U.S. EXPERIENCE:

DECONTAMINATION PROCEDURES FOR MEAT

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Hazards Associated With Foodborne Illness

Foodborne illness incidents/outbreaks due to:

Chemical Hazards 4%
Physical Hazards 2%
Biological Hazards 94%
### Annual Foodborne Illnesses in the U.S.

(Of 9.4/38.4 million est. cases by 31 pathogens/unspecified agents, respectively)

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Rank (cases)</th>
<th>Est. No. Episodes</th>
<th>Hospitalizations</th>
<th>Deaths</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Norovirus (viral)</td>
<td>1</td>
<td>5,461,731</td>
<td>14,663</td>
<td>149</td>
<td>0.0027</td>
</tr>
<tr>
<td><em>Salmonella</em> spp., Nontyphoidal</td>
<td>2</td>
<td>1,027,561</td>
<td>19,336</td>
<td>378</td>
<td>0.0368</td>
</tr>
<tr>
<td><em>Clostridium perfringens</em></td>
<td>3</td>
<td>965,958</td>
<td>438</td>
<td>26</td>
<td>0.0027</td>
</tr>
<tr>
<td><em>Campylobacter</em> spp.</td>
<td>4</td>
<td>845,024</td>
<td>8,463</td>
<td>76</td>
<td>0.0090</td>
</tr>
<tr>
<td><em>Staphylococcus aureus</em></td>
<td>5</td>
<td>241,148</td>
<td>1,064</td>
<td>6</td>
<td>0.0025</td>
</tr>
<tr>
<td><em>Shigella</em> spp.</td>
<td>6</td>
<td>131,254</td>
<td>1,456</td>
<td>10</td>
<td>0.0076</td>
</tr>
<tr>
<td>Non-O157 STECs</td>
<td>7</td>
<td>112,752</td>
<td>271</td>
<td>0</td>
<td>0.0000</td>
</tr>
<tr>
<td><em>Yersinia enterocolitica</em></td>
<td>8</td>
<td>97,656</td>
<td>533</td>
<td>29</td>
<td>0.0297</td>
</tr>
<tr>
<td><em>Toxoplasma gondii</em> (parasite)</td>
<td>9</td>
<td>86,686</td>
<td>4,428</td>
<td>327</td>
<td>0.3772</td>
</tr>
<tr>
<td><em>Giardia intestinalis</em> (parasite)</td>
<td>10</td>
<td>76,840</td>
<td>225</td>
<td>2</td>
<td>0.0026</td>
</tr>
<tr>
<td><em>Bacillus cereus</em></td>
<td>11</td>
<td>63,400</td>
<td>20</td>
<td>0</td>
<td>0.0000</td>
</tr>
<tr>
<td><em>Escherichia coli</em> O157</td>
<td>12</td>
<td>63,158</td>
<td>2,128</td>
<td>30</td>
<td>0.0017</td>
</tr>
</tbody>
</table>
Results of raw ground beef products analyzed for *E. coli* O157:H7 in federal plants.

* In ‘98, FSIS increased sample size from 25 g to 375 g.
** In July ‘99, FSIS changed to a more sensitive analytical method.
*** In Oct ‘05, a new screening method was introduced to reduce the number of screen positives that do not confirm positive.
**** Raw GB through May 20, 2012.
2010 CDC Healthy People Data & Targets

(Accessed May 29, 2012)

E. coli O157:H7  Listeria monocytogenes

Cases per 100,000
USDA-FSIS Prevalence Of *Salmonella* spp. In/On Beef*

* FSIS results of ground beef analyzed for *Salmonella* spp. Data for ’98 through ’05 reflects “A” sample sets, while data for ’06-’09 reflects all samples.

**Since June 2006, establishments have been scheduled based on risk-based criteria designed to focus FSIS resources on establishments with the most samples positive for *Salmonella* and the greatest number of samples with serotypes most frequently associated with human salmonellosis.

***Following 2010, % prevalence became useless because of targeted/class sampling policy.
Sec. 602. Congressional statement of findings

Meat & meat food products are an important source of the Nation's total supply of food. They are consumed throughout the Nation & the major portion thereof moves in interstate or foreign commerce. It is essential in the public interest that the health & welfare of consumers be protected by assuring that meat & meat food products distributed to them are wholesome, not adulterated, & properly marked, labeled, & packaged . . .
FSIS RESPONSIBILITIES

1. Antemortem inspection.
2. Humane methods.
3. Postmortem inspection.
4. Product inspection.
5. Assurance that all plants adopt & use HACCP.
6. Assurance that SSOPs are practiced by personnel.
7. Verification of HACCP System effectiveness (Salmonella performance standards).
8. Oversight of plant generic E. coli testing protocols.
9. Laboratory determinations & assays.
11. Marking, labeling, & inspection insignia.
12. Facilities construction & operational sanitation.
## Pre-requisite Programs to HACCP

<table>
<thead>
<tr>
<th>NACMCF</th>
<th>FDA</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Facilities</td>
<td>(12) Allergen Control</td>
</tr>
<tr>
<td>(2) Supplier Control</td>
<td>(13) Complaint Investigation</td>
</tr>
<tr>
<td>(3) Specifications</td>
<td>(14) Labeling</td>
</tr>
<tr>
<td>(4) Production Equipment</td>
<td>(15) Preventive Maintenance</td>
</tr>
<tr>
<td>*(5) Cleaning &amp; Sanitation</td>
<td>(16) Water Quality &amp; Treatments</td>
</tr>
<tr>
<td>*(6) Personal Hygiene</td>
<td>(17) Document &amp; Record Control</td>
</tr>
<tr>
<td>(7) Employee Education/Training</td>
<td>(18) Internal Audits</td>
</tr>
<tr>
<td>(8) Chemical Control</td>
<td>(19) Calibration</td>
</tr>
<tr>
<td>(9) Receiving/Storage/Shipping</td>
<td>(20) Sensory Testing</td>
</tr>
<tr>
<td>(10) Traceability &amp; Recall</td>
<td></td>
</tr>
<tr>
<td>(11) Pest Control</td>
<td></td>
</tr>
</tbody>
</table>
Plant Pre-Operational Sanitation (SSOPs)

1. Equipment disassembly & dry pick-up (often by plant personnel).
2. Rinsing (from top of equipment or structures down towards the floor).
3. Foaming (w/ cleaner).
4. Scrubbing of all product contact surfaces.
5. Rinsing & 2nd scrubbing as needed.
6. Application of 1st & strongest sanitizer.
7. 3rd Rinse.
SEVEN PRINCIPLES OF HACCP

Following full implementation of written Pre-Requisite Programs (GMPs, SSOPs):

1. Conduct a Hazard Analysis.
2. Identify Critical Control Points (CCPs).
3. Establish Critical Limits (CLs).
5. Determine Appropriate Corrective Actions.
6. Establish Verification procedures to ensure that the system works.
7. Maintain accurate Record-Keeping.
Multiple Hurdles Technology

**Beef Slaughter**

- Antemortem Inspection
- Immobilization
- Stunning
- Exsanguination
- Hide washing
- Hoof removal
- Hide removal
- Head removal
- Pre-Evis washing/OA
- Bunging
- Evisceration
- Splitting
- Postmortem Inspection
- Washing/TP/OA
- Chilling
Carcass Contamination
Prevalence Of *E. Coli* O157:H7 In Feedlot Cattle Feces, Hides, & Carcasses

Of 15 lots tested:

- 87% at least one positive feedlot fecal sample.
- 54% positive hide sample.
- 80% positive colon.
- 47% positive pre-evis.
- 6% positive post-evis.
- 6% positive final intervention.

<table>
<thead>
<tr>
<th>Sample Type</th>
<th>&gt; 20%</th>
<th>&lt; 20%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hide</td>
<td>20%</td>
<td>5.7%</td>
</tr>
<tr>
<td>Colon</td>
<td>46.3%</td>
<td>7.1%</td>
</tr>
<tr>
<td>Pre-Evis</td>
<td>12.5%</td>
<td>7.1%</td>
</tr>
<tr>
<td>Post-Evis</td>
<td>2.5%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Post-Final</td>
<td>0.6%</td>
<td>0.0%</td>
</tr>
</tbody>
</table>

Stratified by % *E. coli* O157:H7 on Pen Floor

Funded by USDA-CSREES
Hide Washing Systems

Cargill's system includes a water and sodium hydroxide mix to release contaminants, followed by a high-pressure rinse and lactic acid application.

Cargill sharpens its edge on E. coli O157:H7

A unique partnership yields a promising new carcass wash system

By Donald J. Nietch, editor

By Donald J. Nietch, editor

Cargill has found a new way to wash carcasses that improves food safety and reduces E. coli O157:H7.

The company has partnered with FoodTech Innovations to develop a new carcass wash system that uses a combination of water, sodium hydroxide, and a high-pressure rinse with a lactic acid application.

The system is designed to reduce the number of E. coli O157:H7 on carcasses by over 99%.

The company has been working on the system for several years and has received positive results from field trials.

"We've seen a significant reduction in E. coli O157:H7 numbers," said Cargill's vice president of food safety.

The system is currently being tested at Cargill's plants and is expected to be fully implemented by the end of the year.

"We're excited to bring this technology to market," said Cargill's CEO.

The company hopes to release the system to other meat processors soon.

"We believe this technology will help improve food safety for everyone," said Cargill's CEO.
Hock/Carcass Steam-Vacuuming
Pre-evisceration Washing/OA Spraying Of Carcasses
Warm-water Carcass Washing/Zero Tolerance Trimming
Thermal Pasteurization Of Carcasses
Organic Acid Spraying
Reductions In Inoculated E. Coli O157:H7 On Beef Carcass Tissue Using Various Decontamination Solutions (Ransom et al., 2001)

*Plated on sorbitol MacConkey agar
Effect of BoviBrom on Hot Carcass Surface TPC

(Pittman et al., 2011)
Plate Counts By Sampling Site
(8 Plants; N = 1,280; Bacon et al., 2000)
### Salmonella On Beef Carcasses At Two In-plant Sampling Sites

(Source: Bacon et al., 2001)

<table>
<thead>
<tr>
<th>Plant</th>
<th>Hide-On (Site 1)</th>
<th>Carcass (Site 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. Positive</td>
<td>% Prevalence</td>
</tr>
<tr>
<td></td>
<td>Samples</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>19</td>
<td>47.5&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>10.0&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>4</td>
<td>9</td>
<td>23.1&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>5</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>6</td>
<td>4</td>
<td>10.0&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>7</td>
<td>7</td>
<td>17.5&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>8</td>
<td>6</td>
<td>15.0&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Total</td>
<td>49</td>
<td>15.4&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
</tbody>
</table>
AMIF Project Summary:
Incidence of *E. coli* O157:H7

<table>
<thead>
<tr>
<th>Beef Packing Plants</th>
<th>n =</th>
<th>Hide-on (%)</th>
<th>Prior to washing (%)</th>
<th>Following Intervention (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>2,248</td>
<td>3.56&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.44&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.00&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

- No beef trimming samples were found to test positive for *E. coli* O157:H7 when sampled on the same days as carcasses.

Source: Incidence Of *Escherichia coli* O157:H7 (AMIF/CSU, 2000)
Organic Acid Systems

- Worker safety hazards are minimized
  - Ventilation
  - In-Line mixing
  - Drainage
  - Air curtains
  - Low application concentrations
Lactic Acid

- Processing Aid at concentrations up to 5% (USDA-FSIS, 2006).
- Human blood contains 8-17 mg /100 ml plasma (USFDA, 1978).
- Humans produce 140 g daily during metabolism (Kreisberg et al., 1971; USFDA, 1978).

**Residual lactic acid on beef samples after dipping for 30 sec at 55°C in lactic acid solution**

<table>
<thead>
<tr>
<th>Lactic acid solution (%)</th>
<th>Control (ppm)</th>
<th>Treated (ppm; mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.5</td>
<td>16.8</td>
<td>28.0</td>
</tr>
<tr>
<td>5.0</td>
<td>33.6*</td>
<td>56.0*</td>
</tr>
</tbody>
</table>

* Assuming a linear relationship between lactic acid spray concentration and meat residue concentration

**Source: Rose et al. (2004)**

- Worst case: Residual concentration from 5.0% LA spray = 56 mg/kg beef.

<table>
<thead>
<tr>
<th>Animal</th>
<th>Route</th>
<th>Acute Toxicity LD₅₀ (mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rat</td>
<td>Intraperitoneal (Na lactate)</td>
<td>2,000</td>
</tr>
<tr>
<td>Rat</td>
<td>Oral (lactic acid)</td>
<td>3,730</td>
</tr>
<tr>
<td>Mouse</td>
<td>Oral</td>
<td>4,875</td>
</tr>
</tbody>
</table>

**Source: WHO (1974)**
LA on Beef Trimmings  (SOURCE: Fouladkhah et al., 2011)

- Untreated control
- 5% Lactic acid, 25°C
- 5% Lactic acid, 55°C

Dipping, 30 s TSA+rif

Graph showing Log CFU/cm² for different STEC Serotypes:
- O157:H7
- O26
- O45
- O103
- O145
- O111
- O121
LA on Beef Trimmings (SOURCE: Fouladkhah et al., 2011)

- Untreated control
- 5% Lactic acid, 25°C
- 5% Lactic acid, 55°C

Dipping, 30 s
TSA+rif/XLD agar
TPC Remaining 0-hr Following Treatment At Various Application Parameters On **Chilled** Beef Brisket Sections

**Graph Description:**
- **X-axis:** Treatment (Concentration)
- **Y-axis:** TPC (log CFU/cm²)
- **Legend:**
  - 1.03 bar 0.22 lpm
  - 1.03 bar 6.62 lpm
  - 4.83 bar 0.22 lpm
  - 4.83 bar 6.62 lpm

**Treatments:**
- Blitz (180 ppm)
- Blitz (220 ppm)
- Citrus Essential Oil (3.00%)
- Citrus Essential Oil (6.00%)
- Inspecx 200 (100 ppm)
- Inspecx 200 (220 ppm)
- Lactic Acid - 22C (2.50%)
- Lactic Acid - 22C (5.00%)
- Lactic Acid - 48C (2.50%)
- Lactic Acid - 48C (5.00%)
- Lactic Acid/Sodium Bisulfate - 22C (3.00%)
- Lactic Acid/Sodium Bisulfate - 48C (3.00%)
- Sodium Bisulfate (2.50%)
- SYNTRX 3300 (3.00%)
- Water
TPC for Differing Inoculants Remaining After Treatment With 1\textsuperscript{st} & 2\textsuperscript{nd} Lactic Acid Applications

Chilled Beef brisket (\textit{Pectoralis major}) & knuckles (quadriceps) inoculated with 6.0 log CFU/cm\textsuperscript{2}
Variety Meat Interventions
## Variety Meat Interventions

(Sources: Delmore et al., 1998; Zerby et al., 1998; CSU/USMEF)

<table>
<thead>
<tr>
<th>Intervention</th>
<th>L. Intestine</th>
<th>Tongue</th>
<th>Oxtail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control/A</td>
<td>4.5&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5.9&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.2&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Control/B</td>
<td>2.4&lt;sup&gt;c&lt;/sup&gt;</td>
<td>5.9&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>AASP or DP/A</td>
<td>3.7&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>3.1&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>2.5&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>AASP or DP/B</td>
<td>2.6&lt;sup&gt;c&lt;/sup&gt;</td>
<td>2.3&lt;sup&gt;c&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>LADP/A</td>
<td>3.3&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.5&lt;sup&gt;c&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>LADP/B</td>
<td>3.6&lt;sup&gt;b&lt;/sup&gt;</td>
<td>3.5&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
</tr>
</tbody>
</table>

<sup>a,b</sup> Means in a column bearing different superscript letters differ (*P < .05*).