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Minerals for Horses, Part II Trace Minerals

*Frederick Harper, Extension Horse Specialist
Warren Gill, Extension Beef Specialist
Department of Animal Science*

Minerals are classified as major (macro-minerals) and trace (micro-minerals). This issue discusses trace minerals. Trace minerals include copper, zinc, selenium, iodine, manganese, iron, cobalt and fluorine. Other trace elements being looked at for horses are aluminum and chromium. The fall issue of Horse Express provided an overview of major minerals and can be obtained from your county Extension office or on the Web at http://animalscience.ag.utk.edu/horses/newsletter_THE.htm.

Most horse owners routinely feed a mineral/vitamin supplement or a commercial grain mix with added minerals. They probably know less about minerals than other nutrients like protein and vitamins. Horse owners are also more familiar with major minerals, such as calcium and phosphorus — knowing their importance for good quality bone in the horse — than they are with trace minerals. Individuals often do not worry about trace minerals, since only small amounts are required, or they think that “natural” feeds supply enough of these nutrients.

As essential nutrients for the horse, trace minerals are key components for most metabolic functions in the body. From the maintenance horse grazing the front pasture to world champions, trace minerals may make the difference in a horse being healthy and a winner — or not. While all horses require major and trace minerals, growth, reproduction, lactation and performance often affect the specific requirement.

Trace mineral requirements are expressed as parts per million (ppm) or as milligrams per kilogram (mg/kg) of dry matter (DM) feed. One ppm is equivalent to one penny in \$10,000. In this article, ppm refers to parts per million per pound of dry matter.

In the last 20 years, much research has been done on trace minerals. A few years ago, a field study of yearlings revealed that those fed higher levels of copper and zinc had fewer skeletal problems known as Developmental Orthopedic Disease (DOD).

Copper

Several copper-dependent enzymes function in the synthesis and maintenance of connective tissues, mitochondria, melanin, mobilization of iron stores and detoxification. It has been postulated that copper plays a role in bone formation.

Feeds commonly fed to horses contain 4 - 80 ppm. Foals have had satisfactory growth when fed 9 ppm. Even lower levels (3.5 ppm) seem adequate for mature horses. The current National Research Council (NRC) requirement for copper is 10 ppm for horses of all ages, regardless of their stage of growth, reproduction or performance. Higher levels are suggested for growing horses and broodmares.

When mares in late pregnancy were fed 30 ppm copper, their foals had less physitis and fewer articular cartilage lesions than did foals from mares not supplemented. Feeding extra copper directly to the foals had no effect. When mares and foals were both given copper, foals had less DOD. Copper fed to the mare in late pregnancy is stored in the fetal liver, aiding the newborn foal until it is eating adequately. Feeding copper to mares during lactation does not appear to increase the copper level of milk. Because of the seriousness of DOD in young, growing horses, most creep feeds are supplemented with 50 ppm copper and weanling feeds with 25 ppm. Low copper levels in older mares may result in fatal rupture of the uterine artery when they foal.

Horses appear to have a high tolerance for copper, with an upper limit of about 800 ppm. This level would be toxic to some animals such as sheep. The major concern with copper is a deficiency, especially for metabolic bone problems in young, growing horses.

Zinc

Zinc is a component of several enzyme systems involved in carbohydrate and protein metabolism. Common feeds contain 15 to 40 ppm. Sources of supplemental zinc are zinc sulfate, zinc oxide, zinc chloride, zinc carbonates and various zinc chelates.

The NRC set the zinc requirement at 40 ppm for all horses. Mature, idle horses may require only 28 ppm. Exercise appears to increase the zinc requirement of performance horses. Horses with poor-quality hoof horn had improved hooves when zinc was added to their rations.

A diet containing 40 ppm of zinc prevented zinc deficiencies in foals. Foals grew normally and maintained normal body stores of zinc. When young, growing horses were fed higher levels of zinc, copper and calcium, they had lower incidences of DOD. Research has shown that for optimal bone mineralization in young, growing horses, higher levels in the range of 60-80 ppm maybe beneficial.

Foals fed zinc-deficient diets have reduced feed intake and growth, parakeratosis, alopecia, diarrhea, lethargy and reduced zinc concentrations serum and tissue.

Horses are apparently quite tolerant of excess zinc. Mares and foals fed rations with 700 ppm had no observed problems. However, foals fed 2 percent of their diet (90 grams per day) as zinc developed stiffness of gait, lameness and enlarged epiphyses.

Selenium

Selenium has received much attention in horse nutrition in recent years. Along with vitamin E, selenium is a key part of the antioxidant defense mechanism. Oxidation converts carbohydrates, fats and protein to energy, water and CO₂. When oxygen is reduced to water, free radicals are produced. If left alone, free radicals damage living cells. Selenium and vitamin E, are scavengers of free radicals.

Most feeds commonly contain from 0.05 to 0.3 ppm. Soil level and pH influence the amount of selenium in a feed. Selenium in plants is mostly in organic forms, such as selenocystine, selenocysteine and selenomethionine. The inorganic forms are sodium selenite and sodium selenate. Organic forms of trace minerals, such as selenium-yeast, are more commonly being added to horse feeds today.

The selenium requirement has been estimated at 0.1 ppm. A level of 0.1 - 0.3 is generally recommended. Some signs of selenium deficiency in foals are white muscle disease, adipose tissue inflammation and insoluble pigment accumulations that cause steatitis or yellow-fat disease. Clinical symptoms are uncommon in horses, except in foals in their first month, but may occur up to 8 months of age. This is a result of an inadequate selenium intake by the mare in late pregnancy or inadequate selenium and/or vitamin E during lactation.

The range between requirement and toxicity is rather narrow with selenium. The maximum tolerable level of selenium is estimated at 2 ppm. Selenium is quite toxic to horses. Feeds eaten by horses may contain 0.01 to 10 ppm selenium. Some plants contain 50-10,000 ppm selenium; fortunately, horses rarely eat these plants as they are not palatable. Most acute selenium toxicity occurs from accidental over supplementation by feeding or injection, feeding more than one supplement at a time or feeding beyond

the manufacturer's recommended level. Unfortunately, all occur in the horse industry.

Some have speculated that General Custer's horses were lame at the Battle of the Little Big Horn from grazing forages with high levels of selenium.

Iodine

Iodine is essential in the synthesis of the thyroid hormones thyroxine and triiodothyronine, which regulate basal metabolism. Iodine can be supplemented by feeding iodized or trace mineralized salt that contains 70 ppm iodine. The iodine requirement has been estimated to be 0.1 ppm or about 1-2 mg per day. Feeds for horses contain from 0 - 2 ppm iodine.

Iodine deficiencies can be prevented by adding 0.5 - 1 percent or as little as 0.5 ounce of iodized or trace mineralized salt containing 70 ppm iodine to the grain mix daily. Iodine-containing trace mineralized salt may not be adequate for pregnant and lactating mares because of variable salt intakes. Horses would have to consume over one pound of trace mineralized salt a day before getting too much iodine.

The thyroid gland, lactating mammary gland and the placenta can concentrate iodine in the thyroid gland to produce hormones in milk for nursing foals and in the amniotic fluid for fetal use. This helps protect the mare, fetus and suckling foal from a deficiency.

Goiter is the common sign of an iodine deficiency or an excess. Foals from iodine-deficient dams may be still-born or weak at birth, have difficulty in standing to nurse and have a rough haircoat. They may have angular limb deformities or DOD because of delayed closure of their growth plates. Mares that are iodine deficient tend to have abnormal estrous cycles but do not have goiters.

The upper limit of iodine intake has been estimated to be 5 ppm. Feeding supplements with a high level of iodine or supplementing with more than one iodine supplement or feeding kelp, a seaweed with about 1,850 ppm, may result in excess iodine intake. Not all seaweeds contain as high a level of iodine as kelp. Before supplementing mares or foals, one needs to determine how much iodine is already in their feed.

In mature horses, thyroid hormone levels decrease with age and when excess amounts of protein are fed. Excess zinc and copper may also reduce the levels of thyroid hormones.

Manganese

Manganese is needed for carbohydrate and fat metabolism and for synthesis of chondroitin sulfate for cartilage formation. Using data from other species, the NRC noted that 40 mg of manganese should be considered adequate. Two recent studies indicate that the manganese required for mature, idle horses is 45 ppm. Higher levels are recommended for growth, reproduction, lactation and performance. Forages contain 40 to 140 ppm, and grains usually have 15 to 45 ppm. Horses in regions with low or marginal manganese in forages could benefit from supplementation.

Toxicity does not appear to occur naturally in horses. Abnormal cartilage development is observed in other species with a manganese deficiency. A manganese deficiency may cause lameness and knuckling-over of joints in

young, growing horses. Severe deficiency may result in re-sorption in utero or death at birth. Irregular estrous cycles have been attributed to manganese deficiency in mares.

Iron

Iron is found in molecules of hemoglobin (60 percent) and myoglobin (20 percent), which are involved in oxygen transport, and in many enzymes. Forages commonly contain 100 to 250 ppm, while grains usually contain about 100 ppm.

The horse's iron requirement has not been researched. Growing foals and pregnant or lactating mares are estimated to require about 50 ppm. However, the requirement is lower (40 ppm) for mature horses. Most common feeds, especially forages and by-products, should provide adequate levels.

The primary sign of iron deficiency is anemia. Clinical anemia is rare in performance horses. Iron deficiency is not normally seen even in nursing foals or mature horses. The body's ability to recycle iron to form new red blood cells is part of the reason for this.

Sucklings are more susceptible to iron deficiencies as milk is low in iron, and the iron requirement of growing foals is high. Chronic or severe blood loss, such as in heavy parasitism, can result in an iron deficiency. Iron in any form should not be given to horses unless there is a confirmed case of anemia and/or an iron deficiency. A clinical iron deficiency is rare in young, growing and mature horses.

In natural feeding programs, iron supplements have not been effective in improving the hemoglobin or oxygen carrying capacity of the red blood cells. The practice of giving oral or injectable supplemental iron is not justified. Such supplementation is mistakenly given, thinking that the hemoglobin or packed cell volume (PCV) will increase, thus increasing the horse's oxygen-carrying ability. Iron toxicity is a real risk with such practices, and there can be an antagonistic interaction with other trace minerals. Excess iron is stored in the liver and spleen, but horses have no system to eliminate these high levels. Hepatitis and other forms of liver damage are possible. Foal death has been attributed to oral administration of digestive inocula containing supplemental iron.

Cobalt

Cobalt is a component of vitamin B₁₂; thus it affects blood formation. Microorganisms in the horse's hindgut use cobalt to produce vitamin B₁₂. However, no data exist indicating a cobalt requirement for horses.

Fluorine

No dietary requirement for fluorine has been established even though it has been shown to be involved in the development of bone and teeth in other species. Horses seem to tolerate fluorine as high as 23 ppm without problems.

Chromium

Humans doing physical activities have an increased chromium requirement, which may have implications for performance horses. In fact, it has been reported that supplementing performance horses with 5 mg of chromium daily as chromium yeast had a beneficial effect on exercise stress in horses. Some recommend from 0.1 to 0.5 ppm chromium, depending on the use of the horse.

Aluminum

One reason for interest in aluminum is that it is often included in products such as antacids formulated for gastric ulcers in horses. One study indicated that 4,500 ppm aluminum decreased phosphorus absorption. Recently, feeding 930 ppm aluminum for one month had negligible effects on nutrient digestibility and mineral metabolism.

Pasture Minerals

Research from Virginia indicates that horse pastures there are deficient in copper, zinc and selenium year round and deficient in phosphorus and vitamin A in winter. Beef cattle pastures in Tennessee have shown deficient or marginal levels of copper, zinc and selenium and high levels of sulfur, which is antagonistic to copper.

Trace Mineral Salt

Trace mineralized salt has long been provided free-choice or in grain mixes to horses on pasture or stalled. Some mixes may not provide the levels of trace minerals needed to balance recently discovered pasture deficiencies. Free-choice trace mineral salt blends typically contain 300-1200 ppm copper and 2000-4000 ppm zinc since the animal consumes only a small amount.

Knowing that certain trace minerals are deficient in the Southeast, it seems advisable to continue providing free-choice trace mineralized salt blends until new products are available. There is virtually no risk of toxic conditions with this practice; for most horses, slight excesses of trace minerals do not appear to be detrimental for growth or performance.

Free-choice trace mineralized salt blends should be available to all horses at all times. However, trace mineral intake is more critical in late pregnancy than in lactation.

Chelated Minerals

Chelated or organic minerals are formed when organic components, such as amino acids, are attached to trace minerals. Based on recent research, it seems advisable that 1/3 to 1/2 of appropriate trace minerals be in a chelated or organic form. Chelates seemed to improve the absorption of minerals from the digestive tract. Data has shown that while minerals, either inorganic or organic, had little effect on performance, the plasma copper and zinc levels of foals nursing mares fed chelated minerals did increase.

Hair Analysis

Hair analysis has been proposed as a method to ascertain the mineral status of horses; however, its validity for a whole-body assessment of trace minerals is questionable.

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Associate Professor, Extension Animal Science

Tennessee Horse Express

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