Campylobacter

Interventions On the Farm and At the Processing Plant

What you do....helps reduce the numbers

What is *Campylobacter*?

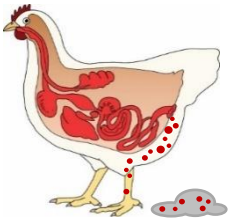
Campylobacter are bacteria that live in the intestine of many animals, including poultry. Most of the time, *Campylobacter* does not cause disease in poultry, in other words, it doesn't make poultry sick.

Why do we need to learn about *Campylobacter*?

When humans eat poultry products that are contaminated with *Campylobacter,* it can make them sick and possibly lead to hospitalization or even death. *Campylobacter* is estimated to affect more than **800,000 people** in the United States every year, which is not far behind *Salmonella* (1 million people each year in the United States). Poultry, particularly meat products are one of the major sources of human *Campylobacter* infections.[1,2] By learning about *Campylobacter* and ways to reduce carcass contamination, you can have a positive impact on human health. You can actually save lives in your community, nationwide or even worldwide.

If *Campylobacter* lives in the intestine of poultry, how does it contaminate poultry products?

Campylobacter can exist in very high numbers in the intestines and feces of poultry, as much as hundreds of thousands (10^5) to billions (10^9) of organisms per gram of feces.[1] Any contact with the intestinal content or feces will result in contamination. On the farm, this spreads *Campylobacter* to other birds. At the processing plant, it spreads the bacteria to poultry products. During processing, close to 50% of poultry carcasses can be contaminated with *Campylobacter*.[1] There are two major ways fecal material or intestinal content can contact poultry carcass:



1) Contamination from feces and soiled poultry feathers and skin, and
2) Contamination with intestinal content during the evisceration step in the processing plant.

Prevention practices on both the **live production side** and on the **processing plant** side can significantly reduce contamination of poultry products by *Campylobacter*.

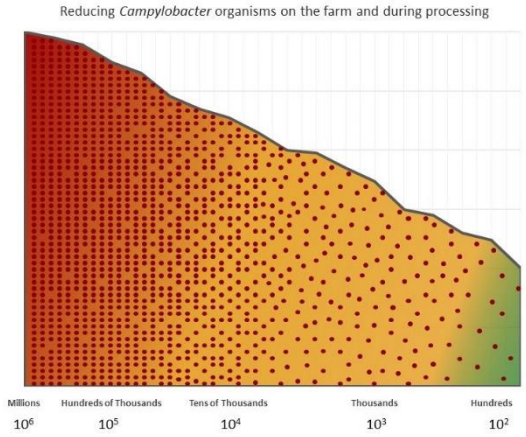
If contamination happens in the processing plant, why is live production important?

While the actual meat contamination can happen only in the processing plant, the process of reducing contamination starts before that—at the farm or production site. Imagine the number of *Campylobacter* cells in the intestines and feces of one particular broiler or turkey flock is **very high**, then it becomes **very difficult** to prevent bacteria from contaminating the meat during processing, no matter how good the processing plant is. Now, imagine the opposite, the number of *Campylobacter* in the feces of one particular broiler or turkey flock is **very low**, this makes it **much easier** to prevent lower numbers from contaminating the meat in the processing plant.

So, prevention efforts to reduce *Campylobacter* from contaminating poultry meat actually starts on the live production side by trying to reduce the number of *Campylobacter* organisms as low as possible. This will then make the processing plant's job much easier and much more effective at reducing product contamination.

It is sometimes hard to grasp the concept and reality of bacterial numbers. When, the bacteria numbers are in the millions or even in the billions, reducing the bacterial load by a hundred fold or a thousand fold, or even ten thousand fold will still be "not enough" to prevent contamination or control infection. But, if the bacterial load coming into the processing plant is reduced to the hundreds or the thousands, then prevention during processing becomes much more effective in controlling contamination.

So, it's "a numbers game!!"



What can be done on the live production side to reduce the number of *Campylobacter* bacteria in the fecal material or intestinal content of meat poultry coming into the processing plant?

Understanding the epidemiology of the infection (i.e., where *Campylobacter* comes from and how it infects poultry) is essential when devising any effective intervention program. Over the past two decades, there has been an extensive amount of research on *Campylobacter*. This research has helped to reveal some unique features of *Campylobacter* epidemiology that can be useful in designing an effective biosecurity program. Listed below are some of these unique features.

Chicken and turkeys carry **high levels of *Campylobacter* in their intestines** without showing any disease.[2] *Campylobacter* is rarely detected in birds **under 3 weeks of age**[2] and vertical transmission (i.e., from parents to progeny through the egg) does not play an important role in *Campylobacter* transmission. But, once a bird is positive **after 3 weeks of age**, it can quickly spread the bacteria to other birds; in fact, **almost all birds in a flock will eventually become positive** (high prevalence).[3,4] However, there is variability in prevalence between flocks and production sites. Some flocks and some farms have consistently low prevalence numbers.[1]

Campylobacter infections are usually higher in prevalence in **the summer** and warmer weather, perhaps because of increased **fly populations** during this period.[5,6] Typically, **organic and free-range** flocks have a higher *Campylobacter* prevalence than conventional flocks.[7,8]

Campylobacter is different from *Salmonella* in that **horizontal transmission** (i.e., directly between birds) and the subsequent environmental contamination are the **primary sources of infection**. This however, provides a better chance in reducing the transmission through good **biosecurity practices**.[9]

Major sources of *Campylobacter* infection include:

- Hands, clothing or footwear of persons on the farm, including both workers and visitors.[10]
- Old litter which contains the microorganism.[11]
- Equipment and transport vehicles which are contaminated from infected birds and feces.[12]
- Rodents, flies and other insects, wildlife species, and domestic pets (which can serve as disease vectors).[5,6]

Interestingly, feed and water are not major contributors to the initial introduction of *Campylobacter*; however, these sources can contribute to the spread of the microorganism among individual birds within infected flocks.[1]

After understanding the epidemiology of *Campylobacter*, it is clear that there are multiple steps can be taken on the live production side to help decrease *Campylobacter* carcass contamination.

Biosecurity

Improved biosecurity can produce a measurable reduction of *Campylobacter* prevalence in poultry populations. Suggested biosecurity practices that can have direct impact on *Campylobacter* prevalence in poultry include:

- Ensure all personnel **wash and sanitize hands** often and use **dedicated footwear** for each poultry barn.
- Ensure the anteroom is clean and sanitized frequently and that footbaths are properly maintained.
- Monitor and control **traffic** and minimize visitors onto the farm.
- Keep poultry away from other **domestic animals**, including livestock, pets or other poultry. (Fecal contamination from other animals can be a major source for *Campylobacter* introduction to poultry).
- Implement vector control processes, including **fly, rodent, insect and wildlife control.**
- Avoid moving **equipment** from house to house unless it is thoroughly cleaned and disinfected. Items such as, litter tillers and transportation crates can easily spread *Campylobacter* to other locations.

Water Treatment

Water acidification, using organic acids like **formic acid**, **acetic acid**, **lactic acid**, and **propionic acid** can reduce colonization, reduce bacterial count in the intestines, and reduce transmission of *Campylobacter* between infected and susceptible birds. *Campylobacter* count has been reduced when water was acidified during feed withdrawal before processing. It is important to note that water acidification can also increase the efficacy of chlorination. Combining water acidification and chlorination can have an impact on *Campylobacter* transmission, colonization and prevalence in the intestinal tract of poultry.

Competitive Exclusion

The idea of using competitive exclusion is to supply the intestine with large numbers of beneficial bacteria that can outcompete pathogens for colonization space in the gut. In poultry, competitive exclusion products have shown variable results when it comes to reducing *Campylobacter* prevalence and load in the intestine.

There are two kinds of competitive exclusion products:

1) **Complex probiotic products** include diverse species of beneficial bacteria. Products like Broilact© (Nimrod Veterinary Products Ltd., Upper Rissington, U.K) uses a preparation of freeze-dried bacteria collected from the intestine of a normal adult fowl. Products like PoultryStar© (Biomin, Herzogenburg, Austria), contain multiple probiotic species, such as, *Enterococcus faecium*, *Pediococcus acidilactici*, *Bifidobacterium animalis*, *Lactobacillus salivarius*, and *Lactobacillus reuteri;*

2) The other type of product is **defined single microorganism competitive exclusion products**. As its name suggests it contains a single species of beneficial bacteria. Complex products tend to affect *Campylobacter* prevalence and bacterial load more than single microorganism products. Still there is inconsistency in probiotics results in general.[1]

Litter Management

Litter acidification and moisture reduction helps to reduce the bacterial count of *Campylobacter* on the farm. Two commercially available chemicals commonly used for litter acidification are **aluminum sulfate and sodium bisulfate**. Combinations of these two chemicals with magnesium sulfate have been shown to be effective, not only in reduction of litter pH, but also in in reducing the moisture of litter (~50%). Recent studies have also found that the treatment of litter with a combination of these three products was highly effective in preventing chickens from getting colonized by natural *Campylobacter* exposure for up to 6 weeks (unpublished data).

Vaccination

Currently there are no commercial vaccines available for control of *Campylobacter* in poultry. To date, inactivated or live modified vaccines have had **limited to no success** in controlling *Campylobacter*. However, very recently, vaccines developed using new technology to prevent colonization by *Campylobacter jejuni* in layer chickens have shown **promise**. Two vaccines resulted in up to a 10-log reduction in *C. jejuni* colonization in the ceca and induced specific antibodies, without altering the gut microbiota composition. These encouraging results strongly suggest the possibility that the use of vaccination to control *Campylobacter* infection on poultry farms may be a practical and economically viable approach in the **near future**. Data also indicates that probiotics and vaccines work synergistically to reduce *Campylobacter* colonization in broilers.[14]

Feed Withdrawal

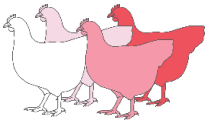
The goal of feed withdrawal is to supply the processing plant with birds that have an empty intestinal tract by the time they are on the evisceration shackles. This reduces the possibility of the intestine breaking during the evisceration process leading to fecal contamination of the poultry carcass. The timing of feed withdrawal is the critical part of this process; the goal is to have the bird's intestine empty but also not to have it empty for too long. If the intestine is empty for too long, it will start digesting itself and become friable and easier to break, which will end up increasing the problem we were trying to avoid in the first place. **The target is 10-12 hours** from the time of feed withdrawal until the birds hang on the evisceration shackles. Catching, loading, transportation and holding time in the processing plant shed should be accounted for when planning the withdrawal timing. This can be a challenge.

Feed withdrawal coupled with water acidification and proper chlorination can be a powerful tool to reduce *Campylobacter* load in the intestine, particularly in the crop.[15]

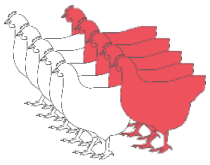
None of the above-mentioned interventions alone are expected to produce significant reductions in *Campylobacter* in the intestinal tract or in the environment. However, the **cumulative effect** of combining some or all of these interventions can result in significant reduction of bacterial load.

Now that we have lower numbers on the live production side, what steps (or interventions) can be used in the processing plant to further reduce or prevent carcass contamination?

The processing plant is an extremely important place for carcass contamination reduction. Two different measurements can be taken to evaluate the **level of carcass contamination** by *Campylobacter:*



Percent of positive carcasses, which means out of 100 processed carcasses how many are positive for *Campylobacter*. This is also known as prevalence.



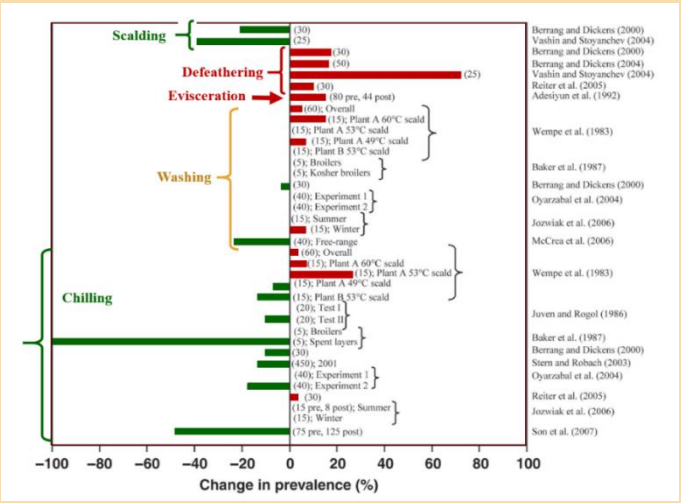
***Campylobacter* concentration**, which means how much bacteria is there on those positive carcasses, is it 100 or is it 100 million.

In processing plants, poultry pass through multiple steps, each representing an opportunity to increase or decrease *Campylobacter* prevalence and concentration.

All plants should evaluate their own processing protocols to evaluate the effect of each step of processing to reduce contamination levels (both prevalence and concentration) of *Campylobacter*. For example, evaluating pre-scalding and post-scalding prevalence and concentration, pre-evisceration and post-evisceration prevalence and concentration…etc. (i.e., process mapping). This will allow for the identification of critical control points and facilitate targeted and customized intervention plan to be developed for each plant.

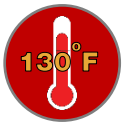
The following diagram, adapted from Guerin et al[16], shows the change in prevalence (or corresponding increase or decrease in contaminated birds) at various stages of the processing line. The bars on the left hand side in green, indicate processes (or interventions) with higher potential to lower the level of contamination, the bars on the right hand side, in red, indicate processes that have higher potential to increase the level of contamination.

In general, the **scalding, washing and chilling** steps represent opportunities to control and **reduce** the prevalence and concentration of *Campylobacter* on poultry carcasses. On the other hand, the **defeathering and evisceration** steps represent areas of risk of **increased** contamination, both in percent positive carcasses and concentration per unit. However, each processing plant is different, and understanding the unique risks and opportunities in each plant is essential for customizing a strategic and targeted intervention plan.[16]



Guerin *et al.* 2010 Poultry Science 89:1070–1084. The change in prevalence of *Campylobacter* on chicken carcasses before and after specific stages of processing reported in 13 studies. Numbers in parentheses indicate sample size. The plot is not weighted by sample size of the studies.

Next, we will discuss each processing step and its effect on *Campylobacter* contamination and potential interventions.



Scalding

In most cases, scalding is an opportunity to reduce prevalence and concentration of *Campylobacter*. **Triple tank counter-current scalders** with temperature **above 130°F (55°C)** seem to produce the most reduction in prevalence and concentration (up to 40% reduction in prevalence).[16]

Defeathering

Most studies that sampled carcasses before and after the defeathering process have shown an increase in *Campylobacter* prevalence and concentration during this step. It is generally agreed upon that the process of defeathering represents a **high risk of contamination** due to fecal material coming out of cloaca due to pressure from the picker fingers on the abdomen. Other than properly adjusting the picker fingers, there are limited opportunities for intervention in the defeathering step. Ensuring the proper maintenance of feather picking equipment and proper sanitization of equipment can help.[16]

Evisceration and Washing Stations

Evisceration (removal of internal organs) is another risk step, where there is an **increased chance for fecal contamination** due to breaking of intestine and the release of intestinal content. Cropping (removal of the crop) is another step of potential carcass contamination. Properly timed feed withdrawal coupled with properly adjusted machines and water acidification could reduce the risk of contamination on the evisceration line. An additional intervention on the evisceration line is the inside out washing stations. Multiple washing stations are strategically placed on the evisceration line, including a final wash immediately before going to the chillers, to remove any fecal contamination. Research data shows mixed results from washing stations; some studies show an increase in prevalence, others show a decrease. But, in general, it can be a powerful intervention step to reduce *Campylobacter* prevalence and concentration on the evisceration line.[16]

Chillers and Post-Chill Processes

Chillers are the last opportunity for interventions before deboning. Some studies show decrease and others show increase in prevalence in water immersion chillers. However, the general trend is decreased prevalence post chillers. Most studies, on the other hand, show a decrease in concentration of *Campylobacter* post chillers. Similar to scalding, **counter-current and multi-tank chillers** are more effective in reducing the prevalence and concentration of *Campylobacter*. While cross contamination is a risk with water immersion chillers, the data indicates this method can be more effective than air chillers in reducing the concentration of *Campylobacter*. Post-chill antimicrobial rinses with potable water and dips in antimicrobial solutions can be used to further reduce the level of *Campylobacter* contamination in poultry meat.[16]

Water Sanitation and pH

Water in the processing plant is essential in reducing contamination. **Scalding water, washing water or chilling water** should all be

sanitized. Monitoring disinfectant concentration and pH in each step is necessary to maintain potency of used product.[1]

The following are FDA approved chemicals that can be used for water sanitation and carcass decontamination:

- acidified sodium chloride (ASC)
- calcium hypochlorite
- cetylpyridinium chloride (CPC)
- chlorine gas
- chlorine dioxide
- 1,3-dibromo-5,5-dimethylhydantion (DBDMH)
- a solution of citric and hydrochloric acids
- a blend of citric, phosphoric, and hydrochloric acids
- ozone
- sodium hypochlorite
- peracetic acid (PAA)
- trisodium phosphate (TSP)

Additionally, **monitoring the intervention** process in the plant is an integral part of its success and introducing modifications and changes when necessary. Similar to intervention in live production, no single step can solely produce the desired reduction in *Campylobacter* contamination in the processing plant. However, targeting high risk steps and **combining multiple strategies** can be effective in reaching carcass decontamination goals.

In summary, there is **not one solution**, **no magic bullet** and **no single remedy** for preventing *Campylobacter* from contaminating poultry products. Multiple interventions on both the production side and on the processing side need to be combined to have a positive impact on reducing the percentage and level of carcass contamination. Controlling foodborne microorganisms, like *Campylobacter*, can be achieved by adopting an **"all of the above"** strategy, by using all feasible interventions to compile all the benefits from each intervention - from one stage to the next, until the end of the process. Always keep in mind that it is **"a numbers game"**, by reducing the numbers in one step, the intervention in the next step becomes exponentially more effective.

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Authors and Reviewers: Mohamed El-Gazzar, DVM, MAM, PhD, DACPV; Yuko Sato DVM, MS, DACPV; Orhan Sahin, DVM, MS, PhD, DACVM; Glenda Dvorak DVM, MPH, DACVPM, Iowa State University College of Veterinary Medicine

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