Visible Ingesta on Prechill Carcasses Does Not Affect the Microbiological Quality of Broiler Carcasses after Immersion Chilling

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Primary Audience: Poultry Processors, USDA Personnel, Quality Assurance Personnel, HACCP Coordinators

SUMMARY

Microbiological quality of broiler carcasses, with or without visible ingesta contamination, was compared at pre- and postimmersion chilling sites. A total of 1,080 carcasses was sampled in seven commercial processing plants and analyzed for aerobic bacteria (aerobic plate count; APC), *Escherichia coli* and *Campylobacter* spp. counts (log_{10} cfu/mL), and incidence of *Salmonella* based on USDA approved microbiological procedures.

In all plants, the APC (4.22 vs. 3.27), *E. coli* (2.36 vs. 1.22) and *Campylobacter* spp. (1.69 vs.0.83) counts (log_{10} cfu/mL), and *Salmonella* incidence (20.7 vs. 5.7%) were significantly ($P < 0.05$) higher on pre- vs. postimmersion chill carcasses, respectively. Microbial load on carcasses collected from pre- and postimmersion chill sites differed significantly among the plants in this study. However, there were no statistically detectable differences ($P > 0.05$) in microbial counts between carcasses with or without visible contamination at both sampling sites. Overall, immersion chilling resulted in about a 1-log reduction in microbial load on carcasses, compared to prechill levels. These results demonstrate the lack of a direct correlation between the presence of visible ingesta and microbial contamination on poultry carcasses.

Key words: broiler, immersion chilling, ingesta, *Campylobacter*, *Salmonella*

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DESCRIPTION OF PROBLEM

Since its introduction in 1996, the Hazard Analysis Critical Control Point (HACCP) System has revolutionized the implementation, monitoring, and assessment of food safety and inspection procedures in meat and poultry plants. Microbial standards for levels of *Escherichia coli* (performance criteria) and incidence of *Salmonella* (performance standard) on carcasses have been introduced and used to validate slaughter procedures and HACCP plans at plants [1]. Additionally, "zero-fecal tolerance" for visible fecal contamination prior to chilling has been implemented as a food safety performance standard that must be addressed by HACCP plans [2].

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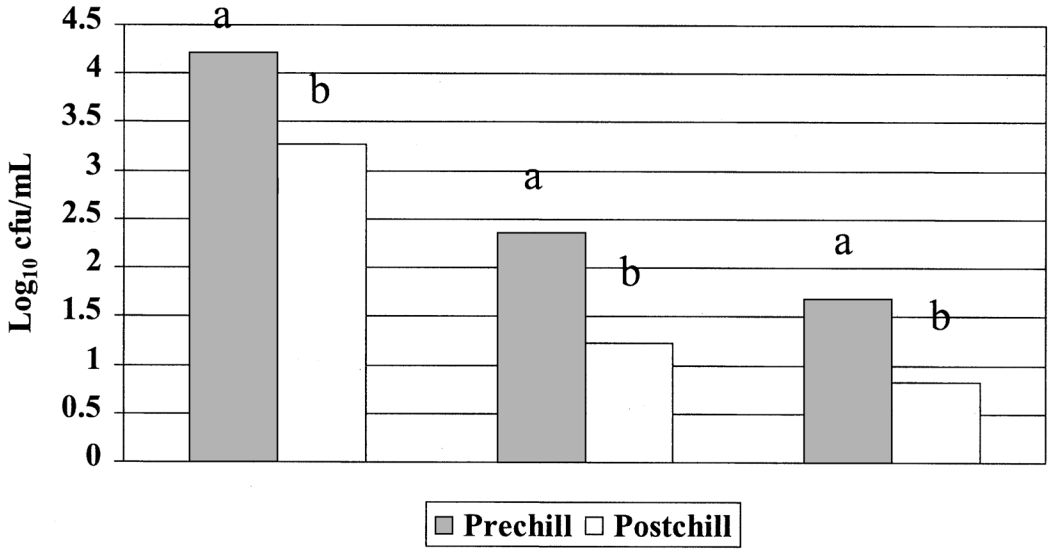

FIGURE 1. Average microbial counts (log_{10} cfu/mL) of carcasses at prechill and postchill sampling sites. [a,b]Means within a microbial group with different letters differ significantly ($P < 0.001$). Pooled SEM = 0.03. APC = aerobic plate count.

In contrast to microbial standards, which are monitored at the end of the slaughter process (i.e., after chilling), the visible fecal contamination standard is enforced prior to chilling [3]. Although often disputed [4], this ruling is based on the assumptions that fecal material is the primary vehicle for foodborne pathogens on poultry carcasses, and, when present on prechill carcasses, may be a source of cross-contamination during the immersion chilling process. The contents of the upper digestive tract (i.e., crop, proventriculus and gizzard) or ingesta may also serve as a source of carcass contamination during processing, especially when accidentally

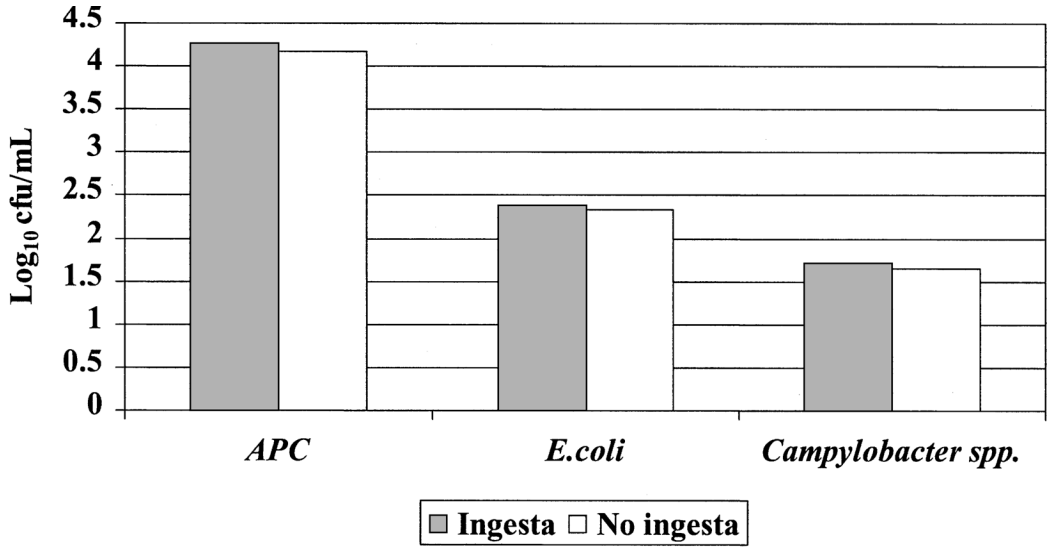

FIGURE 2. Average microbial counts (log_{10} cfu/mL) of carcasses, with and without visible ingesta, at the prechill sampling site. Means within a microbial group did not differ significantly ($P > 0.05$). Pooled SEM = 0.05. APC = aerobic plate count.

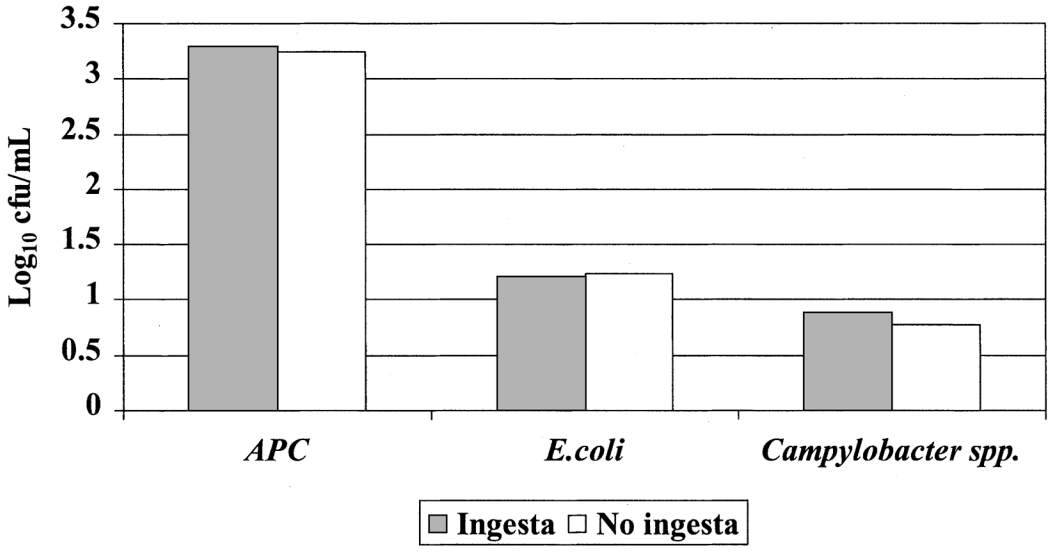

FIGURE 3. Average microbial counts (log_{10} cfu/mL) of carcasses, with and without visible ingesta, at the postchill sampling site. Means within a microbial group did not differ significantly ($P > 0.05$). Pooled SEM = 0.03. APC = aerobic plate count.

ruptured during evisceration [5, 6]. This recent research has introduced the likelihood of a prechill zero-tolerance standard for visible ingesta [2].

The process of chilling poultry in immersion water has undergone many changes since its introduction at the turn of the century. On-line immersion chillers, introduced in the 1950s, improved the efficiency of the process by enhancing heat transfer and significantly extending the shelf life of poultry [7]. Under properly defined and monitored operating conditions (i.e., prechill carcass rinse, dwell time, temperature, agitation, overflow rate, and chlorination), the immersion

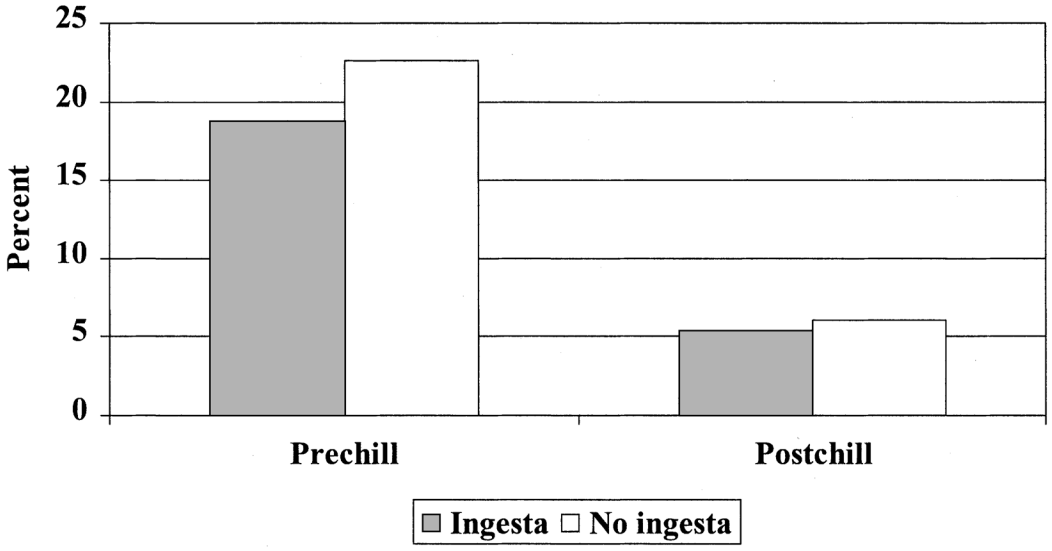

FIGURE 4. Average *Salmonella spp.* incidence (%) of carcasses, with and without visible ingesta, at prechill and postchill sampling sites. Means within a sampling site did not differ significantly ($P > 0.05$).

chilling process has been shown to greatly improve the microbiological quality of poultry carcasses [8]. Research on counter flow immersion chilling systems has demonstrated significant reductions in levels of all microorganisms and cross-contamination [9, 10], especially with chlorination of the water [11, 12, 13]. Application of prechill performance standards ignores the antimicrobial effects of the immersion chilling process and isolates this important food safety intervention step from the slaughter and evisceration processes.

It should be pointed out that carcasses extensively contaminated with digestive tract contents, whether ingesta or fecal material, are removed from the main processing line at inspection stations and are condemned or reprocessed at a separate off-line station. Prechill performance standards for contamination often involves visible specks of <1/16 in., as all carcasses are vacuumed (internal cavity), washed inside and outside with chlorinated water, scrubbed with brushes, trimmed, and rewashed prior to the prechill examination point.

In this study, the microbiological quality of broiler carcasses, with or without visible specks of ingesta contamination, were compared at pre- and postimmersion chilling sites. Data generated under conditions of in-plant commercial operations should allow objective assessment of the scientific basis of a zero-tolerance standard for ingesta.

MATERIALS AND METHODS

Participants and Sample Collection

Seven commercial broiler companies [14], participated in this study. In each of these seven plants, carcasses with and without visible ingesta specks (treatment; Trt) were collected for microbiological analysis, at pre- and postimmersion chilling sites (site) over 4 sampling d. Carcasses were sampled after the final wash and before entry into and immediately after immersion chillers at each plant.

On each sampling day, 40 carcasses (10 carcasses per Trt; 20 per site) were aseptically collected and rinsed with 400 mL of Butterfield's phosphate diluent, as per sampling procedures outlined by the USDA [15]. A total of 1,080 carcasses was sampled (160 per plant, except for one plant with only 120 samples) and analyzed in this study. Given differences in immersion chilling systems in commercial use, no attempt was made to standardize the operational parameters (i.e., type of chilling system, rate of overflow, level of chlorination etc.). However, all the participant plants were under USDA inspection and operating under their respective HACCP plans.

Microbiological Assays

Carcass rinse samples were held at 4 to 5°C prior to, and at less than 10°C during, shipment overnight to the designated laboratory. Samples were appropriately diluted and plated for aerobic plate counts (APC) and *E. coli* counts (cfu/mL rinse fluid), and *Salmonella* spp. incidence (%) by methods described by the Association of Official Analytical Chemists [16]. *Campylobacter* spp. was quantified based on the enumeration method of Line et al. [17].

All quantitative data were transformed to $\log_{10}$ prior to analysis by the general linear models procedure of SAS software [18]. The statistical model used included plants as blocks, main effects of Trt and site, and their interaction. Chi-squared tests were performed to compare *Salmonella* spp. incidence between the treatments at each site, as well as between sites.

RESULTS AND DISCUSSION

Sampling site (prechill vs. postchill) was significant ($P < 0.01$) for all three microbial groups (Figure 1). Carcasses sampled after immersion chilling had lower counts ($\log_{10}$ cfu/mL) of APC, *E. coli*, and *Campylobacter* spp. than those sampled prechill. Overall, immersion chilling resulted in about 1-log reduction in microbial numbers. Similarly, immersion chilling reduced ($P < 0.05$) the incidence of *Salmonella* from 20.7% (prechill) to 5.7% (postchill). The positive effect of immersion chilling on bacterial numbers observed in this study is consistent with effects reported in the literature [19, 20, 21, 22].

Immersion chilling systems have evolved over the years, with the incorporation of many changes, including counter current flow [23], continuous overflow [24], air agitation [25], prechill spray washing [26] and continuous chlorination [27, 28]. All of these changes, no doubt,

have contributed significantly to the effectiveness of modern-day chilling systems in terms of chilling efficiency and microbiological quality.

No significant Trt (visible ingesta vs. no-ingesta) or site by Trt interaction effects were detected for levels (log_{10} cfu/mL) of APC, *E. coli*, and *Campylobacter* spp., or for the incidence of *Salmonella* spp. This result indicates that the incidental presence of visible ingesta specks on broiler carcasses, prior to or after chilling, is not associated with microbiological quality (Figures 2, 3, and 4). This finding is consistent with that of Fletcher et al. [29], who could not demonstrate a significant correlation between visible contamination and subsequent pathogen numbers on broiler carcasses.

Although prevention of carcass contamination with digestive tract contents should be an important goal during processing, the data generated in this study indicate that visible carcass contamination has no predictive value for estimating the microbial quality of the carcass.

CONCLUSIONS AND APPLICATIONS

1. Microbial counts on broiler carcasses were significantly higher at prechill than at postchill.
2. Presence of visible ingesta on prechill or postchill carcasses does not influence microbial counts.
3. Modern immersion chilling systems represent an effective food safety intervention step.
4. There is no scientific basis for using visible ingesta on carcasses during processing as a Food Safety Performance Standard.

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