in many places: processing companies, universities, suppliers, agricultural entities, consulting establishments. Each is playing more roles than previously thought possible. Food scientists need to speak in many tongues: science, markets, manufacturing, agriculture, preferences, costs and values—to name a few. This book outlines briefly where we have been during this century, and attempts to understand why. Where we go depends on the use of knowledge, ethics, and humanity going forward into the 21st century.



Chapter 1

(1900-1929)

Before the beginning of the 1900s, food in the United States was a curious combination of food raised on individual farms, and food that was semi-processed usually locally, and sold through grocery stores and delivery routes; canned foods; baked foods; and confections. Ingredients were produced in quantity: the Pillsbury-Washburn flour Mill, formed in 1889, was producing 10,000 barrels of flour a day and growing. McCormick Company was already founded in Baltimore, selling ground spices and extracts, and cash flows from Calumet Baking Powder had funded Calumet Farms, an establishment of thoroughbred horses in Kentucky.

The beginnings of big business in food was clearly apparent; Cudahy Packing Company had invested in methods of curing meat under refrigeration, permitting hams and bacon to be cured year-round. The Del Monte label had already appeared on canned fruit, trademarked by Oakland Preserving Co., and Fig Newtons had appeared in the factory of the Kennedy Biscuit Works. Other products: shredded wheat, Aunt Jemima Pancake Mix, Hershey caramels were introduced around the turn of the century. Milton Hershey learned about chocolate manufacture at the World's Fair in Chicago.

Canning was a major activity: the California Fruit Canners Association was formed just before the turn of the century, linking eleven old-line canneries that represented about half the volume from California. In the Midwest, Anna Stokely started canning tomatoes, using a hot-pack method and producing several hundred cans a day. Just before the dawning of that new millennium, Coca-Cola was bottled commercially, although most was still being sold at the fountain of the corner drugstore. Campbell Soups (and stews and pork and beans) were sold in cans with a red and white label, celebrating the Cornell football team. This was a major application of retorting high-solids materials experiencing college loyalty.

Battle Creek, Michigan was the center of the breakfast cereal market, Kellogg's (founded in 1898) and Post (founded in 1877) were in competition with many other companies. Cereal technologies including steam puffing, heated rolls for flake making, precooking, and drying were all being developed; and malt and sugar ingredients were



added to provide a good-tasting cereal which stayed crisp when milk was added. Ready-to-eat cereals taught food scientists that corn oil was not particularly stable, and if left in the corn grain without stabilizing it, the formed flakes would rapidly change to a rancid-tasting product. Since the germ of corn was found to contain most of the lipid, flavor could be retained longer by removing that portion. Knowledge about the level of drying necessary for flakes and nuggets, additional ingredients, and grain handling began to accumulate, resulting in the development of better and better products. These became a standard part of the national diet.

As World War I continued into 1917, when the U.S. entered the war, food rationing in Europe was beginning to cause skyrocketing food prices. Woodrow Wilson placed food under government control, and the Food Act of 1917, with its controls, introduced the American public to Herbert Hoover, who administered the Act. Hoover encouraged U.S. farmers to grow more food, with the slogan "Food Can Win the War."

Major company mergers appeared in 1929: Clarence Birdseye's company and Postum formed General Foods, with brands including Jell-O, Minute Tapioca, Swans Down Cake Flour, Hellman's Mayonnaise, Log Cabin Syrup, Walter Baker Chocolate, Calumet Baking Powder, and half-a-dozen other well known brands. General Foods then contracted with Seabrook Farms to develop packaging machines for frozen vegetables to be sold under the Birds Eye label. The merger resulted from the sale of Birdseye patents to Goldman, Sachs for \$20 million, which was then bought by Postum, then headed by Marjorie Merriweather Post. Unilever was formed earlier in 1929, a conglomerate of British Lever Brothers and the European Margarine Union. General Mills was formed of Washburn, Crosby and 26 other flour millers to become the world's largest miller.



The Origin of Ready-To-Eat Breakfast Cereals

(1885 1906)

Al Clausi

Battle Creek, Michigan was the site of the invention, manufacturing and national introduction of a new food category and technology of major significance to the world food supply. It started as a reaction to poor breakfast eating habits at the turn of the century, when dyspepsia was a national disease and The Battle Creek Sanatorium, run by Dr. John Harvey Kellogg, was a Seventh Day Adventist haven for those seeking the "cure" of a vegetarian diet. Dr. Kellogg provided a number of his own recipes to replace meat, coffee, and high-fat breakfast items.

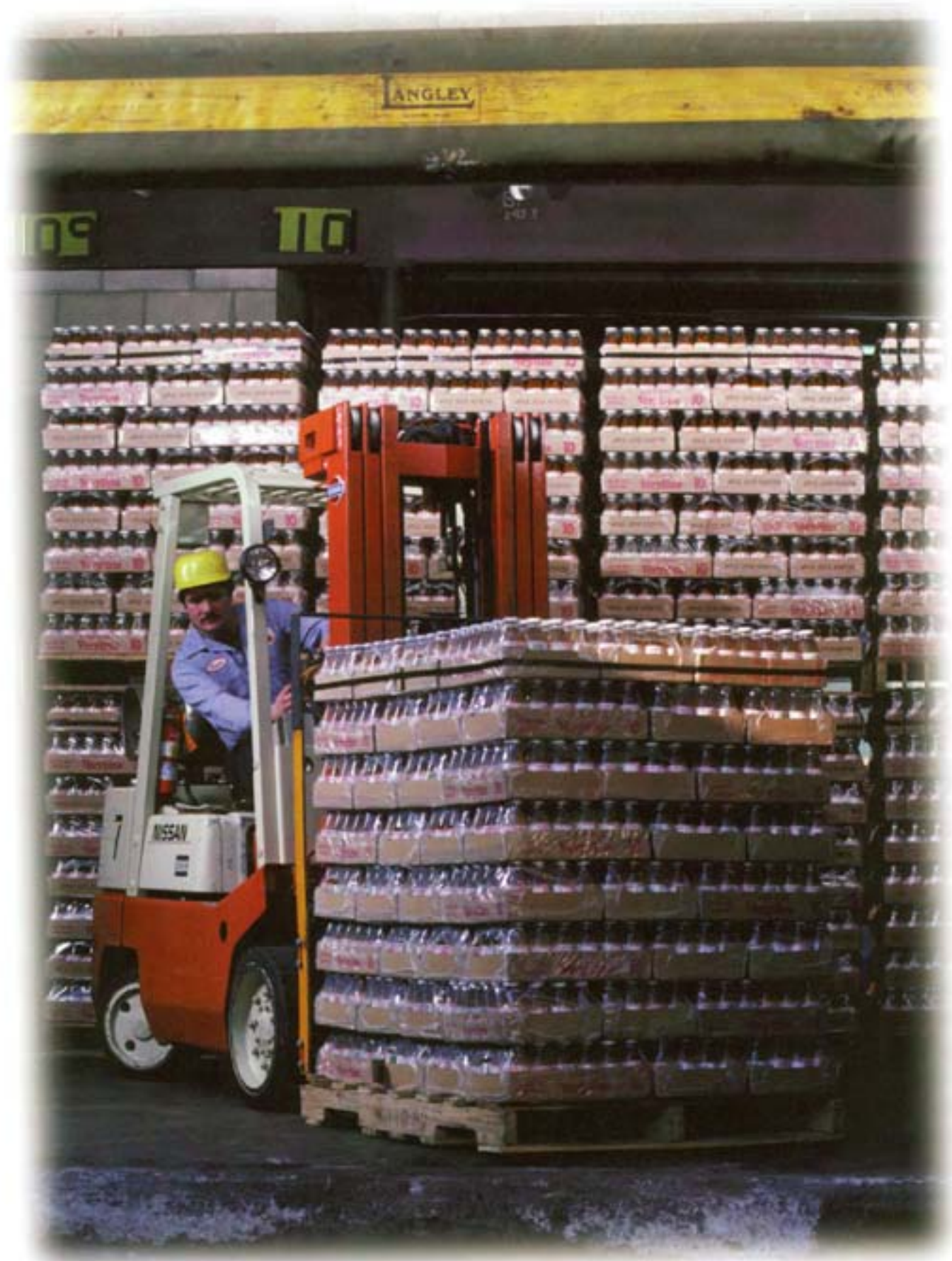
C.W. Post, one of his patients, saw the greater potential of these dishes and beverages. In 1898, Post developed a coffee substitute beverage called Postum, which he sold nationally. Soon thereafter, he introduced a ready-to-eat packaged breakfast cereal called Grape Nuts. It is believed that these two products were patterned after ideas he saw at the sanatorium.

While Dr. Kellogg may have been annoyed by Post's commercial pursuit of his ideas, his brother W.K. Kellogg saw the value and took action. The first Kellogg product was ready-to-eat wheat flakes with limited stability against rancidity and other storage problems. Later, Kellogg produced a ready-to-eat packaged corn flake called Sanitas Corn Flakes, and by 1908, the corn flake had evolved to Kellogg's Corn Flakes.

C.W. Post, not to be outdone, introduced his version of the corn flake, which he called Post Toasties after having attempted, in 1906, to call it Elijah's Manna. This stirred up a storm of protest in the United Kingdom, which felt that the use of "Elijah's Manna" approached blasphemy. Introduction as Post Toasties came in 1908.

Henry Perky, an engineer, founded a process for making a shredded wheat breakfast cereal about 1900-1905. This work was done first in Buffalo, N.Y., and later at Niagara Falls. The Niagara Falls plant was designed for tours, and thousands of honeymooners thought of their honeymoon when they saw shredded wheat, which later became Nabisco Shredded Wheat. But the real action in ready-to-eat cereals was in Battle Creek, Michigan, which became a boom town, with about 42 cereal companies (many of them storefronts) selling cereals. Through the years, companies disappeared and products improved, so that now Battle Creek is the Cereal Capital of America.





Enter the Era of Regulations

As more families moved to city living during this period, food was shipped greater distances and was at least partially processed. Development of new food products were accompanied by safety problems, thus the Food and Drug Administration was formed to ensure that unsafe or adulterated food was not sold to consumers. Much of the food science that was initiated during this era was discovered through observation: for example, some food tasted fresher when frozen instead of being dried or canned; laboratory test animals thrived when fed certain diets. Later in the 20th Century, relationships between food structure and function were better understood.

Because of World War I requirements, there were many advances in food technology and safety. Price pressure caused by both wartime activity and weather problems, triggered changes in agronomics, causing scientists to look for replacement products for imported ingredients and foods. In this era, Harvey W. Wiley, an early official with the government, took the use of poisonous additives in hand and started the practice of requiring safety information for food ingredients or additives. By the time of the stockmarket crash in 1929, significant advances had been made toward a safe, plentiful food supply.

Introduction of the concept of keeping foods pure and unadulterated started citizens thinking about food. As more new products were developed, and as shipping took longer and longer, it became obvious that some controls were necessary. The Food and Drugs Law, approved after considerable controversy by the Senate on February 21, 1906, and by the House on June 23, became a first step in assuring the population that foods they no longer directly controlled would be safe. President Theodore Roosevelt signed the bill into law. Representative Henry Wadsworth (R. NY) introduced a bill that mandated meat inspection, and Congress funded it that same year.

The original concept of telling consumers what was in their food was only a step from limiting the amounts of certain additives, and this came soon after. Wiley, chief of the U.S. Department of Agriculture's Bureau of Chemistry, issued an order limiting the amount of sulfur in foods to 350 ppm, while the French Government imposed a 1,000 ppm sulfur dioxide limit on dried fruits. Companies were obtaining patents and expanding their holdings of new food products, and concern began to grow that food companies might become too big and too rich, affecting food prices. Because of this, Congress debating long and hard, finally decided that companies were restricting free trade. Thus, the Federal Trade Commission and the Clayton Anti-Trust Act, one of the most feared regulations to this day, were born.

The Clayton Anti-Trust Act was signed into law on October 15, 1914, restricting mergers and defining restraint of trade. The Federal Trade Commission was established on September 26, 1914, to prevent unfair competition.

If anyone connected with the food industry believes that today's reluctance to change processing methods is new, they should have observed the massive disagreements about the pasteurization of milk that occurred in the 1920s. Raw milk, particularly when delivered from the farm to the city, included a generous supply of bacteria. Milk fever was common; by the mid 1920s, it was clear that bacteria was the culprit. Despite heated opposition, the mandatory pasteurization of milk was achieved by 1929 after several years of proof that bacteria in raw milk caused undulant fever. Alice Evans, a U.S. bacteriologist, demonstrated the problem and the understanding that "Bangs" disease of cattle was transmittable to humans, causing undulant fever. The disease was eliminated by pasteurizing milk and vaccinating cattle against the fever. Ear tags on cattle herds became a familiar sight, and except for those who were sure that pasteurization eliminated good qualities as well as disease, the new process was finally accepted.



Harvey W. Wiley: Pioneer in Food Safety and Quality

F. J. Francis

Dr. Harvey Wiley is unquestionably the most influential individual in food law history. He was a man with a mission, and he knew how to accomplish that mission.

Born in Indiana on October 18, 1844, he graduated with an M.D. degree from Indiana Medical College 1871, but never actually practiced medicine. Instead he elected to teach science in high school. A meeting of the American Association for the Advancement of Science in Indianapolis convinced him to become an inspired teacher, and he was asked to teach chemistry at both the Indiana Medical College and Northwestern Christian University. To bolster his chemical background, he enrolled at Harvard University's Lawrence Scientific School, where in June 1873 he received a Bachelor of Science degree, cum laude. He was appointed Professor of Chemistry at Purdue University in 1874, where he concentrated on the chemistry of sugars, particularly methods of analysis, and concluded that 90% of the sugar formulations on the market were adulterated. He began to develop his mission in life, to try to minimize the adulteration of food.

In 1883, Dr. Wiley moved to Washington D.C., to become Head of the Bureau of Chemistry in the U.S. Department of Agriculture, at a time when the adulteration of food was pandemic and horror stories abounded. Wiley concluded that there should be three major legislative goals: the control of adulteration of foods and the elimination of misbranding and false advertising of foods. He decided to try to provide the scientific background in food analysis to minimize adulteration. Wiley appreciated the importance of analytical work being done in the agricultural departments of many states, and tried to formalize their contributions by helping to found the Association of Official Agricultural Chemists in 1884. The name was changed in 1966 to the Association of Official Analytical Chemists, and it stands today as the referee association for validation of analytical methods. Wiley was elected president of the AOAC in 1866 and then served as secretary of the organization for 25 years. He became president of the American Chemical Society, helping to reorganize it after a difficult beginning, and held many positions in the American Association for the Advancement of Science. He recognized that, to succeed in this mission, he needed the support of the scientific community and that he must hone his political skills to succeed in his mission.

Wiley persuaded Congress to increase the budget for USDA's Department of Chemistry and then proceeded to launch an all-out attack on adulteration. His staff investigated all major categories of food and reported their findings in his Bulletin 13, Foods and Food Adulterants. Bulletin 13 published 10 parts between 1887 and 1901: dairy products; spices and condiments; fermented alcoholic beverages, malt liquors, wine, and cider; lard and lard adulterants; baking powders; sugars, molasses, and syrup, confections, honey, and beeswax; tea,

coffee and cocoa preparations; canned vegetables; cereals and cereal products; and preserved meats. Wiley was interested in a wide variety of products, including the colorants used to make foods more appealing.

Apparently, a purveyor could add almost anything to foods and frequently did! Copper arsenate and lead chromate were reportedly used to color tea leaves for resale, one druggist gave a caterer copper arsenate to color a pudding for a public dinner. Wiley hired German dye chemist Dr. Bernard Hesse to survey the situation. Hesse evaluated more than 600 "coal-tar" dyes used in industry, 80 of which were offered for food use in the United States. Thirty had never been tested at all. He reduced the list to seven and recommended that these seven dyes should be the only ones certified for food use in the United States.

Wiley knew that, to get legislation passed to control these practices, there would have to be some public outrage. He was a commanding speaker and a prolific writer, but he realized that he would need help, so he enlisted the aid of the public media. They were only too pleased to translate his technical bulletins on adulteration into readable articles that, incidentally, sold a lot of papers. Wiley then instituted the "poison squad" (not his term), 12 volunteers who ingested quantities of food preservatives and tested the outcomes. Boric acid, salicylic acid, sulphurous acid, benzoic acid and its derivatives, and formaldehyde were tested and publically declared harmful. The press, needless to say, loved it.

As consensus was built in legislative circles, it was essential to establish rules to prevent the more blatant practices in food handling and adulteration. In February 1906, novelist Upton Sinclair published *The Jungle*, an account of the handling and packaging of meat in the Chicago stockyards, a truly horrifying report of unsafe handling by any standards, caused public outrage and the Food and Drugs Act of 1906 passed in Congress on June 30, 1906. Wiley was instrumental in promoting of the passage of this Act, and his testimony, including displays of adulterated food, supported its passage. It is important to note, however, that Wiley's main concern was the elimination of deceit instead of the practice of food safety. The Food and Drug Act did not make a poisonous substance illegal; instead, it required that the substance be listed on the label.

Wiley's public career ended over the issue of caffeine. He had asserted that "coffee drunkenness is a commoner failing than the whiskey habit. The most common drug in this country is caffeine." Coffee companies, concerned with the use of roasted cereals as a common adulterant of coffee and mimetic of coffee, expected to have Wiley's support. In 1911, Wiley sued The Coca-Cola Company, charging that caffeine was an illegal adulterant, and lost the case. The next year, as it became obvious that Wiley had made a lot of enemies with his crusading, he was persuaded to resign, at the height of his popularity with the public, in March 1912. He continued to write and make public appearances until his death on June 30, 1930.

Prices and Availability of Foods

In 1900, corn cost 33 cents per bushel, and wheat prices stood at \$0.70/ bushel. Sugar cost 4 cents per lb, eggs about \$0.14 per dozen, and butter about \$0.25 per lb. A turkey dinner at a boarding house cost the single working man 20 cents. U.S. flour consumption went up to 22.5 lb per capita, and commercial bakeries produced about a fourth of the bread eaten. Women were approaching 20% of the workforce, and the growth of urban populations made daily delivery of fresh bread possible.

The average farmworker produced enough food for himself and six other people, almost double the production level of 1875. By 1908, half of all Americans lived on farms or in towns of less than 2,500, and there were six million farms in the U.S.

Sugar consumption stood at about 65 lb per capita; beet sugar production hit 5.5 million tons in 1910; and candy consumption reached 5.5 lb per capita in 1914. Americans, by then moving off the farm, ate 17.5 lb of canned fruits and vegetables in 1910, with only part of that amount processed at home. By the second half of 1918, candy sales moved up again, as the Food and Drug Administration permitted confectioners to use 80% as much sugar as they used before the war, up from 50% in 1917. The Hershey bar, which cost a nickel, gained weight to nearly an ounce, and sales reached \$35 million in 1918, up from \$10 million in 1914. Hershey was rapidly followed by competitors Peter Paul Manufacturing Co and Nestlé.

As candymakers refined their products, the biggest problem became controlling the prices of raw materials. The cost of sugar plummeted in 1920, from \$0.30 per lb in August, 1920, to \$0.08 in December. Hershey lost \$2.5 million in the sugar collapse, and other companies also suffered greatly.

Food rationing, internationally, brought "meatless days" in 1918, with all foods except bread and potatoes on the ration list by early summer. England added soy and potato flour to wheat flour and increased the separation of flour from wheat, producing dark, unattractive loaves. Sugar rationing threatened the soft drink industry. World War I's hostilities ceased on November 11, 1918, but rationing remained in Europe for some time.





The Food Industry Contribution: Preeminence in Science and in Application

John J. Powers

The food industry has made several important contributions to general scientific knowledge, such as the development of methods and knowledge concerning the presence of, quantitation of, and retention of various nutrients in foods. No development exceeds the importance of the clarification of the principles of thermal death time and of sound thermal processing. Prior to 1920, the canning industry earned a bad reputation among consumers because of the frequency with which canned foods caused botulism outbreaks. During the late 1920s and 1930s, the National Canners Association initiated a study which led to placing thermal processing of canned foods on a sound, scientific basis. Not only has the food industry benefitted from the studies undertaken, but the concept of thermal death time has been of great value to microbiology and to other industries, such as the pharmaceutical industry.

In 1921, Bigelow published an article which set forth the fundamental concept of thermal death time. Basically, the concept is that if the time to heat to destruction of an organism or spores of an organism are plotted on a semi-logarithmic scale versus temperature, a straight line results. That simple concept facilitated calculation of the amount of heat needed to destroy any given number of organisms at any temperature chosen.

From 1920 onward, a second important concept was originated: how to calculate the amount of heat put into and removed from a can undergoing various process treatments to achieve commercial sterility. The author of this basic concept was Charles Olin Ball, an employee of the National Canners Association, who later became President of IFT, 1963-64. Ball's first explanation of a mathematical means of calculating sound thermal processes was published in 1923 as a Bulletin of the National Research Council. In 1928, he published a masterpiece, his "Mathematical Solution of Problems of Thermal Processing of Canned Foods," a publication of the University of California Press. Still later, in 1936, he published "Supplement to Mathematical Solution of Problems on Thermal Processing of Canned Foods". The method he devised in 1923 had been immediately put to use, and as a result, from the mid-1920s, the commercial canning industry was not the cause of a botulism outbreak until 30 years later. Very few occurred after that time, and outbreaks were result of negligence on the part of food processors rather than any inadequacy in the calculation of a sound thermal process. One can grasp the significance of the development of these two fundamental concepts, thermal-death-time establishment and sound thermal processes, from the great change in the attitude of consumers toward canned foods. No one worries about being made sick by

canned foods. Anyone, with or without training in food science, but with knowledge of the near absence of mechanical calculators in the 1920s and the crudeness of those which did exist, can only marvel at the dedication and amount of work that Ball had to expend to calculate the extensive tables and illustrations in his publications.

There were other types of contributions made during the NCA project. Proper methods of operating retorts were originated (Ford, 1930; Eckland and Benjamin, 1942; Bigelow et al., 1920). Many early contributions to the development of safe methods of processing canned foods are reproduced in a publication of the American Can Company (1953). Often among these papers, the name John M. Jackson appears. Dr. Jackson, then employed by the American Can Company, preceded C.O. Ball as President of IFT in 1962–63. Though thermal processing before the NCA study was a pack-and-wait process to determine if spoilage did occur (processors retained canned foods for several weeks before shipment, based on results of holding studies), IFT's first president, Dr. Samuel Cate Prescott, published a seminal study in 1926 on how long canned food needed to be processed to avoid spoilage (Prescott and Underwood).

Nearly all that is known today about the destruction of microorganisms stems from the concept of thermal-death-time, an idea elegant in its simplicity. Equally elegant is calculation of the time and temperature process needed to destroy all spoilage organisms at some selected level of probability. The variables which have to be taken into account are complex. Ball's solution reduces that process to a level that is both comprehensive and readily comprehensible.



Ingredient Technology

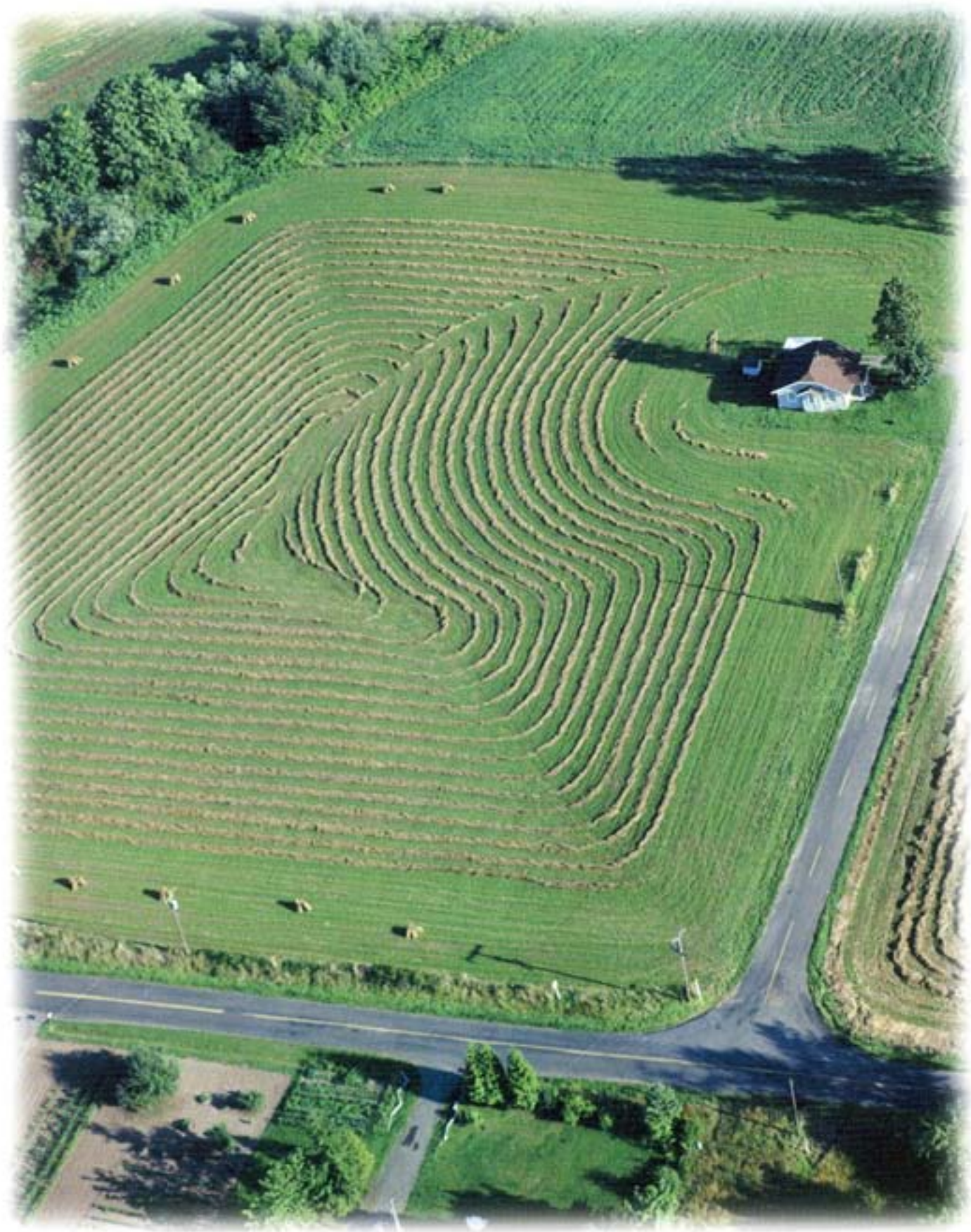
As food products developed, there was an increasing need for ingredients that provided technical attributes, including products that thicken, thin, acidify, color, flavor, or provide other functional and organoleptic attributes. As food products began to be shipped long distances from their manufacturing sites and held in warehouses for delivery to stores or homes, these aspects began to grow in importance. Not only did food have to be safe, it had to continue to taste good, using home cooking as a comparison.

National Starch Manufacturing Co. was founded and began the development of starch products, and New York Glucose began producing corn syrup from starch. Corn Products, beginning with a merger between United States Glucose and National Starch, controlled more than 80% of the starch produced. Karo Syrup, made by acid-hydrolyzing starch, was introduced into the marketplace, but the major use of corn syrups was in baked foods, dairy products, and canned fruits. Syrup was used with sucrose for textural reasons, not as a major replacement until the development of high-fructose corn syrup in the mid-1960s.

In 1903, William Norman received a patent describing a hydrogenation process for fats and oils. The process, introduced in 1901, used a metal catalyst to trigger the transformation of unsaturated fats to saturated fatty acids. This extended the shelf life of foods made with hydrogenated fats, because the fats resisted rancidity.

A commercial flour-bleaching system to make white bread whiter was developed by James Alsop of Cape County Milling Co. The system, similar to one developed by the Andrews Co. in Scotland, used nitrogen peroxide passing over electric arcs to bleach flour. Alsop was able to acquire rights to the Andrews system in the United States, as the similarity of the systems developed patent conflicts.

Corn Products Refining Co. patented a method for making dextrose, developed by William Newkirk while the scientist was trying to find a way to remove molasses from corn. His method produced crystals, and the molasses was removed from the crystals, leaving the somewhat sweet material as a crystal, and further refining the product. This crystalline product would find uses in baking. It fermented easily when used as a food for yeast in bread, and in confections it could be used as a bulking agent, adding texture without excessive amounts. Dextrose (glucose) has about half the sweetening power of sucrose.



Agriculture

Blueberries that were plump and virtually seedless were introduced in 1910 by Fred Covine, a botanist. The new berry proved to be the beginning of a multimillion-dollar industry, making the hunting of wild berries obsolete.

The world sugar market moved from Germany in 1914 to join the Coffee Exchange in New York, and trading in sugar futures began.

Wheat crops expanded greatly in 1915, as wartime prices encouraged farmers to plant more grain. The crop amounted to a billion bushels by the middle of the decade.

Cortland apples, a cross between Ben Davis and McIntosh apples, were introduced. This crop was designed for applesauce makers, as canned and bottled applesauce became a major product.

The market for wheat was cornered in 1909, by speculator James A. Patten, who drove the price up to \$1.34 per bushel on contracts for 35 million bushels. Bakers protested the price manipulation, and the protests eventually affected some trading rules.

By 1912, George Washington Carver had completed experiments that showed the value of peanuts and sweet potatoes in re-establishing the soil fertility of farmed-out fields. Carver's peanut products triggered increased growing of the legume. The mechanism of how legumes fix nitrogen in soil would not be understood for some time, but the effect was clear, and farmers grew peanuts, to provide raw materials for peanut butter and other staple products.

The first row-crop tractors were introduced in 1924, allowing farmers to cultivate rows and plant mechanically. While farmers kept their horses for several years, the mechanical tractors would eventually permit farming of more acres, and change the scope of farming.

Pioneer Hi-Bred Co. began operations in 1926, with the introduction of hybrid corn called "Copper Cross." The company was owned and operated by Henry Wallace, James Wallace, and corn breeder Raymond Baker, starting with \$4,900 raised by selling 49 shares at \$100 per share.

Broccoli was introduced to the United States in 1928 by D'Arrigo Brothers of California. This vegetable, a variety of cauliflower, had been known in Europe, especially Italy, for several decades.



Process Developments

Process developments made new product developments possible: most were about food safety, as the reason for foodborne illness was now understood to be microorganisms, and there was growing interest in processing foods to eliminate dangerous bacteria. But this understanding was not uniformly accepted, and some citizens believed that the processes were harmful, or deleterious to the nutrition in food.

A case in point was homogenized milk, developed by Auguste Gaulin, and described in his patent issued on July 16, 1902. The process was described in an article in *Scientific American* that year, which commented on the flavor improvements resulting from the treatment. The milk was first pasteurized to deactivate lipase to prevent rancidity (as well as deactivate bacteria), and treated by passing the milk through a concave agate valve fitted to a perforated die. The milk was heated to 185°F, and treated at 3,750–4,500 lb pressure (later processes reduced both the temperature and pressure) to reduce the diameter of milk fat globules and suspend them.

Understanding how to deactivate enzymes and the need to deactivate these proteins for improved texture and flavor extended to fruit and vegetable processes by the 1920s. Deactivating enzymes to prevent the continuing aging of vegetables prevented firming textures, hay-like flavors, and discoloration. Blanching with hot water or steam was the usual way to deactivate the enzymes, and blanching times varied greatly. When methods to test activity of enzymes were developed, times and temperatures were standardized, and blanching for both freezing and canning vegetables became a controlled science. As various enzymes were identified and could be measured, the variety of frozen vegetables that became commonly available increased. But published articles on the best methods for blanching continue to appear even today, improving quality and enhancing retained nutrition.

Ice cream sales reached 30 million gallons in 1912, up six-fold from the turn of the century. New freezers provided agitation and air input as well as more rapid freezing, so that ice cream was airy, had fine structure with few ice crystals, and was available in a few new flavors.

Tea bags appeared in 1909, introduced by New York tea wholesaler Thomas Sullivan. Sullivan placed blended tea leaves in small China silk bags and sewed the bags closed. The bags were then steeped in hot water, and the user could drink the tea without straining out the leaves. This new process for making tea beverage was an almost instant success, and Sullivan developed an automatic machine for making the tea bags fairly automatically.

Clarence Birdseye opened Birds Eye Seafoods in 1923 in New York City. Birdseye's invention was patented in 1923, and described a process of pressing packages of seafood between refrigerated metal plates. His initial operation was underfunded, and the New York operation closed late in 1923. In 1924, Birdseye and three partners opened General Seafoods Co. in Gloucester, Mass. The firm processed frozen fish fillets, and introduced seafood as an everyday menu item for families and restaurants alike. By 1926, Birdseye had developed a more economical and faster belt freezer



New Products Proliferate

Crisco, the first solid vegetable shortening made by hydrogenation, became Procter & Gamble's first food product. It first targeted Jewish customers, who could use the vegetable product without dealing with the meat vs milk issue.

Mazola, the first liquid corn oil in general distribution, was introduced by Corn Products Refining Co. in 1911.

Oreo Biscuits were introduced by National Biscuit Co. in 1912. Designer of the cookie, William Turner, was attempting to compete with Hydrox Cookies (Sunshine Biscuit) which had become a success after its introduction a decade earlier. The selection and treatment of the cocoa in the cookie was particularly important to the popularity of the product.

Chocolate manufacturer Clarence Crane developed peppermint Life Savers as an alternate to chocolate candy for summer sales in about 1912. Multiflavored Life Savers were introduced about 10 years later.

J.L. Kraft introduced processed cheese in 1915. The process included grinding cheese products and making an emulsion with added water, then forming the material in to loaves. By the end of 1921, processed cheese was firmly established by purchases amounting to six million tons by the Army.

Quaker Oats Co. introduced Puffed Rice, after Alexander Anderson invented a steam-injection "gun" for puffing cereals.

Little Hershey's "Kisses" introduced their big chocolate taste in 1907. Specialized depositing equipment and wrapping units made these candies possible in suitable quantity. New advances in tempering chocolate improved the texture of the candy.

Hellman's Blue Ribbon Mayonnaise was first produced commercially in 1912, by delicatessen owner Richard Hellman. The salad dressing ingredient was sold in glass jars, with a high enough vinegar content to prevent yeast growth. Gradually the understanding of water and oil phases and the requirement for acid in the water phase was better understood, and new methods of making emulsions and refining them were developed, founding the salad dressing industry as we know it today.

Canned tuna first appeared as a Van Camp Seafood product in 1912. Frank Van Camp, originally from Indianapolis, Indiana, and his son Gilbert bought a California processing plant and developed a method of purse seining to increase the tuna catch. By rushing the catch back to shore for rapid processing, the taste of canned tuna improved and the price could be dropped enough to change the product into an economic staple instead of an expensive delicacy. Albacore tuna disappeared from the fishing waters around San Diego in 1926, and Van Camp Seafood began to promote yellowfin tuna, calling the solid chunks of darker tuna "Chicken of the Sea."

The filling for the Milky Way candy bar was developed from a nougat recipe with an excess of egg white, producing a fluffy material instead of one that was chewy. The same nougat formula was used in other bars as well, but Frank Mars, who called the bar "Milky Way," saw sales increase tenfold, when made with the fluffy nougat center.

Daniel Gerber started his baby food factory in Fremont, Michigan, after a doctor told him to feed his daughter Sally strained peas. Gerber, a food processor, found that strained baby foods were expensive and not readily available. A year later, Gerber had improved his process, which enabled him to sell strained baby foods at six cans per dollar, and by 1929, Gerber was selling nearly 600,000 cans per year.

Kool-Aid, a dry beverage powder, was produced by Edwin Perkins of Hastings, Nebraska. Perkins hired a chemist to convert his Fruit Smack beverage concentrate to a dry mix in about 1915. The business was later moved to Chicago, and sold to General Foods in 1953. The inexpensive beverage was extremely popular with children, and both the flavor systems and solubility were improved over the years.

Mustard (the yellow kind used on hotdogs) was introduced in 1904 by Francis and George French, and manufactured by the R.T. French Company. It was introduced at the St. Louis World's Fair, where it quickly became a standard item. The product was made from a mild mustard and made into a thin paste. At that same World's Fair, ice cream cones appeared. There are several versions of how it happened and who made the very first cone, but the most likely version is that a pastry maker named Ernest Hamri supplied cone-shaped pastries for an ice cream maker who had run out of dishes at the fair, and triggered the popular use of the ice-cream cone.

Nutrition

Vitamin function gained better understanding as British biochemist C.J. Drummond noted that not all coenzymes were amines, and vitamins ceased to be tagged as “vitamines.” Drummond named the fat-soluble activity vitamin A, the water-soluble vitamins B, and the antiscorbutic activity vitamin C. He and Rosenheim found that the human liver could produce vitamin A from the provitamin carotene widely found in fruits and vegetables. Cod-liver oil was the source of an activity that cured rickets and xerophthalmia (dry eye syndrome), recognized and named by physician E.V. McCollum. That activity would be named vitamin D. McCollum and Davis discovered the fat-soluble factor now called vitamin A in butter and egg yolks. Biochemists Osborne and Mendel (Yale) also determined the function of the same factor. This activity began in 1918 and continued for some years. McCollum further found that high diets of calcium produced malformations in test animals similar to those found in human rickets, but the addition of small amounts of cod-liver oil eliminated that problem. By 1924, McCollum had determined part of the role of vitamin D in the deposition of calcium and phosphorus in bone, although the mechanism was not understood. In 1923, Harry Streenbock of the University of Wisconsin found that irradiating foods with ultraviolet light increased their vitamin D content. In 1926, it was found that sunlight converted sterol ergosterol into vitamin D, which explained why children who got little sunlight were more likely to have rickets.

A suggestion of the role of vitamin E was discussed by Englishman Herbert Evans, who determined that an “antisterility” factor was essential if test animals were to reproduce normally.

The findings that iodine prevented the formation of goiter led salt producers to voluntarily add iodine to salt after the Akron study was published in 1916, indicating that a lack of iodine affected the functioning of the thyroid gland, causing the swelling referred to as goiter. Most salt was iodized by the beginning of 1930.



Canadian medical researchers Banting and Best isolated insulin from canine pancreatic tissue, and licensed the Eli Lilly Company to provide the first insulin for diabetes injections. In 1924, the first commercial insulin was sold to diabetics, who could now eat a more normal diet and live longer. This permitted the first real studies of the kinds of foods that diabetics could eat while limiting the risk to health, and led to better overall understanding of metabolic processes.

By 1922, George Whipple of the University of Rochester found that dogs produced hemoglobin more rapidly when fed liver. A year later, Boston doctors Richard Minot and William Murphy showed that eating liver prevented and cured pernicious anemia, and had at least limited efficacy for humans.

B vitamins were found to be more than one enzyme, and it was discovered that pellegra in rats could be cured by feeding a diet with the heat-labile part of vitamin B removed.



Chapter 2

(1929-1945)



The Great Depression and World War II changed food production, food marketing, and food distribution. The drought of the 1930s had a profound effect on the ability of the United States to produce adequate amounts of food. The triple crisis depression, war, and drought triggered a number of government actions designed to keep agriculture as healthy as possible. From a relatively well-off country, the United States became a survivor, struggling to keep food production moving along. Farmers were feeling the pinch, as half of the farm families produced less than \$1,000 per year in cash crops, corresponding to the \$28 weekly wages for the average city folk. About 70 percent of families had incomes below \$2,500 per year. The Agricultural Marketing Act of 1929 was founded, and helped farmer's cooperatives to form.

The Federal Farm Board dispensed nearly \$500 million to buy surplus farm products. Farmers continued to grow as much as they they could, so the purchases didn't help to reduce production very much, according to a reporter of that day. Despite tight money, food companies were using the emerging sciences to provide food, at relatively low price, to feed a growing population as it moved from farm to town.

During this time frame, the beginnings of great companies were seen: of Unilever, an early multinational whose core business was fats and General Foods, formed by the merger of Postum Co. and Clarence Birdseye's General Seafood Co. The Postum Co. had acquired Jell-O from its originator, a cough syrup manufacturer who used a recipe developed by Peter Cooper to provide an easily soluble gelatin mix that contained about 80 percent sugar, plus flavors that were plated on the sugar.

That same year, Standard Brands was formed from Chase and Sanborn, Fleischman, and Royal Baking Powder Co. Standard Brands developed Royal brand gelatin dessert to compete with the General Foods Jell-O product, and the practice of "matching" popular brands caught on.

By the middle of 1930, the Great Depression had put four million Americans out of work, and national income fell by about \$13 billion.



By mid 1932, weekly wages averaged \$17, and one quarter of American families had no breadwinners at all. During this time, companies underwent major shifts, some growing greatly, and others shrinking.

As the horse-drawn ice-wagon became an anachronism, electric refrigerators started to gain in popularity. First offered in the early '20s, refrigerator sales reached 75,000 units in 1925 and continued to grow to 800,000 units in 1929. The average price was slightly under \$300, from double that price in 1920. By 1939, the price of an electric refrigerator dropped to about \$175, making the appliance generally available to most consumers. Still, many families continued to depend on the ice-man, concerned about the cost of electricity, fear of electric appliances, and their perceived lack of reliability. But the refrigerator grew in popularity and ushered in the concept of refrigerated foods, beginning with dairy products. Dovetailing with the refrigerator, dairies started packaging milk in wax-coated cartons in late 1929. The deliveries, in New York City, offered an end to cleaning milk bottles and emphasized better sanitation. Still, the public preferred glass bottles, and it would be several years before the public completely accepted wax-lined cartons.

In 1933, the Pioneer HiBred Company introduced Golden Cross Bantam corn, a hybrid that required care in growing, but started the increase from the 22.8 bushels per acre that was the national average at that time to the 200+ bushels that is common today. Farmers were skeptical, but the increased yields started to make inroads.



In 1933, the boysenberry, a fruit that had been neglected for some time, was introduced into production by Walter Knott, the founder of Knotts Berry Farm, who harvested 5 tons of boysenberries per acre and made them into jam. Plant breeding continued to provide new and better plants, and to increase the variety of products. In 1945, the University of California developed an all-season strawberry, calling it the University berry. By the 1940s, vegetable breeding started to provide canners with vegetables more suited to their requirements.

Soybeans became a major crop, and The Central Soya Company was incorporated in 1934. The plant used a new system for extracting oil from the beans—the expeller process, which is considerably less expensive than the hydraulic process and removes more oil with less damage. In 1936, Soya investigated a solvent extraction process that could reportedly remove 95% of the soy oil. In 1938, the first U.S. application of the Hansa-Muhli process was processing 275 tons of soy daily.

Red meat began its rise in popularity in the late 1930s, as incomes improved and Americans sought their perceptions of a better life. Beef and pork began to replace chicken every Sunday. However, the increase in red meat was somewhat short lived, as the drought in the 1920s cut the corn crop by a billion bushels, and the yield fell to 15+ bushels per acre in 1934 from 22+ bushels per acre in 1922. By 1940, red meat consumption had risen to 142 lb per capita. Meat rationing began in the spring of 1943, but meat consumption was actually higher during rationing than before, as full employment and higher wages made the 28 oz per week affordable. Army personnel consumed 4.5 lb per week, and the Navy got the beef with the gravy—7 lb per week. A fair amount of the meat was in the form of creamed chipped beef, giving rise to a new descriptor to the dish, known by all ex-GIs.

Cheese was rationed from 1943 forward, at 4 lb per week, using the familiar red metal disks that could be used to buy meat. Butter consumption dropped to 11 lb per annum. Americans were allotted 4 oz per week, but many by-passed butter in favor of margarine. Much of the butterfat was used for cheese for Lend-Lease shipments. Later that summer, canned goods and flour joined the list of rationed products.

The war began in 1939, and the Axis powers claimed that England airlifted Colorado potato beetles and dumped them on German potato fields. Germany had stockpiled 8.5 million tons of grain at the beginning of the war, and formed an agreement with Russia to provide one million tons per year. After Germany invaded Russia early in the war, the occupying armies of Germany cut food sources off for many European countries, and shortages emphasized how important agriculture and the food industry were to most populations.



New Product Activity

U.S. scientists identified and found how to propagate the mold spores that produce Roquefort cheese, so that after the fall of France, "French" cheese was widely produced in America. French grapes, left unattended during the conflict, fell prey to disease, and California grapes improved with better resistance to plant diseases.

Frozen orange juice, produced as a thick "sludge" using information developed for the war effort, was produced and sold to civilians by late 1945. The juice tasted better than conventional canned juice. And Special Foods (later Worthington Foods) went into domestic production with the meat analogs developed for the war effort.

In the baked products arena, Continental Baking Co. redesigned its sponge shortcake cups after the 1930 strawberry season, filling the sponge cakes with a sugar and fat filling to sell year-round, what are now known as Hostess Twinkies. The formulation of the filling was essential to prevent moisture migration from sponge cake to filling, and vice versa. General Mills, when designing its biscuit mix called Bisquick, added sesame seed oil to stabilize the shortening in the mix. The chemist at General Mills, Charles Kress, knew that sesame seed oil would not oxidize as rapidly as other shortenings, and used sesame until deodorized, stabilized vegetable oils were available. Chelsea Milling Co. had introduced Jiffy brand biscuit mix the year before. The success of Bisquick triggered 90+ competitors, most of whom rapidly disappeared over the next few years.

The development of refrigeration aided the introduction of refrigerated biscuit dough, packaged under pressure in cylindrical containers. The first such products, Ballard Biscuits, marketed by Ballard & Ballard, of Louisville, Ky., had first been marketed door to door, positioned on baking pans. The second generation consisted of cylinders of dough packaged with metal can ends and a cardboard tube body. This product had a shelf life of a week in the refrigerator, which triggered the search for better combinations of chemical leavening products. Combinations of baking soda and various phosphates provided the amount of shelf life required, and ensured a rapid rise in the oven. Work with refrigerated dough introduced more work on leavenings and understanding of the role of phosphates and leavening acids, which further improved baking mixes and other products.

The late '20s and early '30s saw a great increase in candy consumption in the United States. Possibly because times were hard, candy bars thrived as a small indulgence in a very tough world. And new varieties were introduced often. Some of these bars required a fair amount of science. The understanding of relative humidity made filled bars possible, like the 3 Musketeers bar introduced in 1932, which included three different flavors of nougat (vanilla,

chocolate, and strawberry) coated in milk chocolate. Enrobing chocolate coatings were formulated to be easier to temper, contributing to the development of Mounds (Peter Paul), the Heath Bar(L.S. Heath), and the Milky Way bar. Milky Way moved to England, escorted by Forrest Mars, son of Frank Mars, who started bar production in 1934. By 1935, candy consumption had reached 13.7 lb per capita. Individually wrapped pieces of penny candy were part of the reason for this increase. Fruit flavored Livesavers were introduced in 1935, and the five-flavor rolls of hard candy rivaled mints by 1937. By 1943, candy consumption in the United States topped 20 lb per capita.

In 1945, Chicago baker Charles Lubin developed his first commercial cheese cake, naming it and the company after his daughter, Sara Lee. By 1950, Lubin had developed a method for baking and offering the finished cheese cake, and other baked foods, in an aluminum foil pan, to be used directly from the freezer or shelf.



Health and Food: New Beginnings of a Future Trend

Sometime in 1929, a study showed that 30% of children in Baltimore had some stage of rickets, and a companion study showed that nearly 90% of children in London's East End suffered from rickets at some level. Earlier that year, Dr. Joseph Goldberger had died of cancer, but his published work brought an end to pellegra later in the next decade.

Biochemist Charles King and his Harvard colleagues isolated ascorbic acid and called it vitamin C during the early 1930s, and this work was repeated by Swiss chemist Reichstein, who went on to synthesize the material. In 1939, a paper describing the method of measuring vitamin C, including a treatise on the vitamin C content of fruits and vegetables, was published in the periodical *Food Research*, which later became the *Journal of Food Science*. Average amounts of the vitamin were listed in a table, and the amount of food required to provide 20 mg was listed.

In 1934, U.S. scientist Robert Williams isolated a vitamin that proved to be thiamin from rice husks. Thiamine was found to cure beriberi, a disease prevalent in the Philippines, where Williams was employed. Riboflavin was isolated in Austria that same year by chemist Richard Kuhn. Riboflavin was synthesized in 1935 by German scientists.

Borden, in the meantime, introduced vitamin D-fortified milk, and the Pet Milk Company introduced irradiated evaporated milk.

Activity surrounding the newly increased numbers of vitamins was very active, both in determining the activity and use and in providing ways to manufacture and use the products. Vitamin B-1 was first synthesized in early 1936 by Robert R. Williams, who called the vitamin thiamine. In 1937, crystals of vitamin A were isolated from fish-liver oil, and vitamin K was first produced in crystalline form. But the Federal Trade Commission had gained powers over advertising, and in 1938 enjoined both Standard Brands and Quaker Oats over claims for the efficacy of B vitamins in yeast and oatmeal. So the concerns about health claims and food were already active, and the "turf wars" about control of labeling and advertising had started in earnest.



The war effort cut off wheat and rye consumption in Dutch hospitals. When patients with celiac problems improved, it was determined that gluten, the protein from wheat and rye, was the causative factor for celiac sprue. This led to a dietary response to the disease.

A major intervention in nutrition was the 1941 National Nutritional Conference for Defense called by President Franklin Roosevelt. The reason for this conference was concern about the excessive number of young men who were found not fit for military service, and the concern that their physical defects were caused by poor nutrition. Russell Wilder, a Mayo Clinic diabetes and nutrition expert, convened a panel to study the nutrition of some 2,000 families, thus forming one of the first dietary surveys that were later to become so important in nutrition and food policy making.

South Carolina passed a bill requiring enrichment of white bread with vitamins and iron. This action, the first mandatory enrichment regulation, occurred in 1942. Later that year, both Louisiana and South Carolina enacted laws requiring enrichment of corn meal, corn flour, and grits with vitamins and iron. By the end of 1942, 42% of white bread sold across the nation was enriched. Texas and Alabama enacted bread enrichment laws, but by 1943, 70% of white bread was being enriched, much of it voluntarily. By 1944, Kentucky and Mississippi joined the enrichment movement, and most flour was also enriched, voluntarily. Later that year, by order of the War Food Administration, all yeast-raised products were enriched with the vitamins and iron lost in milling. As could be expected, there were complaints about enrichment, as there had been about pasteurization of milk and other health-related actions.

Folic acid was isolated in 1944. Biochemists Mitchell and Snell found that folacin cured macrocytic anemia by stimulating the regeneration of red blood cells and hemoglobin. In 1948, vitamin B-12 was isolated from animal liver tissue, and was synthesized in 1955. The new vitamin, the last of the 13 essential vitamins, was initially used to control pernicious anemia.

Recommended Daily Allowances (RDAs) were first published in 1943 by the Food and Nutrition Board, National Academy of Sciences. The recommendations, based on the needs of teenaged boys, were later reduced. The original RDAs called for 70 g of protein and 3,300 calories for a 70-kg man.

New Processes and Packages

A new system of homogenization was demonstrated at the U.S. Dairy Exposition in 1940. The equipment featured a coneshaped valve made of stainless steel wires. Produced by Creamery Package Manufacturing Co., which later became Crepaco, the valve replaced the piston ring homogenizer, which was difficult to keep clean. Homogenized milk grew in quantity. By the end of 1940, a third of milk sold was homogenized.

The Pure-Pak milk carton, introduced by Ex-Cello Corp. became available in 1-pt sizes, but glass container companies attempted to block the introduction of this new package by increasing the price under the Milk Control Board. The New York Supreme Court ruled against the Milk Control Board, which would have increased the sale price for milk in the fiber cartons. By 1940, an Illinois judge ruled that Dean Foods could market milk in paper-board. Dean began to market milk in cartons at the same price as bottles, starting its move to become a major force in packaged milk in the Midwest.

Frito's Corn Chips were developed by a candy maker named Elmer Doolin, using a method developed by Mexican restaurateur G. Olguin. Olguin used a potato ricer to cut tortilla dough into strips. Doolin's brother developed a device that operated much like an extruder to force dough out under pressure into hot oil. The Doolins licensed the extruder to local restaurant owners, who paid a license for the device and formulas for the snack.

A process for cooking, then freezing crabmeat was developed sometime in the early 1940s by Lowell Wakefield, a processor of seafood in Maine, after he discovered that low tides sometimes deposited large numbers of Alaskan King crab. This marked the beginning of "factory" ships for shellfish, in which the shellfish are shelled and partially processed by freezing or cooking on board for additional freshness. This also allows the shells to be returned to the ocean.

Libby, McNeill & Libby found that pressing tomatoes while submerged in heated juice provided a better juice that didn't separate as quickly, using some understanding of the process of deactivating pectin-methoxylase



with heat and stopping the enzyme action before it produced the brown color and haylike flavor of the products that were first produced in 1923. The improved juice began to sell, from 100,000 cases in 1929 to 739,000 cases the following year and 4.5 million cans in 1931. The knowledge of heat's activity on pectin revolutionized the juice industry, and provided juice that didn't separate, so it could be sold in glass. By 1939, papers described the use of heat to inactivate pectin-methoxylase. The process provided tomato products that were commercially superior, and greatly improved the character of processed tomato products. Curves showing heat inactivation at different temperatures were shown in an article published in 1939 in *Food Research*, published by the Institute of Food Technologists. The method disclosed was known as the "hot-break" process, as the tomatoes are "broken" under the surface of hot juice.



Food Safety

The emphasis on safely processed foods took major steps ahead with many studies on heat penetration for canned foods, and on understanding that the viscosity of the product affected the heat penetration of the product. Interest in maintaining reduced microbial loads for frozen foods was being carefully studied. A study by Helen Smart, one of USDA's researchers, which appeared in *Food Research* in 1939 discussed the efficiency of washing methods for cultivated blueberries and its net effect on microbial content of processed berries. In that same issue, Dr. Smart also presented studies on the microbial contents of commercial packs of frozen fruits and vegetables.

An article published in *Food Research* described the role of sugars in preserving foods. Authors Vernon McFarlane and Harry Goresline of the USDA noted that "Although sucrose has long been used as a preservative in many foodstuffs, not too much thought has been given to the possibility that it might retard or even inhibit microbial destruction in the foodstuffs that it is preserving. A philosophical thankfulness for the good things we have has arrested much of our curiosity as to the extent of actual microbial destruction in sugar-preserved foods and as to whether one kind of sugar is a better preservative than another, at least from a microbiological standpoint. In recent years, fundamental research on the influence of sugar on microbial behavior has been stimulated by observations that some microorganisms not only remain alive in pure sugar, but they may bring about spoilage in products containing high concentrations of sugar; namely in fruit concentrates, dry sugar packed and syrup packed frozen fruits, preserves and other products."

Concerns were expressed about the possibility of *Clostridium botulinum* in frozen foods, and a paper was published in the July-August 1940 issue of *Food Research*. The conclusion was that frozen foods, kept at 50C, were safe but that foods inoculated with large amounts of toxins could produce toxins under conditions that were broader than was previously thought. Additional papers were published identifying the mechanisms of heat transfer within containers during retorting, as can companies and others sought to completely understand the systems and to avoid food poisoning problems.

In 1942, articles about bacterial spoilage of iced fresh crabmeat showed that rapid growth of microorganisms and changes of pH at temperatures that had been thought safe could occur. Articles began to identify more common species of bacteria. In the same issue, there was a study of the cooking qualities of homogenized milk, in which cooked foods made with homogenized milk were judged preferable to those made with unhomogenized milk. It was noted that this study did not agree with findings made and published a year earlier.

Food safety at this time concentrated on bacteriological spoilage, and constituted an early body of work that formed an important framework for further consideration. Interestingly, there were strong concerns about use of excess temperatures, use of homogenized and pasteurized milk, nutrition and safety of frozen foods, and safety and quality of refrigerated products. A great deal of work focused on the safety aspects of eating foods that were prepared by commercial processors instead of in the home.



Chapter 3

(1945-1965)

In 1945, the big news was the end of World War II, in Europe on May 8 and in the Pacific on August 14. As Americans slowly returned to peace-time activities, the demand for goods and services, particularly food, overwhelmed the food processing industry and brought forward the need for new and better science, fresher-tasting foods with improved levels of safety, and reduced costs. After several years of powdered eggs and milk, the GIs were ready to eat, drink, and recover.

GIs returning from Italy demanded pizza, and oregano sales started a rapid rise. Over the next several years, sales of oregano and other Italian style spices increased by nearly 5000%. Sales of tomato sauces skyrocketed, and a new industry of prebaked pizza crusts was born. The increase in pizza sales increased the demand for shredded cheese, and built an industry in mozzarella, Parmesan, and Romano cheeses. New foods would enter the marketplace in the United States, helping to bring economic recovery.

Wage and price controls were removed in November 1946, bringing meat prices down and triggering a meat-eater's diet. In Europe, food prices were still high, and food was scarce. The Marshall Plan introduced a large volume of food and was followed by the Berlin Airlift of food to Germany. Food export activity led to increased production. While the Russian Army officially lifted the Berlin blockade early in 1949, the airlift continued to operate until September, making more than 275,000 flights. By 1950, farm prices had increased by 28%, reflecting increased agricultural value under the Price Parity Act, which provided some price supports for certain agricultural products.

The baking industry had grown in the previous decades. According to a paper presented by William Cathcart of the Great Atlantic and Pacific Tea Company at the 9th Annual Meeting of the Institute of Food Technologists, new processing methods for baked foods were introduced rapidly. Cathcart noted that the 1949 census measured the value of biscuits, crackers, and pretzels to be \$201 million in 1939. The 1947 census noted 6,797 bakeries with 233,310 employees. City families were spending more on cake and cookies, and mechanized bakeries were producing more bread, using sponge dough methods and giant mixers, molders,



and proof boxes. Cathcart included diagrams of bread and cake production lines, and innovations such as bulk handling of ingredients, prepared mixes, enrichment, active dry yeast, pan glaze, and coated pans. The Oakes continuous mixer was introduced for sponge cakes and for aerating fillings and some sauces. Antioxidants were introduced to retard off-flavors in fats, permitting two- to three-day shelf lives for doughnuts and high-fat cakes. The Patterson mixer provided mixing curves for better uniformity of doughs. Packaging improved. The introduction of bread standards and standardization identified bread products as dependable, nutritious, and wholesome.

The 1950s, the era that treated food both casually and carefully, started off with the new issue of USDA's *Handbook No. 8*, which listed the nutritional contents of 75+ food items, including the content of some frozen foods. Gayelord Hauser published his book, *Look Younger, Live Longer*, which espoused the consumption of blackstrap molasses, yogurt, wheat germ, brewer's yeast, and skim milk. Yogurt sales increased enough that Dannon Company moved to larger facilities and Kretschmer Wheat Germ sales doubled under the influence of the boom.

At the same time, hep teenagers breakfasted on potato chips and colas and visited drive-in restaurants for hamburgers, fries, and malted milk. The drive-ins were popular gathering places, and kids ate what was served there. The comic-strip characters Archie, Jughead, Betty, and Veronica were not consumers of wheat germ or yogurt.

In 1951, there were 153 million Americans, 583 million persons in China, 50 million in England, and 172 million in Russia. A U.S. grocery store carried about 4,000 different items, and growing amount of profit came from new products. By 1956, the median family income in the United States was \$5,087. World population hit three billion in 1960, up from 2 billion in 1930. Only 10% of workers remained on the farm. By 1963, this number would only be 7.3%. By the end of 1965, some corn farmers were producing 120 bushels per acre, with the average at about 85 bushels. Hybrids and liquid nitrogen were responsible for the increased yield, from 22.5 bushels per acre in 1933. The U.S. corn crop topped 5 million bushels. About 85% of corn was fed to meat animals.

The Office of Economic Stabilization was reestablished early in 1946 to help prevent prices from moving out of sight. Inflation had caused meat prices to inflate drastically, but when price controls were removed, prices began to settle back. Congress passed the National School Lunch Act as a means of ensuring that school children received better nutrition. The regulations defined acceptable foods that would provide a third of the RDA for calories, vitamins, and minerals. Food processors began to develop foods especially for School Lunch, and this market became important as a development tool for other new products.

U.S. red meat consumption reached 170 lb and chicken 37.8 lb. In 1965, Americans ate more margarine—9.3 lb compared to 6.7 lb of butter, and 9.4 lb of cheese in 1964.

Agriculture Provided Better Raw Materials

It was a time of raw material riches: the drought period and Dust Bowl were over, and farmers benefitted from research emerging from the dry periods, and better crops:

- The U.S. soybean crop reached 193 million bushels in 1945, from about 78 million bushels in 1940.
- The first long-season strawberry was developed by the University of California's agricultural experiment station in 1945.
- Sweetcorn was being grown from hybrid seed (75% of the total crop) in 1947.
- USDA agronomist Samuel Salmon developed a semidwarf wheat variety called Norin 10, first found at a Japanese experiment station during a tour of duty under General MacArthur's occupation forces in 1945. The variety had problems with common leaf diseases, but crossing the variety with U.S. strains produced a relatively disease-resistant version that later increased yields in India and Pakistan by some 60%. Norin 10 had strong stalks and didn't lodge, making it ideal for rough terrain.
- The formation of the International Rice Research Institute in Los Banos, Philippines, was supported both by the Ford and Rockefeller Foundations and by the Philippines government. The need for better rice varieties was clear, as rice remained the major staple of food during the '60s and later. Asians consumed about 300 lb of rice per annum, compared to 6 lb in the West, and production allowed for neither greater consumption nor population growth. By 1964, IRRI had introduced new, high-yielding dwarf rice varieties by crossing Japan's high-yielding Japonica varieties with Indica rice. This rice, for tropical cultivation, became the major variety in tropical countries.

And a green revolution would be needed. By the mid-1960s, famine would cause the deaths of 20–40 million Chinese, and crop failure hit the Soviet breadbaskets of Kazakhstan and the Ukraine. India was also in trouble because of drought, and a third of U.S. grain exports went to India. Canada sold massive amounts of wheat, mostly to the Soviet Union. Storms had flattened Japan's rice crop in 1963. Another drought flattened India and Pakistan's crops, and the Soviet union suffered another crop failure. Wheat was not shipped to Russia, however, because of a requirement that the wheat be shipped in American ships.



New Products and Packages

By mid-1947, the cheese product known as Kraft Singles was introduced by Kraft Foods, which had invented equipment that individually wrapped processed cheese slices without giving the appearance of being wrapped. Consumers eventually accepted the convenient form of cheese, and processed cheese in single-wrapped slices became a best seller.

Frozen French fries were introduced on February 16, 1946, at Macy's Department Store. They were produced by the Maxson Food Systems of Long Island, N.Y. Shortly after, J.R. Simplot and Ore-Ida both entered the frozen French fry business, learning the specifics of starch type, moisture content, and par-frying techniques partially frying the potato strip to stabilize the starch, then freezing the potato for finish frying. Ore-Ida built a new frozen-food factory outside Ontario, Ore. Mergers with smaller companies expanded the firm into Ore-Ida Foods in 1961 (purchased by Heinz in 1965).

Frozen Deviled Crabs were introduced by the new company called Mrs. Paul's Kitchens, owned by Edward Piszek and short-order cook John Paul.

Dunkin' Donuts started its growth from a coffee and donuts shop in Quincy, Mass., founded by Robert Rosenberg in 1950.

In 1947, Jeno Paulucci, a food salesman, set up shop in a Grand Rapids, Minn. Quonset hut and started growing bean sprouts in a hydroponic garden. Bean sprouts grow rapidly, and Paulucci produced enough to supply a canned chicken chow mein operation. He entered the pizza business shortly afterward, and expanded his plant in Duluth, Minn., by an extra 2 million sq ft in 1950. His slogan, displayed at the front door, noted that "We're in business to make a profit. That's the only reason. But we might as well have some fun at it." Paulucci did indeed have fun with his business, selling Chun King to R.J. Reynolds Foods in 1966, and becoming chairman of R.J. Reynolds Foods.

Duncan Hines Cake Mix started life in Omaha, Neb., in June 1950, at the Nebraska Consolidated Mills. The brand name was licensed from Park Hines, the company that used the food critic Duncan Hines' name. The new brand reached 48% of the prepared cake mix market within three weeks. The mix came in one flavor, white, with yellow and chocolate cakes prepared by ingredient additions. Cake mixes were popular with consumers. The research produced cakes with leavening systems that could withstand shelf-time, and knowledge about the impact of moisture on leavening and the kinds of additions that consumers preferred to add themselves, and why. Adding fresh eggs, according to one survey, helped a home baker feel as if the cake was her own.

Tropicana Products began to produce chilled, pasteurized orange and grapefruit juice. The firm had packed chilled fruit sections in glass as early as 1946. Owner Anthony T. Rossi did the basic studies that determined the optimum temperature and time required to deactivate pectinase enzymes that would cause juice to separate into two phases and trigger off-flavors. He also developed juice blends of several orange varieties to produce a uniform juice year-round. By 1955, Rossi had built a stainless-steel-chambered ship to ship chilled juice to his Whitestone, N.Y., bottling plant from his port in Cape Canaveral, Fla.

Pream, a powdered imitation cream for coffee was introduced in 1952, made from hydrogenated palm-kernel oil, sodium caseinate, phosphates, and emulsifiers, plus sugar, was developed by the M. and R. Dietetic Laboratory of Columbus, Ohio. Pream was followed by a number of dry coffee creamers in the next few years. Understanding the interaction between special fats and protein systems produced improved products that retained the "creamy" look, cost less than cream, and could be used in dry form for a long time without spoilage.

Cheez Whiz, a shelf-stable cheese sauce containing processed cheese, water, whey phosphates, milk fat, and skim milk, plus seasoning, was introduced to grocery stores on July 1, 1953. Housewives used the new shelf-stable cheese to create macaroni-and-cheese, cheeseburgers, and cheesedogs, instead of using the product for Welsh rabbit, which was envisioned by the inventors. Kraft inventors had researched the above-mentioned melted cheese dish, which Americans insisted on calling "rarebit."

Consolidated Foods took a big step forward in market development with the acquisition of Ocoma Foods (Omaha) to increase its reach into frozen poultry, frozen prepared foods, and butter. The company had annual sales of \$225 million in 1952 and continued to grow.

Aluminum cans with "pop" tops were introduced in 1962. Further development of tabs that remained on the can top prevented litter hazardous to people and pets, and the pop top closed 90% of beer cans by 1970. Soda cans were increasingly outfitted with the pop tops that didn't litter.

The first aerosol food product, Reddi-Wip, by Reddi-Wip, Inc. was introduced in 1947. The whipped cream product was aseptically packed in the can, and had improved shelf life.

Boil-in-bags were produced for frozen foods by the mid-'50s, and these products were later used for microwave heating of a variety of food products. These packages were not only convenient, but they prevented development of additional solid waste, which was already becoming an issue in the late 1950s.

Engineering Activities

Research aimed at making dry powdered orange juice for the Army led to a concentrated form of juice that later became a standard form of orange juice for many years. The process included an evaporation method originally developed for use in producing penicillin. National Research Corp. produced the first product in 1945. By 1946, sales of frozen orange juice had reached 4.8 million cans (6-oz), but consumers didn't like the product until a technique developed by Louis Gardner MacDowell, called "cut-back," overconcentrated the juice, then added fresh juice to the concentrate. Other scientists, Atkins and Moore, refined the process to provide a concentrate with uniform sweetness, flavor, and acid content. Concentrated orange juice was nearly wrecked by a bumper crop of oranges and overproduction of canned juice in 1947. Vacuum Foods Co., the forerunner of Minute Maid, lost \$371,000 during that year, but its founder, John M. Fox, got a loan from the Coolidge Co. and survived.

Pre-cut meats packed in plastic films and treated with a carbon dioxide gas flush were seen in an increasing number of supermarkets by the mid-'60s. The treatment increased shelf life by 10–15 days, according to meat cutters. Freezing technologies improved, as nitrogen freezing allowed the production of Individually Quick Frozen (IQF) fish and other foods. IQF, used for individual fruits and vegetables, enhanced the production of 1–1.5 lb plastic bags of frozen produce, and of mixed varieties that were frozen at different times.

The microwave oven became a common appliance in homes, and was also widely used in cafeterias and vending areas. A number of companies, particularly Swift Co. and Armour, produced frozen sandwiches and entrees of a wide variety. Information about changes needed to make these products appropriate for microwaving was beginning to be determined; for example, breads and buns were made denser so they could be heated by microwave energy without turning soggy. Microwavable pizza was developed, often using a susceptor—a foil-covered element that assisted in browning the food.





Nutrition and Food Safety Regulation

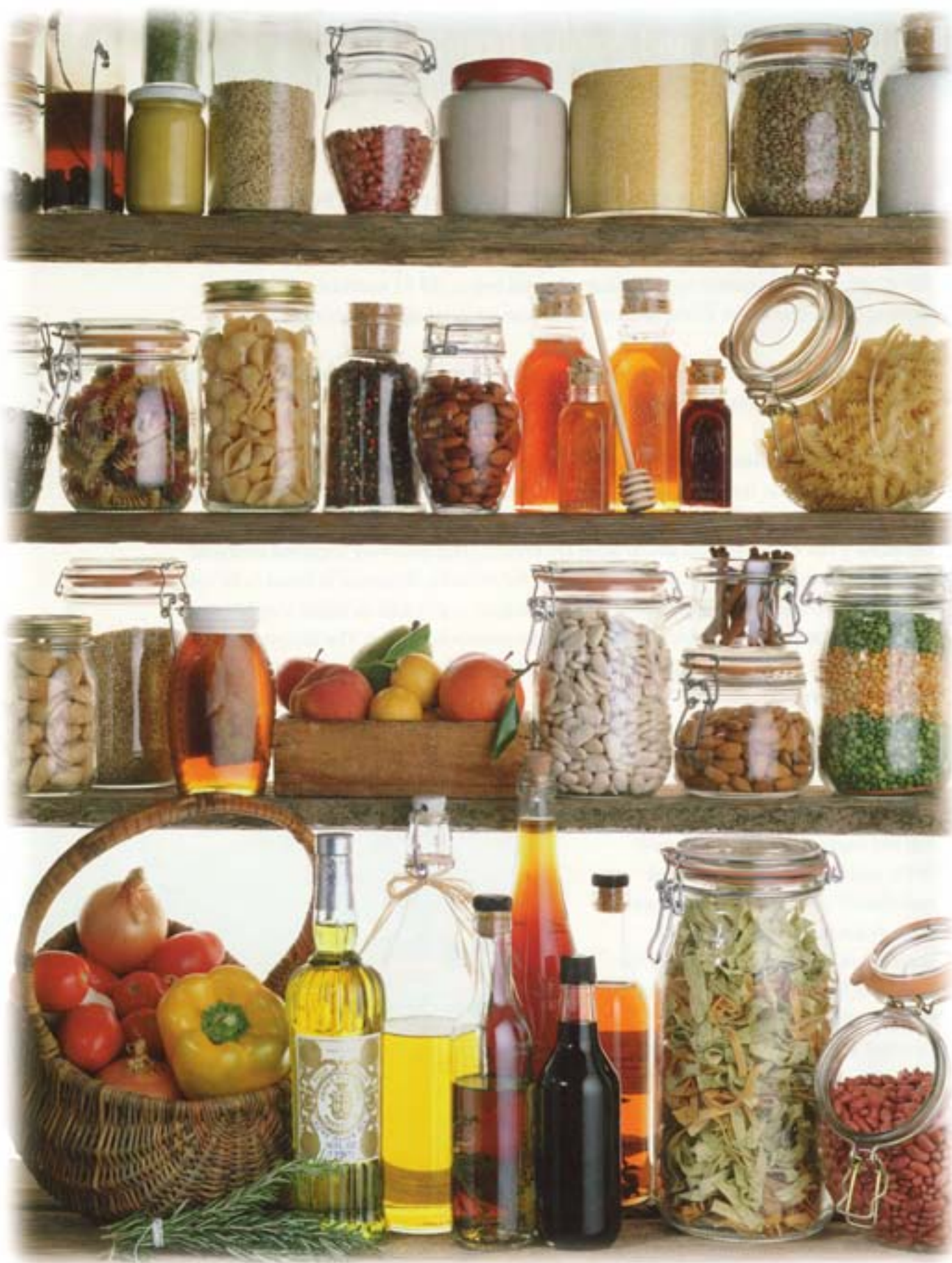
Tryptophan, present in milk, was discovered to be the precursor to niacin (vitamin B-3) in late 1945. Vitamin B-12 was isolated from animal livers, and was found to be useful in controlling pernicious anemia. The vitamin was later synthesized, and a project to analyze the structure of the vitamin by crystallography was begun. All 13 essential vitamins were isolated by the end of the 1940s, and some had been successfully synthesized.

Bread enrichment standards were enacted in 13 states in 1945, and the Federal School Lunch Program was introduced in 1946.

In 1949, William C. Rose, of the University of Illinois, demonstrated that eight amino acids are essential to human health. Feeding studies using pure amino acids demonstrated that the eight amino acids are not produced by the body, although other amino acids are produced if the eight essential amino acids are present. This discovery triggered profound interest in amino acid content in various grains; for example, threonine is found to be deficient in rice, lysine is deficient in corn, and methionine is deficient in beans. Combination of grains was seen as a probable way to ameliorate protein deficiency. The discovery that a single deficient protein could cause malnutrition triggered a several-decade race to develop high-lysine corn.

USDA's survey released in 1955 showed that about 10% of families lived on a "poor" diet, a marked improvement from the mid-1940s surveys. Congress mandated enrichment of rice in 1958, but short-grain rice was not included in the enrichment regulation, and finally the U.S. Food Stamp program was reactivated in 1964. Poor families were provided with the stamps that could be used to purchase certain foods.





Ingredients

Monosodium glutamate was introduced as Ac'cent in about 1945. Butylated hydroxyanisole (BHA) was permitted by FDA in 1947. The compound was used to prevent the oxidation of fats, improving flavor of fried foods, table spreads, and fats for frying.

By the mid-'50s, food starches were being produced to offer both heat stability and freeze-thaw stability. Starches were first cross-linked to "strengthen" the structures, so that the cooked products didn't thin out or break down. Later, other compounds were added to enhance the clarity and texture of the products.

During this time period, waxy starches were introduced. Germplasm from China was multiplied, and the starch was commercialized in about 1946 by National Starch and American Maize-Products. The starch was initially introduced as a replacement for tapioca starch, unavailable after the war. It later became the most popular starch base for modified food starch products. Maltodextrins, partially refined starch products with dextrose equivalents below 20, were bland, water-soluble white powders, generally spray dried and used to replace fats and sweeteners. Corn syrup solids were sweeter versions, dried in vacuum belts and ground in various sizes.

Butylated hydroxytoluene (BHT) was approved as an antioxidant in 1954, and was frequently used with BHA in fats. The two compounds worked synergistically, providing a better result than the use of one alone.

Spice products, especially nutmeg and mace, were in short supply after a hurricane destroyed 75% of the trees on Grenada. Clove trees in Zanzibar were decimated by a fungus disease, reducing the quality and quantity of cloves, and increasing the price. Spice prices skyrocketed: nutmeg, for example, went from \$0.35 per lb to \$2.00.





Genetic researchers James Watson and Francis Crick published a letter to *Nature* on April 25, 1953, elucidating the structure of the salt of deoxyribose nucleic acid (DNA) and suggesting some of the biological functions of this building block of life. A further publication in the journal described how DNA works.

Dairy scientist David Peebles developed a crystallization process for nonfat dry milk that retains the protein, minerals, and carbohydrates of fresh milk, and is easily hydrated.

Development of the concept of freeze-thaw stability of various foods, and the development of the chambered aluminum tray led to the development of the T.V. Dinner in December 1953. C.A. Swanson & Sons, Omaha, Neb., sold the first dinner containing turkey, stuffing, whipped sweet potatoes, peas, and gravy. The whipped sweet potatoes were quickly replaced by white potatoes, as the sweet potatoes "watered off," and the term "syneresis" was widely adopted for the water loss that occurred in some foods when frozen and then thawed. The turkey dinner was soon joined by a fried chicken dinner and Salisbury steak. Other companies soon began to produce less expensive TV dinners (the introduction price was about \$0.98, and dropped to 3 for a dollar within a few years.) The quality problems dealing with cooked, frozen potatoes was described in a 1950 article in *Food Technology* by researchers at the Hampton Institute in Virginia, who found that very rapid freezing and subzero holding controlled the textural condition referred to as "cottoniness."

Commercial frozen French fries were introduced in 1953, by the J.R. Simplot Company, which determined how to blanch and par-fry potato strips to keep them from being excessively soggy, and to freeze them rapidly enough.

The advance in the use of "electrosensing," the use of thermocouples, particularly, was featured at the 9th Annual IFT Convention in 1950. The use of thermocouples and "thermistors" was common in canning operations, and the need to recheck thermal death curves was well understood. Generally, most canners knew that changing formulations required that the process be re-run for safety.

Paper chromatography was used in the 1950s to determine the concentrations of sugars and other components. The technique was tricky and difficult, but was simplified by the appearance of gas chromatography, when it entered common use in the early 1960s. A paper published in *Food Technology* in January 1950 by researchers at the Western Regional Research Laboratory, USDA, noted and identified sugars in citrus juice. The researchers were able to identify sucrose, glucose, fructose, galactose, and rhamnose.

The Annual Meeting of The Institute of Food Technologists addressed the concerns of 1950, with many papers describing better ways to interpret thermal death curves, early aseptic methods, high-temperature short-time methods, technology in breakfast cereals, and other subjects that mirror some of the continuing concerns throughout this and later decades.

Rapid peeling of fruits and vegetables was becoming more important, the volume of canned and frozen food was increasing exponentially, and the speed with which processors could get the produce into cans was closely watched. Consumers were sensitive to freshness, and fast packing was both a quality and a marketing plus. Superheated steam was introduced in the late 1940s, and was adopted by tomato canners. By 1950, superheated steam was being introduced for use on peaches and other "slip skin" fruits. Development of a freeze-thaw-stable yeast product allowed the development of the first frozen bread dough, by Bridgford Foods Co.

Flavor profiles were introduced as a concept during 1950 in an article by principals of the Arthur D. Little Company. Flavor profiles were defined as a series of words which described aroma and flavor so that members of a flavor profile panel described the characteristics in the same way. This method made it easier for researchers to reformulate, or at least to understand the differences between standards and products.



Food Safety and Security

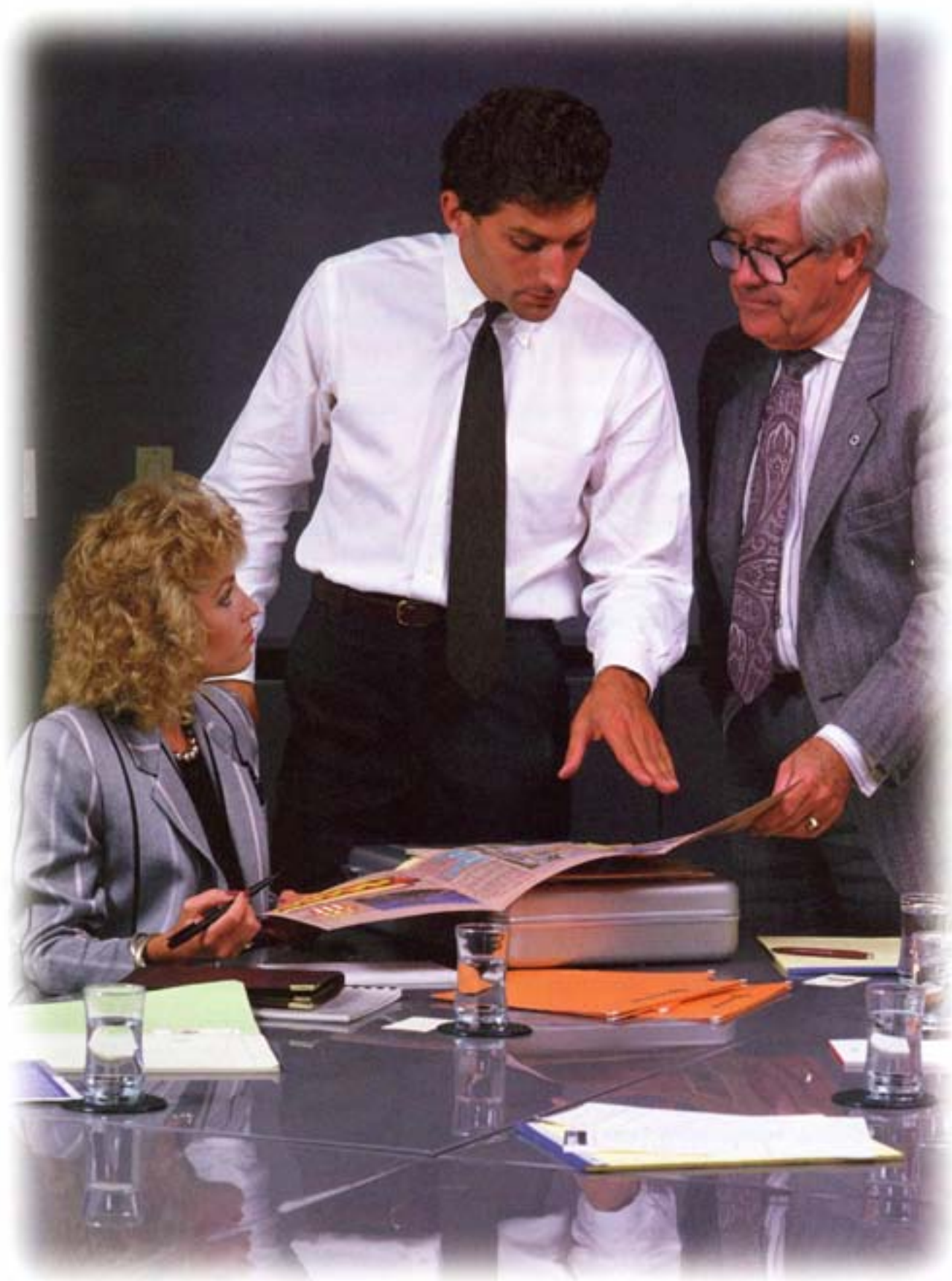
Concern about postharvest spoilage was seen before 1950, but in that year a review paper detailing domestic postharvest loss was published in *Food Technology*, identifying spoilage at the New York markets that averaged 2.1% decay for fruits and 3.8% decay for vegetables, and identifying the causes of this spoilage as bacterial and fungus rot. The use of gases to control rot was discussed, including the efficacy of carbon dioxide, sulfur dioxide, ozone, and nitrogen trichloride. Another method of controlling decay was oiled wraps, treated with pine oil and with diphenyl. A broad variety of water-based washes were discussed, including hot water and hypochlorite. Some of these methods are still used, while some were never used extensively. But the concerns are still present, possibly more today, as semi-fresh products are more in vogue.

Charles Stumbo and researchers from the Food Machinery and Chemical Corporation reported on work in determining the establishment of thermal death time curves for *Clostridium botulinum*. The two-year study concluded that kill times for *Clostridium botulinum* did extend in straight lines, but that temperatures at levels necessary to be assured of kills at high temperatures required new methodology for measuring the thermal resistance of spores.

The Delaney Clause was placed in the 1958 amendment to the Federal Food, Drug, and Cosmetic Act of 1938. The amendment permitted no food additives to be used unless they had been used widely for years, or were Generally Recognized as Safe (GRAS). New additives would have to submit conclusive proof of safety at the intended level of use. The Delaney Clause required that new additives cause no cancer in any laboratory animal at any level, and there was great debate about precisely what “no” meant.

The Cranberry Scare of 1959, caused by the presence of trace amounts of amionotriazole in a fraction of the crop, and seizure of that portion of the crop by FDA caused sales of cranberry products to drop sharply, shortly before Thanksgiving. This seizure was directly attributable to the Delaney Clause, and cranberries from Washington and Oregon were removed from the market.

FDA banned diethylstilbestrol (DES) for use in chickens and capons. DES had been used to promote growth of capons. Ordinarily the pellets, applied in the necks of the birds, would not cause residues in the meat, but there were some residues found in poultry that had been slaughtered in a less-than-optimal manner. The possible feminizing effects of DES, which had been developed by researchers at the University of Iowa, caused it to be removed from use in poultry, although the material was used in beef rations for some time.



Chapter 4

(1965-1980)

P

resident Lyndon Johnson's Great Society programs were outlined in his State of the Union address. The program, initially set at \$1.4 billion to eliminate poverty in the United States, lost funding as the Vietnam War dragged on, and dragged the economy down. In 1965, however, the average American's food bills amounted to about 18.5% of income, the lowest percentage anywhere in the world.

By 1966, drought had begun in the Sahel, that 2,600-mile region just south of the Great Sahara desert, including Mauritania, Senegal, Nigeria, and Ethiopia. Cattle started to die in 1966, and by 1970 famine affected many residents of the region. The drought also affected the acacia trees that provided gum arabic, the natural hydrocolloid that was widely used in drying and encapsulating flavors. Prices for gum arabic hit \$11 from about \$0.33, and a great deal of effort was expended on gum arabic replacers.

In 1971, botulism found in vichyssoise from Bon Vivant Company caused the death of Samuel Cochran Jr. in Bedford Village, N.Y. It was found slightly afterward in a batch of chicken vegetable soup from Campbell Soup Co.'s Paris, Tex., plant, but the product was recalled and caused no adverse effects. These two occurrences shook Americans' complacency about safe foods, and triggered great concerns about processed foods.





New Products, New Packages

Shake N' Bake, a coating that permitted oven-finishing of foods so that they resembled fried products, was introduced in a limited market test in 1965, and reached national distribution the next year. The product used some of the then early learning about water activity, offering a dry powder that provided a crisp crust.

Cool Whip, a combination of vegetable fats and emulsifiers plus sweeteners that retained its air content when whipped and frozen, replaced whipped cream in the family refrigerator. General Foods packaged the product in a white plastic tub, and recommended that it could be used within two weeks if refrigerated, or within a year if frozen. The product had fewer calories than whipped cream, and was convenient to use.

Tang, an orange-flavored beverage, was introduced nationally in March 1965. The product was included in the Apollo space menu. The product, made from sugar, citric acid, gum arabic, and orange flavor, plus other ingredients, featured a sophisticated flavor system that offered the aroma as well as the flavor of a freshly cut orange when the powder was rehydrated. The orange flavor was encapsulated in a sucrose glass by extrusion. The ability to retain flavor and aroma and release it when combined with water was new science, as was the encapsulation technique.

Gatorade, an isotonic beverage, was developed by Robert Cade, University of Florida, for use in rehydrating football players, and later for anyone who played sports. Stokely-Van Camp Co. acquired the license for the beverage, and the original lemon-lime flavor was introduced as the first "sports drink." The ability to formulate a beverage that replaced lost fluid, and retained isotonicity, triggered more research on osmotic pressure.

By the mid-1970s, Granola had become the new craze. Quaker 100% Natural cereal was introduced, and promptly blasted for having "as much saturated fat as a McDonald's hamburger." Snapple was introduced in 1972 by the Unadulterated Food Products Co., which later became Snapple Beverage Co.

Not all new products made it big in the marketplace. The retort pouch, offering faster heat penetration and resulting in fresher flavors and less overcooked texture, was widely advertised. Products entered test market, beginning with the 1977 introduction of Continental Kitchen's line of specialty products, followed by Kraft's Ala Carte line. Libby McNeill and Libby test-marketed a product line called House Dressing, which did not emerge from test marketing. Two Canadian firms, Swan Valley Foods and Magic Pantry Foods, sold product for a time, but retail versions of the retort pouch generally didn't emerge as a success

from test markets. The slowness of packaging the products in retort pouches may have been the major problem, or it may have been the difficulties of packaging and preventing pinholes, or the abundance of overcapacity for cans, but the pouch became a package used primarily for Meals Ready-to-Eat, used by the military, and products designed specifically for outdoorsmen. As the number of military personnel dropped, demand was not enough to keep many retort pouch processors in business.

Aseptic processing, filling sterilized products into sterilized containers in a sterile atmosphere, offered advantages to liquid products. Canned puddings, sauces, and similar foods could be processed with less heat damage. Tomato products were particularly adaptable to aseptic packaging, both in bulk and in individual servings. Bulk product could be filled into drums, tank cars, and large aseptic silos, such as those that held not-from-concentrate citrus juice, permitting a giant business in single-strength orange juice to emerge. Tropicana, one of the first users of bulk citrus juice, built tank farms to hold juice processed aseptically during the orange season, to be blended and packaged when needed.



Agriculture

The Rock Cornish Game Hen, a cross between a White Rock and a Cornish chicken, was small, broad-breasted, and fast to mature—28 days, on average, while on feed, compared to 42 days for normal chickens. The Rock Cornish variety was developed by Don Tyson, and the firm that bears his name became a major force in the poultry business.

By 1967, American farmers, who had furnished the world with grain for several years, found that famine, although still active, was receding elsewhere. Grain prices fell sharply as a bumper crop was harvested in the American heartland. As prices fell, farmers received subsidies, and Agriculture Secretary Orville Freeman was castigated by the farmers he had convinced to plant heavily in anticipation of continued Indian drought.

Heavy corn crops were a major reason for the rapid acceptance of high-fructose corn syrup (HFCS), introduced by Clinton Corn Processing Co. in 1967. By 1972, HFCS was adjusted to a lb-for-lb sugar replacement in sweetness. In 1972, the alternative sweetener was adopted by the major beverage companies, marking a major change in sweetener source. HFCS continued to be tied to the price of corn, although some companies hedged corn price against sugar futures to control costs.

Norman Borlaug, the head of CYMMT (the International Wheat and Maize Improvement Center) was awarded the Nobel Peace Prize in 1969 for his development of high-yielding corn and wheat varieties. Borlaug noted that the "Green Revolution" would only forestall famine by about another 30 years, if population continued at the present rate. Borlaug continued his work with sustainable agriculture, winning the World Food Prize in the early 1990s, and speaking about the need for improved seed and chemicals.

Southern Corn Blight hit the corn crop in 1970, and concern about the lack of diversity in corn germplasm began to be heard. Most of the corn varieties grown shared the common problems of lack of resistance to the disease, and corn breeders started to look to the development of more diverse parentage for seed corn.

In 1972, world agriculture took several hits: drought in Russia and China forced the Soviets to buy American grain or risk meat shortages by cutting cattle herds. Grain purchases in that year included a quarter of the American wheat crop 20-million tons—plus one million tons of soy and several million tons of corn. The anchovy crop was driven away from the South American shoreline, and the fish meal that was formerly used to feed animals in South America disappeared. The reason for the anchovy failure was attributed to El Niño, a phrase that had been unfamiliar but would, in the future, be well discussed. Prices for soy and soy meal increased. Tropical storm Agnes struck the eastern U.S. in June 1972, further damaging crops. The banana fields of Honduras were first affected by black fungus, damaging the banana crop.



Regulations and Nutrition

Concerns about nutrition and the slogan “no good foods, no bad foods” led to much debate about nutrition labeling. There were concerns that nutrition labeling would trigger a “nutrition horsepower race,” and that consumers might become overly concerned about nutrition. In 1967, Congress passed the Fair Packaging and Labeling Act, which called for clear labeling of ingredients, of net weights, and of descriptions of sizes, but listing of nutrients did not enter the scene at that time.

Probably the single most important event during this time period regarding food and nutrition was the White House Conference on Food, Nutrition, and Health, held in December 1969 and reported on in early 1970. The Conference was convened by the Nixon White House to deal with hunger and malnutrition in America, and originally was not intended to consider regulatory initiatives. The Conference, however, emphasized the need for good nutrition expressed in good science that could develop products to fill that need. New leadership emerged at FDA after the White House Conference: Virgil Wodicka, Director of the Bureau of Foods; James Grant, Deputy Commissioner of FDA; Ogden Johnson, Director of the Bureau of Nutrition; Allan Forbes, Deputy Associate Director of the Office of Nutrition; and Peter Barton Hutt, FDA's Chief Counsel. A number of new regulations emerged during the period between 1969 and 1989, including voluntary food labeling information; promulgation of new food standards that didn't follow the old recipe approach; imitation foods defined in terms of nutritional content; definition of special dietary foods; prohibition of false or misleading claims; and deceptive packaging regulations regarding fill and content. The result was that foods could be fortified without violating a food standard.

The Fair Packaging and Labeling Act of 1967 required that the concept of full disclosure of ingredients and the nutrient content resulting from ingredients used in foods be supplied to consumers. While there were many difficulties with analyses, products that made any kind of labeling or advertising claim had to follow the format for labeling and deal with the problems of variability of raw materials.

While the changes in food law took development in a different direction, toward food products with a positive effect on health, there remained concerns that some level of control should be exerted over fortified foods. One area where information was less than perfect was the toxic effects of too much of specific nutrients. Even in the mid-'60s, it was clear that excess food was being consumed and that the “if a little is good, a lot is better” concept could cause problems.

School lunch grew to become big business, with 21 million school kids participating in the USDA-supported program. Nearly four million children received free lunches in 1969. The requirements for foods to fit the school lunch criteria made or ruined a number of food products, and the pressure to fit the criteria forced changes in many products. This was a time of concern about the role of traditional foods vs fabricated foods, and products like fortified-to-the-gills cookies were criticized when added to school lunch and breakfast menus because of the concept of eating cookies for breakfast. This controversy gained steam when plate-waste studies showed that much of the nutritious food approved by the School Lunch Program landed in the waste bin.

The hot dog controversy (how much fat can a hot dog have?) reached a stalemate, then an agreement, as Bess Myerson, the New York City Commissioner of Consumer Affairs, proposed a 25% maximum fat content and USDA proposed a 33% maximum. A compromise sets the amount of fat in a hot dog at 30%, agreed on by Virginia Knauer, Nixon's Special Assistant for Consumer Affairs. USDA's standard for fat content had been 35%. The change was announced in December 1969.

By 1970, Nixon's "hunger consultant," Robert Choate, testified that breakfast cereals were little better than solid sugar, and that children were being fed products with little nutrition. By the following year, many cereals had been reformulated. FDA permitted fortification of foods that had not been fortified, as concerns about unfortified foods being a major part of

some diets surfaced. Concerns about nutritional content vs nutritional claims continued to be voiced, and consumerists, including Ralph Nader and James Turner, began to be heard in books (*The Chemical Feast*, 1970) and articles. Concern about food safety, adequate nutrition, and poverty continue to impact both public policy and food regulation.

The GRAS list came into question over monosodium glutamate (MSG), first for its use in baby foods when the Washington University School of Medicine published reports of damage to neonatal mice from feeding MSG. Damage to the hypothalamus area of the brain fanned concern about "Chinese Restaurant Syndrome." Also in 1969, the GRAS list took another hit when FDA removed cyclamate from the list, citing bladder cancer in rats when fed large

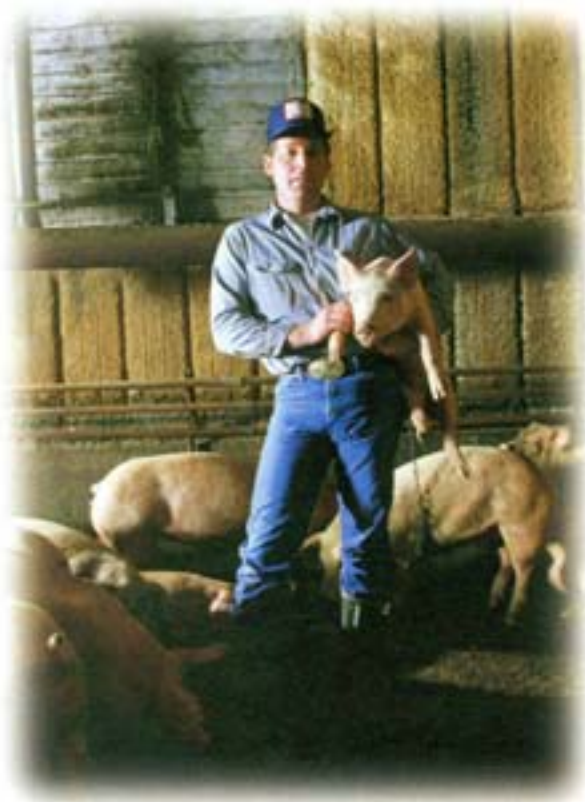


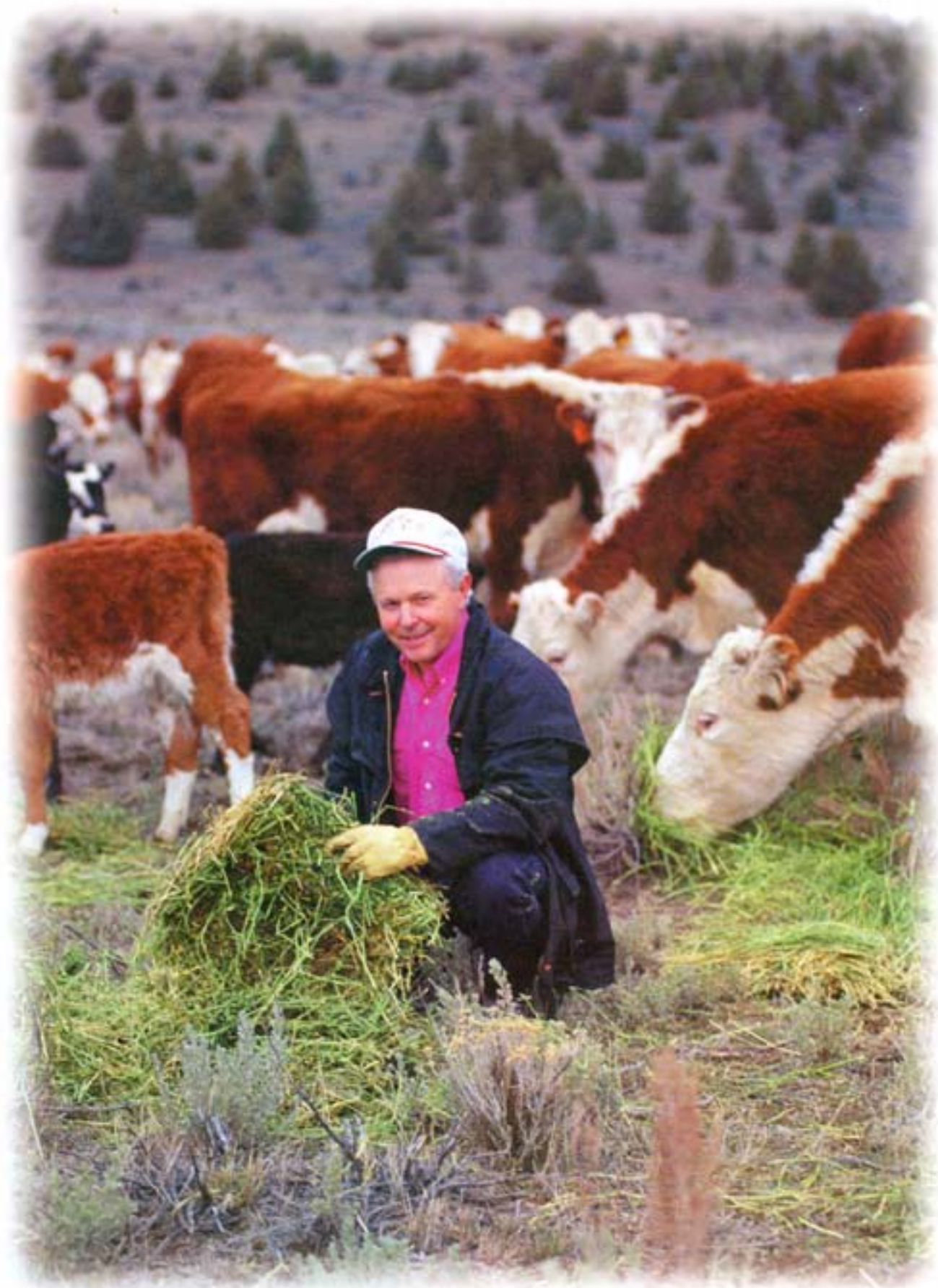
amounts of cyclamate. Because of the Delaney Clause, cyclamate was removed from the GRAS list, at a very large cost to processors who had just finished a large fruit pack containing cyclamate, and large amounts of soft drinks containing the sweetener. Congress ordered a complete ban on the substance, which had been used in amounts up to 20 million lb per year for years, about 70% in soft drinks.

In August 1973, FDA published regulations that would classify vitamin A as an over-the-counter (OTC) drug in dosages over 200% of the RDA. Vitamin D was recommended for classification as a drug in amounts over 100% of the RDA, and most other vitamins and minerals would be considered drugs at 150% of the RDA. Dietary supplement makers put pressure on Congress, and at least 70 bills were introduced to prevent FDA from acting against vitamins and supplements. The result, in 1994, was the Dietary Supplements Health and Education Act (DSHEA), which has permitted supplement ingredients to be used without going through the food additive petition procedures.

In 1977, the USDA published a request for information about the uses of nitrates and nitrites in meats. The publication in the October 18, 1977, issue of the *Federal Register* triggered concern about the use of nitrates and nitrites in meats, the possibility of producing nitrosamines that were carcinogenic, and the difficulty in replacing the nitrates and nitrites as a bacteriostatic ingredient in meats, particularly sausages, bacon, and ham. The American Meat Institute formed a Nitrite Safety Council to investigate the extent of the possible problem, and to determine what replacements could be made.

In 1979, FDA, FTC, and USDA held joint hearings related to label information. FDA had conducted a consumer survey to determine what consumers wanted on food labels. The survey found that most consumers knew about ingredient listing, nutrition labels, and open dating, and about 75% of consumers read and acted on the information. The ingredient list was the most important information, and consumers did use nutrition labeling when it was present. Half of these shoppers read ingredient lists to avoid certain substances, including sugar, salt, fats, and artificial colors. Some consumers noted that they didn't often understand the technical nature of some ingredients. Some consumers wanted percentages of ingredients to be listed. FDA responded that consumers were not generally concerned about nutritional value of foods but were concerned about perceived hazards.





Changes in Consumption

McDonald's, the hamburger chain owned by Ray Kroc and only a few years old in 1969, opened 211 new outlets, and introduced the Big Mac, converting a young people's sandwich joint to a place for the whole family. Big Macs accounted for about 20% of sales. By 1972, McDonald's had introduced the Egg McMuffin, providing a breakfast menu for the outlets.

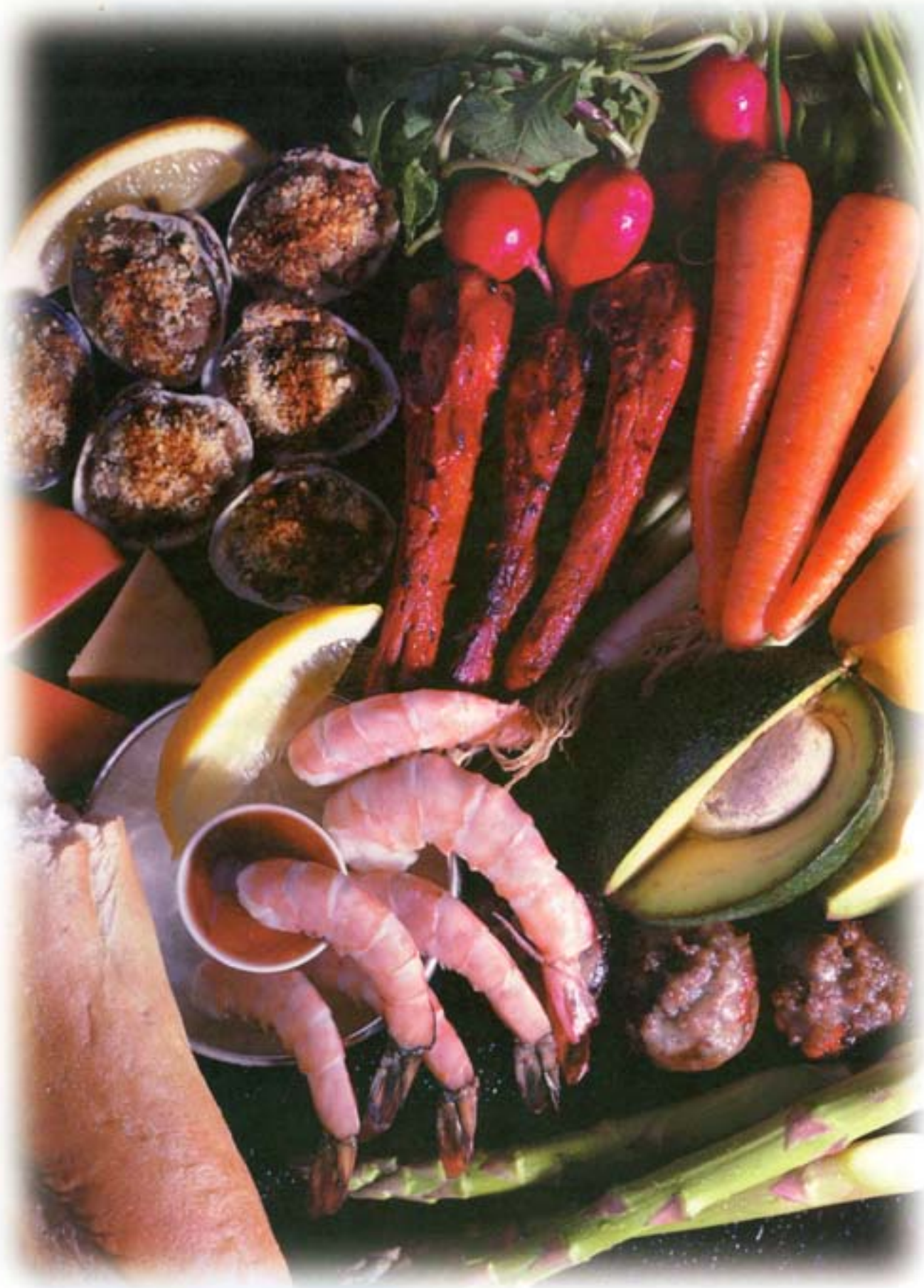
The first Wendy's outlet opened that year, in Columbus, Ohio, first as a hamburger and chili outlet. Reacting to concerns about fat content, owner-entrepreneur Dave Thomas introduced baked potatoes and salad bars in many of the stores. Other franchising chains joined in the fray, including Long John Silver's and others.

Partly because of the rapid rise of fast foods during this era, an official of the Department of Health and Human Services' Centers for Disease Control published an article in *Food Technology* in February 1981 that outlined a hazard analysis of foodservice operations and specific time-temperature combinations. The author, Frank L. Bryan, provided sample flow diagrams for producing specific foods, and discussed how to identify critical operations.

Beef continued to increase in consumption. By 1971, beef consumption stood at 113 lb per capita, and by the middle of the 1970s Americans ate about 50 billion hamburgers per year. But reductions in the beef herd and chicken flocks in 1973, following heavy foreign purchases of grain, affected the price of fast-food items, and sent food researchers looking for new items and new sources.

By 1974, in reaction to high sugar prices, the use of high-fructose corn syrup increased in per capita use to about 10 lb per person, up from about one lb in 1972. The use of immobilized enzymes to "isomerize" or change the form of a sugar from glucose to fructose made the process of making a sweetener from corn starch via glucose quite economical. The enzyme glucose isomerase had been used for a period of time before the immobilization process was developed, but the process of immobilizing and reusing the enzyme bed made the process possible to run in a continuous system.





Chapter 5

(1980-2000)



An event of great importance was the publication, in final form, of "Dietary Goals for the United States," prepared by the staff of the Senate Select Committee on Nutrition and Human Needs. The report, hotly debated by the American Medical Association and the Food and Nutrition Board of the National Research Council, recommended that consumers reduce salt and sugar intake; reduce consumption of saturated fat and red meat; reduce egg consumption by 50%; and increase consumption of whole grains by 66%, fruits and vegetables by 25%, and skim milk by 12%. The Food and Nutrition Board recommended that Americans reduce fat consumption, bringing calories from fat to below 35% from the then-current 40%. The controversy surrounding the report probably triggered interest in fat replacers and reduced-fat foods that occupied about half of most food technologists' time over the next decade.

The Food and Nutrition Board countered with a report titled "Toward Healthful Diets," which made no recommendations about cholesterol consumption for healthy persons, and noted that some segments of the public should eat 40% of calories from fat, especially adolescents and adults doing manual labor, but recommended that sedentary persons reduce the amount of calories from fat, sugar, and other foods that were not nutritionally dense.

At the IFT's 1980 Annual Meeting, D. Mark Hegsted, Administrator of the U.S. Department of Agriculture's Human Nutrition Center, in discussing the joint FDA -USDA Dietary Guidelines for Americans, noted that the country was in a transition period in the definition of a nutritious diet. The guidelines, according to Hegsted, were a consensus of scientific opinion on the issues of that time. "The message," said Hegsted, "is one of moderation... . This represented a departure from prior recommendations which urged increased consumption of products designed to assure adequate intake of essential nutrients... . The Dietary Guidelines do not mean that there is less concern about essential nutrients, but rather that this concern must be combined with a concern for the constituents of the diet. It is not possible to throw a vitamin pill into a product and label it nutritious." It was noted in an article about the role



of cereal grains in the U.S. diet, published in *Food Technology* in March 1981 by Paul Lachance, that grain was the only consumption practice spelled out in the Dietary Guidelines that was positive. Americans were urged to eat more grain products.

In January 1982, the report of an IFT Ad Hoc Subcommittee on Research Needs listed ten areas in which additional research was considered necessary for the future: Food Safety; Energy Use and Conservation; Maintaining and Enhancing the Nutritional Quality of Food; Food Losses; Physical, Chemical and Functional Properties of Foods; Innovation and Technological Developments; Underutilized Resources; New Sources of Food or Ingredients; Utilization of Microorganisms for Producing Nutrients and Food Ingredients from Biomass; and Biomass Conversion to Energy. Discussion of industry-government cooperation in setting food research priorities appeared that month in *Food Technology*, in an article by Howard Bauman, the President of IFT that year and Vice-President of Science and Technology at Pillsbury. Discussions of this type became frequent, as industry, government, and academia all became aware of problems and opportunities for developing food products and sources in a context that included economic realities, agronomic change, and consumer concerns.

The two decades between 1980 and 2000 were decades of consolidation. ConAgra acquired Peavey Milling (1982), Quaker Oats bought Stokely Van Camp (\$208 million, 1983), then spun off the canned vegetable business, Pillsbury bought Haagen Daaz Ice Cream (80 million, 1983) R.J. Reynolds bought Nabisco Brands (\$4.9 billion, 1985), Cadbury Schweppes bought Canada Dry Beverages (from RJR Nabisco, 1985), Nestlé acquired Carnation Co.

(1985), and Beatrice Foods was sold to Kohlberg, Kravis, Roberts. KKR broke up the pieces, selling portions off to finance the deal, which cost \$6.2 billion. In 1988, KKR sold Tropicana Products to Seagram Co., and bought RJR Nabisco in a \$24.9 billion leveraged buyout. That same year, Philip Morris bought Kraft Foods for \$13.1 billion, forming Kraft General Foods.

Research departments were beginning to be modeled after research departments in other industries, and computer modeling of the research process was starting to emerge. Strategic planning was a commonly used phrase, and models that required defining forecast areas, looking at underlying science, identifying scientific trends and technical capabilities, and projections on the rate of innovations were included in strategic plans of research departments. Interaction between technical capabilities and business plans started to



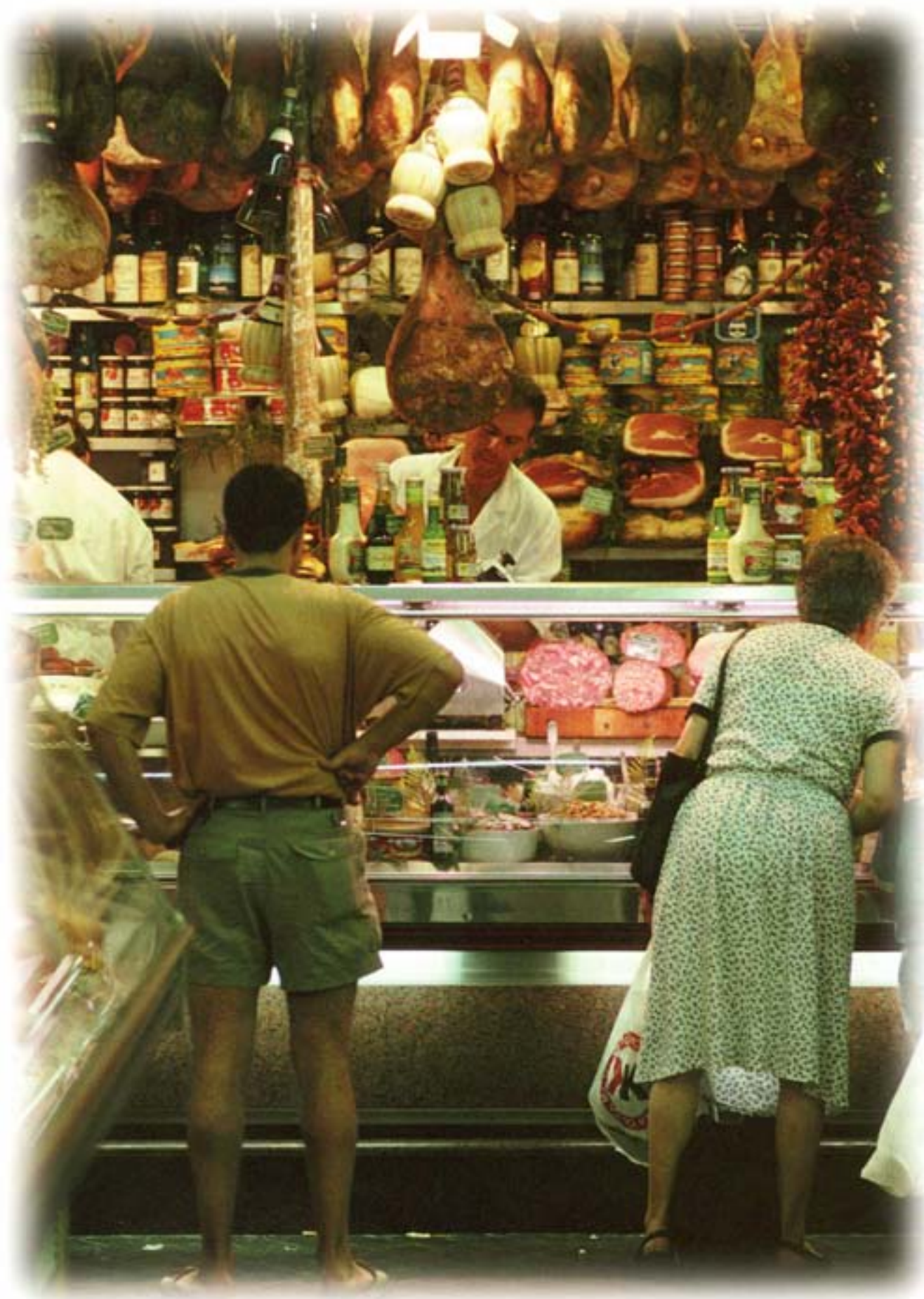
emerge in the mid-1980s. Part of the reason for the expanded use of technical planning was the high rate of new product failure, either as a function of salability or as a function of the ability to manufacture and control products that were at the edge of a company's expertise. An article in *Food Technology* in September 1982 described the process used at General Foods. The article noted:

"The following strategic planning process provides more insight into factors involved in such assessments and also objectives. This planning process is currently used by General Foods Corp. for managing its technical programs. The approach outlined probably will not fit every organization; as a matter of fact, our experience clearly indicates that an essential prerequisite for the success of a strategically oriented planning and assessment process is tailoring it to specific needs. However, some of the components of this process should be suitable in other environments."

General Food's process included a five-year planning phase and an annual planning phase. Strategic planning became a major goal of many companies, and a strategic plan often became a strategic plan, whether it was updated often enough or not.

In the September 1982 issue of *Food Technology*, Kenneth Carlson of A.C. Nielsen described the Food Marketing Environment, and referred to technology assessment as an internal concept. In that same issue, James Albrecht of Nestlé, listed several emerging technologies: genetic engineering of plants and animals, aquaculture, utilization of biomass production, expanded use of chemical sterilization, irradiation with gamma rays, retortable aluminum trays and pouches, and linear low-density polyethylene packages.

Albrecht also referred to major new food products over two decades. For the '70s, they included Pringles (Procter & Gamble); Country Time powdered lemonade (General Foods), Cup a Soup (Lipton), Stove Top Stuffing (General Foods), Hamburger Helper (General Mills), Carnation Breakfast Bar (Carnation) and Soup Starter (Swift). For the 1980s, Albrecht listed Side Quicks (General Mills), Lean Cuisine (Stouffer), Like (Philip Morris), low-sodium soups (Campbell), A La Carte (Kraft), and La Creme (Kraft). When we look at the technologies that assisted in putting these new products on the market (and most of them are still out there today), we find: Pringles (extrusion), Country Time (flavor system developments), Cup-a-Soup (dehydration technologies), Stove Top Stuffing (water activity developments), Hamburger Helper (dehydration techniques), Carnation Breakfast Bar (nutrition), and Soup Starter (dehydration techniques). The technology inputs met consumer needs for convenience, better nutrition on the run, and health-related developments.



Nutrition

Nutrition continued to be a topic of great interest, and discussions about what foods should be fortified, and to what degree, continued. An article published in *Food Technology* in 1995 debated the appropriateness of fortification of non-staple foods with iron compounds, considering the difficulties (which iron compound provided the most bioavailable iron) and whether iron fortification should be emphasized more for underdeveloped and developing countries. There was, of course, the debate over hemochromatosis, a minor disease (at least in number of sufferers) that could be exacerbated by broad fortification. Salt was considered a prime candidate, as was sugar and monosodium glutamate.

The relationship between diet and health was a major concern. Partially because of the Dietary Goals, concerns about sugar consumption were discussed in a number of papers published in *Food Technology*, January 1980, including Sanford Miller's classic paper that discussed sugar and dental caries, headlined "Regulation of a Nonmortal Hazard."

The January 1982 issue of *Food Technology* carried a report of the National Nutrition Consortium's forum on Nutrition and Aging, and reported on the impact of nutrition programs on aging people, in light of the future demographic changes.

Concerns about overweight were being felt: according to USDA, 20% of the \$290 billion spent at the grocery store was for "light" or "diet" foods. This didn't include the usual diet foods such as cottage cheese, skim dairy products, vegetables, and fruits.

Salt was of concern during the 1980s. In July 1983, an article titled "FDA Perspective on Sodium" was published in *Food Technology*, written by several FDA regulators. They summarized the FDA viewpoint by noting:

"Sodium, an essential nutrient, is being consumed in quantities that far exceed the amount necessary for normal development and health maintenance. The public health concern about sodium is based primarily on its relationship to hypertension. The current estimate of people with hypertension in the United States is 60 million, or more than 25% of the population. Persons suffering from hypertension or other sodium related disorders are generally advised by their physician to limit their consumption of sodium.

"A predominately voluntary program has been initiated to address the public health concern about sodium. The goals of the program are to provide more sodium information to consumers on food packages; to decrease the amount of sodium used in processed foods; to improve consumer understanding of sodium labeling, along with providing greater knowledge

about the relationship between sodium and hypertension and, ultimately, to lower the aggregate sodium consumption by the general public."

The result of a great deal of research on the role, metabolism, and function of sodium in the diet was the introduction of a number of foods with reduced sodium, such as the line of low-salt soups by Campbell and vegetables without added salt by Del Monte and other canners. When sodium was added to food labels, the amount of salt used appeared to shrink somewhat. Later a health claim for reduced salt was added to the label under the National Labeling and Education Act (NLEA), but this was removed when a series of clinical studies found little effect of sodium on cardiovascular disease.



New Products

Lean Cuisine was introduced by Nestlé's Stauffer division. The lower-calorie version of the popular "Red Box" entrees performed well over \$120 million in sales the first year (1981) and about a 30% share of market in the premium dinner market within three years. Sauces and gravies were reduced in fat content, and portion size was geared to produce meals with fewer calories.

Yoplait Custard Style, in a variety of fruit flavors, made a hit in 1981 with consumers who found plain yogurt too acidic for their tastes. The General Mills division developed a custard-style product with a creamy but short texture, produced by adding gelatin and modified food starch to the basic yogurt product.

Product improvements continued because consumers wanted better flavor and texture, and "New and Improved" started to replace "New" as a dominant theme on grocery shelves. For instance, Hunt-Wesson added more tomatoes to tomato sauce, in response to consumer wants for thicker tomato sauce for pasta. Campbell jumped on the better-sauce bandwagon by adding visible herbs and spices to a thick sauce, and introducing Prego pasta sauce. By 1983, Prego would be saying that "it's in there" to the tune of \$150 million in sales. Technical issues with the tomato-based sauces included dealing with higher viscosity and added herbs, both conditions that required more care in assuring safety.

Procter & Gamble bought Ben Hill Griffin, a small citrus producer in Frostproof, Fla., and started producing premium-quality orange juice in 1982. By 1986, P&G was using a patented calcium formula to enhance orange and grapefruit juice with calcium that provided improved bioavailability. The brand, Citrus Hill, offered major competition to Tropicana and helped to establish chilled, pasteurized juice as a category.

Hamburger, Tuna, and Chicken Helpers proliferated, giving General Mills a complete line of box dinners. The line, inaugurated in 1970, provided a one-pot meal with the addition of a pound or so of meat. The science involved was in flavor development, texture control, and cost containment. The dry ingredients sometimes were hard to locate, and quality control specifications were reportedly quite strict.

Campbell Soup Co. replaced the aluminum foil tray for its Swanson dinners with plastic trays for microwavability. Also in 1986, Swanson's Great Start breakfast sandwiches were introduced. By 1987, microwave ovens were in 12.6 million homes, and microwavable packaging was considered essential for almost any fast food from the grocery store. A great deal of research was done on placement of components in microwave trays, and on developing foods that were applicable to microwaving.

Awards for innovative packaging given at the 1980 IFT Annual Meeting included a package for lettuce. The award, given to General Mills, marked the clear beginning of the specialization of products that had been considered commodity foods. Leaf lettuce, Bibb lettuce, Boston lettuce, and salad spinach were produced as hydroponic products, and packaged with root systems intact, in inflated plastic bags to protect the plants from damage. By growing the products hydroponically, a continuous, year-round supply was ensured. This was a subtle change; fresh vegetables were specialized, branded, and introduced as a test product.

A patent was issued, assigned to General Foods, that updated the 1961 patent for gasified candy. PopRocks was the resulting product. It had been introduced in the late '60s, and abandoned. The reintroduced product reached cult proportions, engendering wild rumors and interest in the product. By entrapping carbon dioxide in a sugar melt, the candy "popped" in the mouth of the consumer.

Jelly Beans got a boost from the preferences of a popular president. Ronald Reagan loved Jelly Bellies, made by the Hermann Goelitz Candy Company. Jelly Bellies continued to increase the number and exotic nature of jelly bean flavors. In 1988 Hershey Foods test marketed Kisses with Almonds, wrapped in gold foil instead of the familiar silver.

Kellogg's introduced Nutra-Grain wheat cereals in 1981, and this entry was followed by other non-sugar, vitamin-enriched cereals throughout the decade. In 1987, the firm introduced Just Right, a premium "natural" cereal that included grain flakes and dried fruits plus nuts.

In response to consumer concern about overweight, and the cardiovascular concerns of ConAgra's CEO, Mike Harper, Healthy Choice frozen dinners were introduced to the media in January 1989. The dinners contained restricted amounts of saturated fats, salt and calories.

By the mid-1990s, the Healthy Choice line grew to more than 300 items, both by internal development and by strategic alliance.



SnackWells became a popular brand for Nabisco, as the cookies and crackers with reduced-fat or fat-free formulas replaced products that had been involved in "cookie wars," the rapid increase in cookie products that were "crisp on the outside and chewy on the inside." The soft-on-the-inside products eventually resolved themselves into a few prize products. SnackWells, formulated to use sugars and carbohydrates to replace fats, became a popular brand for other products as well, and was the basis for several joint ventures.

New Ingredients

While high-fructose corn syrup had been around since the mid-'60s, the adoption of 100% HFCS by both Coca-Cola and Pepsi replaced about eight million tons of sugar. Tate & Lyle, the British sugar company, bought the A.E. Staley Co. for \$1.9 billion, and became a major player in the HFCS market, hedging against loss of sugar volume in soft drinks.

The rapeseed products, including protein and meal, had reduced levels of erucic acid and glucosinates compared to native product. New varieties of canola were produced by hybrid processes and offered a particularly low content of oleic fatty acid by the late 1990s. Rapeseed with 6% saturated fats was common, and canola oil gained the status that corn oil had enjoyed in the 1970s and early '80s.

Olestra, a sucrose polyester-based molecule, was submitted for FDA approval early in 1987. Later that year, Procter & Gamble found a way to bond vitamin E to the esterified sucrose polyester, preventing loss of the vitamin because of a lack of absorption of the fat into the lower gut.

Simplex, a fat replacer made from albumen and casein and processed to have specific small particle sizes, provided 1.5 calories per gram, and was used in non-fried applications, particularly in frozen desserts.

Polydextrose, a large, randomly linked polymer of cross-linked glucose polymers with sorbitol end-groups and monoester bonds with citric acid, was introduced after a food additive petition was filed with FDA in December 1978. The polymer was particularly useful for use in low-fat foods, as it added structure that was often lacking when an oil phase was removed from foods. The amendment to the food additive regulation was published in the *Federal Register* on June 5, 1981.

High-oleic safflower oil was introduced as a replacement for saturated oils in the early 1980s, and the role of specific fatty acids in flavor development was better understood. Sunflower oil was used to prevent flavor reversion without employing hydrogenation.



Flavors produced by enzyme reaction on protein substrates started to become popular. Enzyme-modified cheeses provided more flavor per volume, and were introduced by a number of companies.

On July 15, 1981, FDA Commissioner Arthur Hull Hayes declared aspartame to be safe for use as a tabletop sweetener and in breakfast cereals, dry bases for beverages, dairy products, toppings, and certain other uses. Aspartame had originally been accepted by FDA in 1974, but its use had been delayed because of safety questions.

Changes in processing of products with the increased use of aseptic processing, high-temperature short-time processing, and other new and improved ways of processing products with less heat and time, resulting in fresher flavors and better retention of nutritive contents, spurred research into developing flavors with better stability under specific processing conditions.

Stellar, a modified food starch that is microparticulated for easier water binding, was introduced by the A.E. Staley Co. in 1990, offered for use in baked foods, frozen products, and other fat-replaced foods. Because the product is a modified food starch, it did not require FDA approval.

The first applications of gellan gum, the extracellular polysaccharide from *Pseudomonas elodea*, were discussed in 1983 in *Food Technology* and trade magazines. Not approved until the early 1990s, the gum was one of a few truly new ingredients under development at this time.



Maltodextrins, first described in enzyme publications in the mid-'60s, were produced and sold in quantity during the 1970s. The "small sugars" with Dextrose Equivalents in the below 20 D.E. range were rapidly soluble, formed films, and were relatively bland. Made as an outgrowth of the corn syrup refining systems and spray dried, the white powders were used as spray-drying aids, bulking agents, and fat-sparing ingredients. The products were considered GRAS, and defined as such in the early '90s.

Food Safety and Regulations

Food safety was an issue both for consumers and for food processors. During the early 1960s, the Flavor and Extract Manufacturers' Association had developed a panel for the establishment of Generally Recognized as Safe affirmation of flavor chemicals and similar substances. FDA accepted the FEMA GRAS list, and the compilation was published in *Food Technology*, first in 1964 and periodically since then. But for substances that weren't involved with flavors, getting a new ingredient approved as a food additive was a time-consuming activity that took years. Industry groups made several attempts to gain agreement with the Food and Drug Administration to push for faster action, and more agreement about which tests were essential and how these would be run. In the late '70s, a group called the Food Safety Council formed and produced a report titled "Principles and Processes for Making Food Safety Decisions," published in the March 1980 issue of *Food Technology*.

The situation with food additives was that the system prevented clearance of products for a very long time, making formulators and manufacturers unsure of what products could be used, and generally slowing new product development. The Food Safety Council evaluated the regulatory process, and found that responsibility was fragmented to a degree between FDA and USDA, with some power to regulate ads assigned to the Federal Trade Commission. The controversy arising over the Delaney Clause led former FDA Commissioner Edwards to comment:

"My personal view and that of the FDA is that we have to have more flexibility of interpretation or we are put into the position that we were in with cyclamates—all or nothing. And it becomes a highly emotional issue at that point, allowing no discretion on our part or anyone else's."

The Food Safety Council's report was published as a talking paper, for consideration of the Food and Drug Administration to use in developing an official position. The introduction of the document made recommendations:

The Social and Economic Committee of the Food Safety Council recommended a new approach to the regulation of food safety. This approach called for the adoption of four governing principles, the observance of three directives for action, and the creation of a structure and procedures to achieve better decisions.

Governing Principles

The regulatory process should:

Promote consumer choice, with regulation to be established only where necessary;

Operate in the interest of consumers and foster those choices that a well-informed consumer would make;

Treat all ingredients, regardless of source, consistently, using the same criteria but recognizing the practical limitations of regulating equally; and

Provide for a broad array of regulatory options adequate to safeguard the public health, yet consistent with prudent choice.

Directives for Action

In implementing the four governing principles, the regulatory process should include:

The full and explicit, as opposed to limited and implicit, weighing of benefits as well as risks when risks are significant;

The generation and dissemination of extensive information on the scientific, social, and economic dimensions of the problem under consideration; and

Full participation on the process by all parties with a stake in food regulation, including representatives of processors and consumers, in an open and public manner.



Procedural Structures

As a substitute for the present regulatory system, the Social and Economic Committee recommended establishing a new, partially independent body called the Food Safety Assessment Committee, composed of a representative cross-section of society, with appropriate supporting technical panels designed to assess difficult policy issues in the food safety arena and to recommend courses of action.

The Committee emphasized that:

The authority of food safety decisions still rests with the Administrators of the regulatory agencies; and

The authority of food safety decisions will continue to be handled by the staff of a regulatory agency, with the FSAC becoming involved only when important and difficult decisions are to be made.

Requirements to tabulate risks and benefits are quite different under the proposed system. A complete accounting of risks, following procedures such as those laid out by the Scientific Committee, must accompany any proposal for use. The tabulation of benefits required will be a function of the risks perceived, and rarely will a comprehensive tabulation be required."

The outcome of the Food Safety Council's directive and, to an extent, that from FEMA, was an increased ability to do risk analysis using scientific methods and a statement of the need for consistency in screening substances for toxicity. The statements from this group was to avoid the stated conditions that held that the "food supply is neither as safe or as abundant and economical as it could be, for the regulatory process is carried out in ways that are inconsistent and wasteful."

In 1981, IFT's Expert Panel on Food Safety and Nutrition published a Scientific Status Summary on the status of open shelf-life dating of food. This document, published in the February 1981 issue of *Food Technology*, evaluated various types of open dating that could be used, and identified the types of dating that would be most appropriate for the products involved.

In the late '70s and early '80s, concern about the presence of aflatoxin in grain increased. Aflatoxin, a powerful carcinogen, had been found in mold-damaged grain, and use of this grain did not meet the requirements of good manufacturing practices, and there was a

- large body of research devoted to identifying the presence and amount of aflatoxin. A new compliance guide for identifying the presence of aflatoxin B1 in foods was issued in early 1982. In 1983, a new compliance guide was issued using negative-ion chemical ionization mass spectrometry for identification of aflatoxin B1 in foods. The new procedure took a few hours instead of about three weeks, and made identification of the toxin more manageable.

Food regulations derived from new processes appeared. A definition, standard, permitted uses, and labeling requirements for “mechanically separated (species), formerly referred to as “mechanically deboned meat,” “tissue from ground bone,” and “mechanically processed product” appeared in the *Federal Register*, June 29, 1982, developed by USDA. The issue of deboned meat and tissue had been discussed for a few years. Clearly, the material was useful to manufacturers, but concerns both about value to the consumer and possible bone chips continued to be a problem.

The Federal Trade Commission terminated its second attempt at advertising rulemaking in 1983, after it found that determining some definitions was unlikely to produce agreement. Some of the subjects of the proposed rulemaking were weight and energy control claims, cholesterol and fatty acid content, and natural food claims, which would be dealt with in later regulations by FDA. The Environmental Protection Agency (EPA) reported that Alar, used to ripen fruit that was picked green and ripened under controlled conditions, particularly apples, posed a significant risk of cancer to those who consumed them. Eighteen months later, the product was banned after a number of supermarket chains had stopped accepting Alar-treated apples. The use of public relations to affect the change was questioned by many, particularly orchardists, who failed to see a connection between actress Meryl Streep's opinions and real damage. Apple growers suffered losses that they set at about \$50 million in unsold apples.

Major signs of problems with a dietary supplement surfaced with the findings of eosinophilia myalgia syndrome. The symptoms included high white cell blood counts, muscle and joint pain, extreme weakness, and the inability to chew normally. The cause was found to be contaminated L-tryptophan. FDA recalled all products that contained tryptophan. Because of this incident, which claimed the lives of 63 people, the concern that FDA would ban supplements grew and may have contributed to the climate that caused Congress to intercede for vitamin supplements, resulting in the Dietary Supplements Health and Education Act.

The decade of the 1990s was clearly a time for food safety concerns, as “fresh” food from all areas of the world came to tables accustomed to commercially sterile foods. More research into specific ways to eliminate foodborne illness, including microorganisms that had not previously been identified, was funded by the Clinton Administration, and emphasized by governmental agencies.

Conclusion: Looking at the New Millennium

Because we're not sure if the "New Millennium" really starts in 2000 or 2001, we can look ahead loosely, until sometime around 2020. At that time, according to the World Bank, the population of the world will have essentially doubled, and the major centers of populations will have shifted to the developing countries away from what we consider today to be the developed world. Farm land will be even farther from urban centers, and a considerable portion of today's most prolific producing areas will be lost to a criss-cross of concrete. The consumer problems relating to genetically modified crops, including both plants and animals, will have reached some level of accommodation, and additional production will meet most of the needs of a recently stabilized population. Barring catastrophe, food will be distributed more efficiently, and the level of starvation will have been alleviated.

Catastrophe has been a silent visitor at the dining table throughout most of human history, and we can assume that the periodic drought, war, pestilence, and disease will accompany humankind during this era. But the knowledge to increase agricultural production is improving daily, and information about better packaging, shipping, and handling will improve the ability to satisfy consumer needs.

The trends at the end of the 20th century were fairly clear: consumers in the developed world were concerned about ease of food preparation or the ease of accessibility through prepared foods; the nutrition and health-giving characteristics of foods; and concern for the "naturalness" and wholesomeness of food and the wider variety of foods in all forms. Price, while it remains important, is a secondary consideration in a major part of the developed world. Price and cost, however, are all-important to developing countries and to the poor in all countries.

The consumption of calories in the United States is leveling off, as are new product introductions. Foods now being developed are following the concept of caloric/nutrient density, a characteristic rejected by nutritionists, food processors, and consumers when it was introduced during the 1970s and 1980s. "No good foods/no bad foods" has gone the way of the buggy whip, and nutritional correctness does not leave much room for foods with high fat levels. Foods will continue to be developed for flavor and for convenience, as the world is unlikely to slow its pace very much.

The biggest hurdle will be feeding all of the world, if we hope to continue to live on planet Earth in any semblance of peace. Biotechnology will most likely to solve its current consumer problems, and more products with better nutrient density will be grown. Will foods be grown in space? The technologies probably exist for success in that role currently, and are

being developed further. The exact kind of foods that will fit the individual human is likely on the horizon. But we humans are a stubborn lot, and slow to adjust to new ideas. Throughout the past century, time and again consumers rejected safe methods until it became clear that there was little choice to change. We would expect that food science and technology will continue to grow with the need for food and that the mission of the Institute of Food Technologists will guide the development of new and better foods.

