A Research Note

Reduction of Salmonella and Campylobacter on Chicken Carcasses by Changing Scalding Temperature

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ABSTRACT

Chickens were processed at three scalding temperatures, 52, 56, or 60°C, and the numbers of Salmonella and Campylobacter attached to the fully processed carcasses in each group were compared. For Salmonella, carcasses scalded at 52 or 56°C showed ~ 0.3 to 0.5 lower log numbers than carcasses at 60°C (P < 0.05). There were no significant differences between the carcasses at 52 and 56°C. For Campylobacter, carcasses scalded at 56°C showed ~ 0.7 lower log counts than the carcasses at 60°C (P < 0.05) in the first two trials; however, no difference was observed in a third trial. Although the reduction of bacteria attached to the chicken carcasses was not as great as shown in previous attachment studies using skin samples (1.0 to 1.4 log cycles), these results show that reductions in bacterial numbers on chicken carcasses can be achieved by simply changing the scalding temperature.

Key words: Scalding temperature, Salmonella, Campylobacter, chicken carcasses

MATERIALS AND METHODS

Experimental design

Live chickens (6 to 7 weeks old) obtained from a commercial company were divided into three groups of 15 birds each and processed at one of three scalding temperatures, 52, 56, or 60°C, at the pilot chicken-processing plant at the University of Arkansas. The scalding times were 2.0, 1.5, and 1.0 min, and picking times were 1.3, 1.0, and 1.0 min for 52, 56, and 60°C scalding temperatures, respectively, as in a previous study (2). Each carcass was hung, eviscerated and inoculated with a mixed culture of Salmonella typhimurium (ATCC 14028) and Campylobacter jejuni (ATCC 33291) by spraying 2.5 ml (10⁸ to 10⁹ CFU per ml of physiological saline) of inoculum on the breast and back surfaces. After 15 min, each carcass was sprayed with tap water (1.2 l per carcass) at 25 psi to remove unattached bacteria and drained for 10 s. Each group of chicken carcasses was chilled in a separate tank containing 100 kg of 4°C water for 30 min. After draining (~5 s) each carcass was bagged separately and mechanically shaken for 1 min with 100 ml of 0.1% peptone water. The wash waters were collected for recovering Salmonella and Campylobacter. The experiment was repeated three times.

Most probable number (MPN) of Salmonella

The procedures previously described were followed (3). Briefly, each wash water was serially diluted from 10⁰ to 10⁴ with phosphate-buffered water (pH 7.3) and 5 ml of each dilution was transferred to three tubes of 5 ml of double-strength buffered peptone water (BPW, Difco Laboratories, Detroit, MI). After incubation for 20 h at 37°C, 1 ml of each culture was transferred to 9 ml of tetrathionate-Hajna broth (Difco) and incubated for 20 h at 43°C. All cultures were streaked on brilliant green sulfa (BGS) agar (Difco), modified lysine iron agar (MLIA) (7), and xylose lysine tergitol 4 (XLT4) agar (5) and incubated for 20 to 24 h at 37°C. Suspect colonies were confirmed by serological test using poly-O antiserum (Difco). The number of salmonellae was calculated using an MPN table (6) and converted to log number of cells per carcass.

MPN of Campylobacter

The procedures described previously (8) were followed with a minor modification. Briefly, 1 ml of each serially diluted...
washed water (described above) was transferred to three tubes of 5 ml of Brucella-FBP broth with oxyrase (Oxyrase, Inc., Mansfield, OH) and incubated for 24 h at 42°C. The subsurface culture was streaked on Campy-Cefex agar (9), and the plates were placed in a microaerobic atmosphere and were incubated for 48 h at 42°C. Suspect Campylobacter colonies were confirmed by their characteristic corkscrew shapes and tumbling motion seen under a phase-contrast microscope. The number of campylobacters was calculated using an MPN table (6) and converted to log number of cells per carcass.

Statistical analysis
The data of the MPN results were analyzed by analysis of variance and the means were separated by Fisher's least significant difference (LSD) procedure.

RESULTS AND DISCUSSION

In the first two trials, the numbers of Salmonella on carcasses scalded at 52 or 56°C were significantly lower (P < 0.05) than the numbers attached to the carcasses scalded at 60°C by about 0.3 to 0.5 log cycles (Table 1). No difference was observed between the carcasses at 52 and 56°C. The differences in the numbers of Campylobacter were even greater than the differences in Salmonella among the three groups of carcasses in the first two trials. The lowest numbers of Campylobacter were recovered from carcasses scalded at 56°C which were about 0.7 log cycles lower than the numbers from 60°C scalding (P < 0.05). Based on a previous study (2), the optimum scalding temperature was 56°C because the resulting skin microtopography allowed less bacterial attachment and entrapment due to the hydrophobicity and smoothness of the stratum corneum surface. Therefore, the lowest level of Campylobacter in the carcasses scalded at 56°C in this study satisfied the previous hypothesis. Although the difference was insignificant, the 52°C scalding generally produced carcasses having lower levels of Campylobacter than 60°C scalding.

No significant differences were observed in the third trial. One possible explanation is that the birds in the third trial may have been younger than the birds in the first two trials since the conditions for scald/picking in this study were set up for 6 to 7 week-old birds. Because younger birds have thinner keratinized epidermal layers than older birds, younger birds may lose the whole epidermis and expose dermis even at the low scalding temperatures, 52 and 56°C. Therefore, the skin microtopographies produced would be similar to those from 60°C scalding, and consequently no differences were observed in the number of attached bacteria among the three groups.

The differences in bacterial loads among the three treatment groups of chicken carcasses were lower (by about 0.3 to 0.7 log cycles) than previous skin model studies where the skins scalded at 60°C allowed 1.1 to 1.3 greater log counts of Salmonella typhimurium and 1.3 to 1.6 greater log counts of Campylobacter jejuni compared to skins scalded at 52 or 56°C (2, 3). Because the birds in this study were normally processed in a pilot plant to mimic the conventional processing line, the exposure of the body cavity by evisceration might be a major factor contributing to the smaller differences in bacterial loads between the carcasses scalded at 60°C and the carcasses at 52 or 56°C, compared with the differences noted in the skin model study.

Although the differences in bacterial load were not as great as the differences seen in previous skin model studies, the carcasses scalded at 52 or 56°C still had about 0.3 to 0.7 lower log numbers (50 to 80% less) of Salmonella and Campylobacter than the carcasses at 60°C. These results again suggest the importance of choosing a proper scalding temperature which produces the optimum skin microtopography that results in the least bacterial attachment to chicken skin during processing.

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REFERENCES


TABLE 1. Numbers of Salmonella and Campylobacter (log MPN per carcass) on chicken carcasses processed at three different scalding temperatures.

<table>
<thead>
<tr>
<th>Bacterium</th>
<th>Scald Temperature</th>
<th>Trial 1</th>
<th>Trial 2</th>
<th>Trial 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salmonella</td>
<td>52°C</td>
<td>3.00 ± 0.52&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.17 ± 0.37&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.09 ± 0.54&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>56°C</td>
<td>3.16 ± 0.55&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.17 ± 0.42&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.34 ± 0.40&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>60°C</td>
<td>3.50 ± 0.61&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.48 ± 0.38&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.36 ± 0.62&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Campylobacter</td>
<td>52°C</td>
<td>3.64 ± 0.60&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.30 ± 1.07&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4.18 ± 0.69&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>56°C</td>
<td>3.39 ± 0.99&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.94 ± 0.62&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.93 ± 0.62&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>60°C</td>
<td>4.08 ± 0.56&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.59 ± 1.04&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.98 ± 0.76&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>a</sup> Values (mean ± SD) with different superscripts are significantly different (P < 0.05).
Attachment of *Salmonella typhimurium* to skins of chicken scalded at various temperatures. J. Food Prot. 56:661-665, 671.


