

# Preventing Foodborne Illness: Yersiniosis<sup>1</sup>

Christopher Pabst, Jaysankar De, Aswathy Sreedharan, Correy Jones, and Keith R. Schneider<sup>2</sup>

## What is yersiniosis?

Yersiniosis is an infectious disease caused by the bacterium *Yersinia* and is characterized by common symptoms of gastroenteritis, such as abdominal pain and mild fever (Al-Khalidi 2012). The bacterium is prevalent in the environment, enabling it to contaminate water and food systems. Outbreaks of yersiniosis have been associated with improperly pasteurized milk, ready-to-eat salad mix, oysters, and more commonly with consumption of undercooked meals containing pork (Al-Khalidi 2012, Longenberger et al. 2013, Macdonald et al. 2012). Yersiniosis incidents are frequently reported in Northern Europe, Scandinavia, and Japan, but rarely in the United States (Al-Khalidi 2012).

## What is *Yersinia*?

The *Yersinia* genus is comprised of 11 species, with four being pathogenic. Of the four pathogenic species, only *Y. enterocolitica* and *Y. pseudotuberculosis* cause foodborne gastroenteritis (Al-Khalidi 2012). The Centers for Disease Control and Prevention (CDC) estimate approximately 0.28 confirmed *Y. enterocolitica* cases per 100,000 persons were reported in the United States in 2014 (CDC 2016). A recent increase in yersiniosis as compared to earlier years is most likely due to higher lab-testing frequencies and advances in detection methods (CDC 2016). However, this approximation may underestimate the actual number because only serious cases are reported. Further, the reported low incidence of *Yersinia* in the US food supply may also be underestimated due to the long incubation time and

misdiagnosis of patients with *Y. enterocolitica* infections, along with the inability to identify the source of infection (Fredriksson-Ahomaa 2007).

*Yersinia enterocolitica* is a facultative anaerobic, gram-negative, coccobacillus (very small, rod-shaped bacteria that can grow at low temperatures. There are more than 70 serotypes (Wauters et al. 1987) of *Y. enterocolitica*, of which only 11 are infectious to humans. The most common serogroups (O:3; O:5,27; O:8; and O:9) have been isolated from countries in Europe, Japan, the United States, and Canada (Bottone 1999, Kapperud 1991). The serogroup associated with the most foodborne illness cases of *Y. enterocolitica* infections is O:3 (Marriott et al. 2018).

Despite the importance of *Y. enterocolitica* as a significant/major foodborne pathogen, the isolation of the microorganism from food samples is still challenging (Fredriksson-Ahomaa 2007). *Yersinia enterocolitica* can grow between 4°C and 45°C (Marriott et al. 2018), though growth is slower at lower temperatures, resulting in a doubling time of 34 minutes at 30°C as compared to 5 hours at 7°C (Al-Khalidi 2012). The bacterium can thrive on food held at refrigerated temperatures for extended periods as long as there are available nutrients and low competition with other psychrotrophic bacteria. The organism can persist for extended periods in a variety of prepared foods (Al-Khalidi 2012), including vacuum-packed meat, boiled eggs, boiled fish, pasteurized milk, cottage cheese, tofu, oysters, raw shrimp, and cooked crabmeat. It can also survive in frozen foods and tolerate both acidic and alkaline conditions (pH

1. This document is FSHN12-09, one of a series of the Food Science and Human Nutrition Department, UF/IFAS Extension. Original publication date June 2012. Revised March 2019. Visit the EDIS website at <https://edis.ifas.ufl.edu> for the currently supported version of this publication.

2. Christopher Pabst, graduate student; Jaysankar De, post-doctoral research associate; Aswathy Sreedharan, former post-doctoral research associate; Correy Jones, former student; and Keith Schneider, professor, Food Science and Human Nutrition Department; UF/IFAS Extension, Gainesville, FL 32611.

The Institute of Food and Agricultural Sciences (IFAS) is an Equal Opportunity Institution authorized to provide research, educational information and other services only to individuals and institutions that function with non-discrimination with respect to race, creed, color, religion, age, disability, sex, sexual orientation, marital status, national origin, political opinions or affiliations. For more information on obtaining other UF/IFAS Extension publications, contact your county's UF/IFAS Extension office.

U.S. Department of Agriculture, UF/IFAS Extension Service, University of Florida, IFAS, Florida A & M University Cooperative Extension Program, and Boards of County Commissioners Cooperating. Nick T. Place, dean for UF/IFAS Extension.

4–7, with the optimum condition for growth being at pH 7.6) (Al-Khaldi 2012).

This organism has been isolated from clinical specimens including feces and sputum (Al-Khaldi 2012), but it is not part of the normal human microflora. The prevalence of *Y. enterocolitica* in soil, water, and animal feces offers multiple routes for its transmission to food supply. Pork has been associated with most cases of foodborne infections with *Y. enterocolitica*. The organism has also been isolated from various other animals, including birds, beavers, cats, and dogs (Galindo et al. 2011). The pathogenic serogroups O:3 and O:9 are harbored by pigs and are frequently found in their fecal matter, on the tonsils and tongue, and as surface contaminants on pig carcasses (Longenberger et al. 2013). Consumption of raw or undercooked pork products has been blamed for most outbreaks of yersiniosis in the United States, along with poor sanitation and improper sterilization techniques (CDC 2016).

## How is *Y. enterocolitica* transmitted?

Although the outbreaks of yersiniosis are uncommon and sporadic, foodborne outbreaks have been associated with consumption of contaminated food or drinks and with places of high pork consumption (Bottone 1999, Kapperud 1991). Drinking untreated water or unpasteurized milk can also transmit yersiniosis (CDC 2016). The most recent *Y. enterocolitica* outbreak in the United States occurred in 2011 and resulted from the consumption of improperly pasteurized milk products (Longenberger et al. 2013). Most outbreaks are associated with improper food processing methods, including poor sanitation and improper sterilization techniques utilized by food handlers. Although less frequently, the pathogen can also be transmitted through the fecal-oral route, resulting from improper handwashing and poor personal hygiene practices (Al-Khaldi 2012). Cross-contamination from cooking surfaces, including cutting boards and utensils, can contribute to the transmission of *Y. enterocolitica* to food.

Outbreaks of yersiniosis in infants have been reported in the United States. Several cases were found to be associated with preparation of chitterlings, a prepared food usually made from the small intestines of pigs and sometimes cattle or other animal intestines (CDC 2016).

Cross-contamination from improper handwashing by caretakers preparing chitterlings before caring for the infants was cited.

## What are the symptoms of yersiniosis?

Yersiniosis is characterized by acute gastroenteritis, with diarrhea and/or vomiting, fever, abdominal pains, and skin rashes (Al-Khaldi 2012). On average, symptoms appear within 3–7 days of eating the contaminated food. Host factors such as the age and physical state of the patient along with the virulence (how effective a pathogen is at causing illness) of the serogroup of *Y. enterocolitica* can determine the appearance and severity of an infection (Fredriksson-Ahomaa 2007, Marriott et al. 2018). Children under the age of five are more susceptible to symptomatic infections of yersiniosis (Marriott et al. 2018). Less than 10% of the infected children may have bloody stools. The illness can range from self-limiting to fatal systemic infection. Yersiniosis may last from a few days to three weeks. If it progresses to chronic enterocolitis, it may last up to several months. However, fatalities are extremely rare (Al-Khaldi 2012).

## What are the long-term effects/ complications from yersiniosis?

Most cases of yersiniosis are uncomplicated and self-limiting. In some instances, lower abdominal pain associated with yersiniosis mimics the symptoms of appendicitis, resulting in misdiagnosis (Marriott et al. 2018). Yersiniosis has also been misdiagnosed as Crohn's disease (Marriott et al. 2018). Reactive arthritis may occur after 1–3 weeks of a serious *Y. enterocolitica* infection. Bacteremia, or entrance of the bacteria into the blood stream, is a rare complication from yersiniosis. In immunocompromised individuals, yersiniosis can lead to meningitis (swelling of the membranes surrounding the brain and spinal cord) and inflammation of the skin (USDA 2016).

## Who is most at risk?

Yersiniosis mostly affects infants, children, and teenagers, although it can also occur in adults, especially the elderly. The infectious dose of *Y. enterocolitica* is estimated to be from 10,000 to 1,000,000 cells (Al-Khaldi 2012). In infants, children, adolescents, and the elderly, a lower number of *Y. enterocolitica* may cause infection. Likewise, a lower level of *Y. enterocolitica* may lead to infection of immunocompromised individuals and those with gastric hypoacidity, where stomach acids are unable to effectively act as a barrier to infection (Al-Khaldi 2012). Individuals with hereditary

hemochromatosis (high iron levels in the body) are also more susceptible to infection by *Yersinia* (Adams and Gregor 1990), as iron is an important growth factor for the organism.

## How can you prevent yersiniosis?

Good hygiene should be practiced during food processing and food preparation; poor sanitation and improper sterilization techniques by food handlers are known reasons for *Y. enterocolitica* outbreaks. The following practices are recommended for prevention of yersiniosis.

### Meat processing:

- Operations carried out on the oral cavity in pigs (inspection, removal of tonsils and tongue, splitting the skull) present a risk of contaminating the meat and must be performed with great care.
- Fecal contamination of the carcass must be avoided using appropriate techniques, especially during evisceration.
- Potable water (i.e., intended for human consumption) must be used during processing.

### Food processing (including cooking at home):

- Operations (e.g., filling, sealing, and labelling, etc.) carried out on foods, especially milk, after any inactivation treatment, must be performed under controlled conditions.
- Potable water (i.e., intended for human consumption) must be used during processing
- The optimum growth temperature of *Y. enterocolitica* is 28°C–29°C (82.4°F–84.2°F); raw and cooked meats not consumed within 2 hours should be stored at refrigerated temperatures. However, microbial growth may continue in the refrigerator if not cooled quickly or if your refrigerator is not set to 4°C (40°F). Freezing foods will prevent the growth of all microorganisms.
- Food should be cooked properly before consumption (for example, pork should reach a minimum internal temperature of 145°F [62.8°C] and rest 3 minutes [https://www.foodsafety.gov/keep/charts/mintemp.html]).
- Wash raw fruits and vegetables thoroughly. While this won't eliminate all the bacteria from the produce, it can help reduce contamination.
- Consume pasteurized milk and dairy products. Products such as raw milk have a higher probability of bacterial contamination.
- Wash hands thoroughly with warm water and soap before and after touching any raw meat products.

- Ensure proper sanitation and hygiene during rearing, harvesting, processing, and transportation of pigs.
- Avoid consumption of raw or undercooked pork products.
- Preparation of raw chitterlings is a known high-risk behavior accounting for *Y. enterocolitica* infection.
  - Decrease the risk during cleaning and cooking of chitterlings by buying pre-cooked chitterlings or boiling them for 5 minutes before cleaning and cooking.
  - After handling raw chitterlings, clean hands thoroughly with soap and water, especially before touching infants or their toys. Infants should never be around an area of chitterling preparation.
- Thoroughly clean all cutting boards, countertops, and utensils with soap and hot water after preparing raw meat. All surfaces and equipment should be properly cleaned before and after any food is prepared to prevent cross-contamination from microorganisms.
- People in a household known to be infected with *Y. enterocolitica* or *Y. pseudotuberculosis* should not handle food.
- Hygienic conditions should be maintained in food processing facilities.

## References

- Adams P. C., and J. Gregor. 1990. Hemochromatosis and yersiniosis. *Canadian Journal of Gastroenterology*. 4:160–162.
- Al-Khaldi S. “*Yersinia enterocolitica*,” in *Bad Bug Book: Foodborne pathogenic microorganisms and natural toxins*, 2nd ed., eds. Keith A. Lampel, Sufian Al-Khaldi, and Susan Mary Cahill (Washington, DC: US Department of Health and Human Services, Food and Drug Administration [FDA], 2012). Available at: <https://www.fda.gov/downloads/food/foodsafety/foodborneillness/foodborneillnessfood-bornepathogensnaturaltoxins/badbugbook/ucm297627.pdf>. Accessed January 24, 2019.
- Bottone E. J. 1999. *Yersinia enterocolitica*: overview and epidemiologic correlates. *Microbes and Infection*. 1:323–333.
- Centers for Disease Control and Prevention (CDC). 2016. *Yersinia enterocolitica* (Yersiniosis). Available at: <https://www.cdc.gov/yersinia/index.html>. Accessed January 24, 2019.

Fredriksson-Ahomaa M. 2007. *Yersinia enterocolitica* and *Yersinia pseudotuberculosis*. Infectious Disease Foodborne Diseases. 79–113.

Galindo C. L., Rosenzweig J. A., Kirtley M. L., and Chopra A. K. 2011. Pathogenesis of *Y. enterocolitica* and *Y. pseudotuberculosis* in human yersiniosis. *Journal of Pathogens*. 1-16.

Kapperud, G. 1991. *Yersinia enterocolitica* in food hygiene. *International Journal of Food Microbiology*. 12:53–65.

Longenberger A. H., M. P. Gronostaj, G. Y. Yee, L.M. Johnson, J.F. Lando, R.E. Voorhees, K. Waller, A.C. Weltman, M. Moll, S.B. Lyss, B.L. Cadwell, L.M. Gladney, S.M. Ostroff. 2013. *Yersinia enterocolitica* infections associated with improperly pasteurized milk products: southwest Pennsylvania, March–August 2011. *Epidemiology and Infection*. 142:1640–1650.

Macdonald E., B. T. Heier, K. Nygård, et al. 2012. *Yersinia enterocolitica* outbreak associated with ready-to-eat salad mix, Norway, 2011. *Emerging Infectious Diseases*. 18:1496–1499.

Marriott N. G., M. W. Schilling, and R. B. Gravani. 2018. *Principles of food sanitation*. Springer International Publishing, Cham.

United States Department of Agriculture (USDA). 2016. Yersiniosis and Chitterlings: Tips to protect you and those you care for from foodborne illness. Available at: [https://www.fsis.usda.gov/wps/portal/fsis/topics/food-safety-education/get-answers/food-safety-fact-sheets/foodborne-illness-and-disease/yersiniosis-and-chitterlings/CT\\_Index](https://www.fsis.usda.gov/wps/portal/fsis/topics/food-safety-education/get-answers/food-safety-fact-sheets/foodborne-illness-and-disease/yersiniosis-and-chitterlings/CT_Index). Accessed January 24, 2019.

Wauters G., K. Kandolo, K. Janssens. 1987. Revised biogrouping scheme of *Yersinia enterocolitica*. *Contributions to Microbiology and Immunology*. (9):14-21.