The microbiological risks of mechanically tenderizing beef products

Trish Desmarchelier
MI & QA meeting September, 2013
Tenderness influences consumer choice
Tenderizing improves less expensive cuts
Questions

• Which beef products are of concern?
• What are the public health and economic concerns?
• What is the evidence for contamination?
• What factors influence contamination?
• What interventions are there?
• What is the risk?
• Sum up
Which products are of concern?

No standard definition

• FSIS proposal for mechanically tenderized beef:
  • raw or partially cooked,
  • blade or needle tenderized,
    – including products injected with marinade or solution

Note: Can apply to all non-intact products

How common are these products?

Australia ??

USA:
• 18% beef at retail, 25% steaks at restaurants mechanically tenderized or chemically enhanced
• = 22.7x10^6 Kg/month; 33% is beef ribeye

Canada:
• up to 25% total production volume
• retailers produce 3x amount of processors
• injected to blade tenderized ratio::1:11

## What are the public health concerns?

### Outbreaks and *E. coli* O157

<table>
<thead>
<tr>
<th>Year</th>
<th>Product attributed</th>
<th>Tenderization process</th>
<th>Solution/process used</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>sirloin steak</td>
<td>needle</td>
<td>?</td>
<td>USA</td>
</tr>
<tr>
<td>2003</td>
<td>bacon-wrapped b/less beef fillet</td>
<td>needle</td>
<td>marinade, injected</td>
<td>USA</td>
</tr>
<tr>
<td>2004</td>
<td>steak</td>
<td>blade</td>
<td>marinade, vacuum tumbled</td>
<td>USA</td>
</tr>
<tr>
<td>2007</td>
<td>tri-tip beef</td>
<td>needle</td>
<td>seasoned marinade, injected</td>
<td>USA</td>
</tr>
<tr>
<td>2007</td>
<td>steak</td>
<td>needle</td>
<td>marinade, injected</td>
<td>USA</td>
</tr>
<tr>
<td>2009</td>
<td>steak</td>
<td>blade</td>
<td>marinade, vacuum tumbled</td>
<td>USA</td>
</tr>
<tr>
<td>2012</td>
<td>steak</td>
<td>needle</td>
<td></td>
<td>Canada</td>
</tr>
</tbody>
</table>

Important features of hazards

- **E. coli O157**
  - few cells present risk of infection in susceptible groups
- **Salmonella**
  - possible contaminant in dried spices used in marinades
- **Contributing factors in outbreaks:**
  - needle > blade tenderization
  - solutions applied
  - inadequate cooking reported
- **Note:** spore formers etc still important

Economic consequences

• **USA**, since 2000
  - ~ 7.7 million Kg beef recalled

• **Canada**, 2012, *E. coli* O157 outbreak linked with XL Foods Inc.
  - ~1,800 product types recalled
    = ~4,000 tonnes beef/beef products domestic & internationally
    = represents ≥ 12,000 head of cattle
  - estimated loss to Canadian beef industry $CAN16-27 million
  - loss customer and consumer confidence in Canadian beef

What is the evidence for contamination?
Contamination below surface in tenderized beef strip loins collected at beef packing plant (Canada)

What factors influence contamination?

From: Food Poisoning Journal, 26/12/09. http://www.foodpoisonjournal.com/food-poisoning-information/my-steak-has-been-needle-or-blade-penetrated-or-hammered-really-what-about-e-coli/#.UiQVGZ1--mQ
Most contamination is in the top 1cm; 3-4% is in the centre

<table>
<thead>
<tr>
<th>Zone</th>
<th>Depth (cm)</th>
<th>% transfer</th>
<th>Initial levels (log cfu(_{10}/g))</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Initial</td>
<td>Transfer</td>
</tr>
<tr>
<td></td>
<td></td>
<td>levels</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(3.19)</td>
<td>(0.6)</td>
</tr>
<tr>
<td>S1</td>
<td>1</td>
<td>32</td>
<td>41</td>
</tr>
<tr>
<td>S2</td>
<td>2</td>
<td>4.6</td>
<td>1.25</td>
</tr>
<tr>
<td>S3</td>
<td>3</td>
<td>0.14</td>
<td>7.5</td>
</tr>
<tr>
<td>S4</td>
<td>4</td>
<td>0.01</td>
<td>0</td>
</tr>
<tr>
<td>S5</td>
<td>6</td>
<td>0.26</td>
<td>0</td>
</tr>
<tr>
<td>S6</td>
<td>8</td>
<td>0.16</td>
<td>5</td>
</tr>
<tr>
<td>Total transfer</td>
<td></td>
<td>37</td>
<td>55</td>
</tr>
</tbody>
</table>

Other findings related to contamination

- Level in centre greater if 2 sides penetrated
- Cross-contamination can occur
  - between sequential cuts
  - with brine re-use
- Same level (%) of transfer regardless of:
  - amount of surface contamination
  - number of incision passes

Pathogens internalized by marinating; increased with use of vacuum

*Salmonella* inoculated on turkey breast

Marinated 5, 10, 20 min at 4°C

What interventions are available?
Pre-harvest and harvest

- No specific interventions
  - GHP, GMP, HACCP etc.
- Minimise surface contamination
- Under current processing conditions there are low prevalences and levels of STEC and Salmonella on carcasses

From: http://ABC Rural //www.abc.net.au/site-archive/rural/news/content/201108/s3289513.htm
Survey *E. coli* O157 on beef subprimals intended for blade tenderization, USA

<table>
<thead>
<tr>
<th>Sample Details</th>
<th>Result Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,014 samples collected over 5 weeks</td>
<td>0.2% (2/1,014) positive using PCR-BAX method</td>
</tr>
<tr>
<td>Sponged over 200 cm²</td>
<td>&lt;0.375 cfu/cm² by MPN</td>
</tr>
</tbody>
</table>

Pathogen growth controlled by chilling; growth with temperature abuse

$L_{\text{10}}$ cfu change

$E.\ coli$ O157 and top 1 cm of tenderized subprimals

Temperature ($^0\text{C}$)/days

Intervention pre-tenderization can reduce surface levels $\sim 1 \log_{10} \text{cfu}/100\text{cm}^2$

Experiments with *E. coli* O157 on beef subprimals:
1. Hot water
2. Lactic acid (2.5 and 5%)
3. 2% activated lactoferrin
4. 2 and 3

Result:
- Mean surface reductions $0.93 - 1.1 \log_{10} \text{cfu}/100\text{cm}$
- Ads to brine??

Inactivation by cooking

Multiple interacting factors such as:

- Method of cooking
- Type of beef cut and tenderizing process
- Insulating effects of fat and connective tissue
- Thickness, cold spots
- Uneven distribution of bacteria
- Bacterial strain differences
- Brine ingredients if used
Less thermal inactivation with injected than blade tenderized beef

Example: *E. coli* O157 reduction in gas flame grilling of beef

<table>
<thead>
<tr>
<th>Process</th>
<th>Internal temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>63°C</td>
</tr>
<tr>
<td>injected</td>
<td>2.7</td>
</tr>
<tr>
<td>blade tenderized</td>
<td>3.8</td>
</tr>
<tr>
<td>intact (control)</td>
<td>4.5</td>
</tr>
</tbody>
</table>

Commercial cooking USA

Experiment with STEC:
• B/less beef ribeye, single pass blade tenderized
• Sear, cook, hot hold

Result: For $5.0 \log_{10}$ cfu/g reduction
• Sear/broil $260^\circ$C/15min
• Cook commercial convection oven to internal temperatures $48.9 - 71.1^\circ$C
• Hold $60^\circ$C for at least 8hr

# Risk relative to intact cuts

**Canada, 2013* E. coli O157 quantitative risk assessment**

<table>
<thead>
<tr>
<th>Product</th>
<th>Intervention</th>
<th>X riskier than intact beef</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanically tenderized</td>
<td>none</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>pre-tenderization (0.4 - 0.6 reduction)</td>
<td>3.6</td>
</tr>
<tr>
<td></td>
<td>pre-tenderization (1.4 - 1.6 reduction)</td>
<td>near =</td>
</tr>
<tr>
<td></td>
<td>cooking</td>
<td>insufficient data</td>
</tr>
<tr>
<td>Ground</td>
<td>none</td>
<td>1,500 – 7,300</td>
</tr>
</tbody>
</table>

North American proposed approach

Labeling

• Label products meeting the proposed definition **unless** destined to be fully cooked at an official establishment

• Label to include:
  – “mechanically tenderized “ and an accurate description of the beef component
  – Validated cooking instructions to ensure they are fully cooked
    ▪ Specified minimum temperature
    ▪ Holding or rest time at that temperature before consumption (if required)

Consumer advice

Example in Australia: NSW Food Authority website cited September 2013

63°C, 3min rest time (medium rare)
Sum up

- Internalization of pathogens can occur
- Multiple factors determine level of pathogens internalized
- Likelihood low; health and $$ consequences can be high
- Minimize risk:
  - implement meat food safety program through chain
  - pre-tenderization intervention??
  - labeling
  - cooking according to product label instructions
Remember: there is only one way to measure the internal temperature of meat!

Thank you