Source Attribution of *Salmonella* in Ground Beef in Non-fed Processing Plants

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**Executive Summary**

**Background**

*Salmonella* in ground beef continues to represent a major challenge for the non-fed sector of the U.S. Beef processing sector. Because of the USDA regulations with respect to the presence of *Salmonella* in ground beef destined for the school lunch program and in general USDA focus on *Salmonella*, it behooves the industry to bring the same level of focus in controlling *Salmonella* as that of controlling *E. coli* O157. A number of Check Off funded projects have determined the prevalence of *Salmonella* as various steps in processing. These projects have also determined that lymph nodes can be a significant source of *Salmonella*. Because the lymph nodes from shank and brisket are not removed in non-fed plants and are subsequently ground, lymph nodes can be a major source of *Salmonella* in ground beef. The other primary source of *Salmonella* in ground beef is carcass surface tissue (originating from hide). In this project we set out to determine the relative contributions of the lymph nodes and carcass in the prevalence of *Salmonella* in ground beef. We will sample carcasses, flank lymph nodes from the same carcasses, brisket lymph nodes from the same carcasses and ground beef made from the same carcasses. We will obtain fingerprint of *Salmonella* isolates from each of the above samples. Comparing the fingerprints observed in ground beef with that of lymph nodes and carcasses will enable us to determine most probable source of *Salmonella* in ground beef. This information should enable the industry to better control the presence of *Salmonella*.

**Objectives**

1. Determine the prevalence of *Salmonella* on cow carcasses after hide removal and before any intervention.
2. To conduct PFGE analysis on *Salmonella* isolates from carcass samples.
3. Determine the prevalence of *Salmonella* in lymph nodes from chuck and flank of the same carcasses sampled above.
4. To conduct PFGE analysis on *Salmonella* isolates from lymph nodes.
5. To determine the prevalence of *Salmonella* in ground beef produced from carcasses sampled above.
6. To conduct PFGE analysis of the *Salmonella* isolated from lymph nodes
7. Using the above information determine the most likely source of *Salmonella* in ground beef and recommend appropriate measures to reduce or eliminate *Salmonella* from ground beef.

**Methods**

100 dairy cows were sampled throughout the harvest process. After harvest hides were sampled and after hide removal carcasses were sampled prior to any interventions. After overnight chilling carcasses were fabricated as a group and trim produced from these carcasses were collected and sampled. Trim was tested for *E. coli* O157:H7 by the cooperating plant and according to their standard protocol and the sample was found to be negative for *E. coli* O157:H7. Trim from theses carcasses were then ground separately and sampled frequently. Superficial cervical lymph nodes were obtained from the chuck of all 100 carcasses. We also sampled the air at each sampling site (harvest floor, fabrication and grinding facilities). All
sampled were analyzed for the presence of Salmonella and all salmonella isolates were analyzed by Pulse-Field Gel Electrophoresis (PFGE).

**Important Results**

Results indicate that while none of the air samples were positive for *Salmonella*, all animal/carcass samples had at least one positive sample for *Salmonella* (see the Table below). Of 457 samples collected 163 were confirmed to be positive for *Salmonella* (35.7%). As expected the highest number of positive *Salmonella* samples (96%) was hide samples followed by carcasses right after hide removal (47%). Eighteen percent of lymph nodes, 7.2% of trim and 1.7% of ground beef were positive for *Salmonella*. The PFGE results indicate that ground beef *Salmonella* had similar pattern as that of carcass and hide isolates but the trim isolate had the same pattern as that of lymph nodes. If we account for sampling errors due to no random distribution of *Salmonella*, the conclusion is that the predominant (if not the sole) sources of *Salmonella* (including multi-drug resistant *Salmonella*) are hide and lymph nodes.

<table>
<thead>
<tr>
<th>Sample</th>
<th># Observations</th>
<th>PCR Screen <em>Salmonella</em></th>
<th>Confirmed <em>Salmonella</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Hide</td>
<td>100</td>
<td>95</td>
<td>96</td>
</tr>
<tr>
<td>Pre-Evisc Carcasses</td>
<td>100</td>
<td>49</td>
<td>47</td>
</tr>
<tr>
<td>Carcasses - Hotbox</td>
<td>50</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Lymph Nodes</td>
<td>100</td>
<td>18</td>
<td>18 (18%)</td>
</tr>
<tr>
<td>Trim</td>
<td>14</td>
<td>1</td>
<td>1 (7.2%)</td>
</tr>
<tr>
<td>Ground Beef</td>
<td>60</td>
<td>1</td>
<td>1 (1.7%)</td>
</tr>
<tr>
<td>Air Samples</td>
<td>33</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Overall</strong></td>
<td><strong>457</strong></td>
<td><strong>164</strong></td>
<td><strong>163</strong></td>
</tr>
</tbody>
</table>

**Impact on the Beef Industry**

In 2009 for the first time ever more ground was recalled due to the presence of MDR *Salmonella* than *E. coli* O157:H7. In a number of industry sponsored meeting the USDA official have made it clear than unless the industry addresses the issue, Salmonella could also become an adulterant in trim and ground beef. To avoid such a regulatory outcome, beef industry needs to prevent more recalls due to MDR *Salmonella*. Know the source of MDR *Salmonella* is required for its control in ground beef. This project was therefore conducted to determine the source MDR *Salmonella* in ground beef. Results indicate that hide and lymph nodes are the source of MDR *Salmonella* in ground beef. We have disseminated this information to the industry and we are collectively attempting to use this information to control MDR *Salmonella* in beef.
Lay Summary

*Salmonella* in ground beef continues to represent a major challenge for the non-fed sector of the U.S. Beef processing sector. Because of the USDA regulations with respect to the presence of *Salmonella* in ground beef destined for school lunch program and in general USDA focus on *Salmonella*, it behooves the industry to bring the same level of focus in controlling *Salmonella* as that of controlling *E. coli* O157. This project was designed to sample all materials that end up in ground beef and test them for the presence of *Salmonella*. Once *Salmonella* is found, they were subject to DNA finger printing. We also did the same for ground beef (look for *Salmonella* and then finger print them). DNA finger printing allowed us to determine the most likely source of *Salmonella* in ground beef. Results indicate that hide and lymph nodes are the source of MDR *Salmonella* in ground beef. We have disseminated this information to the industry and we are collectively attempting to use this information to control MDR *Salmonella* in beef.

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