The goal of this paper is to emphasize the importance of a supplementation program to optimize the essential trace element status of beef/dairy calves to increase growth and especially to enhance immunocompetence and to explain the changes in mineral status from birth to weaning.

Optimal essential trace element status and thus effective trace element functions in calves is often the difference between sick and healthy calves or below or above average calf growth.

Sub-optimal trace element levels in calves can result in a multitude of problems that could affect health/growth negatively, summarized as follow (Arthington, 2008; NRC, 1996):

Sub-optimal **zinc** status in calves can lead to:
- Swollen feet with open, scaly lesions,
- Excessive salivation,
- Alopecia – loss of hair,
- Listlessness,
- Reduced appetite,
- Reduced feed intake,
- Reduced feed efficiency,
- Reduced growth and
- Impaired immune response.

Sub-optimal **manganese** status in calves can lead to:
- Especially skeletal abnormalities:
  - Stiffness,
  - Unsteadiness,
  - Twisted legs,
  - Enlarged, swollen joints,
  - Superior brachynathism – undershot upper jaw,
  - Disproportionate dwarfism.

Sub-optimal **copper** status in calves can lead to:
- Achromotrichia – lack of hair pigmentation,
- Fragile bones,
- Cardiac failure,
- Anemia,
• Failure to respond to vaccination,
• Impaired immune response,
• Reduced growth,
• Diarrhoea and
• Decreased ability to survive cold exposure.

Sub-optimal selenium status in calves can lead to:
• Weak calf syndrome,
• Muscular dystrophy,
• Impaired immune response,
• Diarrhoea,
• Pneumonia and
• Death in young calves.

Trace Minerals FROM BIRTH to WEANING:
Every calf is born with a certain amount of trace mineral deposited in body tissues prior to birth. The following graphs displays the different levels at different ages from birth.

SELENIUM:
The selenium status of the calf at birth, is a reflection of the status of the cow. Selenium is not deposited in a higher concentration.
As can be seen from the graph, attempting to feed selenium through the cow to the calf is not extremely efficient as milk is not high in selenium and at 56 days of age, there was very little change in calf serum selenium levels, regardless of the level fed to the cow.

It is clear that as early as 2-3 months of age, calves can become marginal in selenium status. This is 2-3 months PRIOR to the stress of weaning and 1-2 months Prior to the start of vaccination programs.
ZINC:
Zinc is deposited in higher concentrations in the liver of the calf. From the graph below it is clear that the zinc level of newly born calves is fairly well regulated and consistent, not as dependent on cow levels as selenium. HOWEVER the same metabolic profile is evident, as zinc levels in the calf drops as age advances, with the lowest levels reached from 150 days of age. Again the animal will approach weaning with marginal zinc levels. This poses a risk where animals are expected to perform in a feedlot situation after weaning due to zinc’s effect on appetite and immunity.

![Graph showing zinc levels over age](image)

**Figure 1.** Age-specific estimated value and 95% confidence limits (CL) of the mean liver zinc concentration for a group of calves of a given age. Zinc values are presented in milligrams per kilogram wet weight. The regression equation for the estimated value is $Y = \left\lbrack -0.2(3.038 - 0.001991 \text{ age} + 3.837 \times 10^{-4} \text{ age}^2) + 1 \right\rbrack^{\frac{1}{0.2}}$, where $Y =$ Zn concentration.

COPPER:
Calves are usually born with copper levels exceeding that of the dam. The copper levels in calves, is the mineral which deteriorates the quickest. The reason for this is two fold:

- Copper is metabolized very rapidly in the growing calf due to it’s magnitude of functions.
- Unlike Zinc which is present in milk at more than 3ppm, copper is present only at 0.052ppm

A further point to remember is that any calf recovering from enteric disease is most probably in a negative copper balance.
TRACE MINERAL CONTENT OF MILK:

<table>
<thead>
<tr>
<th>Mineral</th>
<th>MILK (ppm)</th>
<th>NRC recommendation for growth (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper</td>
<td>0.052</td>
<td>10</td>
</tr>
<tr>
<td>Zink</td>
<td>3.960</td>
<td>30</td>
</tr>
<tr>
<td>Manganese</td>
<td>0.021</td>
<td>20</td>
</tr>
<tr>
<td>Selenium</td>
<td>0.1</td>
<td>0</td>
</tr>
</tbody>
</table>

CONCLUSIONS

Most calves are born with reasonable levels of trace minerals. Selenium may be a risk from birth, as cows do not concentrate this mineral in the calf. However the real risk period for marginal trace mineral level and functional deficit starts at about two to three months of age. This should be the age where the first supplementation intervention should be considered. The second major risk event is at weaning, where calves are bound to be marginal at best without supplementation intervention.

The above data suggests that response to vaccination, should be expected to be in correlation with the trace mineral status of the calf. Hence status of trace minerals should be addressed prior to vaccination and again prior to weaning.

A further crucial point is that any calf which suffered from enteric or respiratory disease would suffer from imbalance and this needs to be addressed prior to weaning.

References:

Questions:

1. Which of the following is not a function of copper in the calf:
   a) Proper calcification and hardening of bone
   b) Proper function of neutrophils (immune function)
   c) Prevents muscular dystrophy
   d) Prevents anemia if iron is sufficient
   e) Proper pigmentation of melatonin rich tissue e.g black hair

2. Which of the following is not a function of zinc in the calf:
   a) Proper appetite
   b) Proper development of the skin
   c) Feed conversion as related to growth
   d) Prevents anemia
   e) Proper immune function

3. Which of the following is a function of manganese in the calf:
   a) Proper cartilagegenous development
   b) Prevents Superior brachynathism – undershot upper jaw
   c) Prevents enzootic ataxia due to improper myelinization of nervous tissue
   d) All of the above
   e) a & b

4. Which of the following is a function of selenium in the calf:
   a) Prevents muscular distrophy
   b) Plays a role in the immune function
   c) Plays a role in mediating respiratory disease
   d) all of the above
5. With regards to selenium metabolism in the calf from birth, which of the following is true:
   a) selenium is concentrated in the calf and stored in bone
   b) selenium is not concentrated in the calf prior to birth and reflects the dam’s status
   c) selenium levels decline slowly and no risk of sub-optimal levels exists up to 24 months of age
   d) all of the above
   e) none of the above

6. With regards to copper metabolism in the calf from birth, which of the following is true:
   a) copper is concentrated in the calf and stored in the liver
   b) the copper level of the calf is usually higher than the dam at birth
   c) copper reserves decline rapidly in the calf and sub-optimal levels can be reached as early as 2-3 months of age
   d) all of the above
   e) none of the above

7. With regards to zinc metabolism in the calf from birth, which of the following is true:
   a) Zinc is not concentrated in the calf
   b) Zinc levels in the calf decline slowly and the risk of sub-optimal levels is only a concern at 12 months of age.
   c) There is enough zinc in cow’s milk and additional supplementation should never be considered.
   d) all of the above
   e) none of the above

8. At what age should the first consideration be given to selenium supplementation in the calf:
   a) At three months of age
   b) At weaning
   c) It depends on the cow’s status, as the calf’s status is a reflection of the cow’s and hence problems with low selenium levels can occur at birth
   d) at three months and at weaning
   e) none of the above

9. At what age should the first consideration be given to copper supplementation in the calf:
a) At weaning
b) at 2-3 months of age
c) a & b
d) Usually at 2-3 months of age, provided the calf did not suffer a disease challenge especially enteric disease before this age.
e) none of the above

10. At what age should the first consideration be given to zinc supplementation in the calf:
   a) never
   b) at birth as calf zinc levels reflects the status of the cow
   c) at weaning only
   d) at 12 months of age
   e) none of the above