Overview

• Introduction
• Selenium functions
• Requirements & Toxicity
• Deficiency
  • Cow/Calf
  • Stocker/Feeder
• Florida selenium situation
• Supplementation systems

Selenium also cooperates with vitamin E to reduce oxygen radicals and protect against cell damage.
**Cooperative Antioxidant Functions**  
**Copper and Selenium**

**Why are they important:**
1. The two most limiting trace mineral in most forages and feedstuffs.
2. Both are strongly antagonized by sulfur.

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**Selenium Requirements**

- The Beef Cattle NRC (8th Rev. 2016 Update) suggests a requirement of 0.10 mg/kg.
- This requirement doesn’t consider the influence of source.
- This requirement doesn’t consider the influence of antagonists, such as sulfur.
- However, there is little evidence that dietary concentrations less than 0.10 mg/kg result in deficiency.

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**Selenium Requirements**

- The FDA regulates the addition of selenium to beef cattle diets;
  - 3 mg/head daily for supplements
  - 0.30 mg/kg of finished diets
- The selenium content of free-choice mineral supplements are regulated by the targeted intake.
  - 4.00 oz/head daily = maximum of 27 ppm Se
  - 1.75 oz/head daily = maximum of 60 ppm Se
Selenium Toxicity

- Selenium is the most toxic of all essential minerals.
- Toxicity generally occurs from the careless or accidental formulation or supplementation.
- Some areas of the US are recognized as "seleniferous". Certain plants in these areas have evolved to accumulate selenium – called accumulators or converters.
- Toxicity can be both acute (accidental supplementation) or chronic (consumption of high-selenium forages).

Cow/Calf Production

The physiological functions most impacted by selenium in cow/calf production systems, include;

- Cows: Retained placentas = lengthened anestrous period
- Weak calves = white muscle disease
- Impaired immunity = reduced vaccination response

White Muscle Disease

White Muscle Disease or Weak Calf Syndrome
Figure 1. Relationship between herd Se status and milk SCC (adapted from Weiss et al. (1990).

Liver trace mineral concentrations (m/kg DM)

<table>
<thead>
<tr>
<th>Item</th>
<th>Se</th>
<th>Cu</th>
<th>Mn</th>
<th>Mo</th>
<th>Zn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>0.67</td>
<td>158</td>
<td>10.8</td>
<td>3.4</td>
<td>140</td>
</tr>
<tr>
<td>Deficient</td>
<td>&lt; 0.50</td>
<td>&lt; 75</td>
<td>&lt; 8</td>
<td>------</td>
<td>&lt; 125</td>
</tr>
<tr>
<td>Prevalence</td>
<td>5 of 11</td>
<td>3 of 14</td>
<td>0 of 14</td>
<td>------</td>
<td>0 of 14</td>
</tr>
</tbody>
</table>

Survey of 14 commercial cowherds in Florida (2014)
35% of surveyed cow/calf operations in the Southeast were Se deficient; Dargatz and Ross, 1996

United States Soil Selenium Concentrations

Check the soil selenium content of your county at: http://mrdata.usgs.gov/geochem/doc/averages/se/usa.html
Effect of soil selenium distribution on selenium content of harvested beef

Tissue Se concentrations (mg/kg) from beef steers at slaughter

<table>
<thead>
<tr>
<th>Tissue</th>
<th>High-Se Region</th>
<th>Low-Se Region</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sirloin</td>
<td>1.19 ± 0.05</td>
<td>0.40 ± 0.05</td>
</tr>
<tr>
<td>Liver</td>
<td>0.97 ± 0.14</td>
<td>0.89 ± 0.15</td>
</tr>
</tbody>
</table>

1Steers were obtained from high- and low-Se regions of South and North Dakota, transferred to a feedlot and fed a common Se-adequate diet for 105 d. Initial muscle Se concentrations were 2.10 and 0.40 (±0.10) for high- and low-Se regions, respectively.

Decline in pre-weaned calf selenium status

Decline in pre-weaned calf selenium status
Selenium status of pre-weaned beef calves

1. Milk and forage are poor sources of selenium.

2. Calves often do not consume enough free-choice salt-based mineral to satisfy their selenium requirement.

3. Focus on selenium status of gestating cows to ensure adequate selenium stores in the calf until they begin consuming adequate amounts through supplements.

Impact of supplement-derived dietary sulfur on selenium status of growing steers

- Previous research has shown that dietary sulfur may be responsible for altering selenium metabolism in ruminants:
  - Ivanic and Weiss, 2001 Dairy cows
  - Hintz and Hogue, 1964 Sheep
  - van Ryssen et al., 1998 Sheep
- Molasses feeding model
  - Does selenium react similarly to copper in our molasses feeding model?
  - What sources of selenium are available for use in these natural antagonism models?
Selenium biofortification

- Certain regions of the World have endemic selenium deficiency among people. Because cereal grains and meat are the primary source of dietary selenium, certain measure have been taken to fortify these food sources.
- In Finland, the addition of selenium to NPK fertilizers have increased the selenium content of cereal grains by 15X. As a result, meat and meat products have increased 2 to 6X since the implementation of biofortification.

Pasture fertilization with selenium (alfalfa hay)

Feeding high-selenium hay to growing beef calves

Weaned beef calves were pair-fed high-Selenium hay or Na selenite (or no selenium control) over a 42-day period.
Feeding high-selenium hay to growing beef calves

Limit Creep Feeding
*Increase calf mineral status prior to weaning*

- Limit-fed, trace mineral-fortified creep feed prior to weaning.
  - Exposes calves to
    - Supplemental mineral
    - Concentrated feed
    - Human x feed interaction

Limit Creep Feeding

- Two year study, 3 treatments;
  - No mineral
  - Hydroxychloride sources of Cu, Zn, and Mn
  - Sulfate sources of Cu, Zn, and Mn
- Offered in cow exclusion areas 3X weekly;
  - Maximum limited to 0.25 lb/d
  - Offered for 84 d prior to weaning
Voluntary intake of mineral-fortified limit-fed creep feed

Hydroxy vs. Sulfate; P = 0.01

Total creep intake, kg

<table>
<thead>
<tr>
<th>Source</th>
<th>Ib/d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydroxy</td>
<td>0.24</td>
</tr>
<tr>
<td>Sulfate</td>
<td>0.19</td>
</tr>
<tr>
<td>No Min.</td>
<td>0.22</td>
</tr>
</tbody>
</table>

Limit Creep Feeding (calf mineral status)

Liver mineral concentration, mg/kg DM basis

<table>
<thead>
<tr>
<th>Element</th>
<th>Mineral</th>
<th>No Mineral</th>
<th>SEM</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Co</td>
<td>0.23</td>
<td>0.09</td>
<td>0.032</td>
<td>0.003</td>
</tr>
<tr>
<td>Cu</td>
<td>186</td>
<td>129</td>
<td>35.7</td>
<td>0.07</td>
</tr>
<tr>
<td>Se</td>
<td>0.57</td>
<td>0.25</td>
<td>0.075</td>
<td>0.003</td>
</tr>
</tbody>
</table>

Problem ??
Hand Feeding Creep
Low Moisture Molasses Blocks

Collaboration with Jim Drouillard
Kansas State University

• Eliminates daily hand feedings
• Resistant to rain/weather
• Self limits intake to < 1.0 lb/d
• Delivers functional nutrients

Low-moisture, molasses blocks
Limit Creep
mineral-fortified, low-moisture blocks

Access to blocks in cow excluded areas for 84 d prior to weaning

<table>
<thead>
<tr>
<th>Item</th>
<th>Mineral</th>
<th>No Mineral</th>
<th>P =</th>
</tr>
</thead>
<tbody>
<tr>
<td>Block intake, lb/d</td>
<td>0.60</td>
<td>0.86</td>
<td>0.05</td>
</tr>
<tr>
<td>Calf ADG, lb/d</td>
<td>1.44</td>
<td>1.45</td>
<td>0.97</td>
</tr>
</tbody>
</table>

Limit Creep
mineral-fortified, low-moisture blocks

Mineral status measured at weaning (mg/kg DM)

<table>
<thead>
<tr>
<th>Item</th>
<th>Mineral</th>
<th>No Mineral</th>
<th>P =</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selenium</td>
<td>1.19</td>
<td>0.49</td>
<td>0.001</td>
</tr>
<tr>
<td>Copper</td>
<td>169</td>
<td>86</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Zinc</td>
<td>146</td>
<td>127</td>
<td>0.020</td>
</tr>
<tr>
<td>Manganese</td>
<td>7.8</td>
<td>6.1</td>
<td>0.010</td>
</tr>
</tbody>
</table>

Summary - Selenium

- As an essential trace element, selenium can be both deficient and toxic.
- Likely one of the most impactful trace mineral deficiencies influencing cow/calf production and feeder calf health.
- Regulated by FDA. Toxicity is typically due to formulation, production, or supplementation errors.
- Selenium impacts beef cattle health & performance through its function as an antioxidant.
Summary - Selenium

- Cow/calf production is most impacted by:
  - Calf vigor
  - Anestrous interval
  - Response to vaccination
- Weaned calves in Florida (southeast) are commonly selenium deficient
  - Low selenium content in milk and forage
  - Inadequate free-choice mineral intake

Summary - Selenium

- Forage selenium biofortification is effective to increase calf selenium status, but commercial products are lacking in availability.
- Limit creep feeding is effective in increasing calf selenium status at weaning, but:
  - Special consideration to formulation is essential
  - Hand-feeding is labor consuming
  - Difficult to realize ROI
- Current studies are revealing benefits of self-limited creep supplements

Thank you for your attention

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