



# Texas Agricultural Extension Service

## Bacterial Food Poisoning

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Food borne illness is an ever-present threat that can be prevented with proper care and handling of food products. It is estimated that between 24 and 81 million cases of food borne diarrhea disease occur each year in the United States, costing between \$5 billion and \$17 billion in medical care and lost productivity.

Chemicals, heavy metals, parasites, fungi, viruses and bacteria can cause food borne illness. Bacteria related food poisoning is the most common, but fewer than 20 of the many thousands of different bacteria actually are the culprits. More than 90 percent of the cases of food poisoning each are caused by *Staphylococcus aureus*, *Salmonella*, *Clostridium perfringens*, *Campylobacter*, *Listeria monocytogenes*, *Vibrio parahaemolyticus*, *Bacillus cereus*, and Enteropathogenic *Escherichia coli*. These bacteria are commonly found on many raw foods. Normally a large number of food-poisoning bacteria must be present to cause illness. Therefore, illness can be prevented by (1) controlling the initial number of bacteria present, (2) preventing the small number from growing, (3) destroying the bacteria by proper cooking and (4) avoiding re-contamination.

Poor personal hygiene, improper cleaning of storage and preparation areas and unclean utensils cause contamination of raw and cooked foods. Mishandling of raw and cooked foods allows bacteria to grow. The temperature range in which most bacteria grow is between 40 degrees F (5 degrees C) and 140 degrees F (60 degrees C). Raw and cooked foods should not be kept in this danger zone any longer than absolutely necessary. Undercooking or improper processing of home-canned foods can cause very serious food poisoning.

Since food-poisoning bacteria are often present on many foods, knowing the characteristics of such bacteria is essential to an effective control program.

### Staphylococcus aureus

Man's respiratory passages, skin and superficial wounds are common sources of *S. aureus*. When *S. aureus* is allowed to grow in foods, it can produce a toxin that causes illness. Although cooking destroys the bacteria, the toxin produced is heat stable and may not be destroyed. Staphylococcal food poisoning occurs most often in foods that require hand preparation, such as potato salad, ham salad and sandwich spreads.

Sometimes these types of foods are left at room temperature for long periods of time, allowing the bacteria to grow and produce toxin. Good personal hygiene while handling foods will help keep *S. aureus* out of foods, and refrigeration of raw and cooked foods will prevent the growth of these bacteria if any are present.

### Salmonella

The gastrointestinal tracts of animals and man are common sources of *Salmonella*. High protein foods such as meat, poultry, fish and eggs are most commonly associated with *Salmonella*. However, any food that becomes contaminated and is then held at improper temperatures can cause salmonellosis. *Salmonella* are destroyed at cooking temperatures above 150 degrees F. The major causes of salmonellosis are contamination of cooked foods and insufficient cooking. Contamination of cooked foods occurs from contact with surfaces or utensils that were not properly washed after use with raw products. If *Salmonella* is present on raw or cooked foods, its growth can be controlled by refrigeration below 40 degrees F.

### Clostridium perfringens

*C. perfringens* is found in soil, dust and the gastrointestinal tracts of animals and man. When food containing large number of *C. perfringens* is consumed, the bacteria produce a toxin in the intestinal tract that causes illness. *C. perfringens* can exist as a heat-resistant spore, so it may survive cooking and grow to large numbers if the cooked food is held between 40 degrees F and 140 degrees F for an extensive time period. Meat and poultry dishes, sauces and gravies are the foods most frequently involved. Hot foods should be served immediately or held above 140 degrees F. When refrigerating large volumes of gravies, meat dishes, etc., divide them into small portions so they will cool rapidly. The food should be reheated to 165° F. prior to serving.

### Clostridium botulinum

Botulism accounts for fewer than one of every 400 cases of food poisoning in the U.S., but two factors make it very important. First, it has caused death in approximately 30 percent of the cases; and secondly, it occurs mostly in home-canned foods. In 1975, for example, 18 or 19 confirmed cases of botulism were caused by home-processed foods, and the other was

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caused by a commercial product that was mishandled in the home. *Cl. botulinum* can exist as a heat-resistant spore, and can grow and produce a neurotoxin in underprocessed, home-canned foods. An affected food may show signs of spoilage such as a bulging can or an off-odor. This is not true in all cases, so canned foods should not be tasted before heating. The botulinum toxin is destroyed by boiling the food for 10 minutes.

### **Vibrio parahaemolyticus**

*V. parahaemolyticus* is found on seafoods, and requires the salt environment of sea water for growth. *V. parahaemolyticus* is very sensitive to cold and heat. Proper storage of perishable seafoods below 40 degrees F, and subsequent cooking and holding above 140 degrees F, will destroy all the *V. parahaemolyticus* on seafoods. Food poisoning caused by this bacterium is a result of insufficient cooking and/or contamination of the cooked product by a raw product, followed by improper storage temperature. It is a major problem in Japan where many seafoods are consumed raw. *Vibrio vulnificus* is another member of the *vibrio* genus that is found in the marine environment. *V. vulnificus* is truly an emerging pathogen, but it can be controlled with proper cooking and refrigeration.

### **Bacillus cereus**

*B. cereus* is found in dust, soil and spices. It can survive normal cooking as a heat-resistant spore, and then produce a large number of cells if the storage temperature is incorrect. Starchy foods such as rice, macaroni and potato dishes are most often involved. The spores may be present on raw foods, and their ability to survive high cooking temperatures requires that cooked foods be served hot or cooled rapidly to prevent the growth of this bacteria.

### **Listeria**

Before the 1980's most problems associated with diseases caused by *Listeria* were related to cattle or sheep. This changed with food related outbreaks in Nova Scotia, Massachusetts, California and Texas. As a result of its widespread distribution in the environment, its ability to survive long periods of time under adverse conditions, and its ability to grow at refrigeration temperatures, *Listeria* is now recognized as an important foodborne pathogen.

Immunocompromised humans such as pregnant women or the elderly are highly susceptible to virulent *Listeria*. *Listeria monocytogenes* is the most consistently pathogenic species causing listeriosis. In humans, ingestion of the bacteria may be marked by a flu-like illness or symptoms may be so mild that they go unnoticed. A carrier state can develop. Death is rare in

healthy adults; however, the mortality rate may approximate 30 percent in the immunocompromised, new born or very young.

As mentioned earlier *Listeria monocytogenes* is a special problem since it can survive adverse conditions. It can grow in a pH range of 5.0-9.5 in good growth medium. The organism has survived the pH 5 environment of cottage cheese and ripening cheddar. It is salt tolerant surviving concentrations as high as 30.5 percent for 100 days at 39.2 degrees F, but only 5 days if held at 98.6 degrees F.

The key point is that refrigeration temperatures do not stop growth of *Listeria*. It is capable of doubling in numbers every 1.5 days at 39.2 degrees F. Since high heat, greater than 170 degrees F, will inactivate the *Listeria* organisms, post-process contamination from environmental sources then becomes a critical control point for many foods. Since *Listeria* will grow slowly at refrigeration temperatures, product rotation becomes even more important.

### **Yersinia enterocolitica**

Even though *Yersinia enterocolitica* is not a frequent cause of human infection in the U.S., it is often involved in illness with very severe symptoms. Yersiniosis, infection caused by this microorganism, occurs most commonly in the form of gastroenteritis. Children are most severely affected. Symptoms of pseudoappendicitis has resulted in many unnecessary appendectomies. Death is rare and recovery is generally complete in 1 - 2 days. Arthritis has been identified as an infrequent but significant sequel of this infection.

*Y. enterocolitica* is commonly present in foods but with the exception of pork, most isolates do not cause disease. Like *Listeria* this organism is also one that can grow at refrigeration temperatures. It is sensitive to heat (5%) and acidity (pH 4.6), and will normally be inactivated by environmental conditions that will kill salmonellae.

### **Campylobacter jejuni**

*C. jejuni* was first isolated from human diarrhea stools in 1971. Since then it has continually gained recognition as a disease causing organism in humans.

*C. jejuni* enteritis is primarily transferred from animal origin foods to humans in developed countries. However, fecal contamination of food and water and contact with sick people or animals, predominates in developing countries.

Although milk has been most frequently identified throughout the world to be a vehicle for *Campylobacter*, one anticipates that future investigations will identify poultry and its products and meats (beef, pork, and lamb) as major reservoirs and vehicles.

Bacteria Responsible	Description	Habitat	Types of Foods	Symptoms	Cause	Temperature Sensitivity
<b>Staphylococcus aureus</b>	Produces a heat-stable toxin.	Nose and throat of 30 to 50 percent of healthy population; also skin and superficial wounds.	Meat and seafood salads, sandwich spreads and high salt foods.	Nausea, vomiting and diarrhea within 4 to 6 hours. No fever.	Poor personal hygiene and subsequent temperature abuse.	No growth below 40 degrees F. Bacteria are destroyed by normal cooking but toxin is heat-stable.
<b>Salmonella</b>	Produces an intestinal infection.	Intestinal tracts of animals and man.	High protein foods—meat, poultry, fish and eggs.	Diarrhea nausea, chills, vomiting and fever within 12 to 24 hours.	Contamination of ready-to-eat foods, insufficient cooking and recontamination of cooked foods.	No growth below 40 degrees F. Bacteria are destroyed by normal cooking.
<b>Clostridium perfringens</b>	Produces a spore and prefers low oxygen atmosphere. Live cells must be ingested.	Dust, soil and gastrointestinal tracts of animals and man.	Meat and poultry dishes, sauces and gravies.	Cramps and diarrhea within 12 to 24 hours No vomiting or fever.	Improper temperature control of hot foods, and recontamination.	No growth below 40 degrees F. Bacteria are killed by normal cooking but a heat-stable spore spore can survive.
<b>Clostridium botulinum</b>	Produces a spore and requires a low oxygen atmosphere. Produces a heat-sensitive toxin.	Soils, plants, marine sediments and fish.	Home-canned foods.	Blurred vision, respiratory distress and possible DEATH.	Improper methods of home-processing foods.	Type E and Type B can grow at 38 degrees F. Bacteria destroyed by cooking and the toxin is destroyed by boiling for 5 to 10 minutes. Heat-resistant spore can survive.
<b>Vibrio parahaemolyticus</b>	Requires salt for growth.	Fish and shellfish.	Raw and cooked seafood.	Diarrhea, cramps, vomiting, headache and fever within 12 to 24 hours.	Recontamination of cooked foods or eating raw seafood.	No growth below 40 degrees F. Bacteria killed by normal cooking.
<b>Bacillus cereus</b>	Produces a spore and grows in normal oxygen atmosphere.	Soil, dust and spices.	Starchy food.	Mild case of diarrhea and some nausea within 12 to 24 hours.	Improper holding and storage temperatures after cooking.	No growth below 40 degrees F. Bacteria killed by normal cooking, but heat-resistant spore can survive.
<b>Listeria monocytogenes</b>	Survives adverse conditions for long time periods.	Soil, vegetation and water. Can survive for long periods in soil and plant materials.	Milk, soft cheeses, vegetables fertilized with manure.	Mimics meningitis Immunocompromised individuals most susceptible.	Contaminated raw products.	Grows at refrigeration (38-40 degrees F.) temperatures. May survive minimum pasturization temperatures (161 degrees F. for 15 seconds.)
<b>Campylobacter jejuni</b>	Oxygen sensitive, does not grow below 86 degrees F.	Animal reservoirs and foods of animal origin.	Meat, poultry, milk, and mushrooms.	Diarrhea, abdominal cramps and nausea.	Improper pasteurization or cooking. Cross-contamination.	Sensitive to drying or freezing. Survives in milk and water at 39 degrees F for several weeks.
<b>Yersinia enterocolitica</b>	Not frequent cause of human infection.	Poultry, beef, swine. Isolated only in human pathogen.	Milk, tofu, and pork.	Diarrhea, abdominal pain, vomiting. Mimics appendicitis.	Improper cooking. Cross-contamination.	Grows at refrigeration temperatures (35-40 degrees F.) Sensitive to heat (122 degrees F.)
<b>Enteropathogenic E. coli</b>	Can produce toxins that are heat stable and others that are heat-sensitive.	Feces of infected humans.	Meat and cheeses.	Diarrhea, abdominal cramps, no fever.	Inadequate cooking. Recontamination of cooked product.	Organisms can be controlled by heating. Can grow at refrigeration temperatures.

*C. jejuni* dies off rapidly at ambient temperature and atmosphere, and grows poorly in food.

The principles of animal science will play a significant role in the control of this ubiquitous organism. Hygienic slaughter and processing procedures will preclude cross-contamination while adequate cooling and aeration will cause a decrease in the microbial load. In addition, thorough cooking of meat and poultry products followed by proper storage should assist in maintaining food integrity and less contamination.

### Enteropathogenic *Escherichia coli*

Enteropathogenic *E. coli* is a significant cause of diarrhea in developing countries and localities of poor sanitation. In the U.S. it has been associated with "travelers' diarrhea." However the latest outbreak in North America occurred in a nursing home in Ontario. This was a severe outbreak of *E. coli* 0157:H7 associated hemorrhagic colitis.

There are at least four subgroups of enteropathogenic *E. coli*: enterotoxigenic, enteroinvasive, hemorrhagic, and enteropathogenic. Each strain has different characteristics.

The major source of the bacteria in the environment is probably the feces of infected humans, but there may also be animal reservoirs. Feces and untreated water are the most likely sources for contamination of food.

Control of enteropathogenic *E. coli* and other food-borne pathogens such as *Salmonella* and *Staphylococcus aureus* can be achieved. Precautions should include adequate cooking and avoidance of recontamination of cooked meat by contaminated equipment, water or infected food handlers. Food service establishments should monitor adequacy of cooking, holding times, and temperatures as well as the personal hygiene of food handlers.

### Prevention

The first step in preventing food poisoning is to assume that all foods may cause food-borne illness. Follow these steps to prevent food poisoning:

1. Wash hands, food preparation surfaces and utensils thoroughly before and after handling raw foods to prevent recontamination of cooked foods.
2. Keep refrigerated foods below 40 degrees F.
3. Serve hot foods immediately or keep them heated above 140 degrees F.
4. Divide large volumes of food into small portions for rapid cooling in the refrigerator. Hot, bulky foods in the refrigerator can raise the temperature of foods already cooled.
5. Remember the danger zone is between 40 degrees F and 140 degrees F.
6. Follow approved home-canning procedures. These can be obtained from the Extension Service or from USDA bulletins.
7. Heat canned foods thoroughly before tasting.
8. When it doubt, throw it out.

Infants, older persons, women who are pregnant and anyone with a compromised immune system are especially susceptible to food-borne illness. These people should never consume raw fish, raw seafood, or raw meat type products.

You are the key to preventing food-borne illness. By observing the simple rules of good handling, food poisoning can be eliminated.

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