Copper: An Essential Micronutrient for Beef Cattle

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Throughout the world copper deficiency limits cattle production by reducing growth reproductive performance and immune response. With the exception of phosphorous, copper deficiency is the most sever mineral limitation to grazing livestock throughout extensive regions of the tropics. In many geographical areas copper deficiency can be caused by an excess of molybdenum or sulfur that interfere with copper absorption function or both. In these areas copper consumption may be adequate to meet an animal's needs for copper, but molybdenum renders copper unavailable.

Grazing cattle are more likely to develop a copper deficiency than feedlot cattle. The extent of copper released from forages depends upon forage type and stage of growth. Cattle grazing mature low quality forages during the fall and winter are more likely to develop copper deficiency than those grazing in spring and summer. Two types of soils have a marked influence on copper uptake by the plants or copper absorption by the animal. Muck soils, because of their high organic matter bind copper which in turn makes forage grown on these soils deficient in copper. Soils high in molybdenum can produce forages with high molybdenum content which can interfere with copper metabolism in animals grazing these high molybdenum soils.

Clinical signs of copper deficiency include ill thrift and poor growth in young animals a loss of body condition in the cow and the hair coat may be rough and faded. The change in hair color is the result of loss of pigment in hair follicles. The hair coat will appear more yellow with a red cow and greyer with a black cow. The immune system may also be compromised with animals being more susceptible to infectious diseases and diarrhea. Lameness and in-coordination may be observed in young calves. In older animals rickets like condition or fractures of long bones may be observed. Degenerative heart disease and associated acute heart failure may also be observed (falling disese). Infertility and delayed or depressed estrus and fetal deaths may also be observed.

Diagnosis of copper deficiency is inferred from clinical signs the geographic region and history. A definitive diagnosis is made by testing serum or liver tissue to determine the copper status for an animal. Testing the liver is the best means of determining the copper status. In a live animal, a liver biopsy can be performed to collect tissue utilized in testing the animal's copper status. Serum copper levels will not reflect copper stores unless the liver is depleted. Therefore if the serum tests low for copper the liver stores are depleted. If serum test's normal for copper the liver status for copper storage is unknown.

In general copper is poorly absorbed by the digestive tract. Copper absorption is influenced by: the age and breed of cattle, the amount and chemical form of copper, the level of other minerals molybdenum and sulfur in the diet. If the molybdenum content of the diet is less than 1 ppm dry matter then 8 to 10 ppm copper in the diet should be adequate (8-10 mg per kg). If the molybdenum content in the diet is greater than 2.5 ppm, 10 ppm copper levels may be inadequate and should be increased to 15 ppm. Generally when molybdenum levels are not high, supplements supplying 125 to 140 ppm copper per head per day are usually adequate. The maximum tolerable concentration of copper for cattle has been estimated at 100 mg of copper per Kilogram of diet.

Copper is potentially a toxic mineral and many species of animals cannot tolerate high copper consumption. Sheep and some species of dogs are sensitive to copper toxicosis. Acute copper toxicosis in cattle is associated with abdominal pain, diarrhea, vomiting and death. Chronic copper poisoning is associated with jaundice swollen livers and kidneys a red colored urine. The levels recommended here are for mature cattle as they are less susceptible to copper toxicity than young animals.

When selecting a source of copper and depending on the chemical makeup of the copper source the bio availability for copper will vary. Copper sulfate and chelated sources are good sources for copper. Table 1 provides the relative bio availability for various sources of copper.

Copper levels for cows and bulls from two south Florida ranches were evaluated: tissue levels below 10 µg/g are considered deficient, levels greater than 50µg/gm are considered adequate, levels between 10 and 50 µg/g are intermediate. The levels of liver copper is reported in table 2. This information is intended to aid Florida ranchers when evaluating the copper status for their herd.

Table 1 Comparison of commonly used sources of copper in livestock mineral supplements.

Source of copper	**% copper in the mineral source**	**Relative bioavailability (relative to cupric acetate)**
Cupric sulfate	25.0	High (89%)
Cupric Carbonate	53.0	Intermediate (55%)
Cupric Chloride	37.2	Intermediate
Cupric Oxide	80.0	Low (0.5%)
Cupric Acetate	32.1	High (100%)

Table 2. Copper status liver tissue. µg/gram liver tissue <10µg/gm tissue deficient>50µg/gm tissue adequate, >10 & <50 µg/gm intermediate.

	Mean Liver copper level µg/gram tissue	Range of liver copper levels µg/gram tissue	percent deficient <10 µg/gram	percent marginal 10-50 µg/gram	percent adequate >50 µg/gram
Cows ranch (1) (199 hd) [a]	62[b,c]	4-314	17%	37%	46%
Bulls ranch (1) (19 hd) [a]	91[c]	7-389	32%	16%	52%
Cows ranch (2) (31 hd)	126[b]	17-247	0%	10%	90%

[a] Ranch 1 and 2 were feeding different mineral supplements which were provided free choice prior to tissue collection.

[b] there was a significant difference in mean liver copper levels between cows from ranch 1 and 2, $p<0.001$

[c] there was not a significant difference between mean liver copper levels of cows vs. bulls from ranch 1 $p =0.07$

[d] Tissue samples were analyzed by the Diagnostic Center for Population and Animal Health at Michigan State University. Tissues samples were analyzed on the same day to minimize laboratory error.

References

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