

Making the Case for Caging: Improvements in Egg Safety and Animal Welfare

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After more than half a billion shell eggs were recalled nationwide in 2010 because of concerns about *Salmonella* contamination, some consumers embraced the idea that organic and free-range eggs must be safer. A dozen large organic eggs cost almost twice as much as a regular carton of eggs, but that didn't stop shoppers. Press reports and organic enthusiasts started touting the safety of specialty eggs, claiming sales increases.

Then in 2011, the U.S. Food and Drug Administration (FDA) reported the recall of organic eggs produced by a Minnesota farm and distributed to restaurants, grocery stores, food wholesalers and foodservice companies in Minnesota, Wisconsin and Michigan.

In fact, *Salmonella* is a risk in all eggs, whether they are organic or free-range, whether they are white or brown or blue, or whether they are nutritionally enhanced like omega-3 eggs. In fact, the typical egg that looks clean at the farm actually has about 10,000 colony-forming units (CFU) of *Salmonella* on the shell before washing, even at a well-managed facility [1]. *Salmonella* also can be found inside eggs that appear perfectly normal, which is why consumers are warned to never eat raw or undercooked eggs unless they are pasteurized. Today, on average, one out of every 20,000 chicken eggs—any kind of eggs—could contain a small amount of *Salmonella* deposited into the egg as it passes through the oviduct [2].

How *Salmonella* Infects Eggs

Salmonella lives in the intestinal tracts of animals and birds, and before the 1970s, direct fecal contamination of eggshells was the most common source of *Salmonella* infection associated with eggs. In the 1970s, as salmonellosis began to emerge as a public health problem, stringent procedures for cleaning and inspecting eggs were implemented, and salmonellosis caused by external fecal contamination of eggshells is now extremely rare.

In the late 1970s and early 1980s, however, researchers discovered that *Salmonella* Enteritidis could infect the ovaries of healthy hens and contaminate eggs before the shells formed. Chickens harbor *Salmonella* without any sign of illness, making it impossible to pinpoint which hens are infected. Unlike eggborne salmonellosis of past decades, the 2010 epidemic was due to intact and disinfected grade A eggs.

Chickens can pick up *Salmonella* from feed or from some other source in their environment, which can be contaminated by rodents, flies and other birds if the producer is not diligent about sanitation. If a contaminated egg is laid, it usually contains only a very small number of *Salmonella*, but under ideal conditions, *Salmonella* doubles every 20 minutes. Eggs that aren't cooled quickly can harbor millions of bacteria in just 8 hours.

Salmonella also can be introduced through the shell, because an eggshell contains some 9,000 microscopic pores where *Salmonella* can get in from a contaminated conveyor belt or even a vat of contaminated egg-cleaning liquid. As noted, the typical egg, even at a well-managed facility, has thousands of *Salmonella* CFU on the shell before washing. After the egg is washed, there will be fewer than 20 CFU on the shell. Eggs contaminated by fecal matter, however, have far more CFU and could still have high CFU after washing.

Egg Production Systems

To understand why any kind of egg can be infected with *Salmonella* Enteritidis, it is important to know something about how different kinds of eggs are produced. Today, the vast majority of hens are housed in large laying facilities using cage systems called "battery cages." The birds are protected from the elements, disease, predators and accidents and provided with optimal temperature, humidity, feed, water, laying space and security. Human working conditions are often better at farms that use cages, because there is usually less dust and ammonia and it is possible to automate egg collection. It is also possible to control the hens' diet, resulting in better-fed hens that produce higher-quality eggs. Hens that live in these cages produce some 95 percent of the eggs consumed in the U.S. This traditional housing, which first became prevalent in the 1970s, has gotten a bad name among animal-rights activists because hens are confined in close quarters. When battery cages were first introduced in the 1930s, however, they were considered progressive and more humane than earlier methods because hen mortality dramatically decreased.

This is partly because of the hen behavior that gave rise to the term "pecking order." More dominant, aggressive hens peck at other hens and keep more timid hens from getting to the feed. As a hen starts pecking and pulling at the feathers of other hens, serious injuries and cannibalism sometimes result. Battery-caged hens peck and cannibalize less, which is one of the reasons the cages became standard in the industry. In fact, the mortality rate for hens was about 40 percent annually back in the 1920s and 1930s, when egg production was a backyard industry. The combination of specially designed indoor housing and cage systems has reduced the annual mortality rate of hens to just 5 percent [3]. These cage systems reduce *Salmonella* infection through the shell, because eggs are laid on the sloping floor of the cage, with minimal contact between the egg and the hen, decreasing the possibility of bacterial contamination. Confinement and caging of hens also keeps hens away from their droppings and the pathogens in the droppings, making it possible to dispose of droppings more easily.

Consumers can probably be forgiven for mistakenly associating an increase in salmonellosis with the rise of large farms utilizing battery cages, but professionals should not make that mistake. Many of the appalling conditions shown in animal-rights videos are caused by human cruelty and management's failure to follow existing regulations—not because of the housing system. The former egg mogul whose farms produced the shell eggs implicated in the 2010 outbreak had already paid millions of dollars in fines for numerous violations. At the Iowa farms involved in the outbreak, inspectors found dung heaps eight feet deep in some barns, with manure overflowing and bursting through doors. Escaped chickens scratched loose in the filth, and flies and maggots were everywhere, according to the FDA inspection report [4].

Because chickens pick up *Salmonella* from their environment, filthy surroundings increase the risk that the bacterium will be introduced into a hen's oviduct and infect the eggs. *Salmonella* is also more likely to infiltrate the shell through the microscopic pores when overall conditions are unclean. Many large farm operations are clean and well run, however, and turning back the clock to a time when hens were not confined will not solve the *Salmonella* problem.

Organic, cage-free and free-range eggs are produced for a niche market of consumers concerned about animal welfare, but the eggs taste the same, are the same quality and are no more assured of being free of *Salmonella* than traditional eggs. They are always more expensive than eggs produced in the conventional manner.

First, some definitions:

Cage-free: Hens living in indoor-floor facilities produce “cage-free” eggs. These hens do not necessarily have access to the outdoors but may have access to a multitiered indoor environment called an “aviary.” As noted, mortality rates may be higher because the hens tend to peck at each other, causing injury. Cage-free hens also are subject to “hen hysteria,” the panic behavior that causes them to pile on top of one another, smothering hens on the bottom. Hens laying cage-free eggs theoretically are able to walk, spread their wings and lay their eggs in nests. United Egg Producers guidelines for cage-free hens call for at least 1.5 square feet of space per bird, although this can be lowered to 1 square foot depending on the kind of facility and hen. Birds that lay brown eggs, for example, are bigger than birds that lay white eggs and require slightly more space.

Free-range: “Free-range” eggs are produced by hens with access to the outdoors, but this does not mean they are always kept outdoors. They might be kept in a combination of a barn and outdoor pens called “verandas” or “porches.” Typically, they are kept inside at night for protection from the elements and predators. There is no consensus on how much land per bird constitutes a “range,” and there are no set standards for free-range eggs or mandated third-party auditing. Pasture rearing of chickens is a modification of the free-range system. The hens remain on the pasture all the time, but are confined in a portable pen that is moved to give birds access to fresh pasture. Often, the names “pasture” and “range” are used interchangeably.

Organic: Eggs labeled “organic” are produced by hens whose feed does not contain most conventional pesticides, fungicides, herbicides or commercial fertilizers. The feed is vegetarian and must be certified “organic.” Hens that lay eggs labeled “organic” also must be free to range outdoors. These hens do not receive growth hormones or antibiotics either, but it is illegal to use any kind of hormones in U.S. commercial egg production, and

antibiotics are used only to treat sick birds. Labels touting “no hormones” are misleading, implying that other egg products may contain hormones.

The National Organic Standards Board, appointed by the U.S. secretary of agriculture, has established guidelines that must be met by producers who say their eggs are “organic.” Producers using the word “organic” earn certification from the U.S. Department of Agriculture’s (USDA) National Organic Program, although producers with sales of less than \$5,000 are exempt from certification. “All Natural” on a label is meaningless, because all eggs are natural.

Safety Risks

There is actually greater potential for inadvertent contamination in cage-free and free-range production systems, because *Salmonella* is found widely in nature—even in the soil. Floor eggs, which are laid by cage-free hens in a barn setting, and eggs laid on the range have a greater chance of coming in contact with *Salmonella* in the nest or soil and in fecal matter.

Agricultural Research Service food technologist Deana Jones and her team in the federal agency’s Egg Safety and Quality Research Unit compared environmental and egg microbiology for laying hens in conventional cages and free-range sister flocks, and found no difference in the incidence of *Salmonella* in the two systems [5]. The study actually found more *Campylobacter* in the free-range production environment than in conventional cage environments. Campylobacteriosis is the most common cause of diarrhea in the U.S., and the U.S. Centers for Disease Control and Prevention estimates there are more than 2 million cases of the illness from various sources each year. *Campylobacter* is naturally occurring and was detected in the environment, not in the eggs, and egg consumption is only occasionally the cause of campylobacteriosis.

Listeria also was detected in both environments, again with no difference in prevalence between conventional cages and free-range environments. Fortunately, there have been no documented outbreaks of listeriosis from consumption of eggs or egg products, but studies have detected *Listeria* in raw egg samples. Healthy people may not get sick from eating eggs contaminated with *Listeria*, but people with weakened immune systems, the elderly and pregnant women need to be especially careful that their eggs are cooked.

A Comparison

Because of the controversies surrounding battery cages in egg production, the American Veterinary Management Association (AVMA) in 2010 released a report on the welfare implications of various kinds of housing [6]. The report concludes consumers need to balance the hen’s freedom against exposure to potential hazards such as disease vectors and the cannibalism caused by pecking. Some highlights of the AVMA report:

- The overall mortality rate is better for hens in conventional cages and worse for cage-free and free-range hens.
- Mortality from feather pecking and cannibalism is less in conventional cages.
- Hens in conventional and furnished cages are exposed to fewer disease vectors, such as wild birds. They are also exposed to fewer internal parasites. Free-range hens are exposed to the most disease vectors and parasites.

- There is less “hen hysteria” in conventional cages and small to medium furnished cages. “Piling on” and smothering of other hens is less likely to happen in a conventional cage system.
- On other hen welfare measures, the ratings are opposite. Conventional cages rate as “poor” on “use of nest boxes,” “use of perches” and “dustbathing behavior.” Dust bathing involves tossing and rubbing dust between the feathers to maintain feather and skin condition.
- Air quality—the presence of dust and ammonia—is best with conventional cages and free-range systems. While this is not a safety factor in egg consumption, it is a safety factor for those who work on egg farms.

Cage-free and free-range eggs cost more because these husbandry systems are labor intensive, and feed intake is usually greater—especially in cold wintry months—because the environment is less controlled. For consumers concerned about laying hens closely confined in pens, paying more may be an acceptable trade-off, but the eggs are not necessarily safer.

Other Specialty Eggs

There are numerous other kinds of eggs that fall under the category of “specialty eggs,” but the same safety considerations apply to these eggs as to any other eggs. Brown eggs, of course, are not really specialty eggs—the only difference between brown eggs and white eggs is that brown eggs are produced by hens that have red feathers and red earlobes, such as Rhode Island Reds and Plymouth Rocks. Hens with white feathers and white earlobes, such as the White Leghorn, lay white eggs, and the chickens preferred by commercial growers just happen to be white. The more exotic blue Araucana eggs are produced by the Araucana breed, which comes from Chile. Like brown eggs, these blue eggs are nutritionally identical to white eggs and subject to the same risk of *Salmonella*.

Several kinds of specialty eggs are differentiated by the diets the hens eat. Vegetarian eggs, for example, are produced by hens whose feed is free of animal by-products, while omega-3 eggs are produced by hens fed a diet containing ingredients such as ground flaxseed, marine algae or fish oils rich in this desirable fatty acid. Like omega-3 eggs, lutein eggs are laid by hens fed a specially formulated diet, in this case, a diet including marigold extract. Lutein has been shown to reduce the risk of macular degeneration, the leading cause of blindness in the elderly. Eggs labeled as having lower fat and lower cholesterol also are produced by hens fed an altered diet, the only way so far to affect an egg’s cholesterol content. It is interesting to note that Ken Anderson, a poultry scientist at North Carolina State University, has established there is no difference between the cholesterol in conventional eggs and free-range eggs, despite news reports to the contrary [7].

Pasteurized shell eggs are considered specialty eggs. This is the only category of eggs with a different food safety profile, because these eggs have been heat-treated to kill potential *Salmonella*. Pasteurized shell eggs have only been on the market since the 1990s, when the patented method was developed, and are a good choice for recipes such as Caesar salad or homemade ice cream requiring raw eggs. Pasteurized eggs are coated with food-grade wax to prevent recontamination and stamped with a red P in a circle to distinguish them from other eggs.

The Future of Egg Safety

Eggs are still relatively safe and getting safer. The new FDA Egg Safety Rule, specifically aimed at reducing human *Salmonella* infections caused by eggs, requires producers to be more fastidious about cleaning and disinfecting henhouses and getting eggs into refrigerators within 36 hours after laying. Egg producers must buy chicks and young hens only from suppliers who routinely test for *Salmonella*, and egg producers also must have a written *Salmonella* prevention plan and maintain records documenting their compliance. Starting in July 2010—in the middle of the massive egg recall—large producers were required to implement the rule. These large producers, consisting of operations with 50,000 or more laying hens, represent about 80 percent of the producers in the country. Smaller producers (those with at least 3,000 laying hens) were expected to comply by July 2012. FDA officials estimate that contaminated eggs cause an estimated 142,000 illnesses in the United States annually, a number they say will be cut in half by the new rules. Scientists are also working on new techniques to promote egg safety, such as a *Salmonella* vaccine for chickens, already in use in Europe. When the vaccine was introduced in England and Wales in 1997, there were 14,771 reported cases of the most common type of the bacteria, *Salmonella* Enteritidis PT4. Vaccine trials began that year, and the next year egg producers began vaccinating in large numbers. Last year, according to data from the Health Protection Agency of England and Wales, there were just 581 cases, a drop of 96 percent from 1997 [8].

One-half to two-thirds of American producers already inoculate their flocks, according to industry estimates, but FDA declined to mandate vaccinations in its new Egg Safety Rule, saying there was not enough evidence to conclude that vaccinating hens against *Salmonella* would prevent human illness. FDA has estimated the cost to farmers at about 14 cents a bird to vaccinate, or about \$31 million to cover hens at all large farms in the country. Vaccine company executives dispute that figure, saying the cost can be just a few cents a bird. A single bird can lay about 270 eggs in its lifetime [8].

The future of hen vaccination in the U.S. might take the same course as vaccination efforts in the United Kingdom. There, vaccination is not mandated, but the country's major supermarkets buy only eggs carrying an industry-sponsored red lion stamp that assures the public they have met basic safety standards, including vaccination. Some 90 percent of egg producers meet the standards to utilize the stamp, according to *The New York Times* [8].

Another promising method of controlling *Salmonella* is a patented process that involves rapidly cooling eggs so the *Salmonella* bacteria do not multiply to dangerous levels. The rapid-cooling process, developed by poultry scientists at North Carolina State University, uses liquid carbon dioxide to stabilize the proteins in egg whites so much that they could be rated AA—the highest grade for eggs—for 12 weeks [9]. Eggs cooled under current methods lose the AA grade in about 6 weeks. The rapid cooling also maintains the membranes surrounding the yolks for 12 weeks, which is significant because the membrane keeps harmful bacteria from reaching the nutrient-rich yolk. Earlier research showed the same cooling technology could significantly reduce occurrences of *Salmonella* illnesses.

The rapid-cooling technology takes liquid carbon dioxide and turns it into a “snow” to rapidly lower the eggs' temperature. Eggs are placed in a cooling chamber and carbon dioxide gas at about minus 110 °F is generated. The cold gas circulates around the eggs

and forms a thin layer of ice inside the eggshell. After treatment, the ice layer melts and quickly lowers an egg's internal temperature to below 45 °F, the temperature at which *Salmonella* can no longer grow.

Traditionally, the temperature of eggs when they are placed into the carton tops 100 °F. Thirty dozen eggs are then packed in a case, and 30 cases are stacked onto pallets and placed in refrigerated coolers. The eggs in the middle of the pallet can take up to 142 hours—nearly 6 days—to cool to 45 °F. A 2005 FDA/USDA Shell Risk Assessment report showed that if eggs were cooled and stored at 45 °F within 12 hours of laying, there would be about 100,000 fewer *Salmonella* illnesses from eggs in the nation each year, with no difference in quality [10].

Conclusions

Eggs in general have an excellent shelf life, whether they are white, brown or organic. Conventional eggs are on the store shelf for about 12 days from the date they are packed at the producer's farm, and specialty eggs are usually kept on the shelf about 5 days longer—so if an egg is infected, there is a little more time for *Salmonella* to multiply if not refrigerated correctly. But when kept in the egg carton, clean eggs free of cracks will keep for months. The important thing to remember is that despite occasional claims to the contrary, specialty eggs are no safer than conventional eggs, and all eggs are relatively safe. USDA research has shown there are no substantial quality differences among traditional, cage-free, free-roaming, pasteurized and nutritionally enhanced eggs. Only pasteurized eggs are safer than traditional eggs. The effects of alternative egg production systems on food safety are not completely understood, but research is being conducted.



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