FSHN031

Preventing Foodborne Illness: *E. coli* O157:H7[1]

Keith R. Schneider, Renée Goodrich Schneider, Michael A. Hubbard, and Alexandra Chang[2]

This is one in a series of fact sheets discussing common foodborne pathogens of interest to food handlers, processors, and retailers.

What causes a foodborne illness?

Escherichia coli or E. coli is a bacterium from the family *Enterobacteriaceae* that is usually found in the digestive system of healthy humans and animals and is transmitted through fecal contamination. There are hundreds of known *E. coli* strains, with *E. coli* O157:H7 being the most dangerous. This enterohemorrhagic *E. coli* (or EHEC) strain is responsible for an estimated 70,000 cases of infection and 60 deaths in the United States annually. *E. coli* are generally found everywhere in the environment but mostly occupy animal surfaces and digestive systems, making it important to thoroughly wash anything that comes into contact with these surfaces.

What is *E. coli* O157:H7?

E. coli O157:H7 are Gram-negative rods that have been variously described as verotoxigenic *E. coli* (VTEC) or shiga-like toxin producing *E. coli* (SLTEC). Most recently, the designation has been simplified to shiga-toxin producing *E. coli* (STEC) in recognition of the similarities of the toxins produced by *E. coli* O157:H7 and *Shigella dysenteriae.* These potent toxins are the cause of severe damage to the intestinal lining of those infected. The presence of *E. coli* O157:H7 produced toxins is responsible for the symptoms associated with infection: hemorrhagic colitis, hemolytic uremic syndrome (HUS), and even death. The organism can survive at low temperatures and under acidic conditions, making it difficult to eradicate in nature. The organism has a low infective dose and can be transmitted from person to person, as well as in food products.

What are the symptoms associated with *E. coli* O157:H7?

The acute disease associated with this organism is named hemorrhagic colitis. The symptoms characteristic to this disease are watery and/or bloody diarrhea, fever, nausea, severe abdominal cramping, and vomiting. Because most people recover from this infection on their own, treatment is usually not necessary. Symptoms can appear within hours or up to several days after ingestion of the bacteria and the illness duration is normally 5–10 days.

1. This document is FSHN031, one of a series of the Food Science and Human Nutrition Department, Florida Cooperative Extension Service, IFAS, University of Florida. Original publication date: January 2003. Revised: November 2009. Reviewed by G.E. Rodrick and C.A. Sims, both of the Food Science and Human Nutrition Department, Cooperative Extension Service, IFAS, University of Florida, Gainesville, FL 32611-0370. Please visit the EDIS Web Site at **http://edis.ifas.ufl.edu**.

2. K.R. Schneider, Ph.D., associate professor; R.M. Goodrich Schneider, Ph.D., associate professor, M. Hubbard, laboratory technician, and A. Chang, student, all of the Food Science and Human Nutrition Department, Cooperative Extension Service, IFAS, University of Florida, Gainesville, FL 32611-0370.

Some individuals may develop hemolytic uremic syndrome (HUS). In the very young, this disorder can cause renal failure, hemolytic anemia, or even permanent loss of kidney function. In the elderly, these symptoms as well as thrombotic thrombocytopenic purpura (TTP) (HUS with additional neurological dysfunction and/or fever) may occur.

Who is at risk?

E. coli O157:H7 infection can be serious for healthy people of any age, but it is more likely to cause severe illness in the very young (under age five), the elderly, and immunocompromised patients. There is also a higher risk of infection for workers in certain industries—those working in slaughterhouses, farms, hospitals, nursing homes, nursery schools, and food preparation locations are more susceptible to infections than the rest of the population.

What foods have been commonly associated with *E. coli* O157:H7?

Sources of *E. coli* O157:H7 infections include undercooked or raw hamburgers, sheep, pigs, goats, poultry, game meat, alfalfa sprouts, unpasteurized fruit juices, dry-cured salami, lettuce, cheese curds, unpasteurized or raw milk, contaminated water and ice, and person-to-person transmission. Fruits and vegetables can cause infection from contact with contaminated water. The most common source of infection however, is caused by consumption of undercooked or raw meats. Since there appears to be a very low infective dose for this organism (10–100 cells), adequate sanitation and/or proper processing of foods is critically important.

What sanitation methods are used to prevent infection?

The suggestions below are good examples of how to improve and prevent infections (1):

In the home

- Never thaw food on the counter or let it sit out of the refrigerator over two hours.
- Use refrigerated ground meat in 3–4 days; frozen meat in 3–4 months.
- Cook meat until the center is gray or brown. Meat should reach an internal temperature consistent with FDA Food Code guidelines, determined using a meat thermometer that is calibrated regularly (2). See the "Processing" section below for target temperatures of common meat types, or consult Section 3-401.11 of the 2005 FDA Food Code for more information.
- Serve cooked food with clean plates and utensils.
- Never allow raw foods to contact ready-to-eat foods, utensils, or dishes.
- Avoid unpasteurized dairy or fruit juice products.
- Thoroughly wash fruits and vegetables with clean water.
- Follow rules of personal hygiene, especially after bathroom use and the handling of diapers or soiled personal garments.
- Make sure drinking water has been properly treated.

On the farm

- Use potable quality water for washing fruits and vegetables.
- Manage fecal waste in a way that fresh water will not become contaminated.

In meat processing facilities

- Assure GMPs are being used in slaughterhouses and processing units.
- Apply approved treatments of carcasses to remove fecal bacteria.

Good Practices for Food Product Receiving, Handling, Processing and Storage

The FDA defines Current Good Manufacturing Practices (cGMPs) for food in 21 CRF, Part 110. These cGMPs outline minimal general sanitation requirements in FDA-inspected food handling and processing facilities (3). It is recommended that more specific and stringent standard operating procedures (SOPs) be developed for individual facilities. In addition, the sanitation recommendations for food service and retail food facilities outlined in the 2005 FDA Food Code have been adopted into many state and local regulations. As there may be some variation in Food Code adoption, it is important that each facility check with the appropriate state and/or local regulatory authority. Florida operates under the 2001 FDA Food Code and Title 33, chapter 509 of the Florida statutes (4).

In addition to sanitation requirements, a retail establishment should also develop SOPs for receiving and storage of food products. If food will be processed, appropriate controls and requirements should be established and strictly adhered to. The FDA Food Code outlines appropriate processing and cooking requirements for many food products processed in a retail facility. However, if certain high-risk food products (such as sushi, fresh juice, specialty meats, and others) are processed in the retail establishment rather than in a more traditional processing facility, additional controls and the issuance of a 'variance' by the regulatory authority is required before processing can occur (Food Code 3-502.11). The growing practice of cooking/preparing/packaging foods in retail establishments versus in controlled plant environments raises safety concerns. Any processing of food at the retail level needs to be closely monitored.

As an establishment becomes cleaner, it becomes harder to detect foodborne pathogens. At this point, testing becomes more limited in its ability to prevent foodborne illness. Therefore programs that promote and monitor the use of barriers and/or hurdles are so important. When instituted properly, these activities will reduce the risk of a foodborne illness. Nothing can be done to completely eliminate bacterial contamination short of vacuum sealing, irradiating, and storing products frozen. Since most consumers prefer a fresh product, programs should be implemented that reduce the probability of illness to a point that it is minuscule.

Receiving

Specifications for receiving can be found in section 3-202.11 of the 2005 FDA Food Code. The following guidelines cover the basic points that should be addressed (2):

- Potentially Hazardous Food (PHF) should be at a temperature of 5°C (41°F) or below when received, unless specified by law (e.g., milk, shellfish).
- Raw shell eggs should be received at an ambient air temperature of 7°C (45°F) or below.
- PHFs that are received hot should be at a temperature of 57°C (135°F) or above.
- PHF should be received with no evidence of temperature abuse, such as evidence of thawing.

Processing

One of the easiest ways to prevent foodborne illness associated with *E. coli* O157:H7 is ensuring that foods are cooked thoroughly. It should be noted that foods that are typically served uncooked—raw eggs (used in Caesar salads, homemade mayonnaise, raw cookie dough, etc.) and fresh vegetables—will obviously not benefit from the cooking process. For these items, other factors such as sanitation, worker hygiene, and proper storage take on much greater importance (Food Code 3-401.11 and 3-403.11).

- When using raw eggs in your recipes, try to purchase a pasteurized egg product.
- Cook eggs, fish, meat, or foods containing these items to an internal temperature of 63°C (145°F) or above for a minimum of 15 seconds.
- Cook ground meat products to an internal temperature of 69°C (155°F) or above for a minimum of 15 seconds.

- Cook poultry to an internal temperature of 74°C (165°F) or above for a minimum of 15 seconds.
- Reheat previously cooked material to an internal temperature to 74°C (165°F).

For more, consult the 2005 Food Code (2).

Storage

Once a product has been received and/or processed, it should be displayed or stored. General guidelines governing these practices are outlined below (Food Code 3-501.11 to 3-501.17).

- Frozen food should remain frozen until it is used.
- If frozen food is displayed in a refrigerated case and allowed to thaw, the food should remain at 5°C (41°F) or below.
- Frozen food should be thawed at a temperature of 5°C (41°F) or below or under running water at a temperature of 21°C (70°F) or below.
- Frozen food can be thawed as part of the cooking process.
- Product must be cooled adequately. Refer to sections 3-501.14 and 3-501.15 of the 2005 Food Code.
- Cooked product should be maintained above 57°C (135°F) while displayed and stored at or under 5°C (41°F).
- Properly label all stored product.

Personal Hygiene

Wash your hands! The major cause of foodborne illness in retail establishments comes from poor personal hygiene, particularly a lack of proper hand washing. Dirty hands can contaminate food. Although hands may look clean, the bacteria that cause illness are too small to be seen. Therefore, if while preparing food you come in contact with items that are not part of the assembly process, *rewash your hands.* The same is true even when wearing gloves.

THERE IS NO FIVE-SECOND RULE WHEN IT COMES TO FOOD SAFETY! Millions of bacteria and other germs can be transferred on contact. Below is a list of times when should you wash your hands:

- Before handling, preparing food or serving food.
- Before handling clean utensils or dishware.
- After using the restroom.
- After touching your face, cuts or sores.
- After smoking, eating, or drinking.
- After handling raw meat, especially poultry.
- After touching unclean equipment, working surfaces, soiled clothing, soiled wiping cloths, etc.
- After collecting and taking out the garbage.

Your facility may have even stricter requirements with which you must comply to ensure food safety.

Resources

1. Food Marketing Institute. The major foodborne illnesses and how to control them. Arlington, VA: Food Marketing Institute. (accessed October 29, 2009), Available from: www.fmi.org/media/bg/Major_Foodborne_Illnesses.pdf.
2. United States Food and Drug Administration. 2005 Food Code. Washington, DC: U.S. Department of Health and Human Services, Food and Drug Administration, 2005. (accessed October 29, 2009). Available from: http://www.fda.gov/Food/FoodSafety/RetailFoodProtection/FoodCode/FoodCode2005/default.htm#at.
3. "Current good manufacturing practice in manufacturing, packing, or holding human food," Title 21 Code of Federal Regulations, Pt. 110. 2009 ed. (accessed October 29, 2009). Available from: http://www.access.gpo.gov/nara/cfr/waisidx_09/21cfr110_09.html.

4. "Regulation of trade, commerce, investments, and solicitations: lodging and food service establishments," Title 33 Florida Statutes, ch. 509. 2009. (accessed October 29, 2009). Available from: http://www.flsenate.gov/statutes/index.cfm?App_mode=Display_Statute&URL=Ch0509/part01.htm&StatuteYear=2009&Title=%2D%3E2009%2D%3EChapter%20509%2D%3EPart%20I.

Additional Internet resources:

• United States Food and Drug Administration. Bad Bug Book: *Escherichia coli* O157:H7. Washington, DC: U.S. Department of Health and Human Services, Food and Drug Administration, 2009. (accessed October 29, 2009). Available from: http://www.fda.gov/food/foodsafety/foodborneillness/foodborneillnessfoodbornepathogensnaturaltoxins/badbugbook/ucm071284.htm#at.

• Centers for Disease Control and Prevention. *Escherichia coli.* Atlanta, GA: U.S. Department of Health and Human Services, CDC, Division of Foodborne, Bacterial and Mycotic Diseases, 2008. (accessed October 29, 2009). Available from: http://www.cdc.gov/nczved/dfbmd/disease_listing/stec_gi.html.

• Brown, JC. What the Heck is an *E. coli?* [Internet]. Lawrence, KS: University of Kansas; 1995 (updated 1997 Sept 16; accessed 2009 Oct 29). Available from: http://people.ku.edu/%7Ejbrown/ecoli.html.

• National Foundation for Infectious Diseases. *Escherichia coli* O157:H7 Foodborne Disease. Bethesda, MD: National Foundation for Infectious Diseases, 1996. (accessed October 29, 2009). Available from: http://www.nfid.org/factsheets/ecoli.html.