A Research Note

Microbiological and Hydraulic Evaluation of Immersion Chilling for Poultry

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(MS# 95-54: Received 24 February 1995/Accepted 13 June 1995)

ABSTRACT

Immersion chilling has been identified as a critical control point in commercial poultry processing. A study was undertaken to investigate the impact of immersion chilling on the microbiology of carcasses within a small to medium sized commercial operation. Fifty chilled carcasses (following immersion chilling) sampled over a 10-day period using a whole bird rinse technique exhibited mean standard plate count (SPC) and coliform counts (log colony-forming units (CFU)/ml) of 3.74 and 3.03, respectively. These levels were both significantly ($P < 0.005$) lower (ca. 1 log unit) compared to similar numbers of prechill carcasses (birds exiting the inside-outside washer but prior to the prechiller). Water from the chiller was also shown to contain significantly ($P < 0.005$) lower (ca. 1 log unit) SPC and coliform levels compared to those from the prechiller. Reducing the flow rate of water at the inside-outside washer by 50% did not significantly ($P < 0.001$) affect the SPC and coliform levels of either prechilled or chilled carcasses.

Key words: Microbiology, hydraulic, immersion, chilling, poultry

Consumption of poultry products has continued to increase during recent decades. In Canada, between 1982 and 1992, there was a 33 % rise in the per capita consumption of poultry (5). To help maintain and improve the popularity of poultry products, processors must continue to ensure a supply which is as microbiologically sound as current available processing methods allow. Hazard analysis and critical control point (HACCP) programs are universally being implemented throughout the food industry in order to achieve this goal (2, 4, 6). The chilling process, which consists of immersing unshackled carcasses in agitated, flowing, ice-cold water in large, open tanks, is recognized as a critical control point (11–13).

Immersion chilling, as commonly practiced by the poultry industry, has often come under scrutiny because of the potential for cross-contamination (7–10). In spite of this, other investigators have reported that with properly controlled equipment and adequate water replacement, the washing effect of immersion chilling can reduce bacterial levels (3).

The purpose of this study was to assess the washing effect of immersion chilling on carcasses processed in a small commercial plant with respect to the build-up of standard plate count and coliforms. The effect of reducing the flow rate at the inside-outside (I/O) washer was also investigated in this regard.

MATERIALS AND METHODS

The process

Broiler carcasses were eviscerated at a line speed of ca. 72 birds per min, passed through an inside-outside (I/O) washer and dropped from their shackles into a prechiller tank (4,000 l). Residence time was less than 5 min, after which the carcasses were discharged into a spin-chiller (22,000 l) where they were retained for ca. 25–40 min. Agitation in both tanks was by means of horizontal paddles. Water from the return troughs was directed back through the tanks in the same direction as the carcasses. Fresh make-up water was added to the spin-chiller and the overflow was screened and pumped as make-up to the prechiller. This procedure was used to compensate for moisture pick-up and drip losses by exiting carcasses and to meet the water requirements of a minimum of 2 l per carcass (1). Overflow from the prechiller was discharged.

Baseline survey

Standard plate count (SPC) and coliforms were determined for five carcasses before chilling (after I/O washer but prior to prechiller) on each of ten days. A similar protocol was applied to chilled carcasses (after immersion chilling). Water from the pre-chiller and chiller was also sampled as described previously. In addition, chiller water and chilled carcasses were sampled in duplicate on an hourly basis throughout the major portion (10:30 a.m. – 3:30 p.m.) of the processing shift on each of five consecutive days. All samples were analyzed for SPC and coliforms. Carcass sampling consisted of a whole bird rinse using 100 ml sterile 0.1% peptone contained in a sterile bag (31 by 62 cm). The bag was twisted at the midpoint to form a balloon with the carcass free to move inside. The bag and contents were shaken for 30 s after which the rinse water was poured into a sterile container and stored in ice for transport. Analyses commenced...
within 3 h of sampling. Rinse samples from carcasses and chiller water samples were serially diluted using sterile 0.1% peptone and evaluated for standard plate counts using plate count agar (BBL) (35°C for 48 h). Coliforms were enumerated on violet red bile agar (BBL)(35°C for 24 h) using an agar overlay. Neck skins were analyzed by blending 25-g portions with 225 ml of 0.1% peptone for 60 s. Homogenates were microbiologically evaluated as described previously.

**Statistical analysis**

Results were converted to log and statistically analyzed using Student’s t-test (variances unequal; Fig P. Software Corp., USA).

### RESULTS

Rinse water samples from chilled carcasses contained significantly ($P < 0.001$) lower (ca. 1 log unit) SPC and coliform populations compared to rinse samples from prechiller carcasses (Table 1). In addition, the microbial populations on chilled carcasses obtained shortly after start-up (10:30 a.m.) were similar to those at the end of the processing shift (3:30 p.m.; Fig. 1a) Analyses of neck skin samples from chilled carcasses confirmed the lower (ca. 1 log unit) SPC and coliform levels when compared to prechiller carcasses. SPC and coliform populations (log CFU/g) for neck skin samples on prechiller carcasses were 5.00 and 4.47 respectively. On chilled carcasses the populations were reduced to 4.00 and 3.56 respectively. Compared to the baseline levels, reducing the volume of water used per carcass at the I/O washer by 50% (ca. 45 l/min) did not result in a significant change in SPC and coliform populations in either pre- or postchilled carcasses (Table 1).

Samples of prechiller water contained significantly ($P < 0.001$) higher SPC and coliform levels compared to chiller water (Table 1). SPC and coliform populations in the chiller water at the start of processing (7:30 a.m.) were ca. 2.5 x 10² and 1.4 x 10¹ CFU/ml, respectively. Both populations gradually increased, reaching 3.7 x 10³ and 2.5 x 10² CFU/ml, respectively, by the end of processing (3:30 p.m., Fig. 1b)

### TABLE 1. Coliform and standard plate count (SPC) evaluation for baseline study and with reduced flow at the inside-outside (I/O) washer

<table>
<thead>
<tr>
<th>Sample</th>
<th>No. samples</th>
<th>Log CFU/ml</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>SPC</td>
</tr>
<tr>
<td>Carcass-baseline</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prechill</td>
<td>50</td>
<td>4.70 ± 0.34</td>
</tr>
<tr>
<td>Postchill</td>
<td>50</td>
<td>3.74 ± 0.32</td>
</tr>
<tr>
<td>Water Baseline</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prechiller</td>
<td>10</td>
<td>4.43 ± 0.48</td>
</tr>
<tr>
<td>Chiller</td>
<td>10</td>
<td>3.53 ± 0.41</td>
</tr>
<tr>
<td>Carcass-I/O washer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(50% flow rate)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prechill</td>
<td>15</td>
<td>4.78 ± 0.34</td>
</tr>
<tr>
<td>Postchill</td>
<td>15</td>
<td>3.71 ± 0.27</td>
</tr>
</tbody>
</table>

*Mean ± SD.*

*I/O washer at 90 l/min.*

*Carass mean counts followed by different letters (a, b) within columns are significantly different ($P < 0.001$).*

*Water mean counts followed by different letters (x, y) within columns are significantly different ($P < 0.005$).*

DISCUSSION

The washing effect of immersion chilling was shown to reduce both coliform and SPC populations on poultry carcasses by 90%. These results are in agreement with findings reported by James et al. (7) and Mead et al. (9). Postchill whole carcass rinse counts remained within mean baseline levels regardless of the time of day and despite a 50% reduction in the I/O washer volume. The latter result supports the finding of Wesley (14) who reported that 50% of the USDA required metered chiller input resulted in no detrimental effects on the quality of the chiller water or poultry carcasses. In view of this observation, a substantial saving in water could be gained at the I/O washer without affecting the microbial quality of the chilled carcasses. The water economized at this point could be translated to reduced cost of operation or used for additional pre- or postvisceralization spray washes or for reprocessing uses. The microbiological results obtained imply that perhaps the contact time, rather than the volume of water used at the I/O washer, is more important in regard to bacterial removal.

In conclusion, immersion chilling was shown to reduce bacterial counts on carcasses by ca. 1 log unit; however, this reduction may be very small in relation to the actual number remaining. The potential for more effective use of water at the I/O washer, for example the use of low-volume sprayheads, should be further investigated in regard to microbial decontamination.

REFERENCES


