Blood samples aid in assessing herd health

Guidelines help dairy producers maximize the diagnostic value of blood and tissue samples for assessing the nutritional and mineral adequacy of dairy cattle rations.

By MIKE SOCHA, JERRY TORRISON and NEIL MICHAEL*

PROVIDING dairy cattle with adequate supplies of macro and micro minerals is essential for maintaining production, health and fertility.

Frequently, when dairy cattle performance is not up to expectations, dairy consultants request blood or tissue samples to attempt to evaluate the nutritional status on a herd basis. Consultants are cautioned not to use results from individual diseased animals to make assessments of nutritional status. Meaningful results rely on assessing several factors, including: the type and number of cattle sampled, sample choice, the mineral evaluated and sample handling.

The guidelines in this article are intended to help producers and their consultants maximize the diagnostic value of blood and tissue samples for assessing the nutritional and mineral adequacy of diets.

As a general rule, blood and tissue samples from sick, injured or stressed cows should be avoided when the objective is evaluation of nutritional status, although samples targeting disease diagnosis can sometimes be useful to aid nutritional decisions dependent upon the pathophysiology of the specific disease.

A good example of this would be hypocalemia, where the cow’s homeostatic control mechanism for blood calcium concentration has failed and has dropped such that muscle function is affected.

However, as noted in Figure 1, inflammation due to infectious stress and, to a lesser extent, non-infectious stress affects the mineral content of blood (serum) and the liver. Generally, concentrations of zinc and iron in blood drop, while blood copper concentrations increase when animals are in the disease state. In contrast, liver iron and zinc contents increase, while liver copper content decreases.

The increase in blood copper concentrations is due to the copper-containing acute phase protein ceruloplasmin, which increases in blood when the animal’s immune system battles an infection. Due to both zinc and iron being important for bacteria, the body reduces the availability of these minerals to pathogens by decreasing circulating concentrations and absorption of these minerals. Thus, collecting blood and tissue samples from sick, stressed and injured cows should be avoided.

Additional comments and guidelines for pulling blood and tissue samples for assessing the mineral adequacy of the diet include:

1. Which cows should be sampled, and how many should be sampled? Samples from sick, injured or stressed animals should be avoided. Infectious stress and non-infectious stress affect the zinc, manganese, copper and iron content of blood and the liver.

Renal disease increases serum potassium concentrations, while diarrhea decreases serum concentrations of sodium, potassium and calcium. Trauma or tissue injury can also affect blood concentrations of minerals such as magnesium and iron.

Sample at least 20 cows or 10% of the herd, whichever is less. Strive to sample cows that are healthy and metabolically stable. Generally, cows that are 75-175 days in milk are good candidates to sample for mineral status.

2. Which tissue should be sampled to assess mineral status? As noted in the Table, the appropriate tissue to collect to assess status will vary depending on the mineral in question.

Blood is generally a poor indicator of zinc and copper status because blood concentrations of these minerals are regulated and do not drop until stores of these minerals are essentially depleted. As already noted, blood concentrations of zinc and copper can fluctuate with disease state. Also, when dietary molybdenum levels are high, cattle may be copper deficient even though serum copper levels are normal since molybdenum can be absorbed and tie up copper post-absorption.

While serum can be used to assess a metabolic deficiency of calcium, phosphorus and magnesium, it is of limited utility when assessing whether the dietary supply of these minerals is adequate. Serum concentrations of calcium, phosphorus and magnesium are maintained in a relatively narrow range by mobilizing bone stores of these minerals when dietary supplies are inadequate. Bone can be used to assess the calcium, phosphorus and magnesium status of cattle after death.

Ocular fluid, if collected from animals within 24 hours after death, can be used to assess the calcium and magnesium status of animals.

Milk generally is a poor sample to

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*Dr. Mike Socha is regional RNS manager for North America and Dr. Jerry Torrison is a swine veterinarian with Zinpro Corp. Dr. Neil Michael is a technical field consultant with Vita Plus Corp.

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**Table:** Appropriate tissue for assessing mineral status

<table>
<thead>
<tr>
<th>Mineral</th>
<th>Tissue</th>
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<tbody>
<tr>
<td>Calcium — live animals</td>
<td>Serum</td>
</tr>
<tr>
<td>Calcium — dead animals</td>
<td>Bone, ocular fluid</td>
</tr>
<tr>
<td>Cobalt</td>
<td>Serum/liver B12, serum methylmalonic acid</td>
</tr>
<tr>
<td>Copper</td>
<td>Liver (can “screen” with serum); toxicity, kidney and liver</td>
</tr>
<tr>
<td>Iron</td>
<td>Non-hemolysized serum iron, saturation of iron-binding capacity</td>
</tr>
<tr>
<td>Magnesium — live animals</td>
<td>Serum</td>
</tr>
<tr>
<td>Magnesium — dead animals</td>
<td>Bone, ocular fluid, urine</td>
</tr>
<tr>
<td>Manganese</td>
<td>Liver &gt; whole blood &gt; serum</td>
</tr>
<tr>
<td>Potassium</td>
<td>Serum (dietary potassium)</td>
</tr>
<tr>
<td>Selenium</td>
<td>Liver &gt; whole blood &gt; serum</td>
</tr>
<tr>
<td>Sodium</td>
<td>Serum/urine (dietary sodium)</td>
</tr>
<tr>
<td>Zinc</td>
<td>Pancreas &gt; liver &gt; serum</td>
</tr>
</tbody>
</table>

Source: Modified from J.O. Hal, Utah State University Veterinary Diagnostic Laboratory.
collect. For some minerals such as manganese and copper, concentrations in milk are low, while for other minerals such as calcium, concentrations in milk are regulated and generally do not reflect the mineral status of the animal. Milk is generally a pretty good indicator of the cow’s iodine status.

Urine, in general, is a poor indicator because an animal’s hydration state affects mineral concentrations.

3. Be aware of potential contamination sources. Tissues contaminated with dirt or other foreign material should not be used to assess the mineral status of the animal.

When collecting blood samples to assess the trace mineral status of cows, royal blue-top tubes should be used. Serum-separating tubes or red-top blood collection tubes should not be used due to potential mineral contaminants. For instance, red-top tubes typically use a zinc-containing lubricant on the rubber stoppers, which can result in erroneously high zinc concentrations.

4. Properly handle samples after collection. Lysis of red blood cells or hemolysis will result in elevated concentrations of iron, manganese, potassium, selenium and zinc in serum. Freezing whole blood samples and collecting blood from cows that are sick increases the risk of hemolysis.

Serum should be separated from the red blood cells within one to two hours of sample collection. Failure to do so in a timely manner results in artificially high concentrations of potassium and zinc leak from red blood cells into serum.

5. Use the appropriate reference range. The mineral concentrations of fetal tissues (aborted fetuses) will vary across gestation, and normal mineral concentrations will differ from those of adult cattle. Thus, reference ranges for mineral concentrations of adult cattle should not be used to assess the mineral status of the dam when fetal tissues have been analyzed.

For selenium, normal concentrations in serum and whole blood will differ depending upon whether a portion or all of the selenium was supplied by natural or organic sources compared to when cows are fed only inorganic sources of selenium.

The animal’s life-cycle stage will affect the status of some minerals. As noted in Figure 2, serum vitamin B12 status, an indicator of cobalt supply, drops with the progression of lactation due to lactation-depleting vitamin B12 stores. The copper status of cows is generally lowest right around calving and increases after calving due to the transfer of copper from the cow to the calf prior to birth.

Parity can affect the animal’s mineral status. Copper concentrations in the liver will tend to be higher in older cows than in first-calf heifers when supplemental copper is fed both in the dry period and in lactation. This difference is magnified if the replacement animals on the dairy operation are fed a minimal amount of supplemental minerals. For vitamin B12, blood concentrations in first-calf heifers will tend to be higher than in older cows.

As final note, tissue concentrations may not be indicative of whether or not cows will respond to additional minerals or minerals in different forms.