Reduction of *Escherichia coli* O157:H7 and *Salmonella* using Dry Chilling in small processing plant environments

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**Abstract**

Contamination of beef carcasses during the slaughter process is inevitable. The objective of this study was to verify the use of dry chilling up to 28d as an effective means of reducing *E. coli* O157:H7 and *Salmonella* on beef lean and adipose tissues compared to conventional spray chilling. Inoculation and lean tissue samples were obtained before interventions from a harvest facility and transported back to TTU Pathogen Laboratory. Samples were then inoculated with a cocktail of either three strains of *E. coli* O157:H7 or salmonella from stock culture at Texas Tech University Pathogen Laboratory. Samples were inoculated by dipping and allowed to attach for 20 min before subjecting samples to their respective treatments.

**Materials and Methods**

- **Inoculation**
  - Hot lean and adipose tissue were obtained from a commercial slaughter facility
  - Tissue was fabricated into 20 cm X 20 cm pieces
  - 5 x 5 cm samples were aseptically excised and plated for enumeration using the thin-agar overlay method at 37°C, an air velocity of 0.0 to 0.25 m/s with a relative humidity of 80% to 90%

- **Treatments**
  - **Dry Chilling:** Samples were hung for up to 28 days in an open air chill cooler with a temperature of 3°C, an air velocity of 0.0 to 0.25 m/s with a relative humidity of 80% to 90%
  - **Spray Chilling:** Samples were hung for up to 28 days in an open air chill cooler with a temperature of 3°C, air velocity of 0.0 to 0.25 m/s with a relative humidity of 80%.

- **Bacteriology**
  - Lean and Fat Tissue were excised for enumeration or detection at 0, 24h, 36h, 48h, 7d, 14d, 21d, and 28d post-inoculation.
  - 5 x 5 cm samples were aseptically excised and 25 ml of BPW was added to a stomacher bag containing sample and stomached for 2 min at 2500 rpm.
  - Samples were enumerated by plating *E. coli* O157:H7 on to MacConkey Agar and Salmonella on to XLD Agar using a thin layer agar overlay using TSA (Kong and Fung, 2000) using an Autoplate 4000 spiral plater (Spiral Biotech).

**Results**

- No recoverable *E. coli* O157:H7 or Salmonella were found on fat or lean tissue samples of un-inoculated (control) samples.
- Higher numbers of bacteria were recovered from lean tissue samples compared to fat tissue samples for both Salmonella and *E. coli* inoculants (P<0.05).

**Table 1:** LS Mean comparison of recovery of *E. coli* O157:H7 for Lean and Fat Tissue Samples Inoculated with *E. coli* O157:H7 and Subjected to either Dry or Spray/Wet Chilling Methods over 28d, reported in Log of cfu/cm²

<table>
<thead>
<tr>
<th>Tissue</th>
<th>Treatment</th>
<th>0 d</th>
<th>24 h</th>
<th>36 h</th>
<th>48 h</th>
<th>7 d</th>
<th>14 d</th>
<th>21 d</th>
<th>28 d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lean</td>
<td>Dry</td>
<td>6.05±</td>
<td>5.16±</td>
<td>4.96±</td>
<td>4.45±</td>
<td>3.66±</td>
<td>2.98±</td>
<td>2.89±</td>
<td>1.10±</td>
</tr>
<tr>
<td></td>
<td>Spray/Wet</td>
<td>6.01±</td>
<td>4.44±</td>
<td>4.44±</td>
<td>4.23±</td>
<td>4.50±</td>
<td>4.07±</td>
<td>3.74±</td>
<td>3.67±</td>
</tr>
<tr>
<td>Fat</td>
<td>Dry</td>
<td>5.53±</td>
<td>4.31±</td>
<td>4.24±</td>
<td>3.89±</td>
<td>2.08±</td>
<td>2.12±</td>
<td>0.84±</td>
<td>0.95±</td>
</tr>
<tr>
<td></td>
<td>Spray/Wet</td>
<td>5.75±</td>
<td>3.61±</td>
<td>3.63±</td>
<td>3.81±</td>
<td>3.37±</td>
<td>2.94±</td>
<td>3.05±</td>
<td>3.66±</td>
</tr>
</tbody>
</table>

**For lean tissue samples inoculated with *E. coli* O157:H7:**
- A consistent statistical decline was seen for dry chill samples. While spray chill samples saw an initial decline and leveled out significantly different from 4d until 26d.
- A statistical difference was seen at 14d and continued until the 28d between Spray and Dry Chill treatments.

**For fat tissue samples inoculated with *E. coli* O157:H7:**
- A consistent statistical decline was seen for dry chill samples. While spray chill samples saw an initial decline and leveled out not being statistically different from 24d until 26d.
- A statistical difference was seen at 7d between Spray and Dry Chill Samples, and at 21d and 28d.

**Table 2:** LS Mean comparison of recovery of Salmonella for Lean and Fat Tissue Samples Inoculated with Salmonella and Subjected to either Dry or Spray/Wet Chilling Methods over 28d, reported in Log of cfu/cm²

<table>
<thead>
<tr>
<th>Tissue</th>
<th>Treatment</th>
<th>0 d</th>
<th>24 h</th>
<th>36 h</th>
<th>48 h</th>
<th>7 d</th>
<th>14 d</th>
<th>21 d</th>
<th>28 d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lean</td>
<td>Dry</td>
<td>6.08±</td>
<td>5.13±</td>
<td>4.92±</td>
<td>4.62±</td>
<td>3.76±</td>
<td>2.92±</td>
<td>1.93±</td>
<td>1.50±</td>
</tr>
<tr>
<td></td>
<td>Spray/Wet</td>
<td>6.04±</td>
<td>4.96±</td>
<td>4.96±</td>
<td>4.52±</td>
<td>4.06±</td>
<td>3.62±</td>
<td>3.42±</td>
<td>3.76±</td>
</tr>
<tr>
<td>Fat</td>
<td>Dry</td>
<td>5.71±</td>
<td>4.53±</td>
<td>4.43±</td>
<td>3.94±</td>
<td>2.94±</td>
<td>2.29±</td>
<td>1.72±</td>
<td>0.92±</td>
</tr>
<tr>
<td></td>
<td>Spray/Wet</td>
<td>5.78±</td>
<td>4.14±</td>
<td>4.16±</td>
<td>3.39±</td>
<td>3.03±</td>
<td>2.68±</td>
<td>2.36±</td>
<td>3.11±</td>
</tr>
</tbody>
</table>

**For lean tissue samples inoculated with Salmonella:**
- A consistent statistical decline was seen for dry chill samples.
- A statistical difference was seen at 14d between Spray and Dry Chill Samples, and continued until 28d.

**For fat tissue samples inoculated with Salmonella:**
- A consistent statistical decline was seen for dry chill samples.
- A statistical difference was seen at 21d between Spray and Dry Chill Samples, and continued until 28d.

**Implications**

Based upon results recommendation of a 21 d period of dry chilling under the same conditions should be used to reduce the number of pathogens on beef surface tissue. Results should be verified with an in plant study to use the Dry Chilling as a CCP step. Rapid air movement to facilitate faster desiccation of fat and lean surface tissue should be explored. Furthermore, the economic and environmental impact of water conservation by using dry chilling versus spray chilling is monumental.

**Literature Cited**
