INFO SHEET
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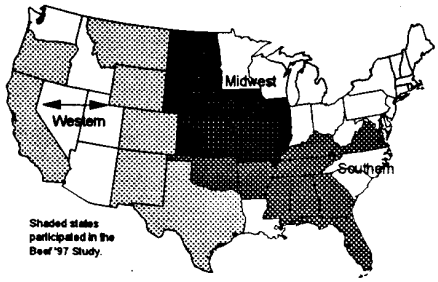
Serum Copper Concentrations of U.S. Beef Cattle

Copper is a trace mineral that is essential for the proper functioning of many cellular processes throughout the body. More specifically, copper has roles in several enzyme systems and is important for normal expression of estrus, maintenance of pregnancy, antioxidant activities, and in the formation and functionality of connective tissues such as bones, tendons and ligaments. The National Research Council has recommended 10 ppm (mg/kg) as the dietary requirement of copper on a dry matter basis for beef cattle.[1]

Loss of hair pigmentation (faded hair coat color), weight loss, bone fractures, anemia, and failure to thrive have all been associated with ***severe*** copper deficiencies. The effects of ***moderate*** copper deficiencies are harder to recognize and cause significant economic losses through impaired immunity and decreased growth rate, feed efficiency, and fertility. As a result, severe and moderate copper deficiencies result in substantial losses to the U.S. cattle industry each year. Importantly, the producer does not recognize these losses in many, if not most, instances.

It is widely accepted that assessment of an animal's copper status is most accurate when a liver sample is analyzed since liver is the primary storage site for copper. On an individual animal basis, serum analysis may not accurately reflect the animal's copper status. A low serum copper concentration is usually indicative of a deficiency. However, an adequate serum copper concentration may mask an inadequate liver store. It has been shown that analyzing serum copper from multiple animals in a herd provides a reasonable assessment of the herd-level copper status.



The USDA's National Animal Health Monitoring System (NAHMS) collected blood-serum samples from cattle during the NAHMS Beef '97 study. This study included 2,713 operations from the 23 leading cow-calf states.[2] Serum samples were collected from cattle on 411 operations with five or more cows, and a maximum of 10 samples were collected from each herd. A total of 3,902 serum samples were analyzed for copper content.

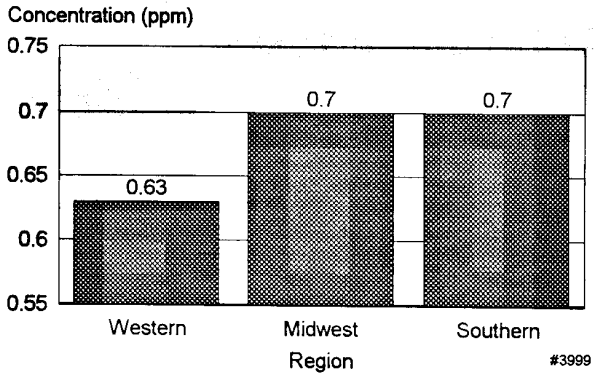
Categories used to describe adequacy of serum copper concentration for individual animals or operation means were:

- *Adequate* (0.65 ppm and greater)
- *Moderately deficient* (0.25 ppm and greater, but less than 0.65 ppm), and
- *Severely deficient* (less than 0.25 ppm).

In general, ***operations in the Western region had lower mean serum copper concentrations*** compared to other regions. The mean serum copper concentration for operations in the Western region was 0.63 ppm, which was significantly different when compared to 0.70 ppm, the mean for both the Midwest and Southern regions (Figure 1).

Figure 1

Serum Copper Concentrations by Region



[1] National Research Council. 1996. Nutrient Requirements of Beef Cattle. Washington, DC: National Academy of Sciences.

[2] Alabama, Arkansas, California, Colorado, Florida, Georgia, Illinois, Iowa, Kansas, Kentucky, Mississippi, Missouri, Montana, Nebraska, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Tennessee, Texas, Virginia and Wyoming.

Approximately 6 percent of operations had at least one severely copper deficient animal, whereas 85.4 percent of operations had at least one moderately or severely copper deficient animal.

Approximately 64 percent of operations provided supplemental copper to their cows, and this proportion was similar among regions. Methods of supplementation for cattle (and percent of operations that supplemented using each method) were free choice minerals (91.6 percent), bolus/copper needle (0.8 percent), added to the ration (7.2 percent) or pasture application (0.4 percent). None of the sampled operations used injectable copper or provided supplemental copper via water.

Cattle on operations that provided any copper supplement had significantly higher blood serum copper concentrations (0.67 vs. 0.65 ppm). Of the operations that did ***not*** provide supplemental copper, 43.2 and 2.7 percent were moderately and severely copper deficient, respectively (Figure 2), whereas 38.0 and 1.1 percent of operations that ***supplemented*** were classified as moderately and severely copper deficient, respectively. Therefore, a higher percentage of operations, though not all, had adequate serum copper concentrations when supplemental copper was provided to cows.

Why so many of the operations that provided copper supplements fell in the deficient category is unclear. Likely this outcome was due to a number of factors, such as:

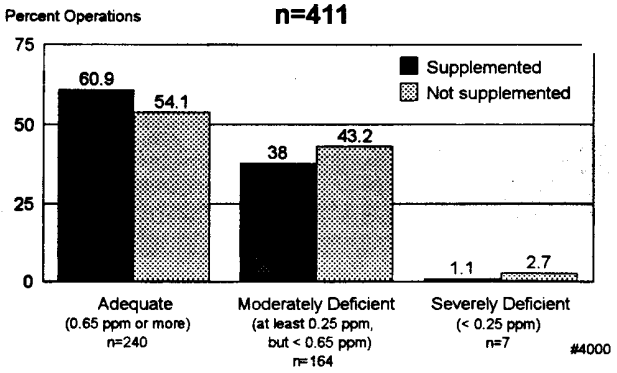
- Not all sources of copper have equivalent bioavailability (percent of copper supplied that is actually absorbed from the gastrointestinal [GI] tract and then incorporated into cellular processes.) For example, copper oxide is reported to be absorbed from the GI tract to a lesser extent than copper sulfate. The choice of copper source may have influenced the number of operations that were considered copper deficient.
- Quantity of supplemental copper and length of time that supplementation was provided may have been insufficient to adequately overcome a pre-existing deficiency (data not collected.)

An important consideration is that ***if no supplementation had been provided to any cattle, the percentage of operations considered deficient in serum copper likely would have increased.***

Results of the Beef' 97 study showed that 41.6 percent of operations and 43.2 percent of cattle were considered ***moderately or severely*** deficient in copper. Further, 1.7 percent of operations and 2.7 percent of cattle were considered ***severely*** deficient. Sixty-seven percent of forage samples collected as part of the same study and

Figure 2

Percent of Operations by Serum Copper Concentration Level and by Supplementation



analyzed for trace mineral content were found to have inadequate copper to meet the requirements for beef cattle.[1] Additionally, many other elements are antagonistic to copper absorption. For example, increases in molybdenum and/or sulfur consumption can decrease copper absorption from the gut. It would seem that supplemental copper provided to the cattle may have been partially successful in improving serum copper concentrations.

It is well recognized that copper supplementation as part of a complete mineral program is indicated on a high proportion of U.S. cattle ranches. However, in spite of supplementation, many cattle maintained inadequate serum copper concentrations for reasons that are unclear. The largest economic losses that result from copper deficiency are due to problems that are hard to recognize, such as decreased growth rate, poor feed efficiency, decreased reproductive performance, and adversely affected immune status. For example, copper deficient females may fail to ovulate and, when they do ovulate, there can be increased fetal losses early in pregnancy. Bulls may have decreased semen quality when deficient in copper. Additionally, calves born to copper deficient dams have increased incidence of scours, GI ulcers, and respiratory disease.

NAHMS Beef '97 results suggest that nutritional analyses should include copper concentration and that, where indicated, adequate quantity and quality of copper supplementation should be provided to cows. Additionally, a thorough nutritional analysis for copper antagonists such as sulfur and molybdenum is recommended when copper deficiencies are identified.

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[1]USDA:APHIS:VS. 1999. NAHMS Forage Analyses in 23 Sstates, N303.499.