

The Effects of Cetylpyridinium Chloride (Cecure® CPC Antimicrobial¹) on *Campylobacter* Spp. on Raw Poultry: A Review

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Abstract: Published findings have clearly demonstrated that between 0.1 and 0.5%, Cecure® is by far the most efficacious antimicrobial treatment available for controlling *Campylobacter* on poultry carcasses. Safe Foods Corporation's commercially available pre-chill and post-chill Cecure® applications should be fully capable of meeting and exceeding any *Campylobacter* government regulation that will be issued, regardless of the sampling plan or specific isolation methodology that may be mandated. Safe Foods' previous laboratory studies and in-plant experience, as well as the published findings of other scientists, suggest that Cecure® will be able to achieve at least a 1-2.5 log reduction in *Campylobacter* levels on pre-chill broilers, with incidence rates being reduced from 80-90% to no greater than 7-9% with a concentration of Cecure® between 0.1 and 0.5%. With a post-chill Cecure® application, the antimicrobial should virtually eliminate the organism (2-3 log reduction) with an expected incidence rate of no greater than 3-5% at a Cecure® concentration between 0.1 and 0.5%.

Key words: *Campylobacter*, poultry, Cecure® CPC antimicrobial

INTRODUCTION

It is estimated that *Campylobacter* spp. may be responsible for a great majority of all cases of food borne illness in the U.S. and in many other countries. Each year, raw and under-cooked poultry products are incriminated in numerous cases of human campylobacteriosis. It is anticipated that in the very immediate future, government regulations will be issued in the U.S. regarding the incidence and most likely, the level of *Campylobacter* that will be acceptable on post-chill poultry. National and international studies indicate that somewhere between 50 and 100% of post-chill broilers are contaminated with *Campylobacter* (62% at retail according to a recent study conducted by Consumer Reports, Anonymous, 2010) and that the level of the organism at post-chill is somewhere in the range of less than 1 log to greater than 3 logs per ml (depending primarily upon sample handling and on recovery methodology). On pre-chill broilers, *Campylobacter* levels are typically 1 log higher and incidence is typically greater than 90%.

General information related to *Campylobacter*: The genus *Campylobacter* (meaning twisted bacteria) includes 14-18 species and subspecies (depending on the authority) with at least eleven of these species being known to cause human illness. The three primary species of concern, in regards to food borne illness associated with poultry, are *Campylobacter* (*C.*) *jejuni*, *C. fetus* and *C. coli* (Ang and Nachman, 2009).

Campylobacter are small, motile, s-shaped, gram negative, microaerophilic (5-10% oxygen), curved rods. *Campylobacter* will grow at 37°C or at 42-43°C but not at 25°C. The reservoir for the organism is the intestinal tract of dogs, cats, poultry, wild birds and a certain percent of the human population worldwide.

It is estimated that 1% of the total human population has symptomatic campylobacteriosis each year, with the greatest number of cases occurring in children less than 5 years of age (especially less than 1 year), in the elderly (especially those > 90 years) and those who are immune deficient. Many researchers believe campylobacteriosis to be the number one cause of food borne illness in the U.S. as well as in many other countries. The routes of transmission for *Campylobacter* include fecal-oral, person-to-person sexual contact, ingestion of contaminated food and water and eating raw or undercooked meat and poultry (Humphrey, 2007).

The vast majority of patients fully recover from campylobacteriosis in 5 days. However, extreme diarrhea (sometimes bloody) can last 7-14 days with cramping, intense abdominal pain that can mimic appendicitis, malaise and headaches (Ang and Nachman, 2009). In a recent retail survey of *Campylobacter* isolates from raw poultry products, 60% of the isolates were resistant to one or more antibiotics (as reported in Consumer Reports, Anonymous, 2010). In addition, infection with *Campylobacter* is the single most identified prior infection associated with the

development of Guillain-Barré syndrome which is a very serious and debilitating autoimmune disorder, resulting in acute flaccid paralysis (Nachamkin *et al.*, 1998). Roughly one out of every 1000 cases of food borne illness associated with *Campylobacter jejuni* results in the subsequent development of Guillain-Barré syndrome.

The incidence and levels of *Campylobacter* spp. on raw poultry products:

A 3-plant study was conducted in 1988 that evaluated the incidence and levels of *Campylobacter jejuni* throughout the various steps involved in poultry processing (Izat *et al.*, 1988). In this study a swabbing procedure was utilized instead of a whole carcass rinse. Thus, the levels of *Campylobacter* (as determined by the MPN procedure) were reported in logs per 1000 cm² of skin surface area. For pre-chill carcasses, levels ranged from 1.7-3.0 logs per 1000 cm². For post-chill carcasses, levels ranged from 1.2-1.9 logs per 1000 cm². Incidence rates for both pre- and post-chill carcasses were close to 100%.

In 1992, a study was conducted that evaluated the combination of six processing modifications (primarily the use of chlorine in various locations and counter current scalding) on the microbiological quality of post-chill broilers (Waldroup *et al.*, 1992). The authors reported *Campylobacter jejuni/coli* incidence rates of 53-100%. Levels of *Campylobacter* (as determined by the MPN procedure) across the six plants ranged from 2.4-4.2 logs (CFU/ml) during the baseline period prior to any plant modifications and from 1.8-4.3 logs (CFU/ml) during the test period in which the six in-plant modifications were incorporated. The authors noted that the six in-plant modifications significantly lowered the *Campylobacter* incidence rate in two of the five plants and the levels of *Campylobacter* in four of the five plants. The modifications made in these plants are now standard processes in most U.S. commercial poultry facilities.

In a 5-plant on-line reprocessing study conducted in 1993 by Waldroup and co-workers, incidence of *Campylobacter jejuni/coli* on pre-chill broilers ranged from 72-93%. The level of *Campylobacter* in this study ranged from 3.7-4.6 logs per ml (as determined by the MPN procedure). The authors noted that manual reprocessing procedures utilizing 20 ppm chlorine did not significantly lower incidence of *Campylobacter* but that levels were typically lower on the reprocessed carcasses.

In 1996, a review paper explored the incidence and levels of various pathogens on raw poultry worldwide (Waldroup, 1996). Included in the review were the incidence and levels of *Campylobacter* spp. on various types of raw poultry products going back to as early as 1974. Incidence ranged from 1.8-100% depending on the specific point of sampling, the species of poultry

sampled, the microbiological methodology and the country of origin. In this review, levels of *Campylobacter* spp. ranged from less than 2 logs (not per ml but on a whole carcass) to greater than 7 logs (not per ml but on a whole carcass).

In a single-plant study conducted by Fletcher *et al.* (1997), pre-chill broilers were evaluated on ten separate days over a 4-week period. Carcasses were sampled at the exit of the final inside/outside bird washer for incidence and levels of *Campylobacter* spp. Incidence ranged from 72-80% while the level of *Campylobacter* ranged from 2.9-3.2 logs per ml (as determined by direct plating).

In a study conducted in 2002 in seven commercial USDA-inspected poultry plants, researchers found that levels of *Campylobacter* spp. (as determined by direct plating) on pre-chill broilers ranged from 1.5-1.75 logs per ml while levels on post-chill broilers ranged from 0.6-0.8 logs per ml (Bilgili *et al.*, 2002). In this study the authors noted that whether or not the carcasses were visibly contaminated with digestive tract contents did not significantly affect levels of *Campylobacter* on pre- or post-chill carcasses. The authors also noted that the immersion chilling process lowered the level of all organisms, including *Campylobacter*, by at least 1 log.

Effects of Cecure[®] on *Campylobacter*: A pilot plant study was conducted in 1999 at the University of Arkansas in Fayetteville (Waldroup *et al.*, 1999). In this study, room-temperature Cecure[®] was applied to pre-chill broilers at 0.2 or 0.5% as a 3-sec mist or at 0.2 or 0.5% as a 10-sec dip. The mist treatment utilized a commercial pre-chill broiler rinse cabinet. Treated carcasses were allowed to drip for 30-60 sec before sampling. The level of *Campylobacter* on the control pre-chill carcasses was 2.3 logs per ml. In this study, the 0.5% Cecure[®] 10-sec dip completely eliminated *Campylobacter*. The other three Cecure[®] treatments (0.2 or 0.5% as a mist or 0.2% as a 10-sec spray) significantly lowered the level of *Campylobacter* by 1.7-2.2 logs per ml.

A study was conducted in 2000 (Waldroup *et al.*, 2000) in a USDA-inspected commercial poultry processing plant. An existing rinse cabinet located at the exit end of the immersion chiller was utilized to spray post-chill broilers with Cecure[®]. In this trial, 2-4 ounces of Cecure[®] per carcass was used at concentrations of 0.25 and 0.4%. Direct chemical contact time was 2-3 sec and the water pressure was maintained at 40 to 60 psi. The 0.25% Cecure[®] spray reduced *Campylobacter* levels by 49% while the 0.4% treatment resulted in a greater than 99% reduction (> 2 logs).

In 2002, a paper was published by researchers at Virginia Tech University entitled "Efficacy of antimicrobials against *Campylobacter jejuni* on chicken breast skin" (Arritt *et al.*, 2002). The researchers

evaluated several different antimicrobials, including 10% trisodium phosphate, 0.1% acidified sodium chlorite (ASC), 1% Tween 80, water at 50°C and 0.1 and 0.5% cetylpyridinium chloride (CPC, the active ingredient in Cecure®). The study was designed to evaluate the effects of these chemical agents on their ability to inactivate, reverse bacterial attachment or inhibit the attachment of *Campylobacter jejuni* to samples of chicken skin. The study evaluated each chemical at three different contact times including 30 sec, 3 min or 10 min. All chemical treatments were misted onto chicken skin samples at 2 ml/sec for 3 seconds using a spray pressure of approximately 8 psi.

In the first phase of the study, the researchers applied the *Campylobacter* inoculum to the chicken skin samples prior to chemical treatment. In the second phase of the study, the chemical treatment was applied to the chicken skin and then the chemically-treated skin was exposed to the *Campylobacter* inoculum. When *Campylobacter* was applied to the chicken skin prior to treatment with 0.1% CPC, a 1.4 log reduction was noted. At 0.5% CPC, a 2.9 log reduction was observed. This reduction was significantly higher (greater than one log better) than the reductions achieved with any of the other chemical treatments. When the chicken skin was treated with 0.5% CPC and was then exposed to *Campylobacter*, a 4.7 log reduction was noted. Again, this reduction was significantly higher than any of the other chemical treatments. In fact, the reduction achieved with 0.5% CPC was 3 logs greater than the next best treatment. It should be noted that when *Campylobacter* was applied to the chicken skin and then the skin was exposed to CPC, the various contact times did not produce significantly different results. In other words, the brief contact time of 30 sec resulted in the same microbial reductions as the longer contact time of 10 min. In summary, the authors stated that "the greatest bacterial population reductions were achieved with the 0.5% CPC treatment when applied before or after inoculation with *Campylobacter jejuni*."

Beers *et al.* (2006) conducted a 3-plant, 12-week study to investigate the use of Cecure® as an online-reprocessing technology. In this study, the application volume of Cecure® per pre-chill broiler carcass was 2 to 3.3 ounces and the authors stated that the concentration was typically around 0.5%. Treatment of the pre-chill carcasses with Cecure®, regardless of whether they were visibly contaminated with digestive tract contents, resulted in a 1-2 log reduction in *Campylobacter*. Untreated carcasses had levels of *Campylobacter* that ranged from 1.5-3.1 logs per ml. Incidence of *Campylobacter* on Cecure®-treated pre-chill broilers ranged from 2.5-9.4% while incidence on untreated carcasses ranged from 83.6-98.7%.

Taking into account all of the published information and most significantly, the combined data from four studies

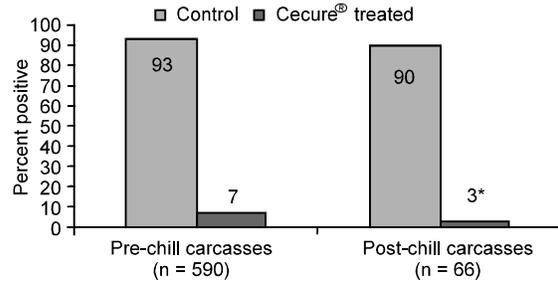


Fig. 1: *Campylobacter* incidence on broilers

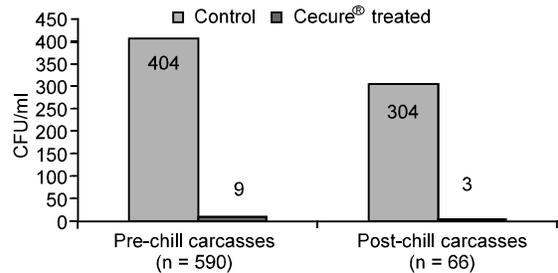


Fig. 2: *Campylobacter* levels on broilers

which specifically evaluated the use of Cecure® for controlling *Campylobacter* on broilers (Waldroup *et al.*, 1999; 2000; Arritt *et al.*, 2002; Beers *et al.*, 2006), Fig. 1 and 2 provide a visual interpretation of what to expect when Cecure® is applied between 0.1 and 0.5% at the pre-chill or post-chill location. Figure 1 depicts the incidence of *Campylobacter* on pre- and post-chill broilers while Fig. 2 indicates the levels of *Campylobacter* typically found on broilers. There is adequate data to accurately predict both incidence and level of *Campylobacter* at the pre-chill location for control and Cecure®-treated carcasses. In addition, there is adequate data to estimate the level of *Campylobacter* at the post-chill location on control and Cecure®-treated carcasses. However, at the post-chill location, specific data related to incidence of *Campylobacter* on Cecure®-treated carcasses is lacking. Based on the extremely low levels of the organism recovered in the two post-chill Cecure® studies (Waldroup *et al.*, 2000; Arritt *et al.*, 2002), a prediction for *Campylobacter* incidence at the post-chill location for Cecure®-treated carcasses is estimated (*) to be no greater than 3-5% (as noted in Fig. 1).

REFERENCES

- Ang, J.Y. and S. Nachman, 2009. *Campylobacter* infections. <http://emedicine.medscape.com/article/970552-overview>.
- Anonymous, 2010. How safe is that chicken? Consumer Reports Magazine. January, 2010. www.consumerreports.org/.../chicken-safety/.../chicken-safety-ov.htm.

- Arritt, F.M., J.D. Eifert, M.D. Pierson and S.S. Sumner, 2002. Efficacy of antimicrobials against *Campylobacter jejuni* on chicken breast skin. J. Appl. Poult. Res., 11: 358-366.
- Beers, K., J. Rheingans, K. Chinault, P. Cook, B. Smith and A. Waldroup, 2006. Microbial efficacy of commercial application of Cecure® CPC antimicrobial to ingesta-contaminated pre-chill broiler carcasses. Int. J. Poult. Sci., 5: 698-703.
- Bilgili, S.F., A.L. Waldroup, D. Zelenka and J.E. Marion, 2002. Visible ingesta on prechill carcasses does not affect the microbiological quality of broiler carcasses after immersion chilling. J. Appl. Poult. Res., 11: 233-238.
- Fletcher, D.L., E.W. Craig and J.W. Arnold, 1997. An evaluation of on-line reprocessing on visual contamination and microbiological quality of broilers. J. Appl. Poult. Res., 6: 436-442.
- Humphrey, T.J., 2007. *Campylobacters* as zoonotic pathogens: a food production perspective. Int. J. Food Micro., 117: 237-257.
- Izat, A.L., F.A. Gardner, J.H. Denton and F.A. Golan, 1988. Incidence and level of *Campylobacter jejuni* in broiler processing. Poult. Sci., 67: 1568-1572.
- Nachamkin, I., B.M. Allos and T. Ho, 1998. *Campylobacter* species and Guillain-Barré syndrome. Clin. Microbiol. Rev., 11: 555-567.
- Waldroup, A.L., 1996. Contamination of raw poultry with pathogens. World's Poult. Sci. J., 52: 7-25.
- Waldroup, A., C. Coleman and H. Brown, 1999. Pilot plant trials-pre-chill application of cetylpyridinium chloride to broilers. U.S. Food Additive Petition No. 2A4736, Appendix VII. Food and Drug Administration, Department of Health and Human Services. Washington, DC.
- Waldroup, A., C. Coleman and K. Beers, 2000. Commercialization of cetylpyridinium chloride for use in the poultry industry. U.S. Food Additive Petition No. 2A4736, Appendix VII. Food and Drug Administration, Department of Health and Human Services. Washington, DC.
- Waldroup, A.L., B.M. Rathgeber and R.H. Forsythe, 1992. Effects of six modifications on the incidence and levels of spoilage and pathogenic organisms on commercially processed post-chill broilers. J. Appl. Poult. Res., 1: 226-234.
- Waldroup, A.L., B.M. Rathgeber, R.E. Heirholzer, L. Smoot, L.M. Martin, S.F. Bilgili, D.L. Fletcher, T.C. Chen and C.J. Wabeck, 1993. Effects of reprocessing on microbiological quality of commercial pre-chill broiler carcasses. J. Appl. Poult. Res., 2: 111-116.

¹Cecure is a registered product of Safe Foods Corporation, North Little Rock, AR 72118, USA.