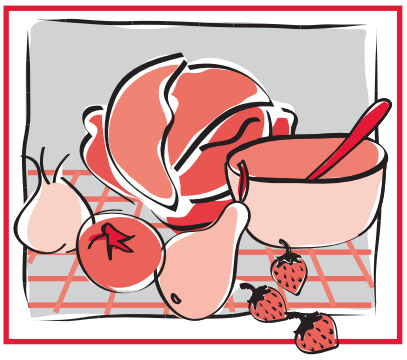
Colorado State University
Extension

Preventing *E. coli* From Garden to Plate

Fact Sheet No. **9.369** Food and Nutrition Series | **Food Safety**

by J.G. Davis and P. Kendall*



Fruits and vegetables are vital to our health and well-being, providing essential vitamins, minerals and fiber. Orchards and home gardens are an excellent source of fresh fruits and vegetables.

Fresh fruits and vegetables once were thought to be relatively free of disease-producing pathogens. In recent years, however, outbreaks of foodborne illness linked to fruits and vegetables have become more common. These outbreaks come from produce grown both in the United States and in other countries. Outbreaks have been linked to *Escherichia coli* O157:H7 and *Salmonella* on apples, lettuce, cantaloupe and sprouts; *Listeria monocytogenes* on cabbage and cantaloupe; *Shigella* on parsley and lettuce; and *Cyclospora* on imported raspberries.

Changes in microorganisms have undoubtedly contributed to this increase, as have changes in growing, harvesting, distribution, processing and consumption practices. *Listeria monocytogenes*, *Clostridium botulinum* and *Bacillus cereus* are naturally present in some soils. Their presence on fresh produce is not uncommon. *Salmonella*, *E. coli* O157:H7, *Campylobacter jejuni*, *Vibrio cholerae*, parasites and viruses can contaminate produce through raw or improperly composted manure, irrigation water containing untreated sewage or manure, and contaminated wash water. Contact with mammals, reptiles, fowl, insects and unpasteurized animal products are other sources of contamination.

Contaminated surfaces, including human hands that come in contact with whole or cut produce, represent potential points of cross-contamination throughout the food system – growing, harvesting, packing, processing, shipping and preparing produce for consumption. It's important to wash all produce well with clean water prior to serving, using a vegetable brush on produce with hard outer surfaces like potatoes, carrots, and melons. Patting dry with paper towels will also help reduce bacterial loads. Although a weak bleach solution (1 to 3 teaspoons of unscented 5.25% chlorine bleach per gallon) is sometimes used to dip fresh produce in commercial operations, it is not recommended for consumers growing their own produce. Because washing alone can't be relied on to totally eliminate pathogens, careful control of all potential points of contamination from production to consumption is essential.

Significance of *E. coli* O157:H7

Many pathogens cause problems with fresh produce. *E. coli* O157:H7, however, is of particular concern because only a few cells are needed to cause illness. The illness can progress quickly to cause severe consequences in susceptible people, particularly young children and the elderly. Also, *E. coli* O157:H7 is quite hardy. It can survive for extended periods in water and soil, under frozen and refrigerated temperatures, and in dry conditions. It also can adapt to acidic conditions. The organism is destroyed by thorough cooking or pasteurization.

Quick Facts

- The bacterium *E. coli* O157:H7 is of particular concern because of its hardiness and the severe consequences of infection.
- Irrigate your garden with potable water.
- Never apply uncomposted manure to growing food crops.
- Compost manure properly to kill most *E. coli* O157:H7.
- Wash your hands thoroughly before working with food.
- Thoroughly wash fruits and vegetables before eating them.
- Cook ground meats thoroughly to 160 degrees F.

www.ext.colostate.edu

*J.G. Davis, Colorado State University Extension soil specialist and associate professor, soil and crop sciences; and P. Kendall, Ph.D., R.D., associate dean of research, food science and human nutrition; . 7/2012

The first recognized outbreaks of illness caused by *E. coli* O157:H7 occurred in 1982. Undercooked hamburger meat was identified as the carrier. While ground beef remains an important cause of outbreaks, many other foods also are carriers. *E. coli* O157:H7 infections have been associated with raw milk, lettuce, untreated water, ground beef, unpasteurized apple juice and cider, deer jerky, produce from manure-fertilized gardens, yogurt, and radish, clover and alfalfa sprouts.

Root crops and leafy vegetables have the greatest risk of infection from manure application to soil. They can also become contaminated through direct or indirect contact with cattle, deer and sheep. *E. coli* O157:H7 is most prevalent in ruminants in general and in cattle in particular (both beef and dairy). Other known carriers include birds, insects and squirrels. While the bacteria do not appear to make these animals sick, the animals carry and shed the bacteria in their feces. Drinking and recreational water have been carriers in several outbreaks, most likely from fecal contamination by infected animals or people.

Like all bacteria, the survival and growth of *E. coli* O157:H7 in foods are dependent on the interactions of various factors such as temperature, pH and water availability. *E. coli* O157:H7 survives refrigeration temperatures. It is quite tolerant of acid, salt and dry conditions, especially at refrigeration temperatures. It is, however, easily destroyed by heat. Cook high-risk items, such as hamburger, to an internal temperature of 160 degrees F.

The severe consequences of *E. coli* O157:H7 can affect all age groups. The very young and very old are most vulnerable to long-term complications.

When *E. coli* O157:H7 attaches to the gut wall of infected people, it sets up an infection known as hemorrhagic colitis (HC). Initial symptoms generally occur within one to two days of eating the contaminated food, although periods up to three to five days have been reported. Symptoms start with mild, nonbloody diarrhea and may be followed by a period of crampy abdominal pain and/or a short-lived fever. The initial diarrhea increases in intensity over the next 24 to 48 hours, up to a four- to 10-day period. Bloody diarrhea is accompanied by severe abdominal pain and moderate dehydration. Life-threatening complications, such as hemolytic uremic syndrome (HUS), also may develop.

HUS symptoms include weakness, low red blood cell counts, lack of urine formation, swelling and acute renal failure. It most often is seen in children under the age of 10. About half of HUS patients require dialysis, and the mortality rate is 3 to 5 percent. HUS-associated complications may include seizures, coma, strokes, colonic perforation, pancreatitis, and/or hypertension. Approximately 15 percent of the cases lead to chronic kidney failure. The development of insulin-dependent diabetes is another potential complication.

A second life-threatening complication is thrombotic thrombocytopenic purpura (TTP). TTP resembles HUS, except it is more often seen in adults and is more likely to cause damage to the central nervous system than the kidneys. Seizures and strokes are commonly seen in people that develop TTP.

If you suspect *E. coli* O157:H7 infection in yourself or those in your care, contact your family physician or the state health department immediately.

Minimizing the Risk

The organism's low infectious dose, survival under adverse conditions, and potential for severe disease require successful prevention strategies. These strategies focus on reducing and eliminating the microorganism, both in the garden and in the kitchen. The following guidelines can greatly reduce your risk for *E. coli* O157:H7 contamination.

Garden Location

Locate your garden in the area with the least potential for contamination from fresh manure. It should be as far away as possible from animal pens (pets or livestock) and from manure or compost piles. If the garden is close to pens or manure piles, consider covering or roofing those areas to prevent rainfall runoff from flowing onto the garden.

Keep pets, livestock and wildlife out of the garden, especially during the growing season. This will prevent them from depositing fecal material onto garden soil and will exclude direct contact of manure with fruits and vegetables.

Check for manure contamination in runoff water from uphill neighbors. Work with them to prevent the runoff from entering your property by building a berm or planting a grass filter strip. See your local U.S.D.A. Natural Resources Conservation Service office for more information on grass filter strips.

Water Use

Water is used not only to irrigate but to deliver liquid fertilizers and pesticides. To avoid *E. coli* contamination, use potable water for these purposes. If this is not possible, groundwater from wells usually has a lower potential for *E. coli* contamination than surface water from canals, creeks or ponds. When wells are properly constructed and maintained, the deeper the well, the less chance there is for contamination of the groundwater.

When using surface water in your garden, check the area around the water source. Is manure stored near the water? Is there a septic system near

Strategies for minimizing your risk include:

- appropriate garden location,
- safe irrigation water,
- proper manure management,
- cleaning up after gardening,
- sound food handling and preparation practices.

the water? Is manure applied to land near the water? Do livestock or wildlife have unrestricted access to the water? Are neighbors allowing contaminated runoff to enter the water?

It is important to prevent direct contact of potentially contaminated water with the fruits or vegetables you plan to harvest. The type of plant affects how you water. If the edible portion of the crop is located above the soil, it is better to water with a drip system or a furrow or flood system than with sprinklers. This will limit direct contact between the water and the crop. If you have a limited drinking water supply, save the best water for the period just prior to harvest. Avoid using potentially contaminated water within 30 days of harvest.

You can have your water tested through Environmental Health Services at Colorado State University or by other laboratories. (See fact sheet 0.520, *Selecting an Analytical Laboratory*.) There are limitations to this testing, however. The test for generic *E. coli* is relatively cheap; analysis for *E. coli* O157:H7 is more expensive. Also, your water supply may be free of *E. coli* at certain times of year and contaminated at others. Therefore, you may have to sample the water on a regular schedule.

Manure Management

Manure is an excellent fertilizer and soil conditioner. However, don't apply fresh manure to the soil in your fruit or vegetable garden. Even aged manure can have *E. coli* present. Composting manure properly will kill most *E. coli*. In order for a manure pile to be composted properly, the following requirements must be met:

- Mix the compost regularly. This is important not only for aeration but also to ensure that the entire pile has reached the required temperature.
- Monitor the temperature with a long-stemmed thermometer (2 to 3 feet). Reaching a temperature within the compost of 130-140 degree F for at least two 5-day heating cycles is critical. Mix the compost between cycles.
- After composting, allow the compost to cure for two to four months before applying it to your garden soil. This allows the beneficial bacteria to kill disease-causing bacteria.

Home composting of manure is riskier than commercial composting due to lower temperatures, greater temperature variability in the compost pile, smaller compost volumes, and inadequate temperature monitoring. Home composting plant materials alone (without manure) avoids potential pathogen problems. See 7.212, *Composting Yard Wastes*, for more information.

When using aged (not composted) manure, the following practices will reduce the potential for contamination:

- Never apply manure to growing food crops.
- Apply manure in the fall after harvest, and mix it in. Fall application allows the longest period from application to harvest.
- Do not leave manure on the soil surface where it can have direct contact with the crop. Always mix it into the soil.
- Wait 120 days from manure application to crop harvest. This can be safely reduced to 90 days if the edible portion is protected by a husk, pod or shell. *E. coli* bacteria can survive freezing temperatures, so this time requirement does not include periods when the soil is frozen.

The above procedures also will help prevent *E. coli* contamination when using composted manures.

After Gardening

After applying manure to your garden, turning your compost pile, or doing any other manure-related activity, thoroughly wash your hands and any other contaminated body parts with soap and warm water. Wash the tools that had direct contact with manure. Don't use the same tools for manure handling that you use for crop harvesting (buckets or gloves, for example). Remove manure-contaminated clothing, including shoes and gloves, before going into the house and especially before eating, drinking or preparing food.

In the Kitchen

Food handling and preparation practices are the last line of defense for preventing infection from *E. coli* O157:H7 and other foodborne pathogens. The following actions can help ensure the safety of the food you serve. They are especially important if you or those you are serving are at risk for foodborne illness. The groups at highest risk include pregnant women and infants, children, the elderly and immuno-compromised individuals.

- Wash hands thoroughly before working with food and after using the toilet, changing diapers, handling animals or helping people who have diarrhea.
- Thoroughly wash raw fruits and vegetables just before preparing or eating them. This not only helps remove dirt, bacteria and stubborn garden pests, but it also helps remove residual pesticides. Separate and individually rinse the leaves of spinach and lettuce. Peel potatoes, carrots, yams and other root vegetables, or clean them well with a firm scrub brush under lukewarm running water. Pat dry with paper towels.
- Clean and sanitize cutting boards, utensils and surface areas used to prepare any raw food before using them to prepare another product, especially if that food will be eaten raw. Use 3/4 teaspoon of chlorine bleach per quart.
- Avoid cross-contamination between raw and cooked foods. Store fresh meat below produce in the refrigerator. Never place cooked meat on an unwashed plate that held raw meat.
- Cook ground meats thoroughly to 160 degrees F. Check the internal temperature with a thermometer.

- Don't drink raw milk. Also, avoid unpasteurized juices or ciders.
- Use only safe, treated water.
- Refrigerate leftovers promptly.

Rinsing some produce, such as leafy greens, with a vinegar solution (1/2 cup distilled white vinegar per 2 cups water) followed by a clean water rinse has been shown to reduce bacterial contamination but may affect the taste.

References

Beuchat, L.R. and J. Ryu. 1997. Produce Handling and Processing Practices. *Emerging Infectious Diseases.* 3:(4)459-465.

Beuchat, L.R. Surface decontamination of fruits and vegetables eaten raw: a review. Available at www.who.int/fsf/new.htm. Accessed March 1, 2000.

Buchanan, L.B. and M.P. Doyle. 1997. Foodborne disease significance of *Escherichia coli* O157:H7 and other enterohemorrhagic *E. coli*. *Food Tech*. 51(10)69-76.

Chang, J. and Fang, T. 2007. Survival of Escherichia coli O157:H7 and Salmonella enterica serovars Typhimurium in iceberg lettuce and the antimicrobial effect of rice vinegar against E. coli O157:H7. Food Microbiology 24: 745-751.

Lynch, L.F., Tauxe, R.V., Hedberg, C.W. 2009. The growing burden of foodborne outbreaks due to contaminated fresh produce: risks and opportunities. Epidemiol Infect. 137:307-15.

McGlynn, W. Guidelines for the Use of Chlorine Bleach as a Sanitizer in Food Processing Operations. Oklahoma State University Food Technology Fact Sheet, FAPC-116. Available from: http://pods.dasnr.okstate.edu/docushare/dsweb/Get/Document-963/FAPC-116web.pdf.