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Clostridium botulinum in Foods

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On July 18, 2007, the U.S. Food and Drug Administration (FDA) issued a warning to consumers not to eat 10-ounce cans of Castleberry's Hot Dog Chili Sauce (UPC 3030000101), Austex Hot Dog Chili Sauce (UPC 3030099533), and Kroger Hot Dog Chili Sauce (UPC 1111083942) with "best by" dates from April 30, 2009 through May 22, 2009 due to possible botulism contamination. Botulism is a serious foodborne illness and can be fatal. If the "best by" dates found on the can lids are not legible or missing, consumers are advised to dispose of the food carefully following the instructions described below.

Clostridium botulinum bacterium

Although *Clostridium botulinum* (or *C. botulinum*) is ubiquitous, being found in the air, soil, waters, intestinal tracts of fish and mammals, and gills and viscera of crabs and other shellfish, it is comparatively harmless in the spore form. But it is the sporulated *C. botulinum* that is able to resist high temperatures and survive a wide range of unfavorable living conditions, such as extreme cold, 5–10 hours in boiling water, and the presence of chemicals. And when the conditions turn favorable for microbial growth, *C. botulinum* reverts to its vegetative form and reproduces just like other bacteria. The significant difference with other bacteria, however, is that *C. botulinum* produces a by-product that is a nerve poison, the botulinal toxin. Fortunately, botulinal toxin is not heat resistant like the spore form. It can be inactivated by boiling temperatures of 212°F (100°C) for at least 10 minutes.

C. botulinum is very specific in its growth requirements. It is a spore former, grows under anaerobic conditions (very little or no oxygen), and likes low-acid foods (with pH above 4.6 and water activity greater than 0.93). Examples of low-acid foods that can support its growth are canned vegetables, processed meats, sausages, smoked fish, and other seafood products. The term "botulinum" comes from the Latin word "botulus," meaning sausage, where it was first isolated after producing the illness. It is important to remember that although most of the foodborne botulism cases are from improperly processed home-canned foods and not from commercially processed ones, sensational media coverage usually results when the outbreak involves commercially processed foods. Unfortunately, the recent botulism case from canned chili, which is a serious foodborne illness that can be fatal, did not get as much media reporting as the previous outbreaks from spinach contaminated with *E. coli* O157:H7 or peanut butter contaminated with *Salmonella*. In recent times, other low-acid foods that might not usually have been suspected as capable of producing the illness but were identified as vehicles of the toxin included sautéed onions, potato salad from improperly handled and stored baked potatoes in foil, kapchunka, bottled chopped garlic in oil, grilled whole fish, chili sauce, chili pepper water (a Hawai'i case), smoked fish wrapped in cellophane, home canned or fermented fish, and, now, chili.

C. botulinum cannot stand competition and prefers to live among weaker and fewer microorganisms. Thus, when one adds an acidifying agent such as in pickling or allows a low-acid food to ferment, other bacteria will grow and inhibit the growth of C. botulinum. The botulinal toxin is also deactivated.

There are seven recognized types of *C. botulinum,* A, B, C, D, E, F, and G. Types A, B, E, and F cause botulism in humans. Types C and D cause botulism in ani-

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mals, mostly wild fowl and poultry, cattle, horses, and some fish. Type G has been isolated from soil in Argentina but has not been linked to outbreaks. Certain strains use protein and produce objectionable odors. They grow best between 86°F (30°C) and 98°F (37°C), although growth can occur between 50°F (10°C) and 100°F (38°C). Other strains use carbohydrates, such as sugars and starch, and do not produce the same odors. Some of these strains are from the marine environment and tolerate lower temperatures of 40°F (4°C), but their spores do not withstand heating to 212°F (100°C).

Botulism

The four recognized types of botulism are foodborne, infant, wound, and "undetermined." Foodborne botulism is the illness resulting from the consumption of foods contaminated with the botulinal toxin. Foodborne botulism is a very rare but serious illness. An average of 110 botulism cases is reported each year in the United States, of which about 28 are foodborne, 80 are infant, and the rest are wound botulism. Everyone is at risk, and those whose immune systems have been compromised (the very young, elderly, and sick) are at higher risk. Only a few nanograms of the toxin may cause the disease. It is so serious that only one botulism incident is necessary to cause an outbreak. Ordinarily, an outbreak is defined as two or more incidences resulting from a common food.

Infant botulism results when infants less than a year old ingest foods with the *C. botulinum* spores that then revert in the infant's intestinal tracts to the vegetative stage, multiplying and producing the nerve toxin. Clinical symptoms include loss of appetite, weakness, altered cry, and striking loss of head control. The one food that has been definitively linked to infant botulism is honey. It is recommended that infants younger than 12 months of age not be fed raw honey.

Wound botulism occurs when *C. botulinum*, by itself or with other microorganisms, gets into an open wound, germinates, reproduces under anaerobic conditions, and secretes the nerve toxin that is then spread to the other parts of the body through the blood system. Symptoms are similar to foodborne botulism. Wound botulism has been reported among injection drug users in Europe and the United States. The undetermined type of botulism occurs in adults and involves food or wound source which cannot be identified. Botulism can also result from injection of an unlicensed pharmacologic preparation of toxin used in treatment-associated botulism.

Symptoms of foodborne botulism

Symptoms usually occur from 18 to 36 hours after the ingestion of the contaminated food, but they may occur as early as 6 hours to as late as 10 days afterward. Descending paralysis occurs from the head to the toes. The characteristic signs are marked fatigue, weakness, and vertigo. These are then followed by blurred or double vision, drooping eyelids, dry mouth, and difficulty in swallowing and speaking. The usual foodborne illness symptoms of vomiting, diarrhea, constipation, and abdominal distention may also occur. The paralysis then progresses to weakness in the neck and arms, then the respiratory muscles, trunk, and legs. Breathing becomes increasingly shallow and difficult, and fingernails start to turn blue due to lack of oxygen. There is no fever, and the mind remains conscious.

Botulism in animals has also been observed occasionally in dogs but has not been reported in cats. Symptoms usually appear 12–24 hours after ingestion of the contaminated food but may occur as early as 2 hours and as late as 2 weeks afterward. As in humans, progressive motor paralysis occurs, including generalized weakness; difficulty in breathing, chewing, and swallowing; and visual impairment. Respiratory failure or cardiac arrest may occur when those muscles are paralyzed.

Diagnosis of botulism

Since foodborne botulism is a rare illness, diagnosis may sometimes be blurred by other diseases with similar symptoms, such as Guillain-Barré syndrome, stroke, and myasthenia gravis. Additional tests can be conducted to exclude these illnesses. The most direct way to confirm diagnosis is to inject the patient's serum or stool into laboratory mice and observe botulinal symptoms to demonstrate the presence of the toxin. Because of the severity of the toxin, its isolation from the patient's serum or stool must be performed only by trained personnel and in specially equipped laboratories.

Treatment of foodborne botulism

If intervention is early, foodborne botulism can be treated with an antitoxin specific to the *C. botulinum* type causing the illness. Symptoms may be halted from progressing, but recovery may take several weeks. If respiratory failure and paralysis have occurred, a ventilator may be employed and the patient will need intensive medical and nursing care. The patient may slowly recover motor

functions, but recovery will also take several weeks. Physicians sometimes use surgery, induced vomiting, or enemas to try to remove contaminated food remaining in the gut. Patients who survive foodborne botulism may experience fatigue and shortness of breath for many years.

Death can result after a complete respiratory failure. The death rate from all types of botulism is about 8 percent. To put this in perspective, the chances of dying after being struck by lightning is 100 times greater than dying from eating commercially canned foods with botulinal toxin.

Prevention of foodborne botulism

C. botulinum toxin is produced from low-acid foods that were improperly cooked, then packed in hermetic or airtight containers (e.g., cans, glass jars, or bottles) under anaerobic conditions. Home canners must follow proper cooking instructions and strict sanitary procedures to reduce food contamination. Cooking must be done under high pressure to kill the *C. botulinum* spores and prevent them from germinating to vegetative cells that are capable of multiplying and producing the toxin. Because most of the foodborne botulism outbreaks are from home canned foods, persons who serve and eat home-canned foods must boil the food for at least 10 minutes before eating them to ensure safety.

Commercial canners also follow strict sanitary processing procedures called the Good Manufacturing Practice (21 CFR 110) under some of the strictest regulations in the world for low-acid canned foods, 21 CFR 113. Under the law, commercial canners must complete a prescribed course of instruction approved by the FDA Commissioner before they are allowed to sell their products in the USA. The course of instruction followed by most of the universities in the United States is a certification course called the Better Process Control School.

Disposal of suspicious foods

Remember that *C. botulinum* toxin is very toxic. Any food that you suspect may contain the toxin must be handled as instructed by the Centers for Disease Control:

Unopened can

- Do not open the can.
- Place the can in a sealable bag, wrap two plastic bags around it, and tape it tightly.
- Dispose the taped bags in household trash out of reach of humans and pets or return it to the store where you bought it.
- Wash hands with soap and running water for at least 2 minutes.

Opened can

If food is in a disposable container

- Wear gloves and eye protection.
- Leave the food in the container.
- Put the containers in a sealable bag, wrap two plastic bags around it, and tape it tightly.
- Dispose the taped bags in household trash out of reach of humans and pets.
- Slowly remove gloves and dispose after use.
- Wash hands with soap and running water for at least 2 minutes.

If food is in a non-disposable container

- Wear gloves and eye protection.
- Place the food in a sealable bag, wrap two plastic bags around it, and tape it tightly.
- Dispose the taped bags in household trash out of reach of humans and pets.
- Fill the non-disposable container with a dilute bleach solution (¼ cup bleach for every 2 cups of water). Without the bleach solution the toxin may not be removed. Let the food soak for at least 15 minutes. Discard the liquid and wash the container thoroughly with soap and running water.
- Slowly remove gloves and dispose after use.
- Wash hands with soap and running water for at least 2 minutes.

Spilled food

- Wear gloves and eye protection.
- Prepare a dilute bleach solution (¼ cup bleach for every 2 cups of water). Without the bleach solution the toxin may not be removed.
- Completely cover the spill with the bleach solution
- Place a layer of paper towels, 5 to 10 towels thick, on top of the bleach.
- Let the towels sit for at least 15 minutes, then dispose the towels in the trash.
- Wipe up any remaining liquid with new paper towels.
- Clean the area with liquid soap and water to remove the bleach.
- Slowly remove gloves and dispose after use.

- Wash hands with soap and running water for at least 2 minutes.

What to do if you suspect contaminated food

Consumers with questions can call FDA at 1-888-SAFEFOOD or visit their website for further details: www.fda.gov/oc/opacom/hottopics/castleberry.html
If you have a Castleberry product, call the Castleberry consumer hotline at 1-800-203-4412 or 1-888-203-8446.

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