Paper No.: 02

Paper Title: The Principles of the Food Processing & Preservation

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Module Title: Historical Developments in Food Processing

2.0 Introduction

Food processing dates back to prehistoric ages, with crude processing methods that included slaughtering, fermenting, sun drying, preserving with salt, and various means of cooking (such as roasting, smoking, steaming, and oven baking). Salt-preservation was especially common for foods that constituted the diets of warriors and sailors, up until the introduction of canning methods. Evidence for the existence of these methods exists in the writings of the ancient Greek, Chaldean, Egyptian, and Roman civilizations, as well as archaeological evidence from Europe, North and South America, and Asia. These tried and tested processing techniques remained essentially the same until the advent of the Industrial Revolution.

Modern food processing technology was largely developed in the nineteenth and twentieth centuries, to serve military needs. In 1809, Nicolas Appert invented a vacuum bottling technique that would supply food for French troops, and this contributed to the development of tinning and then canning by Peter Durand in 1810. Although initially expensive and somewhat hazardous due to the lead used in cans, canned goods later became a staple around the world. Pasteurization, discovered by Louis Pasteur in 1862, was a significant advance in ensuring the microbiological safety of food.

In the twentieth century, World War II, the space race, and the rising consumer society in developed countries (including the United States) contributed to the growth of food processing with such advances as spray drying, juice concentrates, freeze drying, and the introduction of artificial sweeteners, coloring agents, and preservatives such as sodium benzoate. In the late twentieth century, products such as dried instant soups, reconstituted fruits and juices, and self-cooking meals (such as ñMeal, Ready-to-Eat,ò or MRE, field rations) were developed.

In Western Europe and North America, the second half of the twentieth century witnessed a rise in the pursuit of convenience, as food processors marketed their products especially to middle-class working wives and mothers. Frozen foods (often credited to Clarence Birdseye) found their success in the sales of juice concentrates and ñTV dinners.ò Processors utilized the perceived value of time to appeal to the postwar population, and this same appeal contributes to the success of convenience foods today.

2.1 Food Preservation & Processing History

Throughout the history of mankind science has searched into the realms of the unknown. Along with it bringing new discoveries, allowing for our lives to become healthier, more efficient, safer, and at the same time, possibly more dangerous. Among the forces driving scientists into these many experiments, is the desire to preserve the one fuel that keeps our lives going - FOOD.

As early as the beginning of the 19th century, major breakthroughs in food preservation had begun. Soldiers and seamen, fighting in Napoleons army were living off of salt-preserved

meats. These poorly cured foods provided minimal nutritional value, and frequent outbreaks of scurvy were developing. It was Napoleon who began the search for a better mechanism of food preservation, and it was he who offered 12,000-franc pieces to the person who devised a safe and dependable food-preservation process.
The winner was a French chemist named Nicolas Appert. He observed that food heated in sealed containers was preserved as long as the container remained unopened or the seal did not leak. This became the turning point in food preservation history. Fifty years following the discovery by Nicolas Appert, another breakthrough had developed. Another Frenchman, named Louis Pasteur, noted the relationship between microorganisms and food spoilage. This breakthrough increased the dependability of the food canning process. As the years passed new techniques assuring food preservation would come and go, opening new doors to further research.

Canning The process of canning is sometimes called sterilization because the heat treatment of the food eliminates all microorganisms that can spoil the food and those that are harmful to humans, including directly pathogenic bacteria and those that produce lethal toxins. Most commercial canning operations are based on the principle that bacteria destruction increases tenfold for each 10° C increase in temperature. Food exposed to high temperatures for only minutes or seconds retains more of its natural flavor. In the Flash 18 process, a continuous system, the food is flash-sterilized in a pressurized chamber to prevent the superheated food from boiling while it is placed in containers. Further sterilizing is not required.

Freezing Although prehistoric humans stored meat in ice caves, the food-freezing industry is more recent in origin than the canning industry. The freezing process was used commercially for the first time in 1842, but large-scale food preservation by freezing began in the late 19th century with the advent of mechanical refrigeration.

Freezing preserves food by preventing microorganisms from multiplying. Because the process does not kill all types of bacteria, however, those that survive reanimate in thawing food and often grow more rapidly than before freezing. Enzymes in the frozen state remain active, although at a reduced rate. Vegetables are blanched or heated in preparation for freezing to ensure enzyme inactivity and thus to avoid degradation of flavor. Blanching has also been proposed for fish, in order to kill cold-adapted bacteria on their outer surface. In the freezing of meats various methods are used depending on the type of meat and the cut. Pork is frozen soon after butchering, but beef is hung in a cooler for several days to tenderize the meat before freezing.

Frozen foods have the advantage of resembling the fresh product more closely than the same food preserved by other techniques. Frozen foods also undergo some changes, however. Freezing causes the water in food to expand and tends to disrupt the cell structure by forming ice crystals. In quick-freezing the ice crystals are smaller, producing less cell damage than in the slowly frozen product. The quality of the product, however, may depend more on the rapidity with which the food is prepared and stored in the freezer than on the rate at which it is frozen. Some solid foods that are frozen slowly, such as fish, may, upon thawing, show a loss of liquid called drip; some liquid foods that are frozen slowly, such as egg yolk, may become coagulated. Because of the high cost of refrigeration, frozen food is comparatively expensive to produce and distribute. High quality is a required feature of frozen food to justify the added cost in the market. This method of preservation is the one most widely used for a great variety of foods.

Drying and Dehydration Although both these terms are applied to the removal of water from food, to the food technologist drying refers to drying by natural means, such as spreading fruit on racks in the sun, and dehydration designates drying by artificial means, such as a blast of hot air. In freeze-drying a high vacuum is maintained in a special cabinet containing frozen food until most of the moisture has sublimed. Removal of water offers excellent protection against the most common causes of food spoilage. Microorganisms cannot grow in a water-free environment, enzyme activity is absent, and most chemical reactions are greatly retarded. This last characteristic makes dehydration preferable to canning if the product is to be stored at a high temperature. In order to achieve such protection, practically all the water must be removed. The food then must be packaged in a moisture-proof container to prevent it from absorbing water from the air.

Vegetables, fruits, meat, fish, and some other foods, the moisture content of which averages as high as 80 percent, may be dried to one-fifth of the original weight and about one-half of the original volume. The disadvantages of this method of preservation include the time and labor involved in rehydrating the food before eating. Further because it absorbs only about two-thirds of its original water content, the dried product tends to have a texture that is tough and chewy.

Drying was used by prehistoric humans to preserve many foods. Large quantities of fruits such as figs have been dried from ancient times to the present day. In the case of meat and fish, other preservation methods, such as smoking or salting, which yielded a palatable product, were generally preferred. Commercial dehydration of vegetables was initiated in the United States during the American Civil War but, as a result of the poor quality of the product, the industry declined sharply after the war. This cycle was repeated with subsequent wars, but after World War II the dehydration industry thrived. This industry is confined largely to the production of a few dried foods, however, such as milk, soup, eggs, yeast, and powdered coffee, which are particularly suited to the dehydration method. Present-day dehydration techniques include the application of a stream of warm air to vegetables. Protein foods such as meat are of good quality only if freeze-dried. Liquid food is dehydrated usually by spraying it as fine droplets into a chamber of hot air, or occasionally by pouring it over a drum internally heated by steam.

Freeze-drying A processing method that uses a combination of freezing and dehydration is called freeze-drying. Foods that already have been frozen are placed in a vacuum-tight enclosure and dehydrated under vacuum conditions with careful application of heat. Normally ice melts and becomes water when heat is applied. If more heat is applied, it turns to steam. But in freeze-drying, the ice turns directly to vapor, and there is little chance that microorganisms will grow. Freeze-dried foods, like those that are dehydrated, are light and require little space for storage and transportation. They do not need to be refrigerated, but they must be reconstituted with water before they are ready to consume.

Irradiation As early as 1895, a major breakthrough in the world of science had arisen; the discovery of the X-ray by German physicist Wilhelm von Roetengen. This technological advancement, along with the soon to be discovered concept of radioactivity by French physicist Antoine Henri Becquerel, became the focus of attention for many scientifically based studies. Of most importance, to the field of food preservation, these two discoveries began the now controversial process of food irradiation.

Food irradiation employs an energy form termed ionizing radiation. In short, this process exposes food particles to alpha, beta and/or gamma rays. The rays cause whatever material they strike to produce electrically charged particles called ions. Ionizing radiation provides many attributes to treating foods. It has the ability to penetrate deeply into a food interacting with its atoms and molecules, and causing some chemical and biological effects that could possibly decrease its rate of decay. It also has the ability to sanitize foods by destroying contaminants such as bacteria, yeasts, molds, parasites and insects. Irradiation delays ripening of fruits and vegetables; inhibits sprouting in bulbs and tubers; disinfests grain, cereal products, fresh and dried fruits, and vegetables of insects; and destroys bacteria in fresh meats. The irradiation of fresh fruits and vegetables, herbs and spices, and pork was approved in 1986. In 1990 the FDA approved irradiation of poultry to control salmonella and other disease-causing microorganisms. Irradiated foods were used by U.S. astronauts and by Soviet cosmonauts. Public concern over the safety of irradiation, however, has limited its full-scale use. It is still off to a slow start, with only one food irradiation plant open in Mulberry, Florida, but it is seemingly catching the eyes of the producers and the consumers throughout the world.

Miscellaneous Methods Other methods or a combination of methods may be used to preserve foods. Salting of fish and pork has long been practiced, using either dry salt or brine. Salt enters the tissue and, in effect binds the water, thus inhibiting the bacteria that cause spoilage. Another widely used method is smoking, which frequently is applied to preserve fish, ham, and sausage. The smoke is obtained by burning hickory or a similar wood under low draft. In this case some preservative action is provided by such chemicals in the smoke as formaldehyde and creosote, and by the dehydration that occurs in the smokehouse. Smoking usually is intended to flavor the product as well as to preserve it.

Sugar, a major ingredient of jams and jellies, is another preservative agent. For effective preservation the total sugar content should make up at least 65 percent of the weight of the final product. Sugar, which acts in much the same way as salt, inhibits bacterial growth after the product has been heated. Because of its high acidity, vinegar (acetic acid) acts as a preservative. Fermentation caused by certain bacteria, which produce lactic acid, is the basis of preservation in sauerkraut and fermented sausage. Sodium benzoate, restricted to concentrations of not more than 0.1 percent, is used in fruit products to protect against yeasts and molds. Sulfur dioxide, another chemical preservative permitted in most states, helps to retain the color of dehydrated foods. Calcium propionate may be added to baked goods to inhibit mold.

Packaging The packaging of processed foods is just as important as the process itself. If foods are not packaged in containers that protect them from air and moisture, they are subject to spoilage. Packaging materials must therefore be strong enough to withstand the heat and cold of processing and the wear and tear of handling and transportation.

From the time the canning process was developed in the early 19th century until the beginning of the 20th century, cans and glass containers were the only packages used. The first cans were crude containers having a hole in the top through which the food was inserted. The holes were then sealed with hot metal. All cans were made by hand from sheets of metal cut to specific sizes. In about 1900 the sanitary can was invented. In this process, machines form cans with airtight seams. A processor buys cans with one end open and seals them after filling. Some cans are made of steel coated with tin and are often glazed on the inside to prevent discoloration. Some are made of aluminum. Frozen foods are packaged in containers

made of layers of fiberboard and plastic or of strong plastic called polyethylene. Freeze-dried and dehydrated foods are packed in glass, fiberboard, or cans.

Research The research activities of processed food scientists are numerous and varied. New packaging materials, the nutritional content of processed foods, new processing techniques, more efficient use of energy and water, the habits and desires of today's consumer, more efficient equipment, and transportation and warehousing innovations are some of the subjects being studied. The challenge of the food researcher is to discover better and more efficient ways to process, transport, and store food. Processed foods have changed the world. In developed countries they are part of almost everyone's diet. The United States, Canada, France, Germany, Italy, Portugal, Spain, and the United Kingdom all produce large quantities of processed foods, which they sell domestically and abroad.

From the modest canning industries in 1813 to the sophisticated food processing plants of today, food processors have provided the world with more healthful diets, food combinations never before possible, and a convenience unimagined 200 years ago. We as consumers can only imagine what further achievements will be made in the field of food preservation. But one thing is for certain; it is all for the general good of mankind...to reduce starvation levels globally and insure the availability of nutritive foods to all. It is through this way that man survives...and fits in Darwin's hypothesis of the survival of the fittest. For it is only the fit who will prevail in the end.

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