RESEARCH UPDATE ON LISTERIA IN FRESH PRODUCE – POSTHARVEST PROCESSING, PACKAGING AND DISTRIBUTION

Elliot Ryser
Michigan State University

Workshop
Evaluation of Risk Factors for Foodborne Listeriosis
College Park, MD

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## Fresh Produce Recalls: 2010 - 2015

<table>
<thead>
<tr>
<th>Product</th>
<th>Number of recalls</th>
<th>Product</th>
<th>Number of recalls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lettuce</td>
<td>19</td>
<td>Cilantro</td>
<td>1</td>
</tr>
<tr>
<td>Sprouts</td>
<td>12</td>
<td>Honeydew Melon</td>
<td>1</td>
</tr>
<tr>
<td>Cantaloupe</td>
<td>8</td>
<td>Mangoes</td>
<td>1</td>
</tr>
<tr>
<td>Apples</td>
<td>7</td>
<td>Mushrooms</td>
<td>1</td>
</tr>
<tr>
<td>Onions</td>
<td>3</td>
<td>Nectarines</td>
<td>1</td>
</tr>
<tr>
<td>Spinach</td>
<td>3</td>
<td>Peaches</td>
<td>1</td>
</tr>
<tr>
<td>Avocados</td>
<td>1</td>
<td>Peppers</td>
<td>1</td>
</tr>
<tr>
<td>Celery</td>
<td>1</td>
<td>Plums</td>
<td>1</td>
</tr>
</tbody>
</table>

Available at: [http://www.fda.gov/Safety/Recalls/ArchiveRecalls/default.htm](http://www.fda.gov/Safety/Recalls/ArchiveRecalls/default.htm)
THREE KEY POINTS TO CONSIDER

• PROCESSING
  – *Listeria* transfer and spread during commercial preparation of fresh-cut produce
    • Slicing, dicing, flume washing, conveying

• PACKAGING
  – Impact of packaging systems on *Listeria* growth and survival in fresh-cut produce

• DISTRIBUTION
  – Potential for pathogen survival/growth during commercial transport, retail storage and display
Preparation of Fresh-Cut Produce is Highly Variable

• **Commercial Processors**
  – Mechanical
  – Semi-mechanical
  – Manual

• **Foodservice/Supermarkets**
  – Semi-mechanical
  – Manual
Pathogen Transfer during Simulated Commercial Production of Fresh-Cut Leafy Greens


Leafy Green Processing Line
Major Findings

• About 90% inoculum transferred from lettuce to flume water in the absence of a sanitizer
• About 30% of the inoculum on the lettuce transfer was removed during centrifugal drying
• When used as a colored surrogate for iceberg lettuce, 20 lbs. of inoculated radicchio spread to 2000 lbs. of iceberg lettuce with all 40 50-lb lots contaminated
Listeria Transfer during Dicing of Celery Preparation of Fresh-Cut Produce

Percentage of Swiss Chard Transferred

Swiss chard transferred (%) vs Batch

Batch categories: Equipment, Unaccounted For

Values: 0, 10, 20, 30, 40, 50, 60

Note: The graph shows the percentage of Swiss chard transferred across different batches.
Growth of *L. monocytogenes* in Diced Celery at 10°C

Generation time = 0.87 d
Fresh-Cut Celery Inoculated with *L. monocytogenes*, Sanitized, and Packaged


<table>
<thead>
<tr>
<th>Material</th>
<th>Initial Atmosphere</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bio-based polyester</td>
<td>Air</td>
<td>A-BB</td>
</tr>
<tr>
<td>Bio-based polyester</td>
<td>99% Nitrogen</td>
<td>N-BB</td>
</tr>
<tr>
<td>Bio-based polyester</td>
<td>99% Oxygen</td>
<td>O₂-BB</td>
</tr>
<tr>
<td>Bio-based polyester</td>
<td>15% CO₂, 5%O₂</td>
<td>CO₂-BB</td>
</tr>
<tr>
<td>Petroleum-based polyolefin</td>
<td>Air</td>
<td>A-PB</td>
</tr>
</tbody>
</table>
Packaged Celery Sticks Stored at 7°C for 2 Weeks

L. monocytogenes (log CFU g⁻¹)

Storage time (days)

LSD

A-BB
O₂-BB
N₂-BB
CO₂-BB

GREENER
LESS BROWNING
Listeria Transfer during Slicing and Dicing of Onions


Major Findings

• After slicing one onion inoculated at 5.5 log CFU/onion followed by 20 uninoculated onions, onion 1, 10 and 20 yielded average *Listeria* populations of 3.6, 1.3, and 0.9 log CFU/onion, respectively.

• After dicing 2.2 kg of onions inoculated at 4.0 log CFU/g followed by ten 2.2 kg batches of uninoculated onions, batches 1, 5 and 10 yielded average *Listeria* populations of 3.0, 1.3, and 0.6 log, respectively.

• All surfaces of the mechanical slicer were of equal importance in terms of *Listeria* transfer, whereas the drum and rolling dicer blades were of greatest concern for the commercial dicer.
Transfer of *L. monocytogenes* during Slicing of Cantaloupe and Honeydew Melon

1. Dip-Inoculate Melon
2. Slice 2
   - Inoculated Melon Halves
3. Slice 8
   - Uninoculated Melon Halves
4. Remove Rind and Homogenize Slices
5. Enumerate *Listeria* on MOX
Listeria Transfer from Inoculated to Uninoculated Cantaloupe Melon Halves during Mechanical Slicing
Listeria Transfer from Inoculated to Uninoculated Honeydew Melon Halves during Mechanical Slicing
Factors Impacting *Listeria* Transfer and Survival

- *L. monocytogenes* produces a cellulose binding protein for attachment to produce
- Increased surface roughness on equipment enhances biofilm formation and transfer
- Mechanical shear responsible for some death of *Listeria* during slicing
Temperature Abuse during Commercial Transport and Retail Storage/Display


Time/Temperature Histories

- 19 Transport Routes from California to:
  - East Coast (9)
  - South Central (3)
  - Midwest (5)
  - Southwest (2)

- Retail Store Backroom and Display Cases
- Five Supermarket Chains, 17 Stores -
  - California (1), Nevada (3)
  - Kansas (3), Ohio (3)
  - Georgia (3), Pennsylvania (3)
  - New Jersey (1)
Transport

% of time during transit above or below critical temperatures, based on total time from all sensors:

>41°F: 1.45%
>45°F: 0.24%
>50°F: 0.003%
≤31.6°F: 2.15%
Backroom Coolers

• Only 5% of the recorded temperatures were < 31.5°F
• 65 of 112 monitors recorded temperatures above 45°F more than 5% of the time
• Five monitors were continuously above 45°F
  — One cooler above 45°F for > over 50 days
• Peak high: 67.2°F
• Peak low: 29.8°F
Display Cases

Overall results

• 41 of 239 monitors recorded temperatures below 31.5°F more than 5% of the time
• 96 of 239 monitors recorded temperatures above 45°F more than 5% of the time
• One monitor was above 45°F for 65% of the time
• Peak high: 81.7°F
• Peak low: 26.9°F
Growth of *L. monocytogenes* in diced celery during transport, retail storage and display temperature
Take Home Message

• Improved practices are needed to minimize *Listeria* transfer during commercial production of fresh-cut produce.

• Various packaging strategies likely to have a marginal impact on *Listeria* growth/survival in fresh-cut produce

• Temperature abuse at retail is potentially compromising end-product safety