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Trace Mineral Supplementation for Kentucky Beef Cows

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According to the 1996 Beef Cattle NRC, there are at least 17 minerals considered essential for beef cattle (Table 1). Cattle failing to receive some minimum level of these minerals in the diet may exhibit problems of health, productivity, or reproduction.

Minerals may be further classified by the amount needed in the diet (Table 1). Macrominerals are required in relatively large amounts; microminerals are just as essential but required in the diet in only small or trace amounts.

Minerals Have Multiple Functions

Minerals perform many functions in the body, but this fact sheet describes only general categories rather than all functions.

Minerals may function as structural components of bones and teeth, electrolytes in body fluids, and in metabolism of nutrients, nerve conduction, reproductive processes, and immune response, among other functions.

Factors influencing the amount of specific minerals that cattle require include age, rate of growth, stage of pregnancy, and stage and level of lactation.

Different body functions also require varying amounts of minerals, as shown in Figure 1. The figure illustrates that for some trace minerals, the intake required for maximum immune response is greater than that required for growth or reproduction. Cattle can have sufficient trace mineral intake so that no negative impact on growth or reproduction occurs, but at the same time they can be consuming inadequate trace mineral required for maximal or optimal immune function. Intake and absorption of minerals must be adequate to meet all the animal's requirements.

Mineral Content of Forage Important

Although many factors influence intake and absorption of minerals by cattle, a major factor is the mineral content of forages. Results of a 1993 survey by the National Animal Health Monitoring System as part of the Cow/Calf Health and Productivity Audit (NAHMS-CHAPA) of micronutrient status of various forages (alfalfa/alfalfa mix, brome, bermuda, fescue/fescue mix, sudan/sudan x sorghum, cereal, native, grass, silage, and other) are shown in Table 2.

Table 1. Essential Minerals for Beef Cattle

Macrominerals	
Calcium	Potassium
Chlorine	Sodium
Magnesium	Sulfur
Phosphorus	
Microminerals	
Chromium	Manganese
Cobalt	Molybdenum
Copper	Nickel
Iodine	Selenium
Iron	Zinc

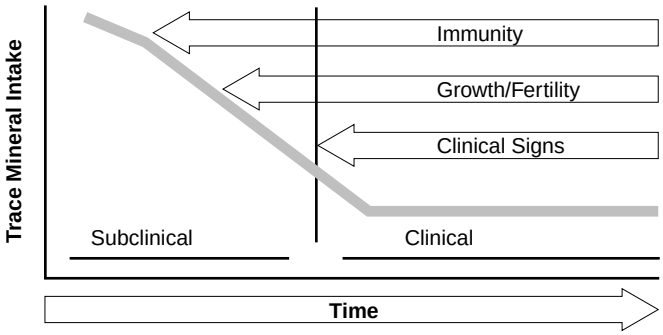
Seventh Revised Edition, *Nutrient Requirements of Beef Cattle,* 1996

Table 2. Levels of Selected Trace Minerals in Forages, Percent of Total Samples[a]

Element	Deficient	Marginal	Adequate	High
Cobalt	48.6	17.3	34.1	--------
Copper	14.2	49.7	36	--------
Manganese	4.7	19.3	76	--------
Selenium	44.3	19.3	19.7	16.7
Zinc	63.4	34.1	2.5	---------

[a] Cow/Calf Health and Productivity Audit, 1993

Figure 1. Trace Mineral Functions



Source: Wikse, 1992 Texas A&M Veterinary Beef Cattle Short Course.

Three hundred and fifty-two forage samples collected from 18 states were evaluated for their content of cobalt, copper, manganese, zinc, selenium (305 samples), iron, and molybdenum. The latter two minerals were measured because of their strong antagonistic relationship with copper. With the exception of manganese, the majority of forages sampled were at least marginally deficient in the important trace minerals shown. In addition, a significant portion of samples contained molybdenum and/or iron at levels sufficient to interfere with copper absorption. Molybdenum levels above 3 parts per million and iron levels above 400 parts per million in the forage are considered high enough to interfere with copper absorption.

Sulfur in the feed or water may also interfere with copper absorption because sulfur levels of more than 0.25 percent in the daily dry matter can reduce copper availability. When antagonists are present, organic forms of the mineral (chelates/proteinates), which appear to be absorbed by a different system than inorganic sources, may be necessary to ensure trace mineral absorption.

Accurate Analysis of Forage Mineral Content Necessary

Producers should always read the ingredients list on the mineral product label. Because the mineral's source greatly influences absorption or bioavailability, mineral supplements must contain sources of high bioavailability of essential elements. Bioavailability of some common sources of selected minerals is shown in Table 4.

The first step in developing a mineral supplement is to accurately determine the feed/forage mineral content. The animal's feed intake and mineral requirements must also be considered. Requirements are presented in parts per million (ppm) of a suggested dry matter intake. If the animals in question are consuming less than the suggested dry matter intake, the mineral requirement must be increased to compensate. Conversely, if actual intake of dry matter exceeds the suggested intake, the requirement (as parts per million of dry matter intake) may be decreased.

A common problem with some products sold in Kentucky is the use of copper oxide as the sole source of copper. Bioavailability of copper from copper oxide is low. In addition, some supplements use high levels of iron oxide as a coloring agent. Iron is not available from iron oxide and also has been shown to interfere with copper's bioavailability.

Mineral availability from feed/forage must also be considered. Simply comparing feed/forage mineral content to animal requirements can lead to inadequate formulations when the bioavailability of the mineral in the feed/forage is low. Useful information concerning biological availability of forage minerals is limited, however.

Table 3. Levels of Trace Mineral Antagonists in Forage, Percent of Total Samples [a]

Element	Marginal	Very High
Iron	17	11.7
Molybdenum	48.6	9.2

[a] Cow/Calf Health and Productivity Audit, 1993

Table 4. Relative Bioavailability of Selected Mineral Sources [a]

Element	Source	Bioavailability
Calcium	Monocalcium phosphate	High
	Dicalcium phosphate	High
	Ground Limestone	Intermediate
Phosphorus	Monocalcium phosphate	High
	Dicalcium phosphate	Intermediate
	Defluorinated phosphate	Intermediate
Magnesium	Magnesium oxide	High
	Magnesium sulfate	High
Copper	Copper oxide	Low
	Copper sulfate	High
	Copper carbonate	Intermediate
Iron	Iron oxide	Unavailable
	Ferrous carbonate	Generally high
	Ferrous sulfate	High
Selenium	Sodium selenite	High
Zinc	Zinc oxide	High
	Zinc sulfate	High

[a] Adapted from McDowell, *Minerals in Animal and Human Nutrition*

Factors Influencing Mineral Availability

Factors influencing mineral availability include:

- age of animal
- previous mineral intake
- animal's current mineral status
- mineral's chemical form
- potential for interaction with other diet components.

Absorption of some minerals from forage (Mn, Fe, Se, Cu) is generally low, although true availability can be difficult to determine due to homeostatic control of absorption. Apparent absorption from fescue may range from 5 to 15 percent for copper, 28 to 32 percent for selenium, 30 to 70 percent for iron, and only 3 to 4 percent for manganese. When specific information concerning trace mineral availability in forages is lacking, formulation errors can be minimized by assuming no greater than 50 percent availability for the mineral in question.

The average mineral composition of fescue is shown in Table 5. Selected mineral requirements for late gestation and early lactation beef cows are shown in Table 6. In the 1996 NRC beef nutrient requirement tables, selenium requirements were decreased from 0.3 to 0.1 parts per million of the ration dry matter. No strong rationale exists for this decrease, and, in most cases, selenium supplementation at the maximum legal level of 3 milligrams per head daily should be practiced.

Table 7 shows two examples of trace mineral formulations. These formulas are based on the requirements in Table 6, the average mineral content of fescue in Table 5, and estimated bioavailable intake of the minerals from fescue. They reflect formulations necessary to supply trace mineral deficiencies from intakes of 2 or 4 ounces of mineral daily. When it is not desirable to estimate bioavailable intake of minerals from forage, formulations should supply 100 percent of the animal's daily requirement.

Products Now in Use May Still Work

The example formulas in Table 7 are not the only ones that can be used. They should be compared with products in current use that may have a different formulation but are being consumed in greater amounts than the suggested 2 to 4 ounces daily—products that may still supply the same amount of mineral nutrient daily as the example formulas.

White salt should never be considered adequate mineral supplementation by itself. Trace minerals must be adequately supplied by another source. Trace mineralized salts generally contain only small amounts of trace minerals, and beef cattle do not usually consume enough of these salts to meet their requirements. Salt intake should be monitored, however, because unusual conditions can stimulate over-consumption of trace minerals.

Beef cattle should be provided a complete product that:

- uses mineral sources of high bioavailability
- contains both macrominerals and microminerals in the proper ratios
- will be consumed in adequate quantity.

Table 5. Average Mineral Content of Fescue, Dry Matter Basis[a]

Mineral	Content
Calcium, % DM	.37
Phosphorus, % DM	.26
Magnesium, % DM	.27
Potassium, % DM	3.64
Sulfur, % DM	.22
Cobalt, ppm	.22
Copper, ppm	5.8
Iron, ppm	99.6
Manganese, ppm	118.6
Molybdenum, ppm	1.0
Selenium, ppm	.059
Zinc, ppm	18.7

[a] Values from NAHMS-CHAPA Southeast Region or JAS 48:607 and JAS 51:704 for Ca, Mg, K, S

Table 6. Mineral Requirements for Beef Cows [a]

Element	Gestation	Lactation
Calcium, % DM	.25	.30
Phosphorus, % DM	.16	.20
Magnesium, % DM	.12	.20
Potassium, % DM	.60	.70
Sodium, % DM	.06 to .08	.10
Sulfur, % DM	.15	.15
Cobalt, ppm	.10	.10
Copper, ppm	10	10
Iodine, ppm	.50	.50
Iron, ppm	50	50
Manganese, ppm	40	40
Selenium, ppm	.10*	.10*
Zinc, ppm	30	30

[a] 1996 Beef NRC, 1200-lb mature cow, gestation 60 days precalving, lactation 60 days postcalving, 20 lb of milk daily.
* For Kentucky, 0.3 ppm as the requirement for beef cattle is still recommended.

Table 7. Example Trace Mineral Formulations for Mature Beef Cows Grazing Fescue[a]

Estimated Daily Intake	Two Ounces	Four Ounces
Cobalt, ppm	22	11
Copper, ppm	2062	1031
Iodine, ppm	109	54.5
Manganese, ppm	7700	3850
Selenium, ppm	52	26
Zinc, ppm	4511	2256

[a] Based on 1996 Beef NRC, 1200-lb cow, first 60 days of lactation, 20 lb daily milk.

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