Sanitation in New Ways of Processing Food

HARRY E. GORESLINE, M.S., Ph.D.

IN 1810, Nicholas Appert gave the world the invention of thermal preservation or canning, and it opened a new way of distributing food to millions of people. The food tasted different than when it was freshly prepared, but it could be transported and stored under adverse conditions, and the invention made possible a wider variety of foods throughout the year. It also sparked a great interest in new means of food preparation that have brought in the last 100 years mechanical refrigeration and freezing, retort canning, mechanical dehydration, pasteurization, concentration, and many others. These advances have added to our ability to live in large cities, increased our national wealth, and given the housewife leisure time.

Advances in food preservation have also added to the problems in public health. We have had to learn safety measures to protect the public against nutritional deficiencies, spoilage, deterioration, and food poisoning. As long as food was prepared or preserved in the home or in each village, hazards associated with food were localized. However, with the emergence of the modern food industry and the possibility of transporting its products to distant points, the hazards are of concern over a wide area. Sanitation has grown in importance with each advance because most of the newer methods have attempted to preserve the particular qualities of fresh foods while producing food that will not spoil.

Let us look at some of the newer methods of food preservation, the reasons why they were developed, and what problems they cause for the food technologist and the public health official.

Precooked Frozen Meals

Precooked frozen meals are not new but their preparation may entail new hazards. In 1945, the Maxson Food System, Inc., introduced the "Strato-Plates" for airline feeding, and although the idea of the complete frozen meal caught on slowly, Vogel has estimated that by 1955 such meals exceeded 50 million pounds in the United States (*1*).

In the production of frozen meals it is necessary to cook each component to a point so that merely warming the whole package to serving temperature will result in a tasty meal. This means that each item in the meal may be cooked and handled differently. The meat is roasted, fried, or grilled to the desired doneness and at that point should contain no pathogens or sanitary index type of organisms and have a very low total bacterial count. However, this meat must be sliced or divided into portions, placed on the compartmental tray, and a sauce or gravy

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Dr. Goresline is deputy scientific director of the Armed Forces Food and Container Institute, U.S. Army Quartermaster Research and Engineering Center, Chicago. He was recently appointed by the Secretary of the Army as a consultant to the Food and Agriculture Organization of the United Nations for a 2-year term in Rome.

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added. This process requires handling, equipment, and working surfaces. The degree of success of this operation, from the microbiological point of view, depends upon the personal habits of the workers, the attitude of the management toward sanitary practices, and the alertness of the particular type of inspection service employed.

If there is a program of personal cleanliness in the plant and a management policy of good food-handling practices, there is great likelihood of low bacterial counts and almost no organisms of sanitary significance. Using forks, spatulas, or tongs to transfer the meat instead of the hands will contribute markedly to a high-quality product.

The same statements apply to the vegetables in frozen meals. Generally, vegetables are cooked only in boiling water until tender in contrast to the lengthy, high-temperature cooking employed to prepare meat. Again, handling after cooking is important, for it is at this stage that vegetables become recontaminated.

Two examples illustrate the need to be observant in tracing contamination and establishing sanitary practices. In one plant high coliform counts were frequently found in certain vegetables. A survey revealed that the perforated dipper used to remove the vegetables from the cooking kettles to the dispensing table was placed on the floor when not in use. The coliforms disappeared when a low table was built upon which to place the strainer. However, high coliform counts were noticed for brief periods at certain times of day. These were traced to the plant's practice, at each break, of hosing down the floor with water from a high-pressure nozzle, with the result that the splatterings from the floor covered the utensils on the newly installed table.

The second example concerns the handling and transfer of an item in the plant. A component of one meal was a potato puff produced from cooked mashed potatoes. The potato was mixed with eggs, rice flour, and seasoning, and rolled by hand into small balls for deep-fat frying. Since the rate of production of these potato balls was slow, they were placed in the chill room until a number sufficient for a day's production accumulated. They were then deep-fat fried, cooled, and transferred to the dispensing tables. The bacterial count in the raw potatoes was 12,800 per gram, in the cooked and mashed potatoes, 10, after mixing with the other ingredients, 500, after forming by hand and standing in the chill room it rose to 1,200,000, and during deep-fat frying it dropped to 400. However, upon reaching the dispensing table the count was found to be 350,000 per gram. Investigation showed that the fried potato puffs had been placed on the same trays on which they had been carried from the chill room and had become grossly contaminated by this action.

The public health implications of lack of sanitary practices in preparing such items are evident. The microbial counts and the types of organisms are largely those of recontamination during handling after cooking or of growth caused by delays in handling under conditions that allow increase in temperature and opportunities for bacterial multiplication. In plants where sanitary and quality controls are tight, such problems seldom occur.

Thermal Processing in Flexible Plastic Film

Thermal processing in flexible plastic film packages is a new process that has been sponsored by the military services. There is a definite need for a lightweight, easily carried food container for the soldier in the field. The metal can is heavy, wasteful of space in transport, and difficult for a soldier to carry during field operations. To overcome this, considerable research has gone into the production of film laminations that would approach the metal can in protection against moisture loss, oxygen transfer, and bacterial contamination. The real difficulty was to laminate flexible materials in such a way as to get permanent bonding and sealing of a package that would withstand retorting under 15 pounds of steam pressure at 250° F. Success came fairly quickly for processing acid fruits at 212° F., but the successful processing of nonacid meat in the retort took longer to achieve. The best packaging material to date is 3 mil polyvinyl chloride, laminated to 0.35 mil aluminum foil and the foil laminated to a 0.5 mil polyester film such as mylar.

The success of the system depends upon short processing times in the retort to minimize the damage to the laminations and seals and the maintaining of uniform pressure within the retort during the entire processing operation. During retorting there is a tendency for pressure developed within the container to split the seal that has become softened by the heat. This is offset by maintaining pressure within the retort during the cooling period so that the pressure on the outside of the package is as great as that on the inside until the package has cooled to a point where the seal is no longer soft.

Sanitation plays an important role in this food-processing system. The length of time necessary to obtain sterility of food in retorting is dependent to a marked degree on the bacterial load and the type of spore-forming organisms the food carries. By practicing good quality control of the item and good sanitary preparation and handling as it goes into the container, the bacterial load can be kept very low. As a consequence, the retorting time at 250° F. can be much shorter than if large numbers of bacteria were present. Thus, a grilled ⅝-inch-thick steak, transferred to the flexible package with a minimum of contamination, can be retorted to sterility in about 20 minutes and later when reheated will taste like a grilled steak.

Difficulties remain in the development of methods to detect pinholding of the flexible package or failure of the seals during transportation and handling. Since this system is in the developmental stage, more experience will be needed to determine the extent and type of spoilage caused by these failures.

Radiation Sterilization of Food

It has been known for many years that living cells are killed by X-rays and similar types of radiation. Research on the use of ionizing radiation to sterilize food has been undertaken only recently. Because such a method was a possible answer to a military problem, most of the research and development of the process and the work on the establishment of wholesomeness has been done with military funds. Similar investigations on the use of low doses of ionizing radiation to extend shelf life of fresh foods is being carried out under the direction of the U.S. Atomic Energy Commission.

The food is sterilized by gamma rays emitted by radioactive cobalt 60 and with accelerated electrons of energies below the threshold at which radioactivity could be induced in the food. The progress and use of this process has been such that a large radiation facility has been constructed by the U.S. Army at the Research and Engineering Command at Natick, Mass. Because this pilot facility is in the building where food preparation is carried out, more rapid progress can be expected than in the past when the food preparation and irradiation facilities were often many miles apart.

The military needs stable foods that can be shipped and stored without refrigeration and that closely resemble familiar foods such as steaks, fried chicken, and baked ham. The radiation process permits the packaging of table-ready foods and the preservation of large items such as whole baked hams or whole roasts of meat or poultry that cannot be canned or dehydrated, as well as sandwich meals for use by the soldier in the field.

Certain problems must be solved before the process will be a complete success. One is the flavor change or off-flavor produced by the treatment. The higher the radiation dose, the greater the flavor change. If lower doses could be used there would be less flavor change, and it is here that sanitation in food preparation is essential.

The dose believed necessary to insure sterility of the product is 4.5 megarads of ionizing radiation. This high dose is necessary because the organism most resistant to the effects of ionizing radiation is *Clostridium botulinum*. It is more resistant than the spore formers which cause spoilage; in contrast, in thermal processing or canning, the highest temperatures are necessary to kill the spore formers. It is believed that, with rigid sanitary controls of the entire handling process, a food product with very low bacterial count, possibly devoid of pathogens, is possible. Such products could pave the way toward the use of lower doses of radiation in processing.

Extensive investigations have been conducted to test wholesomeness of food treated with ionizing radiation, including one of the largest series of animal feeding tests ever carried out. Although all of the research has not been completed on all of the foods under study, it can be said that so far there does not appear to be any adverse effect from the ingestion of irradiated food.

Dehydration of Food Products

The use of dehydrated food is nearly as old as man, but some recent developments such as freeze drying present some problems that warrant attention. Again, the military services have led in the development of many types of dehydrated foods that meet the soldier's need. Swiftly moving troops cannot be impeded with unnecessary weight, and they must have foods that are stable without refrigeration or other activity-limiting equipment. Removing water from the food reduces its weight, yet rehydration returns it to a palatable form. Another method is to reduce weight and save space by putting the food in flexible film, packaging that approaches the protection of the metal can. These are the objectives of a very extensive program, the "quick-serve meal" of the military services, a feeding system that employs cooked dehydrated items. The soldier merely adds hot or cold water, allows the items to rehydrate, and eats the meal. At present there are 21 menus, for breakfast, dinner, and supper, so that for 7 days he need not repeat a menu.

Three main processing techniques are used in producing dehydrated foods. The choice of method depends on the particular flavor and texture qualities that must be preserved, sensitivity of the item to heat damage, rehydration characteristics desired, and the cost of production.

Air drying. Air drying has long been employed to prepare certain types of foods. However, modern methods and mechanized equipment have markedly improved the quality of this type of food through the use of temperature and humidity controls, control of air movement, and new techniques in preparation and handling. With modern continuously operating equipment, heated air at controlled temperatures, humidity, and velocity is directed through beds of the product to be dehydrated so as to minimize heat damage and color, flavor, and texture changes. When rehydrated, these products more closely resemble the fresh counterpart than those produced by older methods.

Vacuum drying. Vacuum drying is employed if heat damage and oxidation are problems. It is generally used in the dehydration of fruits. By air drying the fruit to around 20 percent of its original moisture and then placing it in a chamber and drawing a vacuum of 2 to 3 millimeters of mercury pressure products can be dried more rapidly, with less quality damage, and at much lower temperatures than could be employed at atmospheric pressures.

Freeze dehydration. The freeze dehydration method is beginning to be used commercially. The cost of equipment, length of the drying cycle, and cost of operation have been deterrents to the use of this method until recently. The Armed Forces Food and Container Institute, which pioneered this method to produce many items for possible use by the military services, has developed high quality products, reduced production costs, and led in the adoption of improved techniques. Freeze dried commercial items are now appearing on the civilian market.

Food is prepared in the form in which it is to be used and rapidly frozen. The frozen product is then placed in a chamber and a high vacuum drawn. At a vacuum in the range of 50 to 500 microns of mercury pressure, the moisture in the ice of the product sublimes and is collected on a condenser. Evaporation of the moisture produces a cooling effect that keeps the food frozen. Since energy is required to bring about this evaporation, heat is supplied to the product by heating the shelves or trays holding the frozen product. The length of the drying cycle is determined by the efficiency with which this energy can be supplied to the product being dried and the efficiency of the condenser in removing the water vapor.

The ice crystals formed in the food are slowly sublimed leaving small cavities and an open structure in the tissue, markedly facilitating rehydration. By contrast, as the juices are evaporated in the air drying of a piece of meat the structure collapses, the surface becomes case hardened, and rehydration is difficult and incomplete. Drying in the frozen state eliminates the possibilities of bacterial growth during this stage of processing, but it also minimizes the number of bacteria that are killed during drying.

Foods in production or under development, using the dehydration methods just described, may be divided into the following categories:

- Raw dehydrated vegetables—rehydrated in cold water.
- Blanched dehydrated vegetables—rehydrated in hot water.
- Cooked dehydrated vegetables—rehydrated in hot water.
- Raw dehydrated meat—rehydrated and then cooked.
- Cooked dehydrated meat—rehydrated in hot or cold water.

I will discuss briefly the production of these foods since sanitation is important in the manufacture and handling of each category.

Raw dehydrated vegetables. Cabbage, green pepper, sweet red pepper, and other vegetables are ingredients intended for fresh salads. The field-fresh items are shredded or diced and dehydrated but never heated or blanched. Any natural or acquired contamination remains because only a limited number of organisms are killed in dehydration. Since these vegetables are rehydrated in cold water, all viable organisms in the product will be eaten by the consumer. Therefore, the personal cleanliness and sanitation practiced in the processing plant become of concern to public health officials and sanitarians.

Blanched dehydrated vegetables. Vegetables are blanched by exposing them to steam or hot water long enough to inactivate the enzymes. They can be used after a short cooking period although certain tender ones, such as peas, need only be rehydrated with hot water. The blanching kills most of the bacteria present and should result in a product with a fairly low bacterial and a low coliform count. Dehydration further lowers these counts. Coliforms or other sanitary index organisms found in the final product are an indication of recontamination. Specific organisms are likely to appear in a high bacterial count, and these are indicative of types that are allowed to grow in the equipment of a plant with poor sanitary practices.

Cooked dehydrated vegetables. These vegetables are for rapid rehydration in hot water to produce an "instant" food. The vegetables are cooked to the required point and dehydrated. The cooking kills most of the bacteria, and any sizable population in the final dehydrated product will be the result of contamination during processing and handling. This is particularly true of coliform organisms. Strict sanitation in production is needed, since rehydration in 180° F. water cannot be expected to kill undesirable organisms.

Raw dehydrated meat. These meats are for use where cooking equipment is available. Their ultimate texture and flavor are quite similar to that of the raw product when cooked, and they are tastier than meats cooked before dehydration.

In order to maintain texture and to facilitate rehydration, the product is freeze dried. The raw meat is sliced or formed and rapidly frozen, placed on shelves, and dehydrated in a high vacuum. There is nothing in the process that should kill bacteria except the effect of the desiccation. Therefore, most of the bacteria present in the raw meat and those picked up through handling should be present in the final dehydrated product. It is readily apparent that sanitary practices employed in the killing and dressing of the animal and in manipulation during preparation for dehydration will markedly influence the numbers and types of bacteria in the final product. If the numbers are high, it should be remembered that the meat will be rehydrated and cooked before eating.

Cooked dehydrated meat. These meats are intended for rapid rehydration in 180° F. water and are eaten without cooking. Shrimp used for cocktails, for example, are rehydrated in cold water.

Ground or diced meat products are generally air dried. If texture is a desirable characteristic, such as in sliced roasts or fried patties made from fish or chopped meat, the product is freeze dried. It rehydrates very rapidly and has an excellent texture. Some of the pattie-type items developed by the military will rehydrate completely in 10 to 15 seconds in 180° F. water.

The cooking of meats should render them nearly sterile and the bacterial count should be very low. The presence of coliforms or other undesirable organisms in the final product indicates contamination and lax sanitary practices during the preparation and handling of the cooked food. Since this type of dehydrated food is not cooked before eating but is quickly rehydrated in hot water, it is essential that such products have a good sanitary history.

It is not possible in this short paper to cover all of the new processes. It is hoped that through discussing these four, some of the problems that such processes present have been highlighted. The development of each new method offers a challenge to the sanitarian, for through his efforts in the commercial plant quality control becomes easier and more effective and wholesomeness can be assured.

It is also essential that public health officials understand what the hazards are. It is during the processing and handling that the quality of the final product is determined. The condemning of low quality or contaminated items in the food market is not the place to start. Every food manufacturing concern should be encouraged to install and maintain good sanitation practices to prevent undesirable products from being marketed. It is evident that this step would ease the task of the public health official. It is equally evident that effective sanitation can play an important role in bringing good quality, wholesome, and nutritious products to the consumer.

REFERENCE

(*1*) Vogel, S.: A year of frozen food gains. Canner and Freezer 122: 18–22 (1956).

Goals for Development Decade

The World Health Organization's principal goals during the United Nations Development Decade, 1961–70, concern national health planning, communicable disease control, water systems, malnutrition, and medical manpower.

Preparation of a health plan for a country requires a preliminary fact-finding survey and establishment of objectives and priorities. In the next 2 years, WHO expects to make planning services available to 10 countries, mostly in Africa. The goal for the decade is to provide this service to 30 countries at a cost of about 2.7 million.

In the malaria eradication campaign, the goal is to cover gaps in the program in Africa, the Arabian Peninsula, East Asia, and Oceania.

Yaws still poses a threat to an estimated 75 million people. WHO and the United Nations Children's Fund (UNICEF) intend to spend $800,000 for yaws control in 1963 and in 1964. It is estimated that yaws could be eliminated as a serious public health problem in 6 years at a cost of $2 million annually.

Other communicable diseases for which specific goals have been set in research or control are smallpox, bilharziasis (schistosomiasis), onchocerciasis (river blindness), and trypanosomiasis (sleeping sickness).

WHO sees as an obtainable goal within the Development Decade the provision of safe and adequate amounts of piped water to twice as many people in cities and towns as are now being served. Estimated cost of construction is $400 million per year up to 1970. This annual capital investment in community water supplies would amount to about 0.25 percent of the gross national product of the investing nations. Of the annual expenditures, one-fourth, or $100 million annually, is expected to come from outside sources.

In cooperation with the Food and Agriculture Organization and other agencies, WHO will intensify its efforts against malnutrition.

In some countries without doctors of their own or with only a few, the decade will be two-thirds completed before even a small part of the minimum national staff graduate from medical schools. For instance, in Africa (excluding South Africa), the ratio of physicians to population is less than 1 to 20,000. To raise the proportion even to 1 to 10,000 during the next 20 years, 30 more medical schools would be needed.

Since it is impossible to train enough physicians to satisfy the demand in a short time, auxiliary health workers will play a major part in health programs for some time to come. WHO is seeking ways to train about 250,000 auxiliary workers during the decade.