

Preventing Foodborne Illness: Salmonellosis¹

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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.

What causes a *Salmonella*-associated foodborne illness?

Salmonella is a bacterium that can cause diarrheal illness in people. Illnesses caused by *Salmonella*-contaminated food have been identified for more than 100 years (Crum-Cianflone 2008). In 2007, the Centers for Disease Control and Prevention (CDC) estimated that there were 1.2 million cases and approximately 450 deaths associated with *Salmonella*-contaminated food each year (Scallan et al. 2011). While most go unreported, a significant number, especially those associated with larger outbreaks, are clearly identified to be caused by the ingestion of *Salmonella*-contaminated food. It was estimated that in 2004 alone, the total economic burden caused by *Salmonella* infections in the United States (US) was \$1.6–\$5.3 billion (Scallan et al. 2011).

Outbreaks Associated with *Salmonella*

Fresh produce has become a larger part of the nation's daily diet, but with this increase in consumption, a rise in the number of foodborne illnesses associated with fresh

produce has also been seen (Sivapalasingam et al. 2004). Recently in 2015, an outbreak of *Salmonella enterica* serovar Poona was linked to cucumbers (CDC 2016). During the summer of 2015 and continuing into 2016, illnesses were reported in 40 states across the US. A fresh produce company from California that distributed cucumbers throughout the US, mostly to retailers, food service companies, and wholesalers, was implicated in the outbreak (CDC 2016). To date, 907 total cases were reported, which have led to 204 hospitalizations and 6 deaths. Most recently, an outbreak associated with *Salmonella* *Africa* was linked to cucumbers in 2024, resulting in over 550 illnesses (FDA 2024).

In another outbreak in the fall of 2012, *Salmonella* Bredeney was associated with a nut butter company located in New Mexico. The contamination resulted in 42 ill individuals, 10 of whom needed hospitalization. The ages of those affected ranged from 1 to 79. Twenty states were affected in this outbreak (CDC 2012a). Approximately 100 different types of items made with nuts (e.g., almond butter, peanut butter, cashew butter, blanched peanut, and others) were recalled by the company. Subsequent secondary recalls resulted from the use of contaminated nuts as ingredients (CDC 2012a).

During the summer and fall of 2010, approximately 2,000 people contracted salmonellosis from the consumption of shell eggs (not dried or powdered eggs). Eggs have been

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associated with *Salmonella* contamination for many years, but this recent outbreak was one of the largest in recent history. After investigation, the farms that supplied the eggs were identified as the source of contamination (CDC 2010).

Tomatoes had historically been implicated in foodborne salmonellosis outbreaks, especially during the late 1990s and early 2000s. However, there has not been a significant salmonellosis outbreak linked to tomatoes since 2006, where contaminated tomatoes sickened 183 people (CDC 2006). It was during this time many new protocols, such as Florida's (2007) Tomato Good Agricultural Practices (T-GAPs) program, were introduced. These programs were designed to ensure the safe production, processing, and handling of tomatoes. This focus on good agricultural practices has led to a vast reduction of microbial contamination and outbreaks on tomatoes (Kokkinakis et al. 2007). Recently, FDA enacted the Food Safety Modernization Act (FSMA), a sweeping new set of regulations designed to protect against foodborne illnesses (FDA 2011). One such regulation under the umbrella of FSMA is the Produce Safety Rule (FSMA SEC.105). This new rule will bring mandatory GAPs to all potentially hazardous produce commodities in hopes of reducing the number of foodborne illnesses associated with fresh produce.

What type of bacterium is *Salmonella*?

Salmonella are typically motile, non-spore-forming, Gram-negative, rod-shaped bacteria (Murray et al. 2007). Currently, there are 2,463 types (serovars) of *Salmonella* (ASM 2016). *Salmonella* Typhi and Paratyphi are the serovars that cause typhoid fever, usually a more severe disease than those caused by the other non-typhoidal *Salmonella*. *Salmonella* is widespread in the environment and is associated with all animal species, including mammals, birds, reptiles, and amphibians. It has been found in water, soil, insects, animal feces, raw meats, poultry, seafood, and on factory and kitchen surfaces. While these are common sources, *Salmonella* has been isolated from numerous other food sources as well (Murray et al. 2007).

How is *Salmonella* spread?

A variety of foods have caused salmonellosis outbreaks, including poultry, meats, eggs, milk products, fruit juice, fish, shrimp, frog legs, yeast, coconut, sauces and salad dressing, cake mixes, breakfast cereal, cream-filled desserts and toppings, dried gelatin, peanut butter, cocoa, chocolate, and dried spices. *Salmonella* incidence is much higher in raw agricultural products than in cooked or processed food

products. *Salmonella* can be present in foods as a result of cross-contamination with raw foods, or from contamination from humans, animals, birds, or reptiles (Sanyal et al. 1997). Because of the microorganism's ability to survive in a wide range of environments, *Salmonella* has been found in dry and dehydrated foods (e.g., cocoa, chocolate, dry milk, spices, and cereal products) (Komitopoulou and Peñaloza 2008) and in acidic food products (e.g., non-pasteurized orange juice) (Jain et al. 2009). Thus, preventative measures are extremely important in all food handling and processing steps.

Symptoms of Salmonellosis

Acute symptoms of salmonellosis may include nausea, vomiting, abdominal cramps, diarrhea, fever, and headache. Typically, symptoms develop 12–72 hours after ingestion of contaminated food. Most people infected usually recover without treatment after four to seven days (CDC 2012b). As with many foodborne pathogens, young children, the elderly, and the immunocompromised are the most likely targets of *Salmonella* infections. Depending on host factors, such as the age and health of the host, the infective dose has been estimated to be less than a thousand cells for many of the strains (Blaser and Newman 1982) and as low as 15–20 cells for some strains (FDA 2012a).

In a small percentage of cases, people infected with *Salmonella* can develop chronic, long-term problems associated with the illness. Reactive arthritis may begin three to four weeks after onset of acute symptoms; arthritic symptoms can be debilitating and last for six months or more (Scallan et al. 2011).

High-Risk Populations for Salmonellosis

All age groups are susceptible to infections, but salmonellosis has a more severe effect on the elderly, infants, and anyone whose immune systems are already compromised by other factors (Jacobs et al. 1985). The frequency of salmonellosis in AIDS patients, for example, is estimated to be 20 times higher than that of the general population (Celum et al. 1987). For food products being supplied to school lunch programs, nursing homes, or hospitals, a more rigorous quality assurance program might be necessary. More demanding standards may include increased sanitation, stricter rules governing personal hygiene, and/or increased microbial testing of finished product(s).

Sanitation Methods for Minimizing the Risk of Salmonellosis in the Plant or Food Establishment

Clean

Use hot, soapy water and a sanitizer to wash hands and food-contact surfaces often. 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 *Salmonella*.

- Ensure employees wash hands before, during, and after handling any food, particularly raw meat and poultry.
- Sanitize all utensils, cutting boards, and work surfaces with an approved sanitizing agent before and after use.
- Clean food-contact surfaces such as refrigerator shelving if they come in contact with possible sources of *Salmonella* 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 types of foods separate from items that are not traditionally 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.

- The utensils used for raw and cooked foods should be separate.
- Meats and other potential sources of contamination should be stored in places that rest below storage areas for foods that may be consumed raw.
- Rewrap open packages carefully or store in leak-proof containers to prevent cross-contamination.

Cook

Heat foods to safe temperatures. The 2013 FDA Food Code recommends cooking most potentially hazardous foods to an internal temperature of 165°F or above for at least 15 seconds (refer to Sections 3–4: *Destruction of Organisms of Public Health Concern*, Subparts 3-401 and 3-501 of the 2013 FDA Food Code, for specific details on cooking temperatures) (FDA 2017).

Proper cooking and personal hygiene, good sanitation, and preventing cross-contamination of raw and cooked food are the best measures to control *Salmonella*. Recommendations

to reduce the incidence of foodborne salmonellosis include the following:

- Do not store food in the temperature danger zone between 41°F and 135°F. The refrigerator should be at 41°F or colder. All food should be refrigerated promptly.
- Completely cook or boil foods like hot dogs and poultry products until they become steaming hot (165°F or above).

Storage

Try to limit room temperature exposure of food to 2 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 41°F, and keep the refrigerator clean.
- Observe strictly the “use by” or “best by” dates on refrigerated items.

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

The FDA, under the new FSMA regulations (FDA 2024b), defines current Good Manufacturing Practices for food (cGMPs) in title 21 of CFR (Code of Federal Regulations) part 117 (FDA 2015), formerly 21 CFR 110 (FDA 2012b). 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. Sanitation recommendations for food service and retail food facilities, outlined in the FDA Food Code (FDA 2017), have been adopted into many state and local regulations. As there may be some variation in FDA Food Code adoption, it is important that each facility 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 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 (e.g., 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 (FDA 2017). 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 and 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 miniscule point.

Receiving

Specifications for receiving can be found in Section 3-202.11 of the 2013 Food Code (FDA 2017). The following guidelines cover the basic points that should be addressed:

- Potentially Hazardous Food (PHF) should be at a temperature of 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 45°F or less.
- PHFs that are received hot should be at a temperature of 135°F or above.
- PHF should be received with no evidence of temperature abuse, such as 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 that are typically served uncooked—raw eggs (used in Caesar salad dressings, homemade mayonnaise, raw cookie dough, etc.) 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.

- When a recipe calls for using raw eggs (e.g., Caesar salad dressing), try to purchase a pasteurized egg product.
- Cook eggs, fish, meat, or foods containing these items to an internal temperature of 145°F or above for a minimum of 15 seconds.
- Cook ground meat products to an internal temperature of 155°F or above for a minimum of 15 seconds.
- Cook poultry to an internal temperature of 165°F or above for a minimum of 15 seconds.
- Reheat previously cooked material to an internal temperature of 165°F.

Storage

Once an item has been received and/or processed, it will proceed to storage (or display). 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 or below.
- Frozen food should be thawed at a temperature of 41°F or below. Food can also be thawed under running water at a temperature of 70°F or below. Lastly, the product 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 2013 Food Code.
- Hold cooked product above 135°F while displaying, and under 41°F while storing.
- Properly label all stored product.

For more, consult the 2013 Food Code (FDA 2017).

Personal Hygiene

Wash your hands! The majority of foodborne illness, such as salmonellosis, is caused by 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 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. Following is a list of instances when you should wash your hands:

- 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/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 with which you must comply to ensure food safety.

What is the proper procedure for hand washing?

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

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