AS-1271

Use of Minerals in Dairy Cattle

What they are and why they are important

J.W. Schroeder
Extension Dairy Specialist

All too often, discussions of dairy nutrition are limited to nutrients, such as energy and protein, that have a direct impact on milk production. But what about minerals? What are they? Why are they important? How much do cows need? What happens if we don't provide enough of a particular mineral? Can we provide too much? While varying mineral levels may not have the immediate impact of a major shift in energy or protein levels, the long-term effects on animal health, longevity and growth are significant.

Minerals are inorganic (not of plant or animal origin) elements required by the body for optimum growth and proper muscle and nerve function. In addition, they are essential components of body enzymes, hormones and cells. Recommended mineral levels are not constant; they vary with changing production, body size, environment and other dietary factors. To calculate a cow's true mineral needs, you need to know her physiological status (pregnancy status, milk production level, maintenance requirements and growth rate).

How can you tell if mineral requirements are not being met or are not properly balanced? Generally, problems first will be observed in the areas of animal health and reproduction. The impact will not be immediate. Many mineral deficiencies are noticed only after a prolonged period of underfeeding has occurred. Although clinical symptoms of a mineral deficiency make take time to appear, subclinical deficiencies may have been impairing optimum performance for quite some time. The primary exception to this rule is in the case of a mineral toxicity. At high levels, many minerals can be toxic.

Further complicating our ability to meet mineral requirements is the fact that mineral absorption is lower than absorption of most other nutrients. Mineral absorption varies from one mineral to another and by the form of the mineral. Even when we have determined how much of the correct form of a particular mineral to feed, our job is not complete because we have to consider numerous known interactions between minerals (i.e., high levels of one will decrease utilization of another).

Known mineral interactions include copper-molybdenum, sulfur-selenium, calcium-phosphorus, calcium-zinc, calcium-manganese, iron-manganese and potassium-magnesium. With many minerals, absorption of the mineral decreases as their amount in the diet increases. You also need to note that older animals typically have lower absorption rates.

To minimize costs involved with mineral feeding, nutritionists should try to maximize the percent of minerals provided by typical feedstuffs. However, remember that mineral content in feedstuffs is quite variable. Frequent forage testing (preferably through a wet chemistry analysis) is beneficial for economical mineral feeding. Generally, supplemental trace minerals are supplied through inorganic sources, typically in the form of sulfates, phosphates, chlorides, carbonates or oxide forms of the trace mineral.

Some inorganic sources of trace minerals are more available than others (i.e., sulfates are generally more available than oxides). Organic minerals often are classified as chelates or proteinates bound to amino acids or proteins. They usually are absorbed in the intestine by a different mechanism that may increase their bioavailability and may improve absorption in situations where mineral interactions exist.

Organic minerals are generally more expensive, but they still may be advantageous, particularly as related to immune and reproductive responses. As a rule of thumb, one-third to one-fifth of trace mineral supplementation should come from organic mineral sources, depending on the specific mineral desired.

Macrominerals are needed in greater amounts and usually are expressed as a percentage of the ration dry matter. Calcium, phosphorus, magnesium and potassium are macrominerals that are important to the dairy cow. Microminerals are needed in smaller amounts and are generally expressed as parts per million (ppm). Iodine, zinc, iron, copper, molybdenum, fluorine, cobalt, selenium and chromium are microminerals needed by the dairy cow. **Table 1** (page 2) lists these minerals, their functions, symptoms of deficiency and feed sources used to supply each respective mineral.

Minerals are an integral part of any successful herd management program. Often, correcting an imbalance in mineral levels can solve a nagging problem by improving reproductive performance or animal health with very little additional cost. While research continues to redefine the forms in which minerals are delivered to the cow, their role in animal performance remains the same.

References

DeOndarza, Mary Beth. Minerals. *www.milkproduction.com*

J.G. Linn, M.F. Hutjens, R. Shaver, D.E. Otterby, W.T. Howard, and L.H. Kilmer. 1996. Feeding the Dairy Herd. North Central Regional Extension Publication 346. Dairy NRC 2001.

NDSU EXTENSION SERVICE

June 2012

Table 1. Summarization of minerals in dairy rations.

Mineral	Functions	Deficiency Symptoms and Associated Problems	Feed Sources for Dairy Cattle
Calcium (Ca)	Bone and teeth formation, blood clotting, muscle contraction, 12% in whole milk	Rickets, slow growth and poor bone development, easily fractured bones, reduced milk yield	Alfalfa and other legumes, ground limestone, dicalcium phosphate, steamed bone meal
Phosphorus (P)	Bone and teeth formation, involved in energy metabolism, part of DNA and RNA, .09 percent in milk	Fragile bones, poor growth, low blood phosphorus, depraved appetite, poor reproductive performance	Phosphates, steamed bone meal, cereal grains, grain by-products, oil seed meal
Sodium (Na)	Acid-base balance, muscle contraction, nerve transmission	Craving for salt, reduced appetite, incoordination weakness, shivering	Common salt and butter products
Magnesium (Mg)	Enzyme activator, found in skeletal tissue and bone	Irritability, tetany-increased excitability	Magnesium oxide, forages and mineral supplements
Sulfur (S)	Rumen microbial protein synthesis, found in cartilage, tendons, and acids	Slow growth, reduced milk production, reduced feed efficiency	Elemental sulfur, sodium and potassium sulfates, legume forages
Potassium (K)	Maintenance of electrolyte balance, enzyme activator, muscle/nerve function	Decrease in feed intake, loss of hair glossiness, lower blood potassium	Legume forages, potassium chloride, potassium sulfate
Iodine (I)	Synthesis of thyroxine	Big neck in calves, goitrogenic (enlargement of thyroid gland) substances may cause deficiency	Iodized salt, trace mineralized salt and commercial supplements
Iron (Fe)	Part of hemoglobin, part of many enzyme systems	Nutritional anemia, pale mucus membrane	Forages, grains, trace mineralized salt, ethylene diamine dihydroiodine
Copper (Cu)	Needed for manufacture of hemoglobin, coenzyme	Severe diarrhea, abnormal appetite, poor growth, coarse, bleached hair coat	Trace mineralized salt and commercial supplements
Cobalt (Co)	Part of vitamin B_{12}, needed for growth of rumen microorganisms	Failure of appetite, anemia, decreased milk production, rough hair coat	Trace mineralized salt and commercial supplements
Manganese (Mn)	Growth, bone formation, enzyme activator	Delayed or decreased signs of estrus, poor conception	Trace mineralized salt and commercial supplements
Zinc (Zn)	Enzyme activator, wound healing	Decreased weight gains, lowered feed efficiency, skin/wound problems	Forages, trace mineralized salt, zinc methionine
Fluorine (F)	Not known if it is essential for ruminants, although essential for lab animals	Severe reduction in feed intake, stiffness in legs, enlarged bones	Rock phosphate mineral
Selenium (Se)	Functions with certain enzymes, associated with vitamin E, immune system	White muscle disease, retained placenta, lessens subclinical mastitis	Oil meals, alfalfa, wheat, oats, corn, commercial supplements
Molybdenum (Mo)	Part of the enzyme xanthine oxidase	Loss of weight, emaciation, diarrhea	Widely distributed in feeds, deficiency rarely a problem

500-7-04; web-7-10; web-6-12