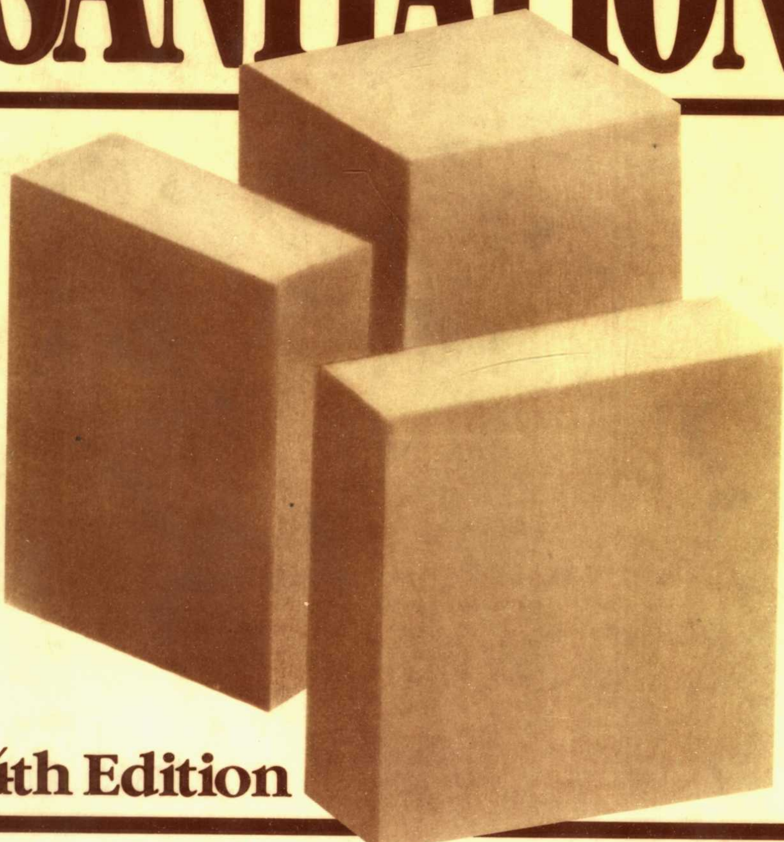
QUANTITY FOOD SANITATION



4th Edition

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QUANTITY FOOD SANITATION

Fourth Edition

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PREFACE

Quantity Food Sanitation was designed as a reference source as well as a college text for students in dietetics and hotel administration. Since publication of the third edition, new information pertaining to the diversified field of quantity food sanitation has become available. New information on the microbiology of foods, new techniques in food processing, and new developments in food service systems have eliminated some sanitary problems in quantity food service and created new ones. A chapter has been added that deals with microbiological considerations in connection with some specific categories of foodservice systems.

In the business of serving food to the public, regardless of the food system used, sanitary control is of great importance. Preventing foodborne illnesses is an obligation that the foodservice operator must shoulder. The chance for success lies in his or her willingness to understand the facts underlying food safety and to diligently apply sanitary control measures all along the way, from the purchase of safe food, through the many steps of preparation and holding, to the finished product at serving time.

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CHAPTER I

FOOD SPOILAGE

SPOILAGE

The term ''spoilage'' is somewhat vague. Spoilage is usually thought of as denoting unfitness for human consumption. Spoilage of food may be due to chemical or biological causes; the latter include action of inherent enzymes, growth of microorganisms, invasion by insects, contamination with trichinae, worms, and the like. About one-fourth of the world's food supply is lost through the action of microorganisms alone.

It is extremely difficult to sharply define ''spoilage'' because different people have different concepts about edibility, or fitness to eat. Spoilage is usually thought of as being associated with decomposition. This latter concept is too limited since it excludes food which, although not decomposed, harbors certain kinds of bacteria, or their toxins, in numbers or amounts which make the food poisonous and thus unfit for human consumption.

The criteria for assurance in foods of fitness to eat are:

1. The desired stage of development or maturity of the food.
2. Freedom from pollution at any stage in the production and subsequent handling of the food.
3. Freedom from objectionable chemical and physical changes resulting from action of food enzymes; activity of microbes, insects, rodents; invasion of parasites; and damage from pressure, freezing, heating, drying, and the like.
4. Freedom from microorganisms and parasites causing foodborne illnesses.

Enzymatic and microbial activities are undesirable when they are unwanted or uncontrolled. An example is the souring of milk; if unwanted, it is spoilage, yet the same process is purposely used in the production of certain cheeses and other fermented products made from milk.

STABILITY

Foods are frequently classified on the basis of their stability as nonperishable, semiperishable, and perishable. An example of the first group is sugar. Few foods are truly nonperishable. Hermetically sealed, heat-processed, and sterilized (canned) foods are usually listed among the nonperishable items. For all intents and purposes, they belong there. However, canned food may become perishable under certain circumstances, when, by accident, a chance for recontamination following processing is afforded: if the seams of the cans are faulty, or if through rusting or other damage the can is no longer hermetically sealed. Spoilage of canned goods may also take place when the canned items are stored at unusually high temperatures. Bacteria which are extremely resistant to heat must be expected to escape the killing effect of heat applied in routine canning. These thermophilic spore-forming bacteria may multiply at high temperatures, with an optimum near 113 F (45 C) and higher. Examples of these thermophiles are the *Bacillus* species which cause flat sour spoilage, the *Clostridium nigrificans* causing sulfide spoilage, and the *Clostridium thermosaccharolyticum*. It should be emphasized here that the organism causing botulism, *Clostridium botulinum,* is eliminated during the appropriate heat treatment given the foods in the canning operation. Certain heat-resistant molds have been found to escape thermal death in the routine canning of fruit, the most common one being *Byssochlamys fulva* (King et al., 1969; Splittstoesser et al., 1971; King et al., 1972).

Classified as semiperishables are usually the dry foods, such as flour, dry legumes, baked goods, hard cheeses, dried fruits and vegetables, even waxed vegetables. Frozen foods, though basically perishable, may be classified as semiperishables provided they are freezer-stored properly.

The majority of our food materials must be classified as perishables. This group includes meat, poultry, fish, milk, eggs, many fruits and vegetables, and all cooked or "made" food items, except the dry and very acid ones.

MICROORGANISMS INVOLVED IN SPOILAGE

Microorganisms which may cause food to spoil include molds, yeasts, and bacteria. The contamination with molds, as a rule, is easily detected because of the presence of furry hyphae or threadlike structures which, in many instances, are colored. They often contribute a musty odor and flavor to the food they invade. Some molds, because of toxins they produce, are not altogether harmless. More will be said about aflatoxins later. Semi-moist foods or foods with low water activity have been partially dehydrated, and the remaining water is sufficiently bound to hold the growth of bacteria, molds, and yeasts in check (Hollis et al., 1968).

Yeasts are unicellular bodies of small sizes which multiply by budding. In general, sugars are the best food for energy for yeast, carbon dioxide and alcohol being the end products of the fermentation they cause. Spoilage due to yeast may usually be recognized by the presence of bubbles and alcoholic smell and taste.

Bacteria spoil food in many ways and it is not always possible to recognize the spoilage by sight, smell, or taste. Unfortunately, some of the bacteria that are important from a public health point of view may multiply to dangerously high numbers in food without changing the appearance, odor, or taste of the food. Disease-producing food has usually no decomposed appearance, but is certainly unfit for human consumption, and must be considered to be spoiled.

It is an important fact that almost any food will spoil if it is moist and not kept frozen. Spoilage must be expected within a wide temperature range. The various types of microorganisms as well as the genera, species, and strains vary in their temperature and food requirements. Thus the bacterial flora of a spoiled food item will vary greatly.

Origin of microorganisms varies also. The microorganisms may include the original flora of the particular food, as well as contaminants added in handling, processing, transporting, storing, preparing, and serving.

MULTIPLICATION

The multiplication of spoilage organisms on or in the food materials depends on many factors—the type of organism involved, its ability to gain nourishment from the food, competition from other microorganisms, initial load, and environmental conditions. Some important conditions are composition of the food, available moisture, pH, oxygen tension, the presence of inhibitory substances, and temperature. For signs of spoilage consult Frazier and Westhoff (1978); Weiser et al. (1971); and Longrée and Blaker (1982).

PROCESSING

Many food materials are processed to halt enzyme action and to destroy specific pathogens and spoilage organisms, thus prolonging the keeping quality for hours, days, months, or even years. Frazier and Westhoff (1978) have summarized the principles of food preservation as follows:

1. Prevention or delay of microbial decomposition:
   a. By keeping out microorganisms (asepsis)
   b. By removal of microorganisms, e.g., by filtration
   c. By hindering the growth and activity of microoganisms, e.g., by low temperatures, drying, anaerobic conditions, or chemicals
   d. By killing the microorganisms, e.g., by heat or radiations
2. Prevention or delay of self-decomposition of the food:

a. By destruction of food enzymes, e.g., blanching
b. By prevention or delay of purely chemical reactions, e.g., prevention of oxidation by means of an antioxidant

3. Prevention of damage because of insects, animals, mechanical causes, etc.

It is beyond the scope of this book to discuss the principles and methodology of commercial food preservation, such as pasteurization, canning, freezing, freeze-drying, dehydration, dehydrofreezing, curing, salting, pickling, use of chemical preservatives, and irradiation; the reader is referred to Frazier and Westhoff (1978), Potter (1986), Desrosier and Desrosier (1977), Weiser et al. (1971), Tressler et al. (1968), and other texts. For a discussion of the principles of irradiation see Urbain (1978), Potter (1986), and Anderson (1978).

At this time federal regulations permit irradiation of potatoes for the prevention of sprouting, and irradiation of wheat grain and wheat flour for insect control. Also, irradiation of certain spices, herbs, and vegetable seasonings has been approved by the Food and Drug Administration (FDA) to control microbial load and insect infestation, provided that the total absorbed dose is not in excess of a certain limit set by the FDA.

In 1985 the FDA gave permission for radiation of pork to control the presence of *Trichina spiralis*, the causative organism of trichinosis in humans. Foods treated by federally approved doses are completely wholesome. And in 1986 irradiation of fresh fruits and vegetables was approved.

The microbial flora of public health significance that may be expected to occur in connection with processed foods are discussed in Chapter VI.

Persons entrusted with serving meals to the public must be familiar with the signs of incipient spoilage although, as was pointed out above, freedom from such signs is no guarantee of wholesomeness; unfortunately there are forms of illness-producing spoilage which do not give us the comfort of noticeable changes indicating that the food has become poisonous. When newly purchased food or stored food is being inspected, signs of incipient spoilage should be familiar to the one doing the job. Consult Longrée and Blaker (1971).

References

Anderson, A. W. (1983). "Irradiation in the processing of food." In *Food Microbiology*, A. H. Rose, Ed., Chapter 5. Academic Press, London.

Desrosier, N. W. and J. N. Desrosier (1977). *The Technology of Food Preservation*, 4th ed. Avi Publishing Co., Westport, Conn.

Frazier, W. C. and D. C. Westhoff (1978). *Food Microbiology*, 3rd ed. McGraw-Hill Book Co., New York.

Hollis, F., M. Kaplow, R. Klose, and J. Halik (1968). "Parameters of moisture content for stabilization of food products." U.S. Army Natick Lab. Tech. Rpt. No. 69–26–FL.

King, A. D., Jr., H. D. Michener, and K. A. Ito (1969). "Control of *Byssochlamys* and related heat-resistant fungi in grape products." *Appl. Microbiol.*, 18:166–173.

King, A. D., Jr., A. N. Booth, A. E. Stafford, and A. C. Waiss, Jr. (1972). "*Byssochlamys fulva,* metabolite toxicity in laboratory animals." *J. Food Sci.*, 37:86–89.

Longrée, K. and G. G. Blaker (1982). *Sanitary Techniques in Foodservice,* 2nd ed. John Wiley and Sons, New York.

Potter, N. N. (1986). *Food Science,* 4th ed. Avi Publishing Co., Westport, Conn.

Splittstoesser, D. F., F. R. Kuss, W. Harrison, and D. B. Prest (1971). "Incidence of heat-resistant molds in Eastern orchards and vineyards." *Appl. Microbiol.*, 21:335–337.

Tressler, D. K., W. B. Van Arsdel, and M. J. Copley, Eds. (1968). *The Freezing Preservation of Foods,* Avi Publishing Co., Westport, Conn.

Urbain, W. (1978). "Food irradiation." In *Advances in Food Research,* Vol. 24. Academic Press, New York.

Weiser, H. H., G. J. Mountney, and W. A. Gould (1971). *Practical Food Microbiology,* 2nd ed. Avi Publishing Co., Westport, Conn.

Additional Readings

Ball, C. O., and F. C. W. Olson. *Sterilization in Food Technology: Theory, Practice and Calculations.* McGraw-Hill Book Co., New York. 1957.

Dack, G. M. *Food Poisoning.* 3rd ed. Univ. of Chicago Press, Chicago. 1956.

Heid, J. L., and M. A. Joslyn. *Fundamentals of Food Processing Operations: Ingredients, Methods, and Packaging.* Avi Publishing Co., Westport, Conn. 1967.

Josephson, E. S. and M. S. Peterson, Eds. *Preservation of Food by Ionizing Radiation,* Vol. II and III. CRC Press, Boca Raton, Fla. 1983.

Rose, A. H., Ed. *Food Microbiology.* Academic Press, London. 1983.

Russell, A. D. and R. Fuller, Eds. *Cold-Tolerant Microbes in Spoilage and the Environment.* Society for Applied Bacteriology, Techn. Services, No. 13. Academic Press, London, New York, San Francisco. 1979.

Sperber, W. H. "Influence of water activity on foodborne bacteria—a review." *Jour. Food Prot.*, 46:142–150. 1983.

Spiher, A. T. "Food Irradiation: an FDA report." *FDA Papers 2* (Oct.): 15–16. 1968.

The International Commission on Microbiological Specifications for Foods. *Microbial Ecology of Foods.* Vol. 1. Academic Press, New York. 1980.

CHAPTER II

SOME BASIC FACTS ON MICROORGANISMS IMPORTANT IN FOOD SANITATION

It is beyond the scope of this book to present a treatise on the elements of food microbiology. However, it was deemed desirable to precede the following chapters with a few brief statements of facts on bacteria and thereby help the reader to reacquaint himself with the terms used in connection with microbiology. Microbiology is only one of the sciences contributing to the understanding and application of food sanitation; examples of others are chemistry, physics, entomology, and epidemiology.

Certain microorganisms and parasites are transmitted through food and may cause illnesses in the persons who ingest the contaminated items. For some microorganisms the food may serve as a mere vehicle of transmission; for others, as a medium in which they multiply to tremendous numbers. Outbreaks of acute gastroenteritis caused by ingestion of food in which certain pathogens have multiplied profusely are popularly referred to as "food poisoning" outbreaks (see Chapter IV).

Microorganisms which may cause foodborne illnesses include bacteria, viruses, rickettsia, protozoa, and parasites such as trichinae. Although most of the microorganisms producing foodborne illnesses are bacteria, it should be remembered that less than 1% of all bacteria are enemies of man and many are his friends.

This discussion will be largely limited to bacteria. Among the bacteria are found some important pathogens transmitted by food, among them those which multiply profusely in food and are capable of causing outbreaks of food infections and food intoxications ("food poisoning").

Bacteria are plants. They are single-celled organisms, and do not contain chlorophyll. The bacterial cell contains a wall through which the cell takes up simple nutrients in solution, which are combined by the cell for its utilization.

CLASSIFICATION, SIZE, SHAPE, MOTILITY, AND ENDOSPORES OF BACTERIA

Classification

In contrast to the molds and yeasts, classification of bacteria on a morphological basis is difficult. In fact, bacteria are so small that morphological differences are inadequate as a basis for a workable classification. For larger grouping, some of the morphological characteristics used are shape, size, and grouping of cells. Gram stain and formation of spores are used also. However, finer subdivisions into species and varieties are largely made on the basis of physiological characteristics such as biochemical activities, pathogenicity, metabolic requirements, antigenic reactions, and reactions to the action of bacteriophages which are viruses pathogenic to bacteria; these viruses attack the bacteria and kill them by lysis. Many phages are known, each active against a specific species or even a strain of bacterium. This specificity has an important practical application in the phage typing of bacteria. Thus, types may be distinguished which otherwise are known to look and react alike.

The standard reference in the field of bacterial classification is Bergey's *Manual of Determinative Bacteriology,* published by the American Society for Microbiology.

Size

Bacterial cells are very small, with some variation among the different species. The majority of bacteria of importance in connection with food sanitation measure approximately 0.5–2.0 × 2.0–10.0 micrometers (μm), staphylococci having diameters 0.75 μm and larger; rods like salmonellae ranging in width from 0.5 to 1 μm and in length from 2 to 3 μm. Filamentous bacteria may be extremely long. The single cell is not visible to the naked eye, the visual acuity of the naked eye being approximately 75 μm. One micrometer equals 1/1000 mm or 1/25,400 inch.

When millions of bacterial cells are suspended in a clear substrate, the suspension will assume a turbid appearance. Thus one may see the bacteria as a population. Also, when bacteria cover a food surface in the form of a slime they are visible to the human eye. Many times, however, the presence of bacteria cannot be seen in food even if the contaminants are present in sufficient numbers to make a person extremely ill.