

*The University of Georgia College of Agricultural & Environmental Sciences
Cooperative Extension Service*

Preventing Food Poisoning And Food Infection

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Bacteria, Food Poisoning and You

Food safety concerns every food handling facility. Each year, thousands of individuals suffer the discomfort and pain resulting from foodborne illness. To prevent such illnesses, understanding the bacteria that cause food poisoning is essential.

The term food poisoning is generally used to describe illness caused by all types of foodborne microorganisms. Food poisoning and food infection are different, although the symptoms are similar. True food poisoning or food intoxication is caused by eating food that contains a toxin or poison due to bacterial growth in food. The bacteria which produced and excreted the toxic waste products into the food may be killed, but the toxin they produced causes the illness or digestive upset to occur. *Staphylococcus aureus* and *Clostridium botulinum* are two species of bacteria that cause food poisoning.

Food infection is the second type of foodborne illness. It is caused by eating food that contains certain types of live bacteria which are present in the food. Once the food is consumed, the bacterial cells themselves continue to grow and illness can result. Salmonellosis is a good example of foodborne infection. *Vibrio parahaemolyticus* is another infection organism and is found primarily in shellfish from polluted waters.

Clostridium perfringens grows in warm food like beef stews or gravies and produces toxins. It also causes a food infection by continuing to grow and producing toxins in the intestinal track. Each of these types of foodborne illnesses will be discussed.

What It Takes to Make You Sick

In order for an outbreak of foodborne illness to occur, whether it is food poisoning or food infection, the following conditions must exist:

1. The microorganisms or its toxin must be present in the food.
2. The food must be suitable for the organism's growth.
3. The temperature must be suitable for the organism's growth.
4. Sufficient time must be given for the organism's growth.
5. There must be enough of the microorganisms or their toxin present to cause illness.
6. You must eat the food.

Food Poisoning Microorganisms

Staphylococcus aureus⁽¹⁾

Staphylococcus is a true food poisoning organism. The coccus, or round-shaped, organism appears in grape-like clusters when viewed under a microscope. It produces a heat stable toxin when allowed to grow for several hours in foods such as chicken pot pie or cream filling. This bacterial growth may not cause any off color, odor, or textural or flavor change, but the toxin will be secreted into the food.

Staphylococcus toxin is not markedly affected by heating or freezing as it is heat stable. Even if the food is heated before eating, the poison in the food will cause illness although the heat has killed the bacterial cells.

The major sources of staph contamination are people and domestic animals. It is commonly found in the nasal passages and on the skin of most people. *Staphylococcus* bacteria can be found in cuts, scratches, boils and pimples on the skin. These bacteria get into the food from cuts and sores on workers' hands or from sneezes during food preparation. This organism grows best at body temperature (98 degrees F), but it can grow over the much wider range of 50 degrees to 115 degrees Fahrenheit. It prefers food with a pH above 4.5, so it is seldom found in acid foods such as tomatoes, pickles and citrus juices.

Symptoms of Staphylococcus Food Poisoning

The symptoms produced by the staph toxin occur very rapidly, four to six hours after eating. These include headache, nausea, vomiting, stomach cramps, diarrhea and a general washed out feeling. Many people suffer from staph food poisoning and never report it or don't realize they have it. Although a large number of cases occur yearly, only a fraction of them are identified as being caused by staph bacteria.

Prevention

The best prevention of staph food poisoning is to properly store food and reduce the temperature below 40 degrees F within four hours after preparation or serving. In order for staph to grow and produce toxin, it must have sufficient time. Approximately two to four hours, depending upon conditions, are required at a suitable growth temperature for toxin production. Therefore, it is important to cool or heat foods through the danger zone of 40 degrees F to 140 degrees F as rapidly as possible.

A second way to prevent contamination by staph organisms is by keeping cuts or sores covered and avoiding hand contact with cooked food. Workers' hands are major sources of contamination. Good personal hygiene and good washing habits are essential in preventing contamination. Rules for personal hygiene are discussed at length in *Food, Hands and Bacteria*, Extension bulletin #693.

***Clostridium botulinum*⁽²⁾**

The other type of true food poisoning is botulism. This organism has received much publicity and rightly so. It does not just cause illness, it is fatal in 60 percent of the cases. It is found in the soil, in water, in sewage and in the intestines of humans and animals. This organism can not grow in the presence of oxygen and thus is referred to as an anaerobe. *Clostridium botulinum* is a rod-shaped organism that forms a heat resistant spore. You can kill the vegetative cells by heating or cooking, but the spores require 240 degrees F at sea level, or pressure canning, to kill them. These spores are much like seed. When they are placed in a dry place or under adverse conditions, they will not germinate. They can withstand long periods of dry conditions and can withstand boiling water for several hours. Once these spores are placed in a food with the proper temperature, moisture and low acid conditions and lack of oxygen, they will germinate and grow. Once the bacterial cells are produced, they can then grow and have the capability of producing toxin. It is for this reason pressure canning is the only safe

method for canning low acid foods.

One can easily understand how *Clostridium botulinum*, a soil and water organism, could gain entrance into a foodstuff. Take green beans, for example. Beans grow in the garden near the ground and often have particles of soil attached to them when they are brought in for processing. Inadvertently, minute particles of soil containing the *Clostridium* organisms may adhere to the beans. Since this organism is anaerobic, foods in which it will grow must be free of oxygen. If food is canned properly, at the specified time and temperature, the process adequately kills all vegetative cells as well as spores of *Clostridium botulinum*.

The key to the growth of *Clostridium botulinum* and production of its toxin is the pH of the canned food. All fruits, vegetables and meats carry this microorganism, but because of their acid nature (pH of 4.6 or below), fruits will not permit its growth. Meats and most vegetables are not acid foods and will support its growth. They have a pH above 4.6.

This microorganism does not necessarily produce adverse effects in the food during growth. For example, the toxin can be present and there will be no swelling, off-color or off-odor.

In order for toxin to develop, the temperature during canning must be inadequate to kill the spores. This organism produces at least seven known toxins. Types A, B and E are most commonly associated with human illness. Toxins are produced best at temperatures between 85 degrees F and 95 degrees F but have been shown to be produced from 38 degrees F to 118 degrees F.

Symptoms of Botulism

In a number of the cases, death is the final result of a botulism outbreak. Specific symptoms may include fatigue, dizziness, headache, vomiting, diarrhea, nausea, acute indigestion followed by constipation, double vision and difficulty swallowing or speaking. Throat constriction and muscle paralysis come in the final stages, followed by death due to suffocation, unless an antitoxin is administered promptly.

Prevention

About 10 to 20 cases of botulism occur each year in the United States. The major source of the problem is home canned foods which have not been properly processed. Remember, always check home pressure canners to make sure the dial is accurate. Always use an approved processing time and temperature when home canning food. Extension publications are available with the most up to date recommendations.

It is interesting to note that about three outbreaks of botulism from commercially canned foods have occurred since 1925, resulting in four deaths; one in 1941, two in 1963 and one in 1971. This is a remarkable record for the commercial canning industry when you consider that over 17 million cans of foods are sold each year in this country. The saying is that you stand 100 times greater chance of being struck by lightning than of getting botulism from commercially canned foods.

Food Infection Microorganisms

***Salmonellae*⁽³⁾**

Over 1200 types of *Salmonella* exist. All are potentially dangerous to people. *Salmonella* live in the

intestinal tracts of humans and animals and are continually passed from person to animal, animal to person, and person to person in a continuous cycle. The prime sources of *Salmonella* contaminants of our food supply come from the intestines of animals. Vermin such as rodents, roaches and flies also carry *Salmonella*.

Salmonellosis has occurred from the consumption of contaminated foods such as cheese, milk, eggs, meat, poultry, pastries, cakes and candies.

Salmonellosis is caused when we eat foods which contain the organism. This is a food infection. These organisms continue to grow and multiply in the small intestines. The result is sickness eight to 24 hours after we eat the contaminated food.

Salmonellosis is the most widespread of all foodborne illness. More than 20,000 cases are reported to the Center for Disease Control annually. This is probably only a small percent of the cases that occur each year.

Symptoms of Salmonellosis

Salmonellosis is characterized by an abrupt onset of diarrhea, nausea, abdominal pain, prostration, chills, fever and vomiting. These symptoms vary in intensity from slight to severe. The symptoms rarely cause death except to infants or the elderly who may rapidly dehydrate.

Prevention

Salmonellosis can easily be prevented. Cooking kills this organism. Sickness most often occurs due to contamination of the food after cooking. *Salmonella* can easily be controlled by good sanitation practices to prevent cross contamination. Cooked food should never be prepared on cutting boards or equipment that has been used to prepare raw products.

Since food infection type bacteria are killed by cooking, foods such as meat, poultry and eggs should be adequately cooked to prevent possible ingestion of the organism.

Prompt refrigeration of cooked foods or leftovers is the first line of defense against this food infection organism. Never store food in containers which will not allow rapid cooling of the food product. Use shallow pans not more than three inches deep. If large quantities must be chilled, use commercial heat exchangers to chill product or agitate the foodstuff in an ice water bath until the product is chilled below the danger zone of rapid bacterial growth (40 degrees F).

***Clostridium perfringens*⁽⁴⁾**

Clostridium perfringens food poisoning has often been tagged as a problem of the food service industry since most outbreaks are associated with mass feeding operations such as cafeterias or at banquets. Each year, a large number of outbreaks of food poisoning from *Clostridium perfringens* occur in home kitchens and fast food establishments, especially those serving gravy, meat stews or broths.

Clostridium perfringens, a soil and water organism, is like *C. botulinum* in that it is a spore former, it is not killed by boiling, and it is an anaerobe. This means that it grows best when there is no air or free oxygen present in its environment. This organism also has strict requirements for growth, thus it is normally associated with meats, gravies or meat dishes. This organism is somewhat different from other food poisoning bacteria because it produces a toxin and also causes a food infection by continuing to

grow and produce toxin in the digestive system after it is consumed.

C. perfringens can grow over a wide range of temperatures, but grows very slowly at low temperatures. Unlike most other food poisoning bacteria, these bacterial spores will germinate and grow best at temperatures between 100 degrees F and 117 degrees F. Unfortunately, this is a temperature range found quite frequently in warm food holding areas in food service facilities, such as steam tables and oven type warmers.

The major reasons *C. perfringens* is associated with food service or mass feedings are that it requires an environment free from air, storage time, high temperatures and a strict nutrient supply. These conditions are usually met when meat stews, sauces, gravies and soups are improperly stored. The food is usually cooked in a large, deep container. After cooking, one assumes (incorrectly) that no bacteria are present, and the large container is placed in the cooler. Because of the container's size and depth, rapid cooling is impossible. The spores germinate and grow to large numbers. When the product is ready to be used, it is heated in the same container. Because of the container's size, reheating is difficult and the bacteria are not killed. When the food is eaten, a large number of people are usually affected.

Symptoms

The symptoms for this food poisoning are relatively mild in most cases and may be called a "stomach virus" and go unreported. If the outbreak occurs at a large gathering, however, such as a banquet or church function, it is usually reported and documented.

Symptoms of the illness include abdominal cramps, diarrhea, occasional nausea, and sometimes fever or vomiting. The symptoms usually appear four to 22 hours after eating and may persist for one to five days.

Prevention

Many foods such as meat and poultry may carry the organism, but the mere presence of *C. perfringens* in food is not enough to cause illness. Millions of growing cells are needed. The prevention of growth of this organism is best accomplished by following the standard food service practices of rapidly chilling prepared foods in shallow containers and keeping cold food cold and hot food hot. Remember, always reduce the level of contamination by keeping all work areas clean and sanitary.

Vibrio parahaemolyticus

Vibrio parahaemolyticus is a particular food infection organism not familiar to many people; it nevertheless is an important problem. This organism is mostly associated with shellfish or other fish coming from contaminated or polluted marine waters.

Vibrio parahaemolyticus is a comma-shaped organism which grows at lower temperatures, 50 degrees F, as well as higher temperatures. It is also a halophilic organism and is able to grow well in salt water.

Symptoms

Large numbers are required to cause illness. Abdominal cramps, nausea and vomiting may result.

Prevention

The major prevention of this foodborne illness stems from the banning of contaminated waters to fishermen. However, the best assurance for a food service establishment to prevent *Vibrio* food poisoning is to keep shellfish properly refrigerated to prevent growth. Always be sure the shellfish are thoroughly cooked. Since many fish, such as oysters, are eaten raw, the restaurant should buy from reputable sources coming from known waters.

Yersinia enterocolitica

Safety problems have occurred as a result of foods becoming contaminated with *Yersinia enterocolitica*. The *Yersinia* bacteria is a pathogenic rod-shaped organism causing food infection in humans. The organism is a facultative anaerobe growing either with or without oxygen. The organism grows best between 66 degrees F and 82 degrees F. Refrigeration only reduces the rate of growth. A growth temperature as low as 24 degrees F has been reported for *Yersinia*. Foods like meat, milk, fruit, vegetables, eggs, fish poultry, tofu and certain acidic foods like mayonnaise are good environments for the bacteria. In acidic foods, a pH less than 4.0 will generally limit growth. Heat and chemical sanitizers will destroy the organism.

Symptoms

Yersiniosis is the name of the infection caused by *Yersinia enterocolitica*. The main symptoms are severe abdominal pains, fever and headache (gastro-enteritis) which can occur 24 to 36 hours after eating the contaminated food and can last for one to two days. Yersiniosis can be confused with appendicitis and has resulted in unnecessary appendectomies.

Prevention

Thorough cooking of foods, preventing cross contamination, practicing good cleanliness and sanitation and personal hygiene are the best means to prevent a foodborne illness. For acidic foods, proper control of pH is necessary.

***Listeria monocytogenes*⁽⁵⁾**

Listeria monocytogenes is food infection bacteria gaining in public awareness as a safety problem in food products. *Listeria* is a small, non-spore forming rod. The general growth conditions required are oxygen, temperatures ranging from 37 degrees F to 104 degrees F and a pH range of 5.6 to 9.8. Since *Listeria* can grow at refrigerated temperatures, withstand milk acid conditions, survive heat treatment up to 170 degrees F, and cause foodborne illness, the bacteria is a major health concern in the food system.

The bacteria was identified as the infectious agent in a foodborne illness outbreak in California involving 86 individuals. The fatality rate in the outbreak was over 30 percent. Mexican cheese was the particular food item identified as the contaminated source. *Listeria monocytogenes* contamination of food is a health hazard to the consuming public. Also, real or assumed contamination of food products with *Listeria monocytogenes* has resulted in the closing of businesses or discontinued production of profitable food products.

Listeria is widespread in nature, living closely associated with the soil and plant matter. The organism has been found in feces of humans and animals, soil, leafy vegetables, decaying corn and soybeans, raw and treated sewage, effluent from poultry and meat processing facilities, normal and mastitic milk and improperly fermented silage. Food is a primary means for transmission of the illness to humans. Other possible ways are plant to humans, animals to humans, air to humans and human to human. The sickness

resulting form *Listeria monocytogenes* is called listeriosis.

Symptoms

In normal healthy individuals, infection with *Listeria monocytogenes* may be symptomless or the illness may be characterized by flu-like symptoms. However, advance states can occur in susceptible individuals. The susceptible person includes pregnant women, newborns, elderly people, cancer patients, AIDS patients, rheumatoid arthritis individuals, diabetics, alcoholics and people receiving steroid, chemotherapy or renal-dialysis.

In pregnant women, listeriosis can result in stillbirth or abortion of the fetus. Immuno-depress individuals may suffer from meningitis and septicemia.

Prevention

The organism is generally destroyed by heat treatment, 170 degrees F for 15 seconds. Neither refrigeration nor freezing will destroy the organism. In fact, *Listeria* can grow and multiply in refrigerated storage. Proper personal hygiene, good sanitation, proper cooking and preventing cross contamination of raw and cooked food are the best control measures known to date.

Campylobacter jejuni

Campylobacter jejuni, a rod-shaped, motile, non-spore forming bacilli is believed to cause more cases of human enteric illness than *Salmonella* or *Shigella*. The bacteria is microaerophilic, requiring an oxygen level of 5 percent for optimum growth and temperature range of 82 degrees F to 104 degrees F. Refrigeration (40 degrees F) will not destroy the organism. *Campylobacter* has been shown to survive a temperature of 0 degrees F for one year. The bacteria does not tolerate acidic conditions and can be destroyed by heat treatment. High temperatures associated with cooking will kill the organism.

Campylobacter is found in animal and human intestinal tracts, feces and is typically associated with poultry products. The bacteria can survive and grow in other food systems. *Campylobacter jejuni* is considered to be an important foodborne pathogen with potential to endanger public health.

Symptoms

Gastroenteritis, which is the inflammation of the intestinal tract, characterized by cramps and a flu-like condition, is the common symptom. The infection occurs in 13 to 72 hours and normally lasts for two to three days but can persist for weeks or months. Death is rare.

Prevention

Thorough cooking of food products, good personal hygiene, proper sanitation and preventing the cross contamination of cooked and raw products are appropriate measures of control. As with most food poisoning organisms, proper refrigeration will retard the growth of *Campylobacter* and proper handling during transportation and storage are keys to preventing contamination of other foodstuffs, counters, tables and equipment. Always clean and sanitize after handling raw products before handling cooked foods to prevent cross contamination.

Trichinella spiralis

No food poisoning and food infection report would be complete unless we cover the basics for controlling the ancient *Trichinella spiralis*. Trichinosis is an exceedingly painful disease and is among the most dreaded human illnesses. The microscopic parasite resides in the muscle of infected pork or in other animals which eat flesh. Although it is not a bacterial food infection, it is an important foodborne illness.

Life Cycle *Trichinella spiralis*

The life cycle of *T. spiralis* in man or swine consists of three stages; intestinal, larval migration, muscular.

- Improperly cooked meat is eaten. The stomach juices release the ingested larvae.
- The larvae travel to the small intestines and mature into adult worms. These worms burrow into the intestinal wall and lay up to 1500 young larvae over a period of four months.
- The larvae migrate by way of the blood throughout the entire body and begin to encyst in the muscle. Upon penetration of the muscle, the larvae grow and begin to coil.

Symptoms

Humans contract the illness by eating improperly cooked infected meat. During the period when the worms burrow into the intestinal walls and lay eggs, human symptoms are nausea, vomiting and diarrhea. When the larvae encyst in the muscle, the symptoms are extreme muscular pain, edema, enlarged lymph nodes and persistent fever.

The most critical phase of illness comes when the larvae grow and begin to coil. Edema, toxemia and dehydration occur. Death may follow. The disease lasts from two to eight weeks after which the larvae cysts calcify and remain dormant in the muscle.

Prevention

Cooking the food breaks the cycle. Prevention is easy. Cook all pork to a temperature of 160 degrees F (medium) to 170 degrees F (well done). For micro-wave cooking of fresh pork, contact your county extension agent for instructions. Because of possible cold spots that can occur during microwave cooking, directions differ for each cut of meat.

Summary

To prevent foodborne illness, follow these suggestions:

- Limit the introduction of microorganisms into the food by washing and sanitizing your hands before handling food; wash all raw foods, clean and sanitize all food equipment, utensils and contact surfaces.
- Destroy the microorganisms that may have contaminated the food by properly cooking the foods, reheating food rapidly to above 140 degrees F, and holding all hot foods above 140 degrees F.
- Limit the growth of microorganisms by promptly refrigerating leftovers, rapidly chilling hot foods by using shallow con-tainers, and checking your refrigeration to insure proper temperature control.
- When in doubt, throw it out.

Appendix

Case History 1

One outbreak of staph food poisoning occurred at a convention in Chicago some time ago. A banquet meal included ham, potato salad, baked beans, rolls, chocolate cake and assorted drinks. Six hours after the meal, about one-third of the conventioners developed cases of staph food poisoning.

When the foods served were examined, the ham was found to be highly contaminated with staph bacteria. Let's see what happened.

The ham had been baked the day before and refrigerated overnight. The next day, a cook with an infected cut on his finger sliced the ham. The sliced ham was stacked in layers, wrapped in aluminum foil, warmed and held for several hours before serving. Let's examine the errors made.

First, the employee with the infected cut should have cleaned and covered it with a bandaid and glove. Second, the contaminated slices should not have been piled in layers but spread so the heat could have penetrated and killed the bacteria. Third, the sliced ham should not have been heated until just before serving, eliminating time for bacterial growth. It should have been held hot, above 140 degrees F, which would have prevented bacterial growth.

Case History 2

One of the most tragic cases of botulism in recent history involved a family of 12 in New Mexico. The mother had canned some chili peppers for her family but had improperly processed the peppers using a water bath method instead of a pressure canner. After they ate the peppers straight from the jar, all family members developed symptoms of botulism and all died of botulism within three days. This tragedy could have been avoided if the correct amount of vinegar had been added to the peppers to lower the pH before processing in the water bath, or if the peppers had been processed in a pressure canner for the correct amount of time.

If toxin is formed in a canned food, it should be destroyed by boiling the food for 10 minutes. For altitudes of 1000 feet or above, 1 minute must be added for each 1000 feet of altitude. Unlike staph toxin, this toxin can be destroyed by heat. Freezing foods will prevent the bacteria from growing, but this will not destroy the toxin.

Case History 3

Let's consider a typical case reported by the Center for Disease Control. Several patients were admitted at a local hospital with abdominal cramps and diarrhea. Stool cultures were positive for *Salmonella*. All were of the same serotype⁽⁶⁾. Investigation revealed that one patient worked at a suburban restaurant and the other two had eaten there four days apart. Forty-seven restaurant patrons were interviewed and 25 were found to have been ill with similar symptoms. Examinations of the restaurant and the food served there showed that ham, prime rib, cooked fish, roast beef, lettuce and coleslaw, as well as the wooden cutting board, were contaminated with *Salmonella* of the same species causing the illness.

When questioned, the employees identified several errors in food handling techniques, including inadequate refrigeration and improper cleaning between handling raw and cooked food. These cases could have been easily prevented by any of the three prevention measures we have discussed.

Case History 4

On January 14, health department officials were notified of a foodborne outbreak associated with a "Meals on Wheels" program for senior citizens in a small town in California. Persons who had received the noon meal on January 13 had become ill. Thirty-nine of the 41 had various symptoms including diarrhea, abdominal cramps, nausea, vomiting, fever and headaches. All patients recovered within six days. Chicken was implicated as the food carrying the food poisoning organisms. Questioning revealed that the chicken had been cooked six days earlier, frozen, thawed on January 11, held refrigerated, and reheated on a steam table on January 13. Laboratory tests of the chicken showed that it contained greater than 100,000 *C. perfringens* as per gram. The manner of preparation and handling of this food is typical of many operations where good food service practices are overlooked. Any of several measures could have prevented this outbreak, the simplest of which would have been to properly thaw and reheat the prepared food item.

Case History 5

In 1981, a Listeriosis outbreak occurred in Nova Scotia, Canada. The outbreak involved 41 cases and resulted in the death of 18 individuals. The source of the food infection was traced to cole slaw and confirmed through bacterial analysis. Further investigation led to the discovery that the cabbage had been grown in a field fertilized with sheep manure. The sheep were infected with *Listeria* and acted as carriers. After harvest, the cabbage was stored under refrigeration for a long time. The extended cold storage allowed the bacteria to grow and become a health hazard.

The risk of Listeriosis could have been reduced by rotating the cabbage in storage. The point to remember is, "first in -- first out." Rinsing fresh produce is another good practice. Dirt, debris and many of the transient bacteria can be readily removed in a rinsing process.

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1. See Case History 1.
2. See Case History 2.
3. See Case History 3.
4. See Case History 4.
5. See Case History 5.
6. Serotype: organisms that produce the same immune response.



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