A Look into the Future of Food Science & Technology

Representatives of IFT's 26 Divisions tell what they foresee happening in their respective Division's area of expertise over the next few years.

Neil H. Mermelstein, Editor

The Institute of Food Technologists has 26 Divisions, which are considered to be the organization's centers of excellence. As we enter a new year, it seems appropriate to ask representatives of these divisions to forecast what they believe will happen in their Division's area of expertise over the next few years. Here is what they told me.

Biotechnology

In recent years, the food industry has begun to experience the vast potential biotechnology offers for improving our food and food production processes through precise engineering. For the first time in our history, the potential to create true designer foods is now a reality. Few would disagree that food biotechnology will be the fastest growing and most visible sector of the food industry over the next several years. Like all high-impact technologies throughout history (such as pasteurization, canning, and air travel), there is a natural initial reluctance to embrace food biotechnology. We are currently witnessing this, and the primary reason for this reluctance in the majority of consumers is the fear of "unknown consequences" from the use of a new technology, currently understood only by trained individuals. History has shown that the remedy for such fears is time, knowledge, and, most important, significant tangible benefits to the consumer.

In the coming years, consumers will realize that genetically modified foods have been part of human diets for many years without negative consequences. We will see a more educated consumer on the realities of genetic engineering. More significantly, we will see products of food biotechnology with unquestionable tangible benefits to the consumer. These will include such designer foods as healthful cooking oils, nonallergenic peanuts and soy, increased cancer-fighting antioxidants in everyday foods, tasty fat-free foods, long-shelf-life natural foods, and anti-aging foods. Other tangible benefits of biotechnology will be increased safety of foods due to more sensitive and rapid detection of microbial and chemical hazards, and the availability of natural, nonmutagenic, effective biopreservatives.

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A Look into the Future

While there are currently numerous fictitious prophecies circulating about food biotechnology, the next several years should see significant growth in this sector buoyed by a more knowledgeable, discernible, and anticipative consumer.
—Daniel J. O'Sullivan, U. of Minnesota

Carbohydrate

Carbohydrates—comprising starch, non-starch polysaccharides (fiber constituents and gums), and processed starch products ranging from maltodextrins to oligosaccharides to sugars and high-fructose corn syrups—have wide-ranging roles in processed food products. In the near future, one can expect that the health benefits from consumption of certain classes of carbohydrates will be emphasized.

In the starch area, "resistant starch"—starch not reacted on by our endogenous amylases—and slowly digesting starches may be put to greater use in processed foods for their role in improved colonic health, generation of beneficial short-chain fatty acids, and slow energy release for those predisposed to diabetes, as well as sports-minded individuals. Such starches that have adequate functionality in foods and retain their digestibility characteristics after processing will be most useful.

Likewise, regarding uses of non-starch polysaccharides and oligosaccharides for health benefit, certain classes of carbohydrates, such as arabinogalactans and inulins, may become more commonly used for their prebiotic property, resulting in improved colonic microflora. The non-nutritive and semi-nutritive sweetener arena may see additional products that can be used in a variety of processed foods and beverages.

In the foreseeable future, though perhaps not significantly in the next five years, genetic manipulation of starch, of both components and structure, will likely spur development of novel starches with unique uses. Already existing products, including high-starch potatoes and amylose-free potato starch, may become more commonly used in the industry. Also, new products will likely be generated that have designed starch structures that give specific and new functionalities.
—Bruce R. Hamaker, Purdue U.

Citrus Products

In the next five years, there will be an emphasis on evaluation of fruit juice products for quality improvement to help U.S. processors compete in a global market. There will continue to be development of juice products from milder processing methods that are less damaging to flavor. The popularity of not-from-concentrate juice continues to rise, and marketing is expanding into the international arena. New techniques will be developed for evaluating citrus, including determination of sensory threshold for important flavor compounds and the correlation of information from sensory panels with qualitative data to help industry provide higher-quality products. This information will also be useful to both the fresh-fruit and processing industry as it contributes to the selection of improved-flavor citrus cultivars.

Processing techniques and storage conditions will be developed and evaluated such that optimal quality and safety will result for citrus juice products. New Hazard Analysis Critical Control Point (HACCP) regulations concerning transport of juice concentrate will require an understanding of the science behind the regulations and determination of the necessary steps for compliance. Value-added products will be developed from citrus peel waste. For example, nutraceutical products will be developed from phytochemicals present in citrus peel, and new industrial uses will be found for citrus pectin.
—Elizabeth A. Baldwin, USDA/ARS

Dairy Products

The dairy industry faces a number of changes and challenges that will affect all areas of its operation, including milk production, finished products, research and development, marketing, sales, and distribution. Changes in the dairy compacts and consolidation of companies and co-ops will affect the production and distribution of milk. These changes may result in shortages—or surpluses—of milk in some regions. Increased consumer demand for innovative foods, in terms of nutrition, nutraceuticals, and ethnic foods, will require processors to develop and utilize novel technologies and ingredients to produce value-added dairy products with superior taste and extended shelf life.

To compete with other beverages and foods, the dairy industry must better inform consumers about the health benefits inherent in dairy products and ensure that dairy products are convenient, appealing, and available everywhere. Therefore, the clinical trials necessary to prove the efficacy of functional dairy foods and food components will progress.

Increased demand, new marketing strategies, and greater availability will result in more dairy products being sold through alternative distribution channels, such as retail and drug store chains. Sales and R&D work will continue to shift to the ingredient market vs. retail. Milk and dairy products will be packed in a new generation of containers and packages. New global market conditions have created the need for development of an effective and fair export/import trade system. Food safety and biosecurity will continue to be of paramount importance.

Universities must continue developing programs to meet the demand for trained and experienced faculty who will prepare qualified students for successful careers in the changing and evolving dairy industry.
—Valente B. Alvarez, Ohio State U.

Education

The greatest challenge of education lies in the recognition that the need for education never ends. From the classroom to the boardroom, from food industry workers to government employees, it is the role of educators to meet the dynamic, rapidly changing needs of individuals by fostering a continued quest for learning, discovering, and challenging accepted doctrines and the status quo.

Futurists have estimated that 20% of what an individual knows today will be obsolete next year, with more data being created in the next three years than in the whole of human history. Today's professionals need the ability to filter a sea of information and make wise, thoughtful decisions quickly. They need to know how to access accurate information instantaneously. They need to be aware of the bottom line, as well as the social, psychological, and environmental implications of their decisions.

The definition of education has moved from the passive of "imparting knowledge" to the active of "critical

thinking, reasoning, and making judgments." Likewise, education methodologies have been transformed from a one-way dialogue complete with chalkboard to multiple dialogues using multimedia technologies complete with simulations and realities from around the globe. CD-ROMs, electronic journals, and computer conferencing are becoming the norm. As a result, food science educators are recognizing that today's learners need skills in digital literacy, innovative thinking, effective communication, and teamwork. Food scientists around the globe have recognized the importance of coaching and peer learning.

In academia and industry, the word "training" is being replaced by "learning." The concept of "teaching" is being replaced by "facilitating student learning." Both "learning" and "facilitating student learning" focus on empowering individuals to set their own objectives, make decisions, and self-assess. Food science education and food science educators are meeting the challenge and succeeding.

—Marilyn A. Swanson, U. of Mississippi

Extension

Food safety will continue to be at the forefront of Extension's role in educating the general public and food handlers. However, the scope of food safety education is expected to widen and encompass new subjects that will go beyond traditional programs focused on minimizing microbiological hazards.

Genetically modified organisms (GMOs), organic foods, irradiation, nonthermal food processing methods, bioterrorism, and other emerging issues or technologies will challenge extension educators in three ways: where and how to communicate about these issues to the lay public in user-friendly formats without much scientific jargon; how to assist small and medium-sized food processing industries in the transfer of new technologies to their operations; and how to maintain the public's view of extension as a reliable and trustworthy source of information and keep projecting the perception of neutral educators on some very controversial issues.

Extension professionals will have to stay very well informed and develop a keen knowledge on a range of subjects and an understanding of all the intricacies and viewpoints surrounding controversial issues.

Extension's bright, successful history in adapting to change quickly and effectively is a good indicator of its potential to deal with these issues in a timely manner over the next five years through creative educational opportunities and appropriate delivery systems.

—Fadi M. Aramouni, Kansas State U.

Food Chemistry

Consumers' food choices are driven by the issues of safety, taste, convenience, health, and value. In the food chemistry arena, these factors provide the impetus for continued research on both convenience foods and foods with healthful or physiologically beneficial components (i.e., functional foods). Although the necessity for traditional nutritional analyses will continue to be an essential component of the discipline, the goals and methodologies employed in food chemistry are evolving and expanding to meet industry, regulatory, and consumer requirements.

> Innovations are expected in transforming bench-scale processes to industrial-scale manufacturing of foods while maintaining desirable quality attributes.

For example, in recent years there has been a tremendous increase in the amount of research focusing on the identification of the naturally occurring chemicals in foods that provide healthful benefits and their use as ingredients in a broad spectrum of products. The tremendous pressure to develop products containing GMOs must be matched with research to determine the safety and compositional attributes of these products. Other safety factors, including food allergens, will continue to be the focus of research.

Despite economic trends, the food industry will continue to respond to consumer demand for healthier, more-convenient foods. It will be the responsibility of the food scientist to develop such products and adopt the analytical methods required to meet these new challenges.

—Wayne C. Ellefson, Covance Laboratories

Food Engineering

The food engineering discipline has provided a strong basis for major improvements to be made in processing operations throughout the food chain—from the farm gate to the consumer. Building on recent advances in food sterilization, dehydration, freezing, extrusion, and separation processes, food engineers are now seeking new approaches to combining these processes synergistically. Innovations are expected in transforming bench-scale processes to industrial-scale manufacturing of foods while maintaining desirable quality attributes. However, processing efficiencies related to the use of resources such as energy and water in a number of food operations will require dramatic improvements.

Recently, there has been a growing interest in the area of nonthermal processing of foods. Emerging technologies using pulsed electric fields and high pressure have engaged food engineers to seek new materials for equipment, determine process conditions for high-quality foods, and ensure the safety and reliability of the process. A continuous stream of new materials has appeared on the market for applications in separation processes, such as a new generation of membranes. These materials will significantly enhance a range of applications in food processing, from minimizing water use in processing plants, to improving efficiency in separating high-value components in foods that have desirable food and nonfood applications.

Food engineers have made pioneering contributions to the quantitative understanding of food properties and processes. Advanced computational techniques will provide a better mechanistic understanding for designing food processes in the future. At the molecular level, knowledge of food properties and reaction kinetics will provide the required basis for creating desirable food structures and functions that can be scaled to the manufacturing level. A quantitative understanding of food properties and advances in sensing technologies, such as ultrasonic and magnetic resonance imaging, will en-

hance the development of advanced online sensors for use in food manufacturing.

These advancements will require food engineers to use highly creative approaches in designing food packaging systems, including the use of edible coatings for increasing shelf life to deliver a high-quality product to consumers.

—R. Paul Singh, U. of California–Davis

Food Laws & Regulations

Although things have been rather quiet in recent years relative to new laws and regulations that require implementation by a significant segment of the food industry, this is expected to change in the coming years. We anticipate laws and/or regulations that deal with subjects such as trans fatty acid labeling, implementation of the U.S. Dept. of Agriculture's organic labeling provisions to Food and Drug Administration–regulated foods, more clarification of applicability of structure and function claims for conventional food products, and more comprehensive regulation of dietary ingredients and supplements.

Many of these issues are a part of FDA's highest priority and certainly are of importance to all segments of the food industry as it attempts to produce and market foods that meet current consumer interests while complying with new and evolving regulatory requirements. In some cases (e.g., structure and function claims), we must be careful to not let marketing messages get ahead of the scientific support of the claim being stated or implied. In other cases (e.g., structure and function claim limitations on dietary ingredients in conventional foods), we must wait for a review and possible modification of these restrictions. Many believe it is unreasonable for structure and function claims to be permitted for dietary ingredients in dietary supplements but not be allowed for those same components in conventional food.

We can expect continued and broad activity in the area of dietary supplements as FDA works with the National Academy of Sciences' Institute of Medicine in review the safety of many dietary ingredients. FDA has a priority for more timely and expedited investigations of adverse event reports as part of the safety assessment of dietary ingredients.

USDA's final rule on organic labeling includes provisions for appropriate statements relative to use of the word "organic" on FDA-regulated foods. Although of lower priority, FDA should provide additional interpretation of these provisions through new or modified labeling regulations.

Food safety continues to be a major emphasis at FDA and USDA. We can expect continuing efforts to ensure safe food. FDA plans to do this in a number of ways, including more inspections of domestic producers of food considered "high risk" for microbiological contamination and more frequent inspection of imported "high-risk" foods.

A final rule on trans fatty acid labeling is scheduled for publication "soon." This will require changing the Nutrition Facts panels on most consumer food packages.

Food scientists and IFT must support vigorously the continued development and implementation of production and marketing requirements that are based on sound science and technology and provide a variety of resources to decision makers as necessary to achieve this goal.

—James L. Vetter, Technical Assistance Services

Food Microbiology

The tragic events of September 11, 2001, have raised the issue of biosecurity in food production throughout the supply chain, from procurement and conversion to distribution and consumption. This has resulted in a heightened awareness of the critical role food microbiologists play in assuring the safety of our food supply. Industry's implementation and reliance on the HACCP approach to ensure food safety has also provided a sound foundation to address this new food safety challenge.

Advances in rapid methodology and identification techniques have enhanced the tools food microbiologists have to manage food safety risks. Similarly, advances in preservation and process techniques such as irradiation improve the food microbiologist's ability to manage these risks. Unfortunately, at this time many of these techniques are commodity specific, haven't been embraced by consumers, still require regulatory approval, or are cost prohibitive.

Continued methodology improvements in characterization and sensitivity are outpacing our understanding of the significance of the findings. Pathogens will continue to emerge as public health tools such as epidemiology are broadly applied throughout the supply chain to assess and manage potential microbial risks. Food microbiologists will continually face the need to identify control strategies for the pathogens of tomorrow using today's tools. At the same time, we need to better prepare ourselves by conducting research to develop new tools to address future food safety challenges.

—William H. Sveum, Kraft Foods North America, Inc.

Food Packaging

Conversion from paperboard or glass to flexible and semi-rigid plastic will continue over the next 2–5 years. Food companies will continue to turn to flexible packaging because of cost savings, source reduction due to thinner films, technological developments such as oxygen-scavenging films, and different package formats such as standup pouches. The trend of branded packaging will demand higher-quality printing, which will include digital, embossing, and holographic technologies. Processors will continue to expand and differentiate their case-ready packaging of fresh meats and prepared foods through package design, added convenience features, and extension of shelf life by the use of novel gases in modified-atmosphere packaging and high-barrier materials.

A main driver for packaging will be consumer convenience, such as ease of opening and reclosability, tamper evidence/resistance, dual ovenability, and features for product dispensing and portability. Packaging equipment will be designed with greater flexibility, faster machine speeds and changeover times, and improved in-line automation. Advances in new materials will lead to improvements in mechanical properties, barrier properties, and stronger sealability at lower temperatures.

Active packaging will continue to grow in market share, especially in the area of oxygen-scavenging technology. Shelf-life extension and product safety could be addressed by active packaging formats, such as antimicrobial packaging, freshness indicators, and time–temperature indicators. In the future, smart packaging, with either a comput-

er chip or a circuit printed on the package, will start to emerge. It will contain information on product identification from raw material to packaging, time–temperature history, pricing, and labeling information, including recipes and cooking instructions, and it will ultimately communicate with household appliances.
—Leslie E. Cook, Cryovac, Inc./Sealed Air Corp.

Foodservice

Among foodservice's future challenges are to have desired food available where and when consumers want it, provide guaranteed food safety and nutritional value, and offer authentic flavors and textures in personalized menus. The following is a peek at one solution.

It's the usual hectic workday, and Pat is driving between appointments. Accustomed to eating in the mobile office, Pat uses a personal digital assistant (PDA) to select a favorite hand-held meal from a food broker. Choices are based on information from Pat's personal chef, offering a menu of various Mediterranean/Asian fusion wraps. Additionally, Pat's nutritional preferences for the day are noted so the correct supplements can be incorporated. The broker's computer transmits the order to a preparation center along Pat's route. There, a robot brings ingredients out of storage, where they were delivered as portions early that morning, assembles the hand-held meal, and places it in an oven to heat rapidly by microwave/impingement. Communicating with Pat's PDA, the oven times the heating cycle correctly to have the meal hot just as Pat drives by. Sensors inside the oven detect any inconsistencies in the meal's weight or formulation and adjust the heating cycle to match Pat's arrival. One of the sensors is set to identify pathogenic organisms or their by-products; the oven adds an electron beam to the microwaves to disable such hazards. Just as Pat's license is scanned for payment, the robot removes the meal from the oven, places it in an insulated package, and hands it to Pat, who is already thinking about a later snack.
—Mel Mann, Domino's Pizza, Inc.

Fruit & Vegetable Products

Fresh-cut products—minimally processed, refrigerated fruits and vegetables—are an important and rapidly expanding food segment of interest to the produce industry, food manufacturers, retail food outlets, restaurants, and institutional food establishments, and the demand for this type of value-added products will continue to increase over the next several years.

These products will be designed to respond to the growing demand for convenience in food preparation and consumption. Included in this area is an increasing demand for minimally processed tropical and other non-native fruits and vegetables. To meet this demand, food scientists and engineers will need to continue to develop novel approaches to ensure safety and increase shelf life. Advances in nonthermal processing may include use of ozone technology or irradiation and novel packaging techniques.

An area of continuing struggle or debate for both producers and consumers will be the use of biotechnology advances to improve the quality of fruits and vegetables.

An area of continuing struggle or debate for both producers and consumers will be the use of biotechnology advances to improve the quality of fruits and vegetables. Additional consumer education regarding the benefits of biotechnology needs to occur prior to consumer acceptance.

Research over the next several years will be geared toward maintaining good flavor and shelf stability in fruit and vegetable products, while delivering different forms of a highly perishable, fresh product in user-friendly packaged sizes.
—JoLynne Wightman, Artemis International, Inc.

International

Food safety, food security, nutraceuticals, new processing and packaging technologies, additional discussions on GMOs, standardization, and modifications to regulatory guidelines will dominate the scene in the world of food science and technology in the next few years. The globalization of the economy will drive many changes in the way foods are processed, distributed, and consumed, and key international organizations like the World Health Organization and the Food and Agriculture Organization will be extremely active in leading efforts to minimize the impact big food business will have on the poor, mainly from underdeveloped countries.

The threat posed by emerging food pathogens, combined with recent developments in microbial inactivation kinetics, will prompt changes in the definition of sterilization and pasteurization, and the revision of these basic concepts will lead to new processing and regulatory guidelines worldwide. These changes will eventually result in the industrial adoption of some carefully selected emerging technologies and a sound combination of conventional and advanced food processing methods. Extensive discussion among key world scientists from industry, academia, and regulatory agencies will take place to develop much more uniform criteria on food labeling, including nutrition claims and the concept of "fresh."

Progress in electronic communication at the global level will facilitate the dissemination of knowledge in food science and technology via, as examples, electronic publishing, virtual conferencing, and Internet teaching. Similar tools will also have a dramatic impact on the international trade of foods.

Through new knowledge, advanced technologies, improved communications, and better regulations, plus the strong desire of most people to live in peace, the world will be better fed in the years to come.
—Gustavo V. Barbosa-Cánovas, Washington State U.

Marketing & Management

Although food scientists and technologists' training is primarily technical, marketing and sales activities may command much of their attention. Over the next 5–10 years, marketing and management skills will become more in demand as the industry experiences further consolidation. This represents both an opportunity as well as a challenge for technology. The challenge

will be in the form of knowing how to manage and communicate technical information so that it is integrated with other product information sources to yield actionable recommendations.

Historically, food scientists and technologists have been content to report information and not be concerned about how that information fits within a brand's business plan. However, success for food scientists and technologists will come from understanding the basis on which decisions are reached and being involved in that process. A variety of programs are being developed by companies and organizations such as IFT to meet these challenges.
—Herbert Stone, Tragon Corp.

Muscle Foods

Certainly, one of the biggest current challenges in muscle foods is that raw products may be contaminated with pathogenic microbes. Tremendous strides have been made in recent years to reduce this contamination, including acid washing of beef carcasses in combination with vacuum-steam treatment, phosphate washing of poultry, and irradiation-pasteurization of red meats and poultry. We will continue to see improvements in microbial quality of uncooked products. New antimicrobial treatments are under investigation, including hydrostatic pressure, pulsed-electric field, and magnetic field treatment of raw trim, and wash treatments using bacteriocins (nisin and related compounds) or activated lactoferrin (antimicrobial milk protein) on carcasses. The challenge is to offer these new antimicrobial treatments without excessive cost.

We will see an increase in the traceability of raw meat products from the retail market back to the packer, feeder, and farm, and even to individual animals, allowing companies to develop brand assurance on issues such as animal feeding regime, country or region of origin, trichinae-free pork, and use or non-use of growth stimulants and antibiotics. Efforts to establish traceability have their roots in the bovine spongiform encephalopathy (BSE) scare in Britain in 1996, and to outbreaks of *Salmonella* in Danish pork at about the same time. These food scares, coupled with a lack of confidence by European consumers in government regulation of food safety, led to the establishment of European traceback systems. Capturing and cataloguing traceback information (animal birth date and site, feeding and handling regimes, slaughter location, grading information, shipment dates, packer, retail outlet) will require electronic systems currently under development for tracking carcasses and carcass parts through the packing house and the retail distribution chain. Although traceability is mandatory in Europe, traceback systems in the United States will develop on a voluntary basis, as companies seek to reassure consumers regarding the microbial quality of their products, even to the farm level.

We will see continued increases in the volume of raw meat products prepared at the packing house in the case-ready format and delivered to retail markets ready for display. The challenge is to maintain acceptable appearance and quality for a period of weeks, rather than days, after packaging. New packaging methods using high oxygen content allow maintenance of desirable red color (bloom) for 10–14 days, but off-flavors develop after about 7 days. New research indicates that beef refrigerated in modified-atmosphere packages (MAP) with 0.5% carbon monoxide and 60% carbon dioxide maintains desirable red color and microbial quality for at least 5–6 weeks. Packaging systems using low levels of carbon monoxide are already approved and widely used in Norway. With the trend to case-ready fresh meats, MAP systems using carbon monoxide will be considered for use in the U.S.
—Daren P. Cornforth, Utah State U.

Nonthermal Processing

The demand for minimally processed, pathogen-free, fresh foods with a refrigerated shelf-life of 1–2 months continues to grow. Irradiation, high pressure, high-temperature/short-time heat pasteurization with rapid cooling, modified and controlled atmospheres, and several chemical additives, including carbon dioxide and bacteriosins, are available. FDA regulations of these technologies include specified treatment conditions on a food-by-food basis for irradiation, broad guidelines for the use of heat for pasteurization, and the need for good manufacturing practices for foods pasteurized by high pressure and distributed under refrigeration. The regulation of processes such as high-pressure pasteurization followed by refrigerated distribution will continue to be studied. The definition of fresh must be resolved so that maximum safety can be obtained from one or a combination of nonthermal preservation technologies. The need for the benefits of nonthermal pasteurization may allow minimally treated foods to be labeled "fresh" on a product-by-product basis.

Current nonthermal technologies, other than irradiation, but including pulsed electric field technologies, cannot be expected to be approved in the next four years for preserving low-acid foods sealed in hermetic containers. Combinations of heat and high pressure or heat and spore-germination inhibitors, other than pH and nitrites, are expected to enter into commercial trials with the objective of obtaining regulatory approval. Commercial developments to watch include the use of high pressure, chemicals, including ozone and carbon dioxide used as processing aids, and generally recognized as safe (GRAS) sanitizing agents. These processes will be applied to cut fruits and vegetables, prepared salads, acidified nutritional drinks, and dips, and to a lesser extent to entrees distributed under refrigeration. Processors will be conducting extensive tests on refrigerated foods, including processed luncheon meats, dairy products, and specialty products, to develop nonthermal treatments to ensure that they are pasteurized (i.e., pathogen free) and have a refrigerated shelf life of more than 6 weeks.

The mechanism of spoilage of nonthermal pasteurized foods during refrigerated storage will be studied carefully to ensure that *Clostridium botulinum* will not grow during refrigerated distribution and in the hands of the user.
—Daniel F. Farkas, Oregon State U.

Nutraceuticals & Functional Foods

The need for food products and ingredients that provide benefits beyond their traditional nutritional value has created tremendous academic, commercial, and public interest. This is primarily due to the recognition that prevention is preferred to treatment and curing. Thus, disease prevention and health promotion through consumption of nutraceuticals and functional foods has received considerable attention, and various products are

now available.

Functional foods may be defined as those with a similar appearance to their traditional counterparts, while nutraceuticals are those derived from different edible sources but consumed in the medicinal form of pill, tablet, or capsule. The term "natural health products" has now replaced "nutraceuticals" in Canada.

The nutraceutical and functional foods sector has expanded rapidly over the past several years, and issues related to efficacy, especially in relation to active components and claims, have begun to provide the necessary scientific support for what was originally anecdotal in nature. However, many challenges remain ahead with respect to regulatory issues and identification of active components and their mode of action. In addition, interaction of bioactive components, both synergistic and antagonistic, with drugs requires attention.

Knowledge of the effect of processing on bioactive components and their absorption and metabolism is another milestone in this area. Development of novel methodologies and their validation present other challenges. Achieving these goals will obviously require full interaction of scientists in taxonomy, biology, chemistry, biochemistry, engineering, nutrition, pharmacy, and medicine. Furthermore, the influence of bioactives at the gene level requires adequate attention. A balanced approach by the media in providing much-needed information to the public on a sound and scientific basis is of paramount importance.
—Fereidoon Shahidi, Memorial U. of Newfoundland

Nutrition

The map of the human genome was completed in 2001. Although debate continues on the number of human genes, several laboratories are using the information to study single nucleotide polymorphisms and functional genomics to understand human disease. The study of functional genomics is the methodical and inclusive analysis of gene products, including mRNA and proteins and their functions. Functional genomics research is currently directed at designer drug development. Another exciting application is identifying how nutrients, phytochemicals, and botanicals from our food supply modulate gene expression to reduce the risk or delay the onset of chronic disease.

Nutrient–gene interactions offer a significant opportunity for future food development focused on the individual to lower disease risk. The advancement of diet and health research depends on understanding the functions of nutraceuticals, phytochemicals, and botanicals at the gene level. Scientists are using various techniques to screen the action of botanical lipids on gene targets in immune cells, transcription factors involved in bone cell function to reduce osteoporosis, and microarrays for studying obesity.

Functional genomics will establish rapid methods for screening genes that will be used to develop food tailored to human polymorphisms associated with chronic disease. New food products will target cardiovascular disease, cancer, diabetes, obesity, and osteoporosis. The groundwork for nutrition research in functional genomics will take time, but this approach to food development has tremendous potential for future health improvement.
—Bruce A. Watkins, Purdue U.

Research in functional genomics . . . has tremendous potential for future health improvement.

Product Development

In the next several years, product development will focus on convenience foods, nutraceutical and functional foods, and products that target particular age groups.

Trends for convenience foods will fall into two main categories: meals-on-the-go and quick-and-easy meals. Meals-on-the-go will focus on bite-sized items, nutrient-loaded beverages, and bakery goods. In the area of quick-and-easy meals, there will be greater emphasis on heat-and-serve meals, packaged meals, and one-dish oven entrees. The demand for pre-cut marinated meat and poultry and fresh-cut salads and vegetables will continue. Easy-prep meals for the elderly and latchkey kids will become popular.

The thrust to develop nutraceutical and functional foods will increase, and regulations governing characterization and labeling of these products will be developed. These activities may lead to challenging and controversial situations. Fortification with prebiotics will become commonplace. The GMO issue will continue to be a challenge, and interest in development of non-GMO functional foods will rise.

There will be a proliferation of food flavors. Flavorful and exotic-flavored foods will be developed for mature consumers. There will be flavor fortification of traditional foods to appeal to various age groups. New flavors will be added to current functional foods that have inherent off-flavors. Production of a wider variety of ethnic foods will increase and will be enhanced by international Internet trading.
—Margaret J. Hinds, Oklahoma State U.

Quality Assurance

Quality assurance can be thought of as a body of knowledge, as a functional part of an organization, and as a process for continuous improvement and innovation. Those in the food and allied industries benefit from the work done in all other industries globally. The high-performance, high-risk industries bring many ideas to us.

Protection from all product insults will expand in scope. The consumer does not consider safety as a characteristic different from quality, but regulators and some executives have been separating them, thereby fragmenting the internal control systems that work best from a total systems point of view. The integration of HACCP into ISO 34, together with ISO 9001, as a quality management system will receive much attention.

From a manufacturing point of view, the goals are quick changeover, less variation, and smaller lot sizes, whether there are batch processes or continuous processes. Quick-response in-line sensors have been a goal for the past 50 years and will continue for the next 50. That and using small factory laboratories for quick tests will reduce or eliminate quality assurance labs.

The management processes by which to control technical and work processes will increase in importance. The quality assurance function will be much more involved in auditing and coaching than in running tests.

A Look into the Future

The best quality assurance departments are those that help all departments in their quality improvement efforts: marketing/sales, human resources, production, accounting/finance, legal, R&D, senior management, and all the rest. The food industry lags the rest of industry in this regard, but must and will catch up.
—William A.J. Golomski, International Technical and Management Consultant

Refrigerated & Frozen Foods

The driving force for the demand for refrigerated and frozen (RF) foods is convenience. We will continue to see improvement in providing more value in terms of taste and/or nutrition and health-based performance. RF foods will also find their place in delis, because delis are not the most cost-effective way to deliver home-meal-replacement (HMR) products, considering the costs associated with equipment, inventory, labor, and training. RF foods will have the advantage of providing high-quality HMR products without the costs associated with on-site food preparation.

Most of the growth in RF foods will come from new product introductions, line extensions, and family-size offerings. We should also see innovation in delivering premium-quality RF foods at the grocery stores to compete with foods in restaurants or delivering RF foods to the restaurants as menu items. Another hot area is ethnic foods (Asian, Mexican, and Italian). The strong growth of recent Asian food sales attributed to the introduction of rice and noodle bowls is a good example of innovation and new product development. We will also see a lot of development in the packaging area for enhancing the appearance, convenience, handling, and distribution of RF foods and for ease and uniform reheating of the product before consumption.

On the processing side, we will see development in improving the quality and efficiency and reducing the cost of producing RF foods. For example, the introduction of impingement freezers significantly reduced the freezing or chilling time and at the same time improved quality (less weight and flavor loss, and less quality deterioration). The industry will also be taking advantage of different freezing systems (mechanical, liquid nitrogen, carbon dioxide, or their combination) and select the system for processing on the basis of performance and economics.

Research will also continue in understanding the effect of refrigeration and freezing on product characteristics such as glass-transition temperatures, ultrastructure evaluations as new products and processes are being developed, safety of refrigerated low-acid foods under modified atmospheres, and cold-chain management for RF foods.
—Yen-Con Hung, U. of Georgia

Religious & Ethnic Foods

Ethnic foods are gaining popularity in the U.S. and Europe. Halal food demand is also growing worldwide as demographics change. The mainstreaming of many different ethnic foods at both the supermarket and restaurant levels is an established part of our future.

Halal foods in particular are becoming an important part of the globalization of the food supply. An important challenge will be to meet modern animal welfare challenges while producing traditional kosher and halal foods. Additionally, educational institutions should include both ethnic and religious aspects of foods into their curricula and courses. Currently, technologists struggle with learning about kosher, halal, and other ethnic foods on the job, or, just like any other consumer, at the restaurant.
—Mian N. Riaz, Texas A&M U.

Seafood Technology

Consumer perceptions of seafood quality, safety, and nutrition and the perceived impacts of seafood harvesting and aquaculture operations on the environment will shape industry and government priorities. In response, harvesters, manufacturers, and regulators will focus on integrated safety and quality control from harvest to plate; domestic and international HACCP and SSOP implementation; developing nutritious, convenient, and functional foods; implementing conventional, Web, and PC-based quality and safety training for industry and regulatory personnel working at all product stages and levels; pathogen and toxin risk assessment and control, including responses to bioterrorism; reducing the environmental impacts of harvesting and aquaculture operations; expansion of aquacultured species and value-added products; moving to total catch utilization; and preserving wild fishery stocks.

The continued popularity of raw, minimally processed, or cooked ready-to-eat seafood will encourage traditional and novel control of known and emerging pathogens. Proposed methods range from harvest area assessment to modified pasteurization procedures, high-pressure processing, irradiation, and rapid testing methods to confirm pathogens. *Listeria* and *Vibrio* species are of particular concern. Rapid testing to identify, quantify, and control bacterial and environmental toxins should address histamine poisoning in scombroid species, ciguatera poisoning, and shellfish toxins.

Safety and liability concerns will encourage the development of effective product tracking systems and time–temperature monitors. Seafood allergies are emerging as an area of increased regulatory, consumer, and industry concern. Global markets will foster collaborations to achieve international agreement on validation of processing technologies and the enhanced surveillance of imported seafood.
—Keith W. Gates, U. of Georgia

Sensory Evaluation

Over the past decade or more, sensory science has observed a shift of test practices from the controlled environment of the sensory lab into the dynamic (and sometimes unpredictable) "consumer" world. This has challenged the sensory science community to develop new methods, mostly focused on better understanding the "subjective" response of a consumer, rather than an "objective" response based on human physiology. So, is sensory still a discipline founded on the principles of food science, or an evolving profession focused on psychology and consumer behavior?

Both product development and marketing functions are requiring new methods and tools to understand the consumer, such as uncovering the "unmet" needs of the consumer, testing in more natural "consumption-and-usage" environments (in the car, at the gym, on vacation), integrating the concept and product throughout all stages of the innovation process, and getting a product to market in record-breaking time. So, within a company, who pro-

vides these tools, methods and insights—the sensory science group as a function of the product development department, or marketing research as a function of the marketing department?

The increased overlap between these two disciplines will require continuing role clarification. However, herein lies the real opportunity for the future of sensory science: to clearly define what role the function can play in understanding all aspects of the product and consumer; to partner with marketing research in this quest; to become a true strategic business partner in the innovation process; and to provide unbiased data to aid in risk assessment and corporate decision making.
—Dana Craig-Petsinger, Kellogg

Toxicology & Safety Evaluation

Contamination of food by naturally occurring toxins such as mycotoxins, phycotoxins, and intrinsic components of plants is unavoidable and unpredictable, posing a unique challenge to food safety. Risks associated with these contaminants or components can be reduced through regulatory limits, monitoring, processing, decontamination, and/or diversion to less risk uses. Monitoring production and processing are necessary to ensure quality and safety of food. When a food safety monitoring program is being established, several elements affect the risk assessment and management strategies by a regulatory agency. The expected gravity and/or probability of an adverse event occurring and the nature of the adverse event are paramount. The success of the strategy is governed by both science and effective risk communication and consumer education. Emerging issues facing regulatory agencies and the food industry with respect to food safety programs and policy include dietary supplements, allergens, genetically modified commodities, and decontamination procedures designed to remove and/or chemically modify toxic contaminants.

Traditional studies used to determine the toxicological significance of risks posed by chemical food contaminants, food additives, etc., have been based on in-vitro and in-vivo assessments and pharmacokinetic/pharmacodynamic feeding studies that require extrapolations from high to low dose and animals to humans. Epidemiological evaluations are used to supplement these studies to have some indication of the exposure assessment and risk characterization. The design of these studies usually includes a well-defined protocol including a single test substance, a specific route of exposure, duration, species characterization, etc.

For the emerging issues identified above, the toxicological significance of other factors must be considered in evaluating the risks posed by the substances, e.g., in dietary supplements, the beneficial and/or adverse effect of other contaminants or constituents in very complex food matrices. There is a need for rapid screening techniques that have a particular toxicological event as the end-point, e.g., cardiovascular, neurological, hepatotoxic, etc.

The role that naturally occurring proteins or the potential role that genetically introduced proteins may have in human allergenic adverse events is another area of needed research. Toxicological protocols to study these issues are not well defined. Studies that have focused on the reduction of risks posed by aflatoxin in animal feed using ammoniation highlight the complexity and difficulty in designing appropriate safety evaluation and toxicological procedures. Not only has the research addressed the efficacy of the ammoniation procedures to reduce aflatoxin contamination levels and determine the effect of ammonia on aflatoxin chemistry, but it has also been necessary to evaluate the toxic potentials of possible ammonia/aflatoxin reaction by-products. This would include not only the reaction products in the treated feed, but the potential transmission of these chemicals to edible tissues such as milk, eggs, and meat products from animals fed the ammonia-treated aflatoxin-contaminated feed. For most of these scenarios, the chemical identities and relative concentrations are not well defined; this means that the safety evaluation/toxicological protocols must take into account these unknowns and uncertainties.

The challenges facing scientists in industry and public health agencies who have the responsibility of assuring a safe, wholesome food supply are enormous and, at the same time, exciting. We invite the participation of all to work together for the benefit of the consumer.
—Douglas L. Park, Food and Drug Administration ●

Developing Foods to Meet the Needs of Women

DEVELOPINGFOODS ***special report***

▶ *from page 45*

tremely important to ensure proper mixing of ingredients and application of the chocolate coatings, she added. If the process is not well monitored and controlled, the nutritional profile could be skewed.

Texture is one of the distinguishing characteristics of the bar, and functional protein ingredients play a huge role in determining it. Understanding how the protein interacts with other ingredients and which protein works best was critical to creating the ideal bar.

Processing variables also play a big role in achieving the optimum texture. It is important to have a good understanding of how the bar reacts to different processing environments, Tompanis said. Temperature and speed controls have a big impact on attributes such as texture, and some ingredients are more delicate and need special handling and in some cases special equipment.

Variations among the different flavors of the bar was another important consideration. There are unique ingredients for each flavor that may react differently in processing. Evaluating each flavor separately and understanding how these ingredient differences might affect the processing, texture, overall moisture, and shelf stability was a key part of creating new flavors for the product.

The energy and nutrition bar category is very competitive, and convincing sales channels to put another bar on the shelf was another challenge, she added. *Luna* was the first bar being marketed to women, and that in itself helped the company overcome this hurdle—as well as the favorable reactions of the distributors and retailers when they actually tasted the product.

In late November 2001, the company announced that *Luna* is now the top-selling brand in the energy/nutrition bar category in grocery stores—the first time a brand other than Nestle's *PowerBar* has topped energy/nutrition bar sales in the grocery channel. *Luna* continues to be the best-selling bar in natural food stores. ●

Food Technology is really a good major and a good degree to work in future. you can begin your own business easily if you want to. Beverage business is becoming the most common these days due to shivering summer prevailing in the south Asia. people are more attracted to drink different beverages to quench their thirst.Â Food science is the science of food - the chemistry of particles inside the food, the bondings of H, C, N, O, P etc., the microbial content of the food, the way the inner science of the food affects its outer physical appearance, shelf-life, safety etc. As you can see the lists of both food technology and food science have a huge impact on the human body. Well weâ€™ll look a little more at this topic shortly, but we start, as ever, with a question and itâ€™s a food-based question. In which continent did tomatoes originate? Is itâ€¦Â Neil Information about future trends is very important for companies in the food business. How does she actually predict these trends? Sam She says she starts with a hunch.Â Lots of companies are rushing to install technology to make offices and workplaces safer. Should we wear a face mask? Episode 200702 / 02 Jul 2020. Journal/Book Title/Conference. Food Technology. Volume. 56.Â Access to this article can be purchased directly from the publisher Institute of Food Technologists. Recommended Citation. Cornforth, D. P. 2002. A look into the future of food science and technology- Muscle Foods. Food Technol. 56:47-52. Link to Full Text. At the Foodâ€™s Future Summit 2019, held at Asia Society Hong Kong, we spent two days gaining insight into what will show up on our plates in the years to come and what part we will play in this | by Foods Future Global.Â Alejandra Espinoza, founder of contemporary Ecuadorian restaurant SOMOS, introduced us to the food of her heritage, where it is built into the culture to use every bit of a food. â€œIn Ecuadorean food, we use every part of the watermelon. We cook with banana peel.