Producers

Campylobacter in Poultry

Campylobacter is highly prevalent in poultry worldwide, including broilers, layers, turkeys, ducks, and geese, while causing little or no clinical disease. *Campylobacter* is a commensal organism that establishes persistent and benign infections with colonization levels up to 1010 colony-forming units (CFU) per gram of feces in broilers. *Campylobacter* shedding by poultry varies by season, being highest in summer and autumn months. *Campylobacter* is highly prevalent in commercial poultry and in chickens raised on organic or free-range farms, indicating that different production systems are equally vulnerable to invasion by this organism.

Colonization of poultry by *Campylobacter* occurs primarily in the lower intestinal tract (cecum, colon, and cloaca). However, the organism can also be recovered to a lesser extent from the small intestines and gizzard, and infrequently from the liver, spleen, and gall bladder. *Campylobacter* does not adhere directly to epithelial cells, but mainly locates in mucous layer of the crypts. No gross or microscopic lesions are induced in chickens and invasion of intestinal epithelium usually does not occur. These observations indicate that *Campylobacter* is well adapted to the poultry host, and may be seen as a normal enteric flora by the host. Once a broiler chicken becomes infected, large numbers of *Campylobacter* can be detected in its intestinal tract and excreted in feces for at least 12 weeks. Despite extensive colonization in the intestinal tract, *Campylobacter* infection produces little or no clinical disease in poultry. *Campylobacter* can also be isolated at a high rate from crops of market-age broilers, and feed withdrawal prior to slaughter (a common commercial practice used to reduce fecal contamination of carcass) significantly increases isolation frequency from crops. Typically, the prevalence of *Campylobacter* increases as the birds grow and reaches highest points at the slaughter age for boiler chickens. In commercial production conditions, *Campylobacter* is rarely detected in young birds less than 2 to 3 weeks of age, although newly hatched chickens can be experimentally infected with *C. jejuni*. Once the first bird in a flock becomes colonized, infection spreads to the entire flock in just a few days. This rapid spread of *Campylobacter* throughout the flock is a result of high levels of shedding and efficient fecal-oral transmission compounded by communal water and feed. Once chickens and turkeys become infected, *Campylobacter* colonization of the intestinal tract persists until slaughter, leading to carcass contamination at the processing plant. Up to 100 % of broilers at slaughter-age may harbor the organism.

Potential Sources of Infection

Campylobacter is widespread in the intestinal tract of many wild and domestic animals and birds, and ubiquitous in the poultry production environment, which makes transmission from environment to the broiler houses likely. Epidemiological studies indicate that horizontal transmission from the environment to poultry farms is the main source of *Campylobacter* colonization. No single factor has been found to be the major risk for infection of poultry and it is most likely that introduction of *Campylobacter* to chicken and turkey flocks is mediated by multiple sources. *Campylobacter* is very sensitive to oxygen and drying. Due to its low moisture content, feed is an unlikely source for the introduction of *Campylobacter* into the broiler. However, feed can be contaminated from other sources, such as feces, in the chicken house. Potential sources of flock infection include old litter, untreated drinking water, wild birds, other farm animals, domestic pets, wildlife species, insects, equipment and transport vehicles, and farm workers.

1. *Re-Used Litter.* In the U.S., it is a common practice that litter is re-used for multiple flocks in a poultry house before replaced. This is due to economic reasons and an industry-held belief that old litter tends to provide better gut health for birds. However, re-used litter harbors pathogens. *Campylobacter* associated with litter have been detected in varying densities, normally increasing when the litter ages. *Campylobacter* can survive for prolonged periods in re-used litter as compared to fresh and partially used litter and chicken colonization with *Campylobacter* is significantly reduced in pens containing fresh litter, suggesting that managing litter can potentially reduce the prevalence of *Campylobacter* on poultry farms. Furthermore, “wetness” of the litter might be a critical factor for *Campylobacter* survival. These observations highlight the importance of managing litter in reducing *Campylobacter*.

2. *Untreated Drinking Water*. Groundwater is frequently used for drinking water on poultry farms, and unchlorinated drinking water has been implicated as the source of *Campylobacter* for chickens. Due to its microaerophilic characteristics and inability to grow below 31o C, *Campylobacter* is unlikely to propagate in environmental water. The presence of this organism in streams, rivers, groundwater, and drinking water is a sign of a recent contamination with feces of livestock or wild birds. Drinking water on poultry farms generally becomes positive with *Campylobacter* only after chickens are colonized and water becomes contaminated by fecal droppings.

3. *Insects*. House flies, darkling beetles, cockroaches, mealworms can act as mechanical vectors, and may transmit *Campylobacter* from animal reservoirs to chicken flocks. Insects in poultry houses are usually not positive for *Campylobacter* until the organism has been isolated from birds in the house. However, insects (e.g., flies) may carry the organism from one location to another within or between flocks, especially in summer months as indicated by recent studies in several European countries.

4. *Rodents.* Mice and rats can carry *Campylobacter* in their intestinal tracts and are likely sources of *Campylobacter* introduction into grow-out houses. Rodents and insects that leave a poultry house and then return after the house has been cleaned and disinfected may explain persistence *Campylobacter* during successive flocks.

5. *Wild Birds. Campylobacter* has a wide distribution in wild birds. Owing to their great mobility, wild-living birds may spread *Campylobacter* to poultry through fecal contamination of the environment, feed, and surface water.

6. *Farm Animals.* Farm animals on poultry farms, including pigs, cattle, sheep, and fowl other than chickens, have been associated with an increased risk of *Campylobacter* infection in

poultry. Identical *Campylobacter* genotypes between cattle and broiler isolates from the same farm and between swine and broiler isolates from the same farm have been observed in some studies. Sheep, horses, cats, and dogs can also be infected with *Campylobacter* and serve as sources of infection.

7. *Farm Workers and Equipment.* Humans are a key risk factor for introducing Campylobacter contamination into a poultry flock. Movement of contaminated personnel and equipment between farms may carry *Campylobacter* into a poultry house. Farm workers loading birds for transport to slaughter may carry *Campylobacter* from one flock to another if they move between different flocks without changing clothes and boots. The organism has been isolated from footbath water, farmer's boots, and transport crates.

Preharvest control strategies for *Campylobacter* in poultry.

Three general strategies have been proposed to control *Campylobacter* on the poultry farm, including 1) reduction of environmental exposure (biosecurity measures); 2) an increase in poultry's host resistance to reduce *Campylobacter* carriage in the gut (e.g. competitive exclusion, vaccination, and host genetic selection); and 3) the use of antimicrobial alternatives to reduce and even eliminate *Campylobacter* from colonized chickens (e.g. bacteriophage therapy and bacteriocin treatment).

1. *Biosecurity.* Theoretically, reduction of environmental exposure of chickens to *Campylobacter* should protect poultry against *Campylobacter*. However, even the most stringent biosecurity measures do not always have a consistent and predictable effect on controlling *Campylobacter*. In addition, stringent biosecurity measures are cost-prohibitive, hard to maintain, and their effectiveness seems to vary with production systems.

2. *Vaccination.* Currently, there are no commercially available vaccines. However, *Campylobacter*-specific maternal antibodies (MAB) have been shown to be highly prevalent in broilers during the first week of age, but disappear by the third and fourth weeks of age, which coincides with appearance of *Campylobacter* infection in commercial poultry flocks, suggesting a protective role for MAB. *Campylobacter*-specific MAB delayed the onset of colonization and reduced the rate of horizontal spread of different *Campylobacter* strains in young chickens. Also, specific MAB do not seem to affect the development of systemic active immune responses against *Campylobacter* in young birds. Clearance of *Campylobacter* infection appears to be correlated with development of an active immune response. These findings provided strong evidence supporting the feasibility of development of immunization-based approaches for control of *Campylobacter* in poultry. Vaccination against *Campylobacter* is a promising strategy but requires a good deal of basic research to reveal protective antigens and optimize vaccination regimen (e.g., induction of mucosal immunity and practical delivery systems).

3. *Competitive Exclusion.* Currently, there are no commercially available competitive exclusion

products. Competitive exclusion has been of low effectiveness and poorly reproducible in control of *Campylobacter* in poultry.

4. *Bacteriophage therapy and Bacteriocin Treatment*. Currently, there are no commercially available bacteriophages or bacteriocin treatments, although some promising results obtained under laboratory conditions have recently been reported. Anti-*Campylobacter* bacteriocins have been shown to be effective in reducing *Campylobacter* load in market-aged chickens, but it is unknown if bacteriocins can be produced in a cost-effective manner for commercial use and if they will meet regulatory approval and public acceptability. Although some promising results with bacteriophages are reported in laboratory studies, their practical use in poultry production is questionable because phages are strain-specific and bulk production of phages using *Campylobacter* is of low efficiency and raises a concern for safety.

On-Farm Measures to Reduce *Campylobacter* Contamination

1. **Visitors.** Limit visitors on the farm and in houses. No visitors should be allowed to enter poultry houses unless absolutely necessary. Visitors who have had contact with other poultry, pet birds, or wild birds or livestock during the preceding 48 hours should not enter poultry houses. Clean coveralls (or disposable suits), disinfected boots (or shoe covers), and hairnets should be available and required for visitors to wear before entering poultry houses.

2. **Vehicles and Drivers.** The outside of all vehicles should be cleaned before entering a poultry farm. Drivers of feed delivery trucks should use a hand sanitizer before leaving the cab and should not enter poultry houses.

3. **Hand Hygiene**. Handwashing or hand-sanitizing stations should be available at entry points to poultry houses and everyone should wash/sanitize their hands before entering and after leaving poultry houses. Hands should be washed with soap and water for 15 to 20 seconds or hand disinfectants should be used.

4. **Footwear.** Footwear disinfection stations, site-provided footwear, or site-provided foot covers should be available outside all external entrances. Everyone should clean and disinfect their footwear or wear site-provided footwear or footwear covers prior to entering poultry houses. If footbaths are used, they must be changed at least daily or more often if the footbath collects dirt and manure.

5. **Equipment.** Prevent contaminated equipment from moving among houses. Sharing equipment between farms is not recommended. In the event that equipment must be shared, effective cleaning and disinfecting must take place between uses.

6. **Feed.** Feed bins must be secured to prevent contamination by wild birds or rodents. Spilled feed should be cleaned up promptly to prevent attracting wild birds and rodents.

7. **Water.** Water sources must be secure and not accessible to free-flying birds or rodents. Use of chlorine or another appropriate water sanitizer is recommended.

8. **Litter Management.** It is important to maintain proper levels of litter moisture (20-30%). Litter moisture can be evaluated by squeezing it in the hand. When litter is released, it should slightly adhere to the hand and break down when dropped. Avoid wet litter to reduce the level of potential *Campylobacter* contamination.

9. **Farm Animals and Other Poultry.** No other farm animals should reside on poultry farms. Farm employees should not own poultry or pet birds and should avoid contact with all birds not owned by the business. Keep stray poultry out of houses and no other domestic birds should be allowed to roam on premises outside poultry houses.

10. **Wild Birds, Cats, Dogs, and Other Animals.** Keep wild birds, cats, dogs, and other animals out of poultry houses. Houses should be bird-proofed against wild or free-flying birds. Control measures to discourage the presence of wild and migratory birds on the premises should be implemented.

11. **Rodent Control.** Monitor rodent population by visual inspection and mechanical traps or glueboards and institute rodent control measures when needed. Remove debris inside and outside poultry houses and remove vegetation around poultry houses to eliminate places for rodents to hide.

12. **Fly and Insect Control.** House flies, darkling beetles, cockroaches, and mealworms can act as mechanical vectors and may transmit *Campylobacter* from animal reservoirs to chicken flocks. Monitor fly populations by spot cards, Scudder grills, or sticky traps and institute fly control measures when needed.

13. **All-In, All-Out Management.** All poultry should enter a house on the same day and leave the house on the same day. Partial depopulation of flocks increases the risk of *Campylobacter* infection of birds remaining in the house.

14. **Cleaning and Disinfection between Flocks.** Cleaning and disinfection of poultry houses between successive flocks is a useful way to break a cycle of infection. Infection of a previous flock and inadequate cycle breaks between flocks increase the probability of *Campylobacter* infection in a new flock entering a poultry house.