

# Salmonella and Eggs

Chicken eggs are a common source of human infection with *Salmonella*. They can become contaminated by two routes: fecal contamination of the eggshell and transovarian transmission from an infected chicken.

Fecal contamination of eggs occurs when *Salmonella* from the intestinal tract of an infected hen or in the environment from another source, such as rodents, contaminates the shell of the egg after it has been formed. Fecal contamination of the shell can contaminate the egg contents through

- cracks in the eggshell
- naturally occurring pores in the eggshell
- contact between the eggshell and the egg contents when an egg is broken for preparation

Transovarian transmission of *Salmonella* occurs when the hen laying the egg has an infection of the ovaries or oviduct and the contents of the egg are contaminated before the eggshell is formed. Only a small fraction of the eggs laid by infected hens are contaminated with *Salmonella* through this means. The hen typically shows no signs of infection but can lay intact and unbroken eggs that are internally contaminated with *Salmonella*. Chicks hatched from contaminated eggs can also be infected with *Salmonella* and can contaminate their own eggs or pass the infection to other chickens.

## Contamination, Survival, and Growth

Based on the typical egg production process in the United States, possible sources of contamination of eggs with *Salmonella* include

- infected egg-laying hens
- contaminated feed, water, or litter
- contaminated environmental surfaces in pullet houses or poultry houses, for example, cages, conveyor belts, collection containers, or storage containers
- infected wildlife such as rodents, birds, or pests that can contaminate the environment
- contaminated human hands
- pooling of eggs (a common restaurant practice in which the contents of multiple eggs are combined into a single bowl), which results in contamination of the entire batch if one egg in the batch was contaminated

Opportunities for survival of *Salmonella* already present in or on eggs result when the shell is not washed and sanitized adequately after the eggs are collected, the eggs are not processed in a way that kills *Salmonella*, such as pasteurization, or the eggs are not cooked adequately before consumption.

Opportunities for growth of *Salmonella* already present in or on eggs occur when eggs are not refrigerated before cooking. Growth can also occur when cooling is insufficient, if eggs are held too long beyond their pack date, and if cooked eggs are held at room temperature for too long or at an inadequate hot holding temperature.

## Prevention of Egg-associated Salmonellosis

The goals of prevention and control of egg-associated salmonellosis are

- to reduce internal and external contamination of eggs with *Salmonella*
- to reduce survival and growth of *Salmonella* already present in or on eggs

Cleaning the eggshell will decrease external contamination of eggs with *Salmonella* and contamination of the contents when eggs are cracked during preparation. Rejection of cracked eggs during processing will decrease the number of eggs with *Salmonella*-contaminated contents that make it to market. These actions, however, will not prevent contamination of egg contents through naturally occurring pores in the shell or transovarian transmission. Only a clean environment and prevention of infection among laying hens can prevent these routes of contamination of egg contents.

Because the risk for egg-associated salmonellosis increases with exposure to larger numbers of *Salmonella*, adequate cooking and refrigeration, which reduce survival and growth of *Salmonella* already present in eggs, are also critical.

## Farm-to-Table Prevention of Egg-Associated Salmonellosis

To prevent egg-associated salmonellosis, measures should be taken at each step in the egg production process (i.e., production, processing, storage and transport, and preparation and serving).

### Production

- Procure chicks and pullets from sources that are not infected with *Salmonella*.
- Control rodents and pests systematically.
- Cleanse and disinfect poultry houses between flocks.
- Perform environmental testing at egg-producing farms, such as culturing swabs from poultry houses, equipment, and litter surfaces for *Salmonella*.
- Test eggs for *Salmonella* to identify infected flocks.
- Use recommended egg-handling practices.
  - Protect eggshell strength.
  - Gather eggs frequently.
  - Refrigerate eggs during storage and transport.
- Procure chicken feed from safe sources.
- Prevent contamination of chicken feed.
- Consider vaccination of hens against *Salmonella* infection.

### Processing

- Cleanse eggshells.
- Send eggs from known *Salmonella*-positive flocks to pasteurization.
- Pasteurize shell eggs in addition to egg products.
- Consider use of ionizing radiation.

- Place safe handling instructions on egg cartons such as the following:  
SAFE HANDLING INSTRUCTIONS: To prevent illness from bacteria, keep eggs refrigerated, cook eggs until yolks are firm, and cook foods containing eggs thoroughly.

## Storage/Transport

- Refrigerate eggs at or below 45°F (7°C) during transport and storage.
- Use raw shell eggs within 3-5 weeks of packing.
- Rotate eggs in storage to facilitate use within 3-5 weeks of their pack date.

## Preparation/Serving

- Use pasteurized eggs in recipes that contain raw or undercooked eggs, such as homemade ice cream, uncooked custard, or soft-boiled eggs.
- Discard cracked or dirty eggs.
- Cook eggs thoroughly, until the yolk is firm.
  - Cook fried eggs for 2-3 minutes on each side. Cook for a total of 4 minutes in a covered pan.
  - Cook scrambled eggs until firm throughout.
  - Cook poached eggs for 5 minutes in boiling water.
  - For hard-boiled eggs, hold in water at a rolling boil for at least 10 minutes.
  - Foods with eggs in them should reach an internal temperature of 145°F or above.
- Do not pool more eggs than you will cook in a short period.
- Hold scrambled eggs for serving at 140°F or hotter.
- Do not add just-cooked eggs to leftover eggs.
- Eat eggs promptly after cooking.
- Refrigerate unused or leftover egg-containing foods at or below 40°F (4°C).
- When refrigerating leftover egg-containing foods, divide into small, shallow containers for quicker cooling.
- Use hard-cooked eggs within 1 week of preparation
- Use leftover whites and yolks within 4 days.
- Wash hands, utensils, equipment, and work areas with soap and water after contact with raw eggs.

Prevention of egg-associated salmonellosis requires efforts by egg producers, distributors, retail stores, the food service industry, consumers, and government agencies. Special care is needed by institutions such as hospitals and nursing homes that serve food to high risk persons, because the effects of salmonellosis are likely to be more severe in the elderly, the immunocompromised, or persons already ill with other conditions.

For current information, go to <http://www.foodsafety.gov/keep/types/eggs>.