

Preventing Foodborne Illness: *E. coli* “The Big Six”¹

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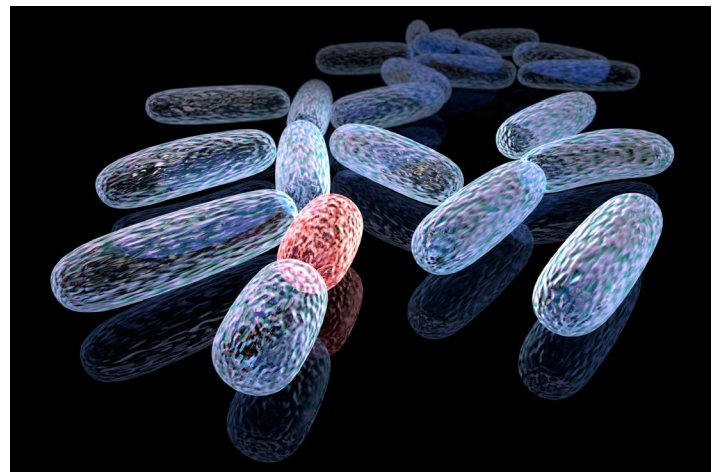
This is one in a series of fact sheets discussing common foodborne pathogens of interest to food handlers, processors, and retailers. For the rest of the series, visit http://edis.ifas.ufl.edu/topic_foodborne_illness.

What Causes an *E. coli*-associated Foodborne Illness?

Escherichia coli (*E. coli*) is a bacterium from the family *Enterobacteriaceae* usually found in the digestive system of healthy humans and animals and transmitted through fecal contamination.^{1,16} There are hundreds of known *E. coli* strains, with *E. coli* O157:H7 being the most widely recognized because of the severe illness it causes.⁵ *E. coli* live in the digestive tracts of animals and can be found everywhere in the environment, making it important to thoroughly wash anything that comes in contact with fecal material.^{1,16}

What Are the “Big Six”?

Certain types of *E. coli*, such as O157:H7, produce shiga toxins that can cause severe illness. In addition to *E. coli* O157:H7, other *E. coli* (serotypes) have been shown to produce these toxins and cause foodborne illness. The U.S. Food and Drug Administration (FDA) has identified six serogroups, known as the “big six,” which includes *E. coli* O26, O45, O103, O111, O121, and O145. Serogroups are a designation scientists use to group different serovars (“strains”) of *E. coli*. The “O” refers to the O (somatic) antigen or a surface structure that differs among serovars of *E. coli*.¹¹ These particular six serovars are the most commonly seen types of *E. coli* found in food in the United



States that are not O157:H7, and they cause approximately 37,000 cases per year in the United States.^{4,9}

Outbreaks Associated with Non-O157:H7 *E. coli*

The most recent outbreak of a non-O157 reported by the CDC was *E. coli* O145 during the summer of 2012.⁵ *E. coli* O145 caused 18 people to become ill in nine different states, with one fatality reported. Unfortunately, researchers were unable to determine a source of contamination for this outbreak.

One of the largest outbreaks of non-O157 *E. coli* was in 2011 when bean sprouts from Germany were contaminated with *E. coli* O104:H4. This outbreak had the highest percentage of hemolytic uremic syndrome (HUS) ever

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recorded, even surpassing *E. coli* O157:H7.¹⁴ More than 3,800 people became ill, 845 of those contracted HUS, and 54 people died.¹⁴ Researchers are still attempting to understand why this strain of *E. coli* is much more virulent than other strains.

Large non-O157:H7 *E. coli* outbreaks currently contaminate similar substances to *E. coli* O157:H7. In the last three years, major outbreaks occurred on both bean sprouts and lettuce.⁵ However, beef, other meat products, milk, and even water are also potential sources of contamination.^{2,13} Livestock and runoff from animal farms are a main source of agricultural contamination, but secondary infections can occur during an outbreak, making it difficult to correctly and definitively identify the source of the non-O157:H7 *E. coli*.²

What Type of Bacterium Is *E. coli*?

E. coli 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* and *Shigella dysenteriae*.^{6,11} These potent toxins cause severe damage to the intestinal lining of those infected. *E. coli*-produced toxins are responsible for symptoms associated with infection, including hemorrhagic colitis, HUS, and even death.¹¹ The organism can survive at low temperatures and under acidic conditions, making it difficult to eradicate in nature.¹² The organism has a low infective dose and can be transmitted from person to person, as well as in food products.³

How Are the “Big Six” *E. coli* Bacterium Spread?

Monitoring for the “big six” is relatively new, so determining how they are spread is challenging. For the few cases in which the source was determined, non-O157:H7 *E. coli* is mainly spread through person-to-person contact, followed by unknown sources, and dairy, meat, and water. This is quite different from O157:H7, which is mainly spread through water, meat, and dairy products.⁹

Currently, surveillance for the “big six” is limited, but this will change with new regulations enacted by the USDA. As of June 2012, the Food Safety and Inspection Service (FSIS) began testing facilities for both O157:H7 and the “big six” in ground beef.¹⁷

Symptoms of *E. coli* Infection

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.^{6,15} 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 usually lasts 5–10 days. Some individuals may develop HUS. In the very young, this disorder can cause renal failure, hemolytic anemia, or even permanent loss of kidney function.^{6,15} These same symptoms also occur in the elderly, as well as thrombotic thrombocytopenic purpura (TTP) (HUS with additional neurological dysfunction and/or fever).¹⁵

High-Risk Populations for *E. coli* Infections

E. coli infection can be serious for healthy people of any age, but it is more likely to cause severe illness in the very young (those under age five), the elderly, and immunocompromised patients.¹⁵ Workers in certain industries also have a higher risk of infection; those working in slaughterhouses, farms, hospitals, nursing homes, nursery schools, and food preparation locations are more susceptible to infection than the rest of the population.¹⁰

Minimizing the Risk of *E. coli* in Plant or Food Establishments

Sanitation Methods

CLEAN

Use hot, soapy water and a sanitizer to wash hands and surfaces that contact food. Wash hands, cutting boards, dishes, and utensils after they come in contact with raw food. Clean liquid spills in the refrigerator, especially spills from products associated with *E. coli*.

- Ensure employees wash hands before, during, and after handling any food, particularly raw meat and poultry.
- Sanitize all utensils, cutting boards, and work surfaces before and after use, using an approved sanitizing agent.
- Clean surfaces that contact food, such as refrigerator shelves, if they come in contact with possible sources of *E. coli* contamination.
- Wash all vegetables and fruits thoroughly before consumption.

SEPARATE

Treat all RTE (ready-to-eat) foods, raw meat, poultry, and seafood as possible sources of contamination. Keep these foods separate from items that traditionally do not get cooked or potentially can be eaten raw, such as vegetables, fruits, breads, and other already-prepared, edible foods. This reduces the chance of cross-contamination.

- Use separate utensils for raw and cooked foods.
- Store meats and other potential sources of contamination in areas below foods that may be consumed raw.
- Rewrap open packages carefully or store in leakproof containers to prevent cross-contamination.

COOK

Heat foods to safe temperatures. The 2009 FDA Food Code recommends cooking to an internal temperature of 165°F or above for 15 seconds for most potentially hazardous foods (refer to Sections 3–4: *Destruction of Organisms of Public Health Concern*, Subparts 3-401 and 3-501 for specific details on cooking temperatures).⁸

At the present time, the best measures to control *E. coli* are proper cooking, preventing cross-contamination of raw and cooked food, proper personal hygiene, and good sanitation. Follow these recommendations to reduce the incidence of foodborne *E. coli* contamination:

- Don't store food in the temperature danger zone between 41°F (5°C) and 135°F (57°C).⁸ The refrigerator should be at 39.2°F (4°C) or colder. All food should be refrigerated promptly.⁸
- Completely cook or boil foods such as hot dogs and poultry products until they become steaming hot, meaning 165°F (73.8°C) or above.

STORAGE

Limit the amount of time food is exposed to room temperature to two hours or less before returning perishables and RTE foods to the refrigerator or freezer.

- Cover all food to prevent cross-contamination.
- Place all cooked food in the refrigerator within one hour of cooking.
- Place uncooked meat, poultry, fish, or other raw products below cooked or RTE foods in the refrigerator to prevent cross-contamination.
- Maintain the refrigerator temperature at or below 39.2°F (4°C), and keep refrigerator clean.
- Follow the “use by” or “best by” dates on refrigerated items.

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

The FDA defines current Good Manufacturing Practices for food (cGMPs) in title 21 of CFR (Code of Federal Regulations) part 110.7 These cGMPs outline the minimum required general sanitation practices in FDA-inspected food handling and processing facilities. 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 FDA Food Code have been adopted into many state and local regulations.⁸ Because of the variation in Food Code adoption, each facility must check with the appropriate state and/or local regulatory authority. The Florida Statutes can be found online at <http://www.leg.state.fl.us/statutes/>. Title 33, Chapter 509 specifies some of these regulations.

In addition to setting and adhering to strict sanitation requirements in the facility, a retail establishment should also develop SOPs for receiving and storing food products and ingredients. If food processing is being done, appropriate controls and requirements should be established and strictly followed. The FDA Food Code outlines appropriate processing and cooking requirements for many food products processed in a retail facility. However, processing certain high-risk food products (e.g., sushi, fresh juice, specialty meats, and others) in the retail establishment rather than a more traditional processing facility requires additional controls and the issuance of a “variance” by the regulatory authority before processing can occur.⁸ The growing retail practice of cooking/preparing/packaging foods traditionally processed 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. This is why programs that promote and monitor the use of barriers and/or hurdles are so important. When instituted properly, these activities reduce the risk of foodborne illness. Nothing can be done to completely eliminate bacterial contamination short of irradiation. 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 2009 Food Code.⁸ The following guidelines cover the basic points that should be addressed:

- Potentially Hazardous Foods (PHF) should be at a temperature of 41°F (5°C) or below when received, unless specified by law (e.g., milk, shellfish).
- Raw shell eggs should be received at an ambient air temperature of 44.6°F (7°C) or less.
- PHFs that are received hot should be at a temperature of 140°F (60°C) 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 salmonellosis is ensuring that foods are cooked thoroughly. It should be noted that certain foods typically served uncooked—raw eggs (such as in Caesar salads, homemade mayonnaise, or raw cookie dough) and fresh vegetables—would 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.

- Purchase a pasteurized egg product when using raw eggs in your recipes.
- Cook eggs, fish, meat, or foods containing these items to an internal temperature of 145°F (62.7°C) or above for a minimum of 15 seconds.
- Cook ground meat products to an internal temperature of 155°F (68.3°C) or above for a minimum of 15 seconds.
- Cook poultry to an internal temperature of 165°F (73.8°C) or above for a minimum of 15 seconds.
- Reheat previously cooked material to an internal temperature of 165°F (73.8°C).

Storage

Once a product has been received and/or processed, it now will be displayed or stored. There are some general guidelines governing these practices as well.

- Frozen food should remain frozen until it is used.
- If frozen food is displayed in a refrigerated case, the food should remain at 41°F (5°C) or below.
- Frozen food should be thawed at a temperature of 41°F (5°C) or below. Food can also be thawed under running water at a temperature of 69.8°F (21°C) or below. Lastly,

the product can be thawed as part of the cooking process.

- The product must be cooled adequately. Refer to sections 3-501.14 and 3-501.15 of the 2009 Food Code.
- Hold cooked product above 140°F (60°C) while displaying, and under 41°F (5°C) while storing.
- Properly label all stored products.⁸

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. Whenever you are preparing food and come in contact with items 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. You should wash your hands in all of the following situations:

- Before handling, preparing, 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/or taking out the garbage

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

What Is the Proper Procedure for Hand Washing?

1. Wet your hands with warm water.
2. Apply soap and wash your hands for 20 seconds.
3. Rinse and dry with a single-use paper towel.
4. Use the paper towel to shut off the water.

Resources

“Current Good Manufacturing Practice in Manufacturing, Packing, or Holding Human Food,” Title 21 Code of Federal Regulations, Pt. 110. 2009 ed. Accessed February 2013. http://www.access.gpo.gov/nara/cfr/waisidx_09/21cfr110_09.html.

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