Campylobacter Update in Poultry

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CAMPYLOBACTER AND FOODBORNE ILLNESS

Campylobacter is the most common cause of diarrheal illness due to bacteria. According to the Centers for Disease Control and Prevention (2010), over 2.4 million people are affected each year. In 2011, the CDC estimated that Campylobacter accounts for 9% of all foodborne illness, 15% of hospitalizations, and 6% of deaths. Moreover, the total basic cost of illness associated with Campylobacter in the U.S. was reported as $1.56 million (Sharff, 2011), making infection with this foodborne pathogen a serious economic burden.

The two most common serotypes implicated in human illnesses are Campylobacter jejuni and Campylobacter coli (Corry and Atabay, 2001; Friis et al., 2005). Of these serotypes, Campylobacter jejuni is responsible for the majority of the cases of Campylobacter-related gastroenteritis reported worldwide especially in developing countries (Friedman et al., 2000). The infective dose for Campylobacter is estimated to be 500 - 800 cfu/gram based on human studies involving healthy adult males (Robinson, 1981; Black et al., 1988). Furthermore, epidemiological studies have shown that consumption of undercooked poultry or foods that have been cross-contaminated from raw poultry have been linked to over half of the Campylobacter illnesses reported (Tauxe, 1992; Allos, 2001). More recently, a report of food-pathogen pairing linked poultry as the primary source for Campylobacter related illnesses (Batz et al., 2011). Human infection associated with C. jejuni can lead to varying degrees of illness. These illnesses can range from mild gastroenteritis to more severe secondary diseases such as Guillain-Barré and Miller Fisher syndromes which are autoimmune diseases resulting in demyelinating polyneuropathies and paralysis (Nachamkin et al., 1998).

Campylobacter spp. are characterized as gram-negative non-spore forming spiral shaped rods that have a darting motility utilizing a single flagella. Campylobacter spp. do not ferment carbohydrates and require a microaerophilic (5% O₂, 10% CO₂, and 85% N₂) environment for growth. Campylobacter spp. are susceptible to stresses such as drying, low pH, heat, freezing and prolonged storage yet they persist in poultry. Typical selective plating media will have nutrients, oxygen scavengers, antibiotics to suppress competing bacterial growth, and yeast and mold inhibitors to reduce background contamination and improve recovery of Campylobacter from a sample. Prior to plating, selective enrichments can be used that will include nutrients and typically an antibiotic to improve recovery when plating. The typical enrichment broth is Bolton’s, and typical selective plating media are Campy-Cefex and modified CCDA. Enrichment is generally 24-48 hours at 42 C followed by plating on a selective media with an additional 48 hours of incubation. Because detection can take up to 96 hours, there is a need for research to optimize the detection time and methods for basic culturing.

Performance Standards for Campylobacter in Poultry

Prior to 2011, there had been no performance standards for Campylobacter in poultry yet poultry was known as a major contributor to the illnesses attributed to Campylobacter. There were several reasons performance standards were slow in coming primarily lack of national prevalence data, concern over how to address anticipated prevalence data, and the need for adopted and implemented testing methods. USDA adopted and implemented sampling and detection methods for Campylobacter prior to conducting the Nationwide Microbial Baseline in 2007-2008 for Young Chickens and Turkeys in 2008-2009. These baselines estimated the prevalence of Campylobacter in poultry and validated methods for Campylobacter sampling and detection. The methods used by USDA were adopted and implemented as the official analytical method, and these can be found in the USDA-FSIS Laboratory Guidebook as a 2010 update. Although, USDA used specific enrichments and plating media, there are other AOAC approved methods and USDA provides a disclaimer indicating that fact.

Results of the baseline indicated that Campylobacter prevalence was 40.23% in young chickens from post-chill samples while it was estimated to be 1.46% for turkeys (an average of both qualitative and quantitative testing).
In addition to the baseline data collected, Healthy people 2010 benchmarks for reducing illnesses associated with Campylobacter were established. In 2010, benchmarks for Campylobacter were 6.8 cases of illness per 100,000 people; whereas, estimates of reported illnesses attributed Campylobacter during that year were 13.6 cases (Food Safety Net Data, 2011). It was clear that goals were not being met in terms of reducing the illnesses associated with Campylobacter, and with poultry being linked as a source, performance standards soon followed.

New performance standards implemented for Campylobacter in all poultry processing plants required that the percentage of positive samples must be below 10.4% for Campylobacter (USDA-FSIS, 2011). Passing the performance standards would require no more than eight positive samples in a 51-sample set for young chickens and no greater than three positive samples in a 56-sample set for turkeys. A major debate regarding Campylobacter testing methodology for young chickens and turkeys was over qualitative vs quantitative detection methods. Quantitative methods for chicken rinses would include direct plating 1 ml of the 400 ml post-chill rinsate (buffered peptone water, BPW) onto 4-Campy-Cefex, mCCDA or other AOAC approved plating media in 250 µl aliquots per plate. Instead of whole carcasses rinses, turkeys sampling is conducted using sponges where one sponge is used to swab for Salmonella on the left side of the bird and another sponge is used to swab the right side of the turkey for Campylobacter detection. The sponges for Campylobacter detection in turkeys are added to 25 ml of BPW. In turkeys, the direct plate method consists of plating 1 ml of the 25 ml BPW soaked sponge using the same plating media used for young chickens. Direct plating is intended to detect high levels of contamination, and these methods are currently being used to determine pass/fail for the sets that FSIS are currently collecting. Originally, the methods called for enrichment in double strength blood free Bolton's broth if the 1 ml samples tested negative to determine positive or negative. Enriching would detect very low levels, and industry fought to not have the results of enriched sample used in the determination of pass/fail for a set. Instead, USDA will use enriched samples for internal analysis (Federal Register Notice vol. 76, no 54, 2011). It is highly likely that many plants would not pass the Campylobacter performance standards if samples were enriched to detect low numbers because the prevalence is high and carcass loads of Campylobacter are high coming into the plant.

Another caveat to Campylobacter detection is that the microorganism can form a viable but not culturable cell state (VBN). The changes in Campylobacter occur when the microorganism is exposed to conditions not supporting growth and survival. Specifically, the cell morphology changes from a spiral rod to a coccoid shape. In the coccoid-shape, Campylobacter will not grow on typical selective media used and mentioned above. Alternatively, DNA detection techniques would be needed to detect presence.

Campylobacter in Poultry and Pre and Post-Harvest Challenges and Controls

Poultry represents a natural reservoir for Campylobacter. Campylobacter is commonly found in the gastrointestinal tract of poultry and is considered to be a commensal microorganism. Additionally, Campylobacter can be detected at each level of the poultry production continuum: breeders to hatcheries to grow-out/live production for broilers (young chickens) to processing establishments and finally retail. Although the prominent modes of transmission are not well understood, it is known that Campylobacter may be spread through horizontal transmission from environmental sources such as water, insects, feces of animals and other birds (Stern et al., 2002) and through vertical transmission from breeder flocks (Hiett et al., 2002 and Cox et al., 2005). Campylobacter has been detected in chicken’s reproductive tracts (Cox et al., 2005), and in hatcheries samples from egg shells, tray liners and feather fluff (Byrd et al., 2007; Doyle 1984, Cox et al., 2002, Stern et al., 2002). These data along with the environment data suggest that both horizontal and vertical transmission need to be addressed to reduce Campylobacter at the farm level. Once the microorganism is introduced at grow-out, it spreads rapidly throughout the flock. It has been estimated that 6 days post introduction, that 95% of the flock could become Campylobacter positive (van Gerwe et al., 2005). Colonization of Campylobacter in chickens generally does not occur until broilers are about 3 weeks of age. It is thought that delay in the onset of Campylobacter colonization in poultry may be attributed to the presence of maternal antibodies; however, this has not been proven.

Controlling Campylobacter at the farm level is challenging at best. Unlike Salmonella, there are no commercial vaccines developed for controlling Campylobacter in the breeding flock or grow-out flock. Therefore, biosecurity and overall farm management are critical in controlling Campylobacter. In a recent survey representing 10,317 grow out facilities for broilers, strict biosecurity, litter management, and water acidifying treatments were identified as some of the best practices for controlling Campylobacter at the farm level (McKee, 2012). Litter management may be key a factor in controlling Campylobacter because it is sensitive to drying or desiccation. In experience with previous studies, recovering Campylobacter from poultry litter samples was difficult in dry environments and easier when the weather was rainy or poultry litter was moist. Campylobacter is not very resilient and not overly competitive with other microflora yet studies have shown that up to 87.5% broilers tested positive prior to transporting to the plant (Stern et al., 2001). Additionally, Campylobacter levels coming into the processing plant can be high. Research has shown that 4-5 logs cfu/ml could be detected early during processing (Berrang and Dickens, 2000).

Poultry processing is highly automated and there are many opportunities for cross contamination. One of the
first major points of cross contamination is feather removal in the picker. At this step, flexible rubber finger remove feathers from scalded birds. Most processors would prefer this be a neutral step in terms of cross contamination; however, that is not the case, and Campylobacter levels have been shown to increase 1-2 logs after picking (Berrang and Dickens, 2000). Other research on the processing of poultry, indicates that Campylobacter levels are reduced during processing, but positive samples are still detectable after chilling (Hinton et al., 2004). Furthermore, levels of Campylobacter have been reported at 1.5 log cfu/ml on post-chill carcass rinses (Berrang and Dickens, 2000). Because Campylobacter levels can be 1.5 log cfu/ml on post-chill carcasses, it is important to target a 2 log reduction when choosing antimicrobials that will be effective in eliminating Campylobacter in a post-chill application. Pathogen control strategy used to be “if you can control Salmonella, you can control Campylobacter”; however, the reality that it is the opposite situation. Salmonella levels and prevalence are lower, and in actuality, “if you can control Campylobacter you can control Salmonella”.

Ideally, pathogen reduction during processing is a multi-hurdle approach where specific sites for reduction would be targeted. One of the first stages would be OLR or spray cabinets placed after evisceration. Spray applications of antimicrobials have not provided major pathogen reduction, but have instead become part of the multi-hurdle approach for pathogen reduction. Spray applications of antimicrobials have limited effect because the application does not provide the optimum contact time nor coverage. Although most processors would like to see a 1 log reduction at this step, in commercial applications, it is more likely to observe a 0.5 log reduction depending on the antimicrobial used.

One of the primary sites antimicrobials have been applied is in poultry chillers. Poultry immersion chilling is designed to reduce the temperature of the bird to 4 C within 4 hours. The chiller is an immersion tank that can hold 25,000+ gallons of water. The chiller has also historically served as the site where antimicrobials are added to reduce Salmonella but now Campylobacter as well. The contact time in a chiller is 1-2 hours depending on the system, and chlorine had previously been the primary antimicrobial used at that step. With stricter pathogen performance standards, processors have had to seek better antimicrobials and technologies. Historically, chlorine was added to the chiller water as an antimicrobial, and the concentration ranged from 20-50 ppm with an average of 35 ppm being used. Other antimicrobials have been tested, and peracetic acid is one compound that has been found to be more effective in reducing Salmonella and Campylobacter in poultry. Bauermeister et al. (2008) found that 85 ppm peracetic acid reduced Campylobacter by 43.4% compared to 12.8% reduction using 30 ppm chlorine.

Using antimicrobials in a poultry chiller with the volume of water being treated is an expensive proposition. Also, the prolonged contact time increases the opportunity for negative product quality changes associated with antimicrobial treatments. To reduce the cost, improve antimicrobial reductions, and reduce negative effects on product, new processing technologies have been added over the past few years as well as new antimicrobials. In a survey of poultry processors, post-chill dip tank and/or Finishing Chiller was viewed as a best practice for reducing pathogens in poultry (McKee, 2011). Post-chill dip tanks or a Finishing Chiller which is a small piece of equipment (approximately 400 gallons) is placed immediately after the primary chiller. The Finishing Chiller was developed and is commercially available from Morris and Associates.

Advantages of post-chill technologies include treating smaller volumes of water, fresh water and antimicrobial input, short dwell times, and being able to use higher concentration of chemicals that are effective in reducing pathogens but do not negatively impact poultry quality. In the survey conducted by McKee (2011), peracetic acid was the predominant chemical used in poultry chillers and post-chill dip applications which changed from a previous survey conducted in 2006 that had shown chlorine to be the primary chemical used. In unpublished data, Nagel et al. (2012), has found peracetic acid levels of 400-700 ppm in a Finishing Chiller application to reduce levels of Campylobacter to meet performance standards. Ranges are given because individual facilities can differ in levels of pathogens they are trying to eliminate.

Overall, managing food safety is a challenge, but significant improvements have been made by using multi-hurdle approach. Poultry facilities need to understand what food safety challenges they face in order to develop the best intervention strategies. While this information includes some of the best practices and technologies available for the various processing steps identified, individual plants need to validate the antimicrobial interventions they choose.

REFERENCES


USDA. Federal Register Notice vol. 76, no 54, 2011.

