



FOOD SAFETY

Few factors are more important in assuring the wholesomeness of food than handling practices—from processing plant to your customers' kitchens—including *good sanitation* and *proper temperatures*. Some of the most significant instances of food-borne illnesses, resulting from product contamination—or exposure of foods to harmful bacteria, including meat foods—have been the result of poor handling and storage and improper cookery. Such contamination may occur at the processing plant, in transit from the plant, in the retail store cooler or retail case, or in a shopper's basket, car or home. In other words, bacteria are everywhere! The key to food safety is to minimize, or eliminate, harmful bacteria in or on meats during processing, handling and packaging.

Spoilage bacteria vs. pathogenic bacteria. As food **spoils**, the color, odor and texture deteriorate, thus reducing its desirability and acceptability. These signs are a signal, alerting an observer that taste, food safety, and quality have diminished. While the foodstuff may still be safe to eat, it has become unpalatable. However, when food is *contaminated* with **pathogenic organisms**, it has been exposed to microorganisms which can *cause food-borne illness in humans*. There often are no alerting signs of contamination with food pathogens, such as off-odor or color.

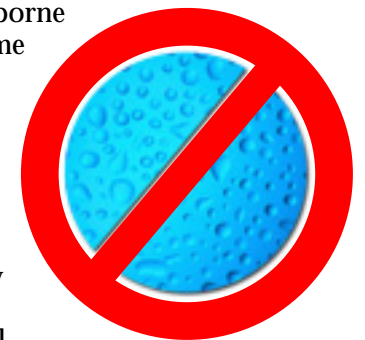
Therefore, it is essential that exposure to pathogenic contamination be minimized, if not prevented altogether. Much can be done through careful product control at every step of handling.

Conditions

Proper storage is essential to maintain food safety and quality. For microorganisms to thrive, there must be conditions which encourage growth. Factors which should be controlled are *moisture, temperature, oxygen, exposed meat surface areas* and *degree of acidity or alkalinity*. Several types of mold and yeast, as well as microorganisms such as bacteria and viruses, can grow **on** meat.

Bacteria are the leading offender. Molds/yeasts are less frequently seen on meats but do grow under certain conditions. Viruses are a potential cause of food-borne illness. A few parasites are also potential problems in meat. We'll discuss some of these troublemakers, but first, let's look at conditions.

Moisture. Moisture must be present for microorganisms to grow. Molds grow in dryer environments, but there is enough natural water in fresh meats to satisfy the growth of both. The moisture level in meat is affected by air flow, humidity and temperature in the storage area. Air flow increases evaporative losses in unwrapped meat. The relative humidity in storage affects the amount of moisture drawn to the surface. When relative humidity is high, condensation of moisture occurs. If the relative humidity is low, moisture evaporates and meat surfaces stay relatively dry, inhibiting bacterial growth. When the combination of desired low relative humidity and proper temperature



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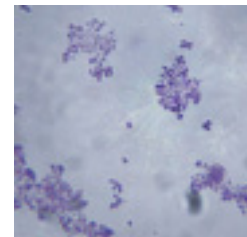
levels is maintained, spoilage will be retarded and shrinkage, discoloration and dehydration will be minimized.

Temperature. Temperature is a critical factor during meat handling and storage. One class of microorganisms that grows well between 32°F and 68°F includes some strains of bacteria and some yeasts and molds. They are called “psychrotrophs.” But most bacteria thrive at temperatures of 60°F to 104°F. They are “mesophiles.” A few grow at higher temperatures of 104°F to 150°F and are called “thermophiles.”

Most of the bacteria that can cause food-borne illness will not grow well at normal refrigerator temperatures (32°F to 40°F). Temperatures below 40°F retard (but do not stop) bacterial growth. And as the temperature nears 28°F (freezing point of meat), few microorganisms grow and reproduction is greatly retarded. That’s why refrigeration and freezing prolong shelf life. At temperatures higher than 40°F quality, appearance and safety are in jeopardy. A good rule of thumb is to remember that, “Life begins at 40°F” for most microorganisms.

Oxygen. Some microorganisms, called *aerobic* bacteria, must have free oxygen to grow. All molds and most yeasts that grow in meat are aerobic. Other microorganisms grow only in the absence of oxygen. They are *anaerobic* bacteria. Yet another group, called *facultative*, will grow either with or without oxygen.

Aerobic conditions are present primarily on the surface of meat cuts, allowing for the presence of bacteria that need oxygen. The growth of *anaerobic* bacteria might occur when contaminated cuts are vacuum packaged and the internal surfaces are not exposed to air. *Facultative* organisms also might exist on the surface or inside portions of blocks of ground meat, but never inside an intact, healthy muscle. (An exception would be meat injected with curing or tenderizing agents, or meat which is needle tenderized, in the possible case of contaminated ingredients or equipment.)



Vacuum packaging extends shelf life by reducing the exposure of meat to oxygen, inhibiting the growth of *aerobic* bacteria. However, if the meat had been improperly handled before packaging, a vacuum could allow *anaerobic* bacteria to grow; therefore, proper refrigeration is still critical with vacuum packaged meats.

Exposed surface area. The interior portions of intact muscles are generally free of microorganisms. Meat surfaces, however, are susceptible to exterior contamination and subsequent spoilage. The greater the surface area, the greater the potential for microbial growth. A large roast would have a relatively smaller surface exposed than a package of ground meat, which has hundreds of surfaces exposed. Because of the greater potential for



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needle-tenderized or ground meat to be contaminated, great care is necessary during handling and storage, including sanitary conditions of the grinder or needles, as well as hands, table and tray surfaces. While refrigeration will inhibit growth, avoiding exposure to both spoilage and pathogenic bacteria is a critical goal.

Acidity or Alkalinity. The “pH factor” describes a measurement of the acidity (below pH7) or alkalinity (above pH7) of a substance. For most bacteria, the optimal pH level is around pH7 (neutral), but most will grow between levels of pH5 and pH8. On either side of this pH range, the environment for microorganisms is less hospitable. Fresh meat has a natural pH value ranging from pH5.3 to pH6.5, good growing conditions for bacteria, should they be present.

Among substances which increase the acidity are vinegar and citric acid. Both are used in food preservation, since they inhibit bacterial growth.

Bear in mind that some molds and bacteria are beneficial. Both Roquefort and blue cheese, for example, have their distinct characteristic flavors developed by the blue molds that are safe to eat. Summer Sausage is a fermented sausage with a *lactobacillus* bacteria culture added, thus increasing acidity through a controlled fermentation, also achieving the desired flavor.

Food-Borne Illnesses & Infections

Food-borne illness is caused by eating foods containing toxins produced by pathogenic bacteria or by infectious organisms. Bacteria that can grow and produce toxins in meat include *Clostridium botulinum*, *Staphylococcus aureus* and *Clostridium perfringens*.

Infections occur from eating meat, poultry, fish or other protein foods contaminated with pathogenic organisms which then multiply in the human intestinal tract, causing illness. *Escherichia coli O157:H7 (E.coli O157:H7)*, *Salmonella* and *Listeria* are examples. *Trichinella spiralis*, a parasite, also multiplies in the intestinal tract and migrates into muscles. (The disease, *Trichinosis*, is rarely seen in the U.S., since the advent of laws which require cooking of garbage which may be fed to pigs [most states have outlawed garbage feeding altogether]. Additionally, the vast majority of market hogs are fed a grain-based diet and therefore would not come in contact with the parasite.)

Special mention is made of *E.coli O157:H7*, due to its severity and cause of death in humans. If present in the intestinal tract of an animal, and if improper sanitary handling of the animal occurs during the slaughtering and further processing, the bacteria may be transferred to the surface of the meat and thence into consumption as with any facultative bacteria. *E.coli O157:H7* may also be transferred from humans to meat, or from humans to humans. It could be present in the intestinal tract and feces of a meat handler. If an infected handler does not properly wash his/her hands after defecating, the transfer to the surface of meat or meat dishes is possible. Outbreaks of *E.coli O157:H7*



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food-borne illness have occurred most frequently after consuming foods from foodservice operations, but it is also possible to have contamination occurring in meat sold at the retail meat case.

Some foodborne illnesses can be fatal, while others can cause from mild to severe illness and discomfort. Of special concern are very young children, older adults, and immuno-compromised (HIV/AIDS) individuals.

The table at the end of this chapter provides a brief glance at the characteristics of some common food-borne illnesses.



HACCP

A food safety system that the food industry and government have implemented is “*Hazard Analysis Critical Control Points*,” or *HACCP*. *HACCP* is designed to identify certain points in the processing system—from farm to the consumers’ shopping cart—as critical to assuring food safety, thus points need to be carefully monitored. The USDA’s Food Safety and Inspection Service has joined with the meat industry in the common goal of making *HACCP* principles the foundation for the safest possible meat and poultry inspection system.

While *HACCP* efforts in the meat industry have initially been concentrated at meat processing operations, retail store and foodservice management have become increasingly aware of *HACCP* principles and applications.

Quality control encompasses product composition, specifications, processing, packaging, storage and distribution, as well as microbiological safety in relation to a plant’s equipment, sanitation and pest and rodent control. A quality assurance program requires the concerted involvement and all-out effort by all persons involved—management, supervisors and all workers—in order to produce and deliver wholesome, quality products to consumers.

For consumers at home, avoiding most spoilage and hazards to pathogenic organisms can be assured through proper cooking and handling. Tips for meat preparation and handling are noted in the Meat Cookery section of this manual.



NOTE: One is not guaranteed complete safety of meats by following the advice in this chapter.

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Characteristics of Some Common Food-Borne Illnesses

Illness: **Botulism** (food poisoning)
Causative Agent: Toxins produced by *Clostridium botulinum*
Symptoms: Impaired swallowing, speaking, respiration, coordination. Dizziness and double vision.
Typical Time from Ingestion to Onset of Symptoms: 12 to 48 hours
Foods Usually Involved: Canned low-acid foods including canned meat and seafood, smoked and processed fish.
Preventive Measures: Proper canning, smoking, and processing procedures, including the use of nitrites. Cooking to destroy toxins, proper refrigeration and sanitation.

Illness: **Staphylococcus** (food poisoning)
Causative Agent: Enterotoxin produced by *Staphylococcus aureus*
Symptoms: Nausea, vomiting, abdominal pain due to gastroenteritis (inflammation of the lining of the stomach and intestines).
Typical Time from Ingestion to Onset of Symptoms: 30 minutes to 8 hours
Foods Usually Involved: Custard and cream-filled pastries, potato salad, dairy products, cooked ham, tongue, and poultry.
Preventive Measures: Pasteurization of susceptible foods, proper refrigeration and sanitation.

Illness: **Clostridium perfringens** (food poisoning)
Causative Agent: Toxin produced by *Clostridium perfringens*
Symptoms: Nausea, occasional vomiting, diarrhea and abdominal pain.
Typical Time from Ingestion to Onset of Symptoms: 8 to 24 hours
Foods Usually Involved: Cooked meat, poultry and fish held at non-refrigerated temperatures for long periods of time.
Preventive Measures: Prompt refrigeration of unconsumed, cooked meat, gravy, poultry or fish; maintenance of proper refrigeration and sanitation.

Illness: **Salmonellosis** (food infection)
Causative Agent: Infection produced by ingestion of any of over 1200 species of *Salmonella* that can grow in the gastrointestinal tract of the consumer.
Symptoms: Nausea, vomiting, diarrhea, fever, abdominal pain; may be preceded by chills and headache.
Typical Time from Ingestion to Onset of Symptoms: 12 to 24 hours
Foods Usually Involved: Insufficiently cooked or warmed-over meat, poultry, eggs and dairy products; these products are especially susceptible when kept unrefrigerated for a long time.
Preventive Measures: Avoid contamination, proper refrigeration and packaging, cleanliness and sanitation of handlers and equipment, pasteurization.

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Characteristics of Some Common Food-Borne Illnesses - continued

Illness: **Listeriosis** (food infection)
Causative Agent: Produced by *Listeria monocytogenes*
Symptoms: Fever, headache, nausea, vomiting, monocytosis, meningitis, septicemia, miscarriage, localized external or internal lesions, pharyngitis.

Typical Time from Ingestion to Onset of Symptoms: Unknown, probably 4 days to 3 weeks
Foods Usually Involved: Milk, milk products, eggs, meat and poultry.
Preventive Measures: Use of good hygiene practices.

Illness: **Trichinosis** (food infection)
Causative Agent: *Trichinella spiralis* (a nematode worm) found in pork
Symptoms: Nausea, vomiting, diarrhea, profuse sweating, fever and muscle soreness.

Typical Time from Ingestion to Onset of Symptoms: 2 to 28 days
Foods Usually Involved: Insufficiently cooked pork and products containing pork.
Preventive Measures: Thorough cooking of pork (to an internal temperature of 144°F or higher); freezing and storage of uncooked pork at 5°F or lower for a minimum of 20 days (category 1 products) or for 30 days (category 2 products); avoidance of feeding hogs raw garbage.

Illness: **Colibacillosis** (food infection)
Causative Agent: Infection caused by *Escherichia coli* (*E.coli*) O157:H7
Symptoms: The spectrum of *E.coli* O157:H7 infection includes asymptomatic infection, non-bloody or bloody diarrhea and hemolytic uremic syndrome (HUS), which occurs in approximately 6% of cases and is a leading cause of acute renal failure among U.S. children.

Typical Time from Ingestion to Onset of Symptoms: 3 to 4 days
Foods Usually Involved: Various foods, beverages and human-to-human activities have been reported. Consumption of undercooked ground beef accounts for the greatest number of foodborne illnesses infections.
Preventive Measures: Avoid contamination; properly refrigerate meats before cooking and cook until done (160°F internal temperature is recommended by the U.S. Dept. of Agriculture). Avoid recontamination after cooking and avoid cross contamination between raw and ready-to-eat foods.

Sources: *Modified from Principles of Meat Science, The Meat We Eat and Lessons on Meat.*

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