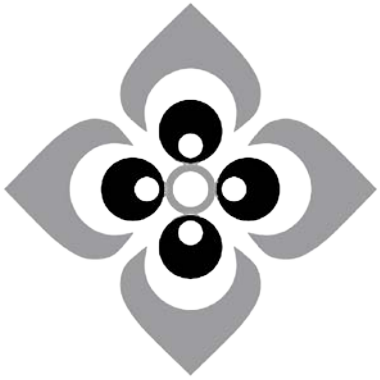

Consortium for Educational Communication

Module
on

Introduction To Food Science

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TEXT

1. **INTRODUCTION:**

Food science is a discipline concerned with all technical aspects of food, beginning with harvesting or slaughtering and ending with cooking and consumption. Food science is the study of the physical, biological, and chemical makeup of food; the causes of food deterioration; and the concepts underlying food processing. Food science draws from many disciplines such as biology, chemical engineering, and biochemistry in an attempt to better understand food processes and ultimately improve food products for the public. The discipline of food science has developed over the years as methods to preserve foods and ensure public safety began to develop. Hundreds of years ago, the food system was much different than it is now. People in rural areas bought bulk staples such as flour, grains and sugar in large quantities for preparation at home and supplemented their staples with whatever fruits and vegetables they could grow or gather or whatever animals they could raise. People in the cities bought these products at farmers' markets, a tradition that continues today in many places. Some foods, such as potatoes, would keep for months when stored in cool dark places called root cellars. Before modern-day refrigerators became available, people bought large blocks of ice cut from the surfaces of frozen lakes and rivers and kept perishable foods in their ice boxes.

Numerous methods for preserving foods have been developed throughout history, such as salting meat, drying fruits and vegetables in the sun or over low fires and converting milk into cheese. In the early 1800s, Frenchman Nicholas Appert developed a method for preserving food in glass jars. Aptly known as the father of canning, Appert also is considered by some as the father of food science. Modern food science, however, involves much more than food preservation.

Food scientists and technologists apply scientific disciplines including chemistry, engineering, microbiology, and nutrition to the study of food to improve the safety, nutrition, wholesomeness, and availability of food. Depending on their area of specialization, food scientists may develop ways to process, preserve, package, and/or store food according to industry and government specifications and regulations.

Food science therefore 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. Associated with food, spring various areas of practical importance.

Food Technology:

Food technology is the application of food science to the selection, preservation, processing, packaging, distribution, and use of safe food. Related fields include analytical chemistry, biotechnology, engineering, nutrition, quality control, and food safety management.

Food Processing and Manufacturing:

Food processing is the treatment of food substances by changing their properties to preserve it, improve its quality, or make it functionally more useful. Food processors take raw animal, vegetable, or marine materials and transform them into edible products through the application of labor, machinery, energy, and scientific knowledge. Chemical, biological, and mechanical processes are used to convert relatively bulky, perishable, and typically inedible food materials into shelf-stable, convenient, and palatable foods and beverages. Food manufacturing is the mass production of food products from raw animal and plant materials, using principles of food technology.

Food Research:

Food research is the careful, systematic study, investigation, and compilation of information about foods and their components.

Product Development:

Product development is the creation of new flavors, colors, or varieties of existing products and/or the creation of entirely new products.

Quality Assurance and Quality Control:

Both quality assurance and quality control involve the process of ensuring that products are manufactured correctly and that ingredients and finished products are tested and

meet safety and quality specifications.

Food Regulation:

Food regulation is the process of determining standards for products, defining safety, and inspecting products. Regulations are set by governments.

2. IMPORTANCE OF FOOD SCIENCE:

Applications of science and technology within the food system have allowed production of foods in adequate quantities to meet the needs of society, as it has evolved. Today, our production-to-consumption food system is complex, and our food is largely safe, tasty, nutritious, abundant, diverse, convenient, and less costly and more readily accessible than ever before. Scientific and technological advancements must be accelerated and applied in developed and developing nations alike, if we are to feed a growing world population.

2.1 *Availability of food*

Food science makes it possible for the majority of the world's current population of 7 billion to have much greater access to an abundant, diverse food supply that is largely safe, flavorful, nutritious, convenient and less costly than ever before. Food science is becoming even more important as the world population expands and poses with even expanding demand of food.

2.2 *Sustainability*

In a world without food science, much of the food produced would be lost to spoilage and waste. Food scientists work to conserve resources during the entire chain of production. They make sure land and water are conserved and protected as a crop is grown and as a food product is made. They create packaging that is reduced, recycled and reusable to minimize waste. They place food production plants in areas where food can be transported and distributed efficiently.

2.3 *Food safety*

In a world without food science, food safety would be a guessing game. It would be up to consumers to decide what is safe, what is not. They would have to try to figure

out what sort of microorganisms might be on their food and whether or not they should give it to their family. Food science provides the scientific base that ensures our food supply is safe—from initial storage through processing, transportation, and retail channels, until the consumer purchases the product—and beyond. Every day, food scientists are developing new processes, monitoring conditions and testing foods for contamination in order to prevent foodborne illness. Pasteurization of milk is just one of many examples of processes that reduce the risk of foodborne illness and extend shelf life.

2.4 *Longevity and health*

The dramatic changes in population demographics, and the consequent pressure on healthcare and aged services spending, highlight the need to move from a health system built primarily on treating disease to one that is balanced with a preventative approach. In essence, to move the focus from 'therapeutics' to 'prophylactics', and to ensure that as consumers age that they maintain active, healthy, productive and fulfilling lives. In this quest, food science plays a critical role. Foods and beverages are important in moving the focus from treating disease to reducing the risk and even preventing illness. Some 2,500 years ago, Hippocrates espoused, "let food be thy medicine and medicine be thy food", and this tenet forms the basis for modern day functional foods and nutraceuticals designed to provide consumers with both nutritive value and a specific health benefit. Some well known and successful examples of functional foods include table spreads incorporating plant sterol esters to lower the absorption of cholesterol, and fermented dairy drinks containing peptides that clinically lower hypertension. Both these products have been designed to serve as prophylactic agents in addressing the issue of cardiovascular disease (CVD), and food science played a central role in their development. Other functional ingredients and products will be needed to address 21st century lifestyle and age-related issues, including obesity, diabetes, muscle health, and osteoporosis. As the world's population ages rapidly, food scientists have developed new, novel, and attractive foods and beverages for the elderly. These foods address geriatric health challenges like osteoporosis and sarcopenia, for example.

Without food science what world would look like:

- No way to keep food fresh

- Nutrition would be a guessing game

- Food would look and taste bad

- Food would cost a lot more

- Food would be unsafe to eat

- There wouldn't be enough food for everyone

Thousands of dedicated food science professionals are preventing this frightening scenario from becoming a reality. They are developing safe, nutritious, healthy, and plentiful food that consumers eat everyday. So, food science provides and identifies the full range of products that consumers want; processes the products safely; identifies preferences of consumers and improves the final product in ways the consumer may not articulate, but will accept enthusiastically; keeps prices within affordable market values; ensures shipping and provide protective packaging that is appropriate; handles the waste materials resulting from preparation; and improves and identifies the nutritive content of the product and fit that nutritive content to human needs. Food science occurs in many places: processing companies, universities, suppliers, agricultural entities, consulting establishments. Each is playing more roles than previously thought possible.

3. ACTIVITIES OF FOOD SCIENTISTS

Some suggest that food science covers all aspects of food material production, handling, processing, distribution, marketing, and final consumption. Others would limit food science to the properties of food materials and their relation to processing and wholesomeness. Since definitions can be misleading, the activities of today's food scientists can be illustrated by way of examples. It has been estimated that as many as 2 billion people do not have enough to eat and that perhaps as many as 40,000 die every day from diseases related to inadequate diets, including the lack of sufficient food, protein, and/or specific nutrients. Many food scientists are engaged in developing palatable, nutritious, low-cost foods. Dried milk can supply the needed

calories and protein but is relatively expensive and is not readily digested by all. Fish “flour” prepared from fish

of species not commonly eaten can be a cheaper source of protein. As food losses during storage and processing can be enormous, food scientists are involved in adapting and developing preservation methods appropriate and affordable to various regions of the world. Food scientists have developed thousands of food products including those used in the space shuttle program. Currently, food scientists are developing systems, which “recycle” foods for space voyages into deeper space. If astronauts are to be in space for extended periods without resupply, foods will have to be grown and processed in space. The problems inherent in such systems present unique challenges to the food scientist. Perhaps the largest single activity of food scientists working in industrial organizations is the improvement of existing and development of new food products. Consumers like to have new products available. Industrial food scientists must find creative ways to meet this consumer demand for new and different products. Food scientists today are often involved in altering the nutrient content of foods, particularly reducing the caloric content or adding vitamins or minerals. Reducing the caloric content is accomplished in several ways, such as replacing caloric food components with low or non-nutritive components. In other cases, food scientists reduce the caloric content of fat containing foods by replacing the fat with substances which have similar properties but are not metabolized in the same way as fat. For example, low-fat ice cream can be made by removing the normal milk fat and adding specially treated proteins. These proteins are made into very small particles, which give ice cream the smooth texture associated with the fat. Protein has four calories per gram, whereas fat has nine. Thus, the net effect is a decrease in the caloric content of the ice cream. Food scientists also find ways to add desirable vitamins and minerals to foods. Breakfast cereals are good examples of such foods. Most cereals have some added nutrients and some have a whole day’s supply of several nutrients. These vitamins and minerals must be added in such a way as to be evenly dispersed in the product and be stable.

One of the most important goals of the food scientist is to make food as safe as possible. The judicious application of food processing, storage, and preservation methods helps prevent outbreaks of food poisoning. Food poisoning is defined as the occurrence of disease or illness resulting from the consumption of food. Food-borne

diseases are caused by either pathogenic (i.e., disease causing) bacteria, viruses, parasites, or chemical contaminants.

Food scientists need to speak in many tongues: science, markets, manufacturing, agriculture, preferences, costs, and values-to name a few. Because food interacts directly with people, some food scientists are also interested in the psychology of food choice. These individuals work with the sensory properties of foods. Food engineers deal with the conversion of raw agricultural products such as wheat into more finished food products such as flour or baked goods. Food processing contains many of the same elements as chemical and mechanical engineering. Virtually all foods are derived from living cells. Thus, foods are for the most part composed of "edible biochemicals," and so biochemists often work with foods to understand how processing or storage might chemically affect foods and their biochemistry. Likewise, nutritionists are involved in food manufacture to ensure that foods maintain their expected nutritional content. Other food scientists work for the government in order to ensure that the foods we buy are safe, wholesome, and honestly represented.

4. DISCIPLINES AND AREAS INVOLVED IN FOOD SCIENCE:

As food science involves the applications of various basic and allied sciences, it is pertinent to understand how these frame their utility in food science. Following examples help to understand this:

Biology, Cell biology: These disciplines help in the understanding of postharvest plant physiology, food quality, plant disease control and microbial physiology, food safety.

Biotechnology has enabled production of rice with increased content of beta-carotene, enzymes for cheesemaking, breadmaking.

Chemistry assists food analysis, improvement in food quality, extending shelf life, and development of functional foods.

Computer Science aids food manufacturing process control, data analysis.

Materials Science facilitates effective packaging, understanding of how materials properties of foods provide structure for texture, flavor, and nutrient release.

Microbiology provides understanding of the nature of bacteria (beneficial, and disease-

causing), parasites, fungi, and viruses, and developments and advances in their detection, identification and control.

Nutrition science has made possible production of foods fortified with vitamins and minerals for health maintenance, functional foods for addressing specific health needs of certain subpopulations; development of diets that match human nutrient requirements.

Physics, Engineering enable efficient food manufacturing processes to preserve food attributes and ensure food safety, waste reduction efforts.

Sensory Science helps to understand chemosenses to meet different flavor needs and preferences.

Toxicology involves the assessment of the safety of chemical and microbiological food components, food additives.

Apart from the basic sciences, food science itself associates various other fields based on the application of basic sciences such as:

- *Food Chemistry:* It covers the basic composition, structure, and properties of foods and the chemistry of changes occurring during processing and utilization. *Food physical chemistry* is the study of both physical and chemical interactions in foods in terms of physical and chemical principles applied to food systems, as well as the application of physicochemical techniques and instrumentation for the study and analysis of foods

- *Food Analysis* deals with the principles, methods, and techniques necessary for quantitative physical and chemical analyses of food products and ingredients. The analyses should be related to the standards and regulations for food processing.

- *Food Microbiology* is the study of the microbial ecology related to foods, the effect of environment on food spoilage and food manufacture, the physical, chemical, and biological destruction of microorganisms in foods, the microbiological examination of foodstuffs, and public health and sanitation microbiology.

- *Food Processing* covers general characteristics of raw food materials; principles of food preservation, processing factors which influence quality, water and waste management, and good manufacturing practices and sanitation procedures.

- Food packaging is packaging of food to preserve food after it has been processed and contain it through distribution. Its main objective is to provide physical and barrier protection for food. In most cases food packaging contains labels bearing nutritional and other information about the specific food. Food packaging is mostly done by using packaging machines.

- *Food Engineering* involves study of engineering concepts and unit operations used in food processing. Engineering principles should include material and energy balances, thermodynamics, fluid flow, and heat and mass transfer.

- *Sensory Science*

  New Product Development: Create new flavors, develop products that are more convenient, more nutritious, more fun. This means everything from winning an award for a new flavor of iced tea to developing a more nutritious cracker for children in a developing country. Taste panels work with consumers and trained experts to determine what is most desirable in a product. Since it involves lots of interaction with people, it is a highly valuable part of product development.

5. **FOOD SCIENCE AND FOOD SECURITY:**

Food security features as one of the dynamic and complex challenge that the humanity ever faced in its history. According to the Food and Agriculture Organization (FAO): *'Food Security' exists when all people, at all times, have physical and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life.* Analysis of the nature of global food security challenge reveals that it is associated with several other issues; increasing world population, changing diet patterns, falling water tables, growing number of hungry individuals,

deteriorating agriculture soils, decreasing agriculture yields, climate change, and running short of time. The world population clock is ticking continuously and every second passed adding to our total number dwelling on the earth. Therefore, complexity of this challenge demands urgent measures rather to assume that the food crisis will develop after couple of decades in 2030 or 2050. A single event that may create large scale emergency such as poor harvest in a vast region, drought or famine would be enough to disrupt the world food supply, thus could force thousands of families to go hungry and end up with life threatening situation, i.e., severe malnutrition or even death. A time when world is heading toward potential shortage of food for human consumption, the news about possibilities to increase productivity and yields is grim. Agricultural productivity is vulnerable and poor crop and livestock yields are predicted due to several factors - climate change is one of the major one. Many reports have pointed out that climate change will alter the stability of food supplies and create new food security challenges as the world seeks to feed nine billion people by 2050. The solution of food security challenge requires world to ensure supply of sufficient, safe, and nutritious food to everyone on our planet. This is not a simple task and multiple sectors – science and education, research and development, social, political and regulatory changes need to move forward in a systematic and synchronized manner. Food science as a discipline has a lot to offer by maintaining the stability of food supply. A better understanding of the nature of changes in food with climate change could inform us more appropriate processing technologies. Therefore, food science and allied disciplines have a role to play in food process innovation, food safety and quality improvement and an efficient supply chain development.

This will ultimately contribute to the availability of more and safe foods for a longer time period. One example how food science will be able to improve food security is removing the food allergens through food processing. This could put more food on table for people with specific conditions such as lactose or gluten intolerant. Another example where food science seems a major contributor is reducing the food wastage through improvement in food safety and quality as well as improved utilization. According to the United Nations, approximately 1.3 billion tons of food (about a third of the world's food supply) was wasted in 2013. A reduction in this wastage will help to decrease the number of hungry individuals - currently 1.2 billion people are facing hunger and extreme poverty.