Food Safety and Methemoglobinemia (Blue Baby Syndrome)

Michele Yacopucci, Ph.D.
State Hygienic Lab at the University of Iowa
State Hygienic Laboratory

Milford

Ankeny

Coralville
State Hygienic Laboratory
State Hygienic Laboratory
Food Chemistry at SHL

- **FERN- Food Emergency Response Network**
  - Funded through FDA
  - One of 14 state labs throughout the US that provide surge capacity
  - Perform testing for a wide variety of potential contaminants in food
    - Melamine in dairy and pet food
    - PAHs in seafood after Horizon oil spill
Laboratory Accreditation

• ISO Accreditation
  – ISO: International Organization for Standardization
    • Defines rules and standards for laboratory testing
    • Ensures that test results are reliable and traceable

The Food Safety Modernization Act –
A Series on What is Essential for a Food Professional to Know
Article 7. Laboratory Accreditation
Methemoglobinemia -- Blue Baby Syndrome

• Cause: Nitrate ingestion
  – Usually from drinking water
  – Some vegetables are naturally high in nitrates, i.e. carrots, beets, spinach

• Biochemistry:
  – Nitrate is converted to nitrite in the gut
  – Nitrite takes the place of oxygen on hemoglobin in the blood
## Dietary Nitrate

<table>
<thead>
<tr>
<th>Vegetable</th>
<th>Nitrate content, mg/100g fresh weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Celery, lettuce, red beetroot, spinach</td>
<td>Very High (&gt; 2500)</td>
</tr>
<tr>
<td>Parsley, leek, endive, Chinese cabbage, fennel</td>
<td>High (100-250)</td>
</tr>
<tr>
<td>Cabbage, dill, turnip</td>
<td>Medium (50-100)</td>
</tr>
<tr>
<td>Broccoli, carrot, cauliflower, cucumber, pumpkin</td>
<td>Low (20-50)</td>
</tr>
<tr>
<td>Artichoke, asparagus, eggplant, garlic, onion, green bean, mushroom, pea, pepper, potato, summer squash, sweet potato, tomato, watermelon</td>
<td>Very Low (&lt;20)</td>
</tr>
</tbody>
</table>

[Adapted from Hord et al. 2011; Santamaria 2006]
Other Sources of Nitrate

- Vegetables account for about 80% of the nitrates in a typical human diet [Hord 2011; Pennington 1998].
- The remainder of the nitrate in a typical diet comes from drinking water (about 21%) and from meat and meat products (about 6%) in which sodium nitrate is used as a preservative and color-enhancing agent [Alexander et al. 2010; Gilchrist et al. 2010; Lundberg et al. 2009; Lundberg et al. 2008; Norat et al. 2005; Chan 1996; Saito et al. 2000].
- For infants who are bottle-fed, however, the major source of nitrate exposure is from contaminated drinking water used to dilute formula [Hord et al. 2010; EPA 2007].
- Bottled water is regulated by the U.S. Food and Drug Administration (FDA) as a food. It is monitored for nitrates, nitrites and total nitrates/nitrites.

healthyeating.sfgate.com

http://healthyhabitshub.com/could-salad-be-bad-for-you/
Event Timeline

8/17
- 2 Cases
- Water, Milk, Molasses?

8/17
- Well water: Negative for NO₃

8/20
- IC Method
- Emergency Response

8/23
- Herbal supplements? Antibiotics?

8/27
- High Nitrate in Sorghum Syrup

08/28
- Commerce

09/04
- Consumer Advisory
Spectroscopy
Fourier-transform infrared spectroscopy
Raman spectroscopy
Atomic absorption spectroscopy
Inductively coupled plasma atomic emission spectroscopy
Radiochemistry
Gas-flow proportional counters
Liquid scintillation counters
Alpha spectrometer
Gamma spectrophotometer
Chromatography
Gas chromatography
High performance liquid chromatography
Ion chromatography
Mass spectrometry
Ion trap
Triple quadrupole
LC/ICP mass spectrometer
SHL Tool Suite
Nitrate Detection in Foods

- Ion Chromatography
- Samples are diluted in water, then tested
- Peaks areas are compared to known amounts of nitrate
Sample Results

- Blue = Sample (diluted 1:10)
- Black = 1000 ppm (1 mg/ml) standard
- Final concentration of nitrate in the sorghum syrup ~ 19 mg nitrate per gram of syrup
Current Testing

• FERN - Other sweeteners for nitrate and nitrite
Final Thoughts

• While most people think of food testing as microbiology testing, chemical testing can also be important
• SHL is a highly experienced, highly qualified food testing lab
• We are here to help!