Processed Natural Meats

Jeff Sindelar

University of Wisconsin
Madison, WI
Cured Meat Products
Purpose of Sodium Nitrite/Nitrate

- Cured meat color
- Cured meat flavor
- Preservative properties
  - Growth of *Clostridium botulinum*
- Powerful antioxidant
  - Effective in controlling fat oxidation
Cured Meat Color Development

Addition of sodium nitrite

Nitric oxide (gas)

Myoglobin → Nitrosomyoglobin → Nitrosohemochrome (Pink cured meat color)

Heat
Uncured Meat Products
Natural, Organic and Conventional Labeling Claims

- **Organic**
  - 100% organic
  - Organic
  - Made with organic
  - Less than 70% organic

- **Natural**

- **Uncured**

More Restrictive

Less Restrictive
USDA Definition of Uncured Meat Products

- Definition found in 9 CFR 317.17 and 9 CFR 319.2
  - Normal cured products that can be made without nitrites or nitrates added
  - Regulations effective for products found to be similar in size, flavor, consistency and general appearance to products prepared with nitrate and/or nitrite
- Other normal ingredients are allowed
  - Dextrose, phosphates, etc…
Required Label Modifications for Uncured Meat Products

- **Statements/words that must be added**
  - “Uncured” before common name
    - i.e. *Uncured Frankfurters*
  - “No Nitrate or Nitrite Added” statement must be added
  - “Not Preserved – Keep Refrigerated Below 40°F At All Times” statement must be added
USDA Revised Labeling

- “Uncured” Meat Products (April, 2006)
  - USDA Labeling Division verbally announced changes for new label approvals of uncured meat products
  - Changes take effect with all new label submissions
Reasons for Labeling Revisions

In response to:

- Realization that uncured meat products may be found to contain nitrates/nitrites
- Concern that products and product labels may not be truthful to consumers
- Emergence of rapid growth of product category
New Labeling Changes for Uncured Meat Products

- When submitting a label for uncured meat products:
  - If USDA Labeling Division notices an ingredient that MAY contain nitrates or nitrites, a disclaimer will have to be added
  - New labeling changes will be reflected in new Food Standards and Labeling Policy Book
  - “No Preservatives” statement claim can no longer be used
Labeling Disclaimer for Uncured Meat Products

- “No nitrates or nitrites added except for naturally occurring nitrates or nitrites found in …..”

- Celery juice powder, beet juice powder, carrot juice concentrate, sea salt, or any ingredient determined to contain nitrates or nitrites by USDA.
Types of Uncured Meat Products

- No intention of replacing nitrite/nitrate
  - Uncured appearance and flavor

- Intention to replace nitrite/nitrate
  - Cured appearance and flavor
Types of Uncured Meat Products

- No intention of replacing nitrite/nitrate
Types of Uncured Meat Products

- Intention is to replace nitrite/nitrate
Uncured Meat Product Manufacture
Two Approaches to Curing Review

1. Addition of nitrite during product manufacture
2. Cook
3. = Cured meat product

1. Addition of nitrate containing source
2. Incubation – (conversion of nitrate to nitrite)
3. Cook
4. = Cured meat product
Cured Meat Color Development

Addition of nitrate source and starter culture.

Myoglobin

Nitric oxide (gas)

Incubation reduces nitrate to nitrite

Heat

Nitrosomyoglobin

Nitrosohemochrome (Pink cured meat color)
Step # 1:

Addition of nitrate containing source
&
Nitrate reducing ingredient
Ingredients Necessary

- **Nitrate sources**
  - Vegetables
    - Juices
    - Powders
  - Sea salt
  - Raw sugar
  - Others…

- **Nitrate reducing source**
  - Lactic acid starter culture
### Natural Sources of Nitrate

**Vegetable sources of “natural” nitrate (avg. ppm):**

<table>
<thead>
<tr>
<th>Vegetable</th>
<th>ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radishes</td>
<td>2600</td>
</tr>
<tr>
<td>Celery</td>
<td>3151</td>
</tr>
<tr>
<td>Lettuce</td>
<td>2330</td>
</tr>
<tr>
<td>Spinach</td>
<td>2470</td>
</tr>
<tr>
<td>Carrots</td>
<td>274</td>
</tr>
<tr>
<td>Beets</td>
<td>3288</td>
</tr>
<tr>
<td>Cabbage</td>
<td>712</td>
</tr>
<tr>
<td>Beans</td>
<td>466</td>
</tr>
<tr>
<td>Tomatoes</td>
<td>80</td>
</tr>
<tr>
<td>Potatoes</td>
<td>150</td>
</tr>
<tr>
<td>Turnip Greens</td>
<td>9040</td>
</tr>
<tr>
<td>Onions</td>
<td>235</td>
</tr>
<tr>
<td>Melon</td>
<td>4932</td>
</tr>
<tr>
<td>Rhubarb</td>
<td>2900</td>
</tr>
<tr>
<td>Broccoli</td>
<td>1014</td>
</tr>
</tbody>
</table>

R. Walker (1990), Food Add. Contam. 5:717-768.
Limitations of Ingredients

- **Vegetable Juice Powder**
  - Minimum of 0.2%
  - Maximum of 0.4% ?
    - Depends on amount of spices in product

- **Starter Culture**
  - 25 g per 225 kg
# Uncured Sausage Sensory

<table>
<thead>
<tr>
<th>TRTa</th>
<th>Cured Aroma</th>
<th>Cured Flavor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>8.41</td>
<td>8.10&lt;sup&gt;e&lt;/sup&gt;</td>
</tr>
<tr>
<td>2</td>
<td>8.77</td>
<td>8.66&lt;sup&gt;e&lt;/sup&gt;</td>
</tr>
<tr>
<td>3</td>
<td>8.12</td>
<td>8.57&lt;sup&gt;e&lt;/sup&gt;</td>
</tr>
<tr>
<td>4</td>
<td>8.45</td>
<td>9.01&lt;sup&gt;de&lt;/sup&gt;</td>
</tr>
<tr>
<td>C</td>
<td>9.33</td>
<td>9.93&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>SEM</td>
<td>0.40</td>
<td>0.38</td>
</tr>
</tbody>
</table>

<sup>a</sup>TRT: 1 = 0.20% VJP + 30 min incubation  
2 = 0.20% VJP + 120 min incubation  
3 = 0.40% VJP + 30 min incubation  
4 = 0.40% VJP + 120 min incubation  
C = 156 ppm (mg/kg) sodium nitrite

<sup>d-e</sup> Means within same column with different superscripts are different (P<0.05).

<table>
<thead>
<tr>
<th>TRT&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Ham Aroma</th>
<th>Veg Aroma</th>
<th>Ham Flavor</th>
<th>Veg Flavor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7.33&lt;sup&gt;df&lt;/sup&gt;</td>
<td>3.54&lt;sup&gt;f&lt;/sup&gt;</td>
<td>7.80&lt;sup&gt;de&lt;/sup&gt;</td>
<td>2.17&lt;sup&gt;f&lt;/sup&gt;</td>
</tr>
<tr>
<td>2</td>
<td>6.01&lt;sup&gt;def&lt;/sup&gt;</td>
<td>4.26&lt;sup&gt;df&lt;/sup&gt;</td>
<td>7.04&lt;sup&gt;de&lt;/sup&gt;</td>
<td>3.78&lt;sup&gt;df&lt;/sup&gt;</td>
</tr>
<tr>
<td>3</td>
<td>4.82&lt;sup&gt;e&lt;/sup&gt;</td>
<td>6.63&lt;sup&gt;d&lt;/sup&gt;</td>
<td>6.28&lt;sup&gt;d&lt;/sup&gt;</td>
<td>5.05&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>4</td>
<td>4.64&lt;sup&gt;e&lt;/sup&gt;</td>
<td>6.15&lt;sup&gt;d&lt;/sup&gt;</td>
<td>6.28&lt;sup&gt;d&lt;/sup&gt;</td>
<td>4.65&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>C</td>
<td>7.27&lt;sup&gt;f&lt;/sup&gt;</td>
<td>2.68&lt;sup&gt;f&lt;/sup&gt;</td>
<td>8.19&lt;sup&gt;e&lt;/sup&gt;</td>
<td>1.96&lt;sup&gt;f&lt;/sup&gt;</td>
</tr>
<tr>
<td>SEM</td>
<td>0.62</td>
<td>0.64</td>
<td>0.50</td>
<td>0.64</td>
</tr>
</tbody>
</table>

<sup>a</sup> TRT: 1 = 0.20% VJP + 0 min incubation  
2 = 0.20% VJP + 120 min incubation  
3 = 0.35% VJP + 0 min incubation  
4 = 0.35% VJP + 120 min incubation  
C = 156 ppm (mg/kg) sodium nitrite

<sup>d-f</sup> Means within same column with different superscripts are different (P<0.05).

Step #2: Incubation - conversion of nitrate to nitrite
Requirements for Nitrate Conversion

- **Proper incubation of product**
  - Internal temperature held
    - 50-113 °F (86 °F optimum)
    - ~ 1-2 hours
    - Depends on product diameter
      - Frankfurters = 2 hours
      - Ham = 1 hour

- Optimum time for starter culture function
  - Nitrate reductase enzymes reduce nitrate to nitrite

- Longer time = more nitrate to nitrite conversion
## Uncured Sausage Nitrate and Nitrite

<table>
<thead>
<tr>
<th>TRT&lt;sup&gt;a&lt;/sup&gt;</th>
<th>PPM Residual Nitrite</th>
<th>PPM Residual Nitrate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-Incubate</td>
<td>Post-Incubate</td>
</tr>
<tr>
<td>1</td>
<td>0&lt;sup&gt;h&lt;/sup&gt;</td>
<td>5.6&lt;sup&gt;i&lt;/sup&gt;</td>
</tr>
<tr>
<td>2</td>
<td>0&lt;sup&gt;h&lt;/sup&gt;</td>
<td>24.5&lt;sup&gt;h&lt;/sup&gt;</td>
</tr>
<tr>
<td>3</td>
<td>0&lt;sup&gt;h&lt;/sup&gt;</td>
<td>7.7&lt;sup&gt;i&lt;/sup&gt;</td>
</tr>
<tr>
<td>4</td>
<td>0&lt;sup&gt;h&lt;/sup&gt;</td>
<td>46.0&lt;sup&gt;g&lt;/sup&gt;</td>
</tr>
<tr>
<td>C</td>
<td>59.1&lt;sup&gt;g&lt;/sup&gt;</td>
<td>NA</td>
</tr>
<tr>
<td>SEM</td>
<td>0.62</td>
<td>1.22</td>
</tr>
</tbody>
</table>

<sup>a</sup> TRT:  
1 = 0.20% VJP + 30 min incubation  
2 = 0.20% VJP + 120 min incubation  
3 = 0.40% VJP + 30 min incubation  
4 = 0.40% VJP + 120 min incubation  
C = 156 ppm (mg/kg) sodium nitrite

<sup>g-j</sup> Means within same column with different superscripts are different (P<0.05).

### Uncured Ham Nitrate and Nitrite

<table>
<thead>
<tr>
<th>TRT&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Pre-Incubate</th>
<th>Post-Incubate</th>
<th>PPM Residual Nitrite</th>
<th>Pre-Incubate</th>
<th>Post-Incubate</th>
<th>PPM Residual Nitrate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.00&lt;sup&gt;h&lt;/sup&gt;</td>
<td>NA</td>
<td></td>
<td>40.8&lt;sup&gt;jk&lt;/sup&gt;</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>0.00&lt;sup&gt;h&lt;/sup&gt;</td>
<td>19.5&lt;sup&gt;h&lt;/sup&gt;</td>
<td></td>
<td>46.6&lt;sup&gt;ij&lt;/sup&gt;</td>
<td>10.4</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>0.00&lt;sup&gt;h&lt;/sup&gt;</td>
<td>NA</td>
<td></td>
<td>78.2&lt;sup&gt;g&lt;/sup&gt;</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>0.00&lt;sup&gt;h&lt;/sup&gt;</td>
<td>36.1&lt;sup&gt;g&lt;/sup&gt;</td>
<td></td>
<td>81.0&lt;sup&gt;g&lt;/sup&gt;</td>
<td>14.6</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>61.1&lt;sup&gt;g&lt;/sup&gt;</td>
<td>NA</td>
<td></td>
<td>22.5&lt;sup&gt;hk&lt;/sup&gt;</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>SEM</td>
<td>1.16</td>
<td>0.97</td>
<td></td>
<td>4.59</td>
<td>1.30</td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup> TRT:  
1 = 0.20% VJP + 0 min incubation  
2 = 0.20% VJP + 120 min incubation  
3 = 0.35% VJP + 0 min incubation  
4 = 0.35% VJP + 120 min incubation  
C = 200 ppm (mg/kg) sodium nitrite

<sup>g-k</sup> Means within same column with different superscripts are different (P<0.05).

Step #3: Cooking
Cooking Requirements

- Besides the addition of an incubation step, no other changes are necessary.
Uncured Frankfurter
Smokehouse Schedule

<table>
<thead>
<tr>
<th>Step</th>
<th>Step Type</th>
<th>Time</th>
<th>Dry Bulb (°F)</th>
<th>Wet Bulb (°F)</th>
<th>RH (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cook</td>
<td>IT: 100 F</td>
<td>105</td>
<td>103</td>
<td>93</td>
</tr>
<tr>
<td>2</td>
<td>Cook</td>
<td>2:00</td>
<td>105</td>
<td>103</td>
<td>93</td>
</tr>
<tr>
<td>3</td>
<td>Cook</td>
<td>00:20</td>
<td>140</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>Smoke Cook</td>
<td>00:30</td>
<td>150</td>
<td>118</td>
<td>38</td>
</tr>
<tr>
<td>5</td>
<td>Cook</td>
<td>00:20</td>
<td>160</td>
<td>145</td>
<td>67</td>
</tr>
<tr>
<td>6</td>
<td>Cook</td>
<td>IT: 160 F</td>
<td>185</td>
<td>178</td>
<td>85</td>
</tr>
</tbody>
</table>

*** Step 2 is where conversion of nitrate to nitrite will occur.***
### Uncured Smoked Sausage Smokehouse Schedule

<table>
<thead>
<tr>
<th>Step</th>
<th>Step Type</th>
<th>Time</th>
<th>Dry Bulb (°F)</th>
<th>Wet Bulb (°F)</th>
<th>RH (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cook</td>
<td>IT: 100 F</td>
<td>105</td>
<td>103</td>
<td>93</td>
</tr>
<tr>
<td>2</td>
<td>Cook</td>
<td>1:30</td>
<td>105</td>
<td>103</td>
<td>93</td>
</tr>
<tr>
<td>3</td>
<td>Cook</td>
<td>00:45</td>
<td>120</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>Smoke Cook</td>
<td>00:30</td>
<td>120</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>Smoke Cook</td>
<td>00:30</td>
<td>145</td>
<td>120</td>
<td>47</td>
</tr>
<tr>
<td>6</td>
<td>Smoke Cook</td>
<td>00:30</td>
<td>165</td>
<td>140</td>
<td>50</td>
</tr>
<tr>
<td>7</td>
<td>Cook</td>
<td>IT: 160 F</td>
<td>170</td>
<td>160</td>
<td>78</td>
</tr>
</tbody>
</table>

*** Step 2 is where conversion of nitrate to nitrite will occur.***
### Uncured Ham Smokehouse Schedule

<table>
<thead>
<tr>
<th>Step</th>
<th>Step Type</th>
<th>Time</th>
<th>Dry Bulb (°F)</th>
<th>Wet Bulb (°F)</th>
<th>RH (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cook</td>
<td>IT: 100 F</td>
<td>105</td>
<td>103</td>
<td>93</td>
</tr>
<tr>
<td>2</td>
<td>Cook</td>
<td>1:00</td>
<td>105</td>
<td>103</td>
<td>93</td>
</tr>
<tr>
<td>3</td>
<td>Cook</td>
<td>00:30</td>
<td>160</td>
<td>110</td>
<td>21</td>
</tr>
<tr>
<td>4</td>
<td>Cook</td>
<td>00:30</td>
<td>165</td>
<td>115</td>
<td>22</td>
</tr>
<tr>
<td>5</td>
<td>Cook</td>
<td>01:00</td>
<td>170</td>
<td>120</td>
<td>24</td>
</tr>
<tr>
<td>6</td>
<td>Cook</td>
<td>00:45</td>
<td>170</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>7</td>
<td>Cook</td>
<td>00:30</td>
<td>170</td>
<td>150</td>
<td>60</td>
</tr>
<tr>
<td>8</td>
<td>Cook</td>
<td>IT: 160 F</td>
<td>180</td>
<td>180</td>
<td>100</td>
</tr>
</tbody>
</table>

*** Step 2 is where conversion of nitrate to nitrite will occur.***
Expect a different appearance between cured and uncured, no nitrate or nitrite added emulsions/batters.
Whole Muscle Processing

Requirements

- Starter culture must be injected into whole muscle cuts
  - Not water soluble
  - Will not penetrate meat during tumbling or immersion curing
Injection Calculations

- Amount of nitrate containing ingredient and starter culture needed to add to brine is calculated from total injected weight basis.

- Calculation factors needed to know:
  - lbs of non-injected meat weight
  - Injection percentage
  - % nitrate containing ingredient desired
  - % starter culture desired
Example Calculation

- 25 lb of meat to inject
- 25% injection level
- 0.25% nitrate containing ingredient

**Step 1**
25 lb meat x 1.25% injection = 31.25 lb total injected weight

**Step 2**
31.25 lb x 0.25% (nitrate containing desired) = 0.0781

**Step 3**
0.0781 / 6.25 lb of brine added to 25 lb of meat

= 0.0125 = 1.25% of brine should be nitrate containing ingredient
Processing Concerns
“Natural Curing” Quality

- Water and protein binding
  - Control of raw materials
  - Modifications to processing
  - Control of pH
  - Ingredient choices
“Natural Curing” Quality

- **Antioxidant protection**
  - ~ 50 ppm nitrite
  - Dependent on amount of unsaturated lipids
  - Natural alternatives?

- **Maintaining cured color**
  - 2-14 ppm nitrite induces cured color
  - 40-50 ppm nitrite generally considered adequate
  - pH considerations

- **Antimicrobial protection**
  - Ingredients?
  - Processes?
“Natural Curing” Safety

- **Clostridium Botulinum inhibition**
  - 50-60 ppm ingoing nitrite?
  - Difficult to assess without challenge studies
    - Difficult to quantify true amount of nitrite generated
  - Currently being investigated
## Uncured Sausage - Residual Nitrite

<table>
<thead>
<tr>
<th>TRT&lt;sup&gt;a&lt;/sup&gt;</th>
<th>0</th>
<th>14</th>
<th>28</th>
<th>56</th>
<th>90</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>16.1&lt;sup&gt;e&lt;/sup&gt;</td>
<td>10.6&lt;sup&gt;f&lt;/sup&gt;</td>
<td>8.8&lt;sup&gt;gh&lt;/sup&gt;</td>
<td>4.9&lt;sup&gt;gh&lt;/sup&gt;</td>
<td>4.9&lt;sup&gt;gh&lt;/sup&gt;</td>
</tr>
<tr>
<td>2</td>
<td>24.7&lt;sup&gt;e&lt;/sup&gt;</td>
<td>21.7&lt;sup&gt;e&lt;/sup&gt;</td>
<td>17.2&lt;sup&gt;f&lt;/sup&gt;</td>
<td>12.0&lt;sup&gt;gh&lt;/sup&gt;</td>
<td>9.1&lt;sup&gt;h&lt;/sup&gt;</td>
</tr>
<tr>
<td>3</td>
<td>21.3&lt;sup&gt;e&lt;/sup&gt;</td>
<td>16.6&lt;sup&gt;fi&lt;/sup&gt;</td>
<td>12.9&lt;sup&gt;gh&lt;/sup&gt;</td>
<td>9.9&lt;sup&gt;gh&lt;/sup&gt;</td>
<td>8.5&lt;sup&gt;g&lt;/sup&gt;</td>
</tr>
<tr>
<td>4</td>
<td>58.5&lt;sup&gt;e&lt;/sup&gt;</td>
<td>44.3&lt;sup&gt;f&lt;/sup&gt;</td>
<td>33.1&lt;sup&gt;g&lt;/sup&gt;</td>
<td>22.3&lt;sup&gt;hi&lt;/sup&gt;</td>
<td>16.3&lt;sup&gt;i&lt;/sup&gt;</td>
</tr>
<tr>
<td>C</td>
<td>46.9&lt;sup&gt;e&lt;/sup&gt;</td>
<td>31.4&lt;sup&gt;f&lt;/sup&gt;</td>
<td>22.0&lt;sup&gt;g&lt;/sup&gt;</td>
<td>12.4&lt;sup&gt;hi&lt;/sup&gt;</td>
<td>8.7&lt;sup&gt;i&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

SEM = 1.02

<sup>a</sup> TRT: 1 = 0.20% VJP + 30 min incubation  
2 = 0.20% VJP + 120 min incubation  
3 = 0.40% VJP + 30 min incubation  
4 = 0.40% VJP + 120 min incubation  
C = 156 ppm (mg/kg) sodium nitrite

<sup>e-i</sup> Means within same row with different superscripts are different (P<0.05).  
<sup>n-r</sup> Means within same column with different superscripts are different (P<0.05).
### Uncured Ham - Residual Nitrite

<table>
<thead>
<tr>
<th>TRT&lt;sup&gt;a&lt;/sup&gt;</th>
<th>0</th>
<th>14</th>
<th>28</th>
<th>56</th>
<th>90</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>n21.0&lt;sup&gt;e&lt;/sup&gt;</td>
<td>n14.6&lt;sup&gt;ef&lt;/sup&gt;</td>
<td>n18.4&lt;sup&gt;e&lt;/sup&gt;</td>
<td>n13.4&lt;sup&gt;ef&lt;/sup&gt;</td>
<td>n7.2&lt;sup&gt;f&lt;/sup&gt;</td>
</tr>
<tr>
<td>2</td>
<td>n19.3&lt;sup&gt;e&lt;/sup&gt;</td>
<td>n15.6&lt;sup&gt;ef&lt;/sup&gt;</td>
<td>n18.3&lt;sup&gt;e&lt;/sup&gt;</td>
<td>n11.7&lt;sup&gt;ef&lt;/sup&gt;</td>
<td>n8.8&lt;sup&gt;f&lt;/sup&gt;</td>
</tr>
<tr>
<td>3</td>
<td>nq 27.7&lt;sup&gt;e&lt;/sup&gt;</td>
<td>nq 23.6&lt;sup&gt;eh&lt;/sup&gt;</td>
<td>nq 25.4&lt;sup&gt;eg&lt;/sup&gt;</td>
<td>nq 19.4&lt;sup&gt;fgh&lt;/sup&gt;</td>
<td>n11.7&lt;sup&gt;f&lt;/sup&gt;</td>
</tr>
<tr>
<td>4</td>
<td>oq 36.0&lt;sup&gt;e&lt;/sup&gt;</td>
<td>oq 32.6&lt;sup&gt;eh&lt;/sup&gt;</td>
<td>oq 32.8&lt;sup&gt;eg&lt;/sup&gt;</td>
<td>oq 25.4&lt;sup&gt;fgh&lt;/sup&gt;</td>
<td>o21.3&lt;sup&gt;f&lt;/sup&gt;</td>
</tr>
<tr>
<td>C</td>
<td>p63.4&lt;sup&gt;e&lt;/sup&gt;</td>
<td>p61.1&lt;sup&gt;e&lt;/sup&gt;</td>
<td>p56.0&lt;sup&gt;e&lt;/sup&gt;</td>
<td>p45.0&lt;sup&gt;f&lt;/sup&gt;</td>
<td>p34.1&lt;sup&gt;g&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

SEM = 1.72

<sup>a</sup> TRT:  
1 = 0.20% VJP + 0 min incubation  
2 = 0.20% VJP + 120 min incubation  
3 = 0.35% VJP + 0 min incubation  
4 = 0.35% VJP + 120 min incubation  
C = 200 ppm (mg/kg) sodium nitrite

<sup>e-h</sup> Means within same row with different superscripts are different (P<0.05).  
<sup>n-q</sup> Means within same column with different superscripts are different (P<0.05).

Finished Product Considerations

- **Shorter shelf life?**
  - Vacuum packaging
  - Gas flushing and high oxygen-barrier films

- **Store product in cold refrigeration temperatures**
  - < 40°F
Organic and Natural Claim

Resources

- USDA Food Standards and Labeling Policy Book
  - [www.usda.fsis.gov](http://www.usda.fsis.gov) (then use “Search FSIS”)

- USDA 21 CFR 101.22
  - [www.access.gpo.gov/cgi-bin/cfrassemble.cgi?title=200721](http://www.access.gpo.gov/cgi-bin/cfrassemble.cgi?title=200721)
  - Foods; labeling of spices, flavorings, colorings and chemical preservatives

- National Organic Program (NOP)
Questions?