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Minerals for Horses
Part I: Major Minerals

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Many horse owners routinely feed a mineral/vitamin supplement or a commercial grain mix with added minerals and vitamins. Owners are most likely motivated to use supplements because of the vitamin content rather than the minerals. Protein and vitamins are the "big" items to many horse owners. While minerals are commonly supplemented to horses, owners often know less about their importance than that of other nutrients.

One reason minerals may not be glamorous is that they are inorganic elements, like rock, and usually only a small amount is needed compared to other nutrients. The body contains only 4 percent minerals; however, minerals are needed for the physiological well-being of the horse, its growth, reproduction and performance.

What minerals do horses need? What do they do in the horse's body that is so important that they are "essential" or required? How much of the various minerals does your horse need? These are some of the questions we will answer as we investigate the world of minerals.

All horses require minerals, but their age and activity (performance, growth, reproduction and lactation) affect the specific requirement for each mineral. Minerals are classified as major (macrominerals) or trace (microminerals). This issue will discuss the major minerals.

The major minerals are calcium (Ca), phosphorus (P), sodium (Na), chlorine (Cl), magnesium (Mg), potassium (K) and sulfur (S). The letters in parentheses are the chemical symbols for the minerals. "Major" does not imply that these minerals are more important than trace minerals. Rather, major minerals are required in larger amounts than trace minerals, often as grams per day; and levels are commonly expressed as percentages.

Trace minerals are needed in very small amounts – parts per million (PPM) per day. For example, 10 PPM would be equivalent to one penny in $10,000. The trace or microminerals are copper, zinc, selenium, cobalt, iron, iodine, manganese, fluoride, chromium, molybdenum, nickel and silicon. They will be discussed in Part II.

Minerals have many functions in the body. The two general ones are 1) as major components of bone providing structural support of the skeleton and 2) as part of various biochemical reactions.

Feeding more minerals than needed does not improve health or performance. In fact, some minerals in excess can be toxic. The balance of minerals is often critical, as they can affect each other resulting in antagonistic interactions.

Most horse owners are familiar with calcium and phosphorus, the major minerals in bone, and sodium chloride, or salt. Horse owners should be concerned with calcium, phosphorus and magnesium in young, growing horses and with sodium, chlorine and sometimes potassium in performance horses that sweat a lot.

Calcium and Phosphorus

Calcium and phosphorus are the major components (70 percent) of bones and represent 30-35 percent of the minerals in milk. Each has additional functions in the body. Skeletal strength is more important in the horse than in other farm animals. Horses are more active animals that can only function properly if they have a sound skeleton, and horses also live longer than other farm animals. It is not uncommon to find horses in their late 20s to 30s being ridden and still reproductively active. Having sound feet and legs for 30-plus years is not an issue with beef or dairy cattle, hogs, or sheep.

Calcium makes up about 35 percent of the skeleton and is involved in muscle contractions, blood clotting, regulation of several body enzyme actions, cell membrane function and temperature regulation. About 99 percent of the body's calcium is in bones and teeth. Calcium is important for the integrity of the hoof wall and essential in

bonding the hoof's keratin cells together. Calcium is digested and absorbed in the upper part of the horse's small intestine.

Homeostasis (a relatively stable state of equilibrium) of the blood level of calcium is critical, and the skeleton serves as a calcium reservoir. If dietary calcium is inadequate, calcium can be removed from the skeleton to meet the metabolic demands of the body. Since the body's homeostatic mechanism maintains calcium within a tight range, serum calcium is a poor indicator of a horse's calcium status.

The classic calcium deficiency in foals is rickets — enlarged joints and crooked limbs. Nutritional Secondary Hyperparathyroidism is rare but occurs when horses are fed high grain rations along with limited forages or diets low in calcium without adequate levels of calcium supplementation.

Inadequate calcium or phosphorus in growing foals delays the closure of the epiphyseal plates of the long bones. This results in Developmental Orthopedic Disease (DOD). Lameness and bone fractures are noted in adult horses fed inadequate calcium and phosphorus rations.

Calcium levels are normally higher in forages and lower in cereal grains, while grains are high in phosphorus but low in calcium. Legume forages, such as alfalfa, have a higher calcium level than grass forages. Calcium can be provided by limestone or dicalcium phosphate, which supplies both calcium and phosphorus.

A 1,200-pound mature maintenance horse requires about 23 grams of calcium daily. Performance, growth, reproduction and lactation increase calcium requirements. There is evidence suggesting the calcium needs of horses may be higher than currently listed in the National Research Council's Nutrients Requirement of the Horse (1989), especially for young horses in training.

Training has been shown to increase calcium, phosphorus and magnesium requirements above current recommendations. The cannon bone goes through a period of demineralization and remineralization following the start of training. Calcium needs increase when there is reduced calcium absorption, increased calcium is excreted in the urine or bone is demineralized. Young horses in training should be fed diets containing 0.4 percent calcium.

Phosphorus accounts for 14-17 percent of the skeleton. About 80 percent of the body's phosphorus is in the bones and teeth. It also functions in many energy metabolism reactions and is important in the synthesis of several compounds.

Phosphorus absorption ranges from 30-55 percent; however, phytate phosphorus (organic phosphorus) is poorly absorbed in horses and can result in such problems as DOD in young, growing horses. Wheat bran is high in phytate phosphorus and has long been associated with "big head" disease.

A 1,200-pound mature maintenance horse requires about 15.6 grams of phosphorus daily. A growing foal weighing 473 pounds and gaining 1.87 pounds per day would require about 15.1 grams of phosphorus daily, similar to the needs of a mature 1,200-pound horse, because of the rapid bone growth in young, growing horses.

Lack of adequate phosphorus in young, growing horses will also cause such bone problems as rickets. Others signs of inadequate phosphorus are reduced feed intake, weight loss, poor condition, rough hair coats, and prolonged lameness and fractures.

If too much phosphorus is fed, it reduces the rate of calcium absorption, resulting in a calcium deficiency and Nutritional Secondary Hyperparathyroidism or big head disease. Since calcium is important in the blood clotting mechanism, the parathyroid gland takes calcium from bone in order to keep the blood level of calcium constant. This homoeostasis is one way the body protects itself from deficiencies or excesses. The maximum tolerable level of dietary phosphorus is 1 percent of the diet.

Pastures in the eastern United States have been shown to be deficient in phosphorus and several trace minerals, thus prompting the need for supplementing horses' diets. In addition to the phosphorus in feeds, dicalcium phosphate and phosoric acid are other good sources.

Calcium and Phosphorus Ratio

While the required amounts of calcium and phosphorus are critical, the calcium-to-phosphorus ratio is also important. A range from 1.5:1 to 2:1 is often noted as ideal. A ratio up to 6:1 is acceptable for mature horses. A ratio in the range of 1.8:1 to 2.5:1 seems to be acceptable for young, growing horses, but it should not exceed 3:1.

The phosphorus level should never be higher than that of calcium; in other words, the ratio should not be inverted. A high phosphorus-to-calcium ratio is often observed in weanlings and/or yearling horses fed high grain ration, with limited hay. All horses must have 1) an adequate level of calcium and phosphorus, 2) a proper calcium-to-phosphorus ratio, and 3) adequate vitamin D for the absorption and utilization of these minerals.

Sodium and Chlorine

Salt is an important dietary need for all animals. Sodium and chlorine combine to make salt, or sodium chloride. Sodium, chlorine and potassium are electrolytes. Electrolytes are inorganic substances that, in solution, dissociate into electrically charged particles called ions. Cations (sodium) are positively charged ions or minerals while anions (chlorine) have a negative charge. Since they have opposite charges, sodium and chlorine can combine to make salt, or sodium chloride.

Sodium is the major extracellular (outside the cell) cation and important in acid-base balance and the osmotic regulation of body fluids. About 45 percent of the body's sodium is in extracellular fluids, 10 percent is in intracellular fluid, and the remainder is in the bones. Sodium in bone is not available for exchange with fluid compartments.

Most horse feeds are low in sodium; therefore, salt is recommend in a horse's diet. Salt is normally added to commercial feeds at a rate of 0.5 to 1.0 percent and should also be offered free-choice, especially when commercial feeds are not fed. Loose, trace mineralized salt can easily be mixed with grain. Salt at a level of 2-4 percent of the grain mix will reduce feed intake.

Sodium needs for maintenance, growth, pregnancy and lactation are about 0.1 percent of the diet on a dry

matter basis. So, 0.25 percent salt would be adequate, as salt is 39 percent sodium and 61 percent chloride. Performance increases sodium needs to 0.3 percent. Horses will consume enough sodium if salt is available. This is the only nutrient that animals have an appetite for.

Performance horses need extra salt, especially in hot, humid environments so salt is often added to their rations to encourage increased drinking. Sweat contains a significant amount of sodium. Dried salt crystals can often be seen on a horse's croup in hot summer weather.

Sodium intake is most likely to be deficient during lactation or in moderate to intense performance. If sodium intake is low, the body increases sodium absorption and reduces sodium excretion in urine, milk and sweat. If sweating decreases, the ability to eliminate the heat produced during exercise also decreases. The result of reduced salt intake would be lack of performance. A deficiency will occur only if salt is not available.

Stalled horses that are bored will increase their salt intake, drink more water and urinate more, resulting in a wet stall. If this occurs, remove the salt (block or loose) and add 3 ounces (2 tablespoons) of salt per day to the grain.

Horses are tolerant of high levels of salt if they have free access to fresh, clean drinking water. Toxicity is rare but can occur when excess salt intake is coupled with limited water intake and results in colic, diarrhea, increased urination, weakness, staggers and even death.

Chloride is an important extracellular anion. It is part of bile and also hydrochloric acid, which is secreted in the stomach and important in early digestion.

The NRC does not list a chlorine requirement. Recent research noted a chloride requirement of 30-40 grams per day for an 1,100-pound horse at maintenance.

In general free-choice, commercial trace mineralized salt blocks formulated for horses are preferred over plain, white salt. Loose minerals are also preferred over blocks since horses, like sheep, are not lickers but nibblers. Some horses learn to lick a salt block, while others will nibble or chew on it.

Potassium

Potassium is a major cation within the cell. About 90 percent of the body's potassium is in cells, and most of this (70-75%) is in skeletal muscle. Intracellular potassium has a key role in initiating muscle contractions and nerve impulse transmission. The outflow of potassium from skeletal muscle during exercise augments blood flow to working muscles. After exercise the high potassium level in cells is reestablished. It also functions in acid-base balance and osmotic pressure.

Horses getting adequate forage as pasture or hay should not have a potassium problem. Forages and oilseed meal, such as soybean meal, contain 1-2 percent potassium on a dry matter basis. Common grains (oats, corn, wheat) contain 0.3-0.4 percent potassium. If 1/3 of the ration is good-quality forage, horses should get ample potassium.

Potassium deficiency is most likely to occur in horses, such a halter and some performance horses, fed a high grain, low forage diet. The result can be muscle weakness, fatigue and exercise intolerance, resulting in poor performance and decreased water and feed intake. This is more likely to occur in horses doing moderate to intense performance in high temperature and humidity. Potassium-deficient horses usually have a decreased water and feed intake, which serves to further reduce potassium intake. So, horses may reduce feed intake and lose weight. Foals with persistent diarrhea may become potassium deficient. Foals fed potassium-deficient rations refused to eat, lost weight, were unthrifty and had lowered serum potassium levels. Excess potassium is excreted in the urine and is rarely a problem. Pregnancy, lactation, growth and performance all require increased potassium over that of maintenance.

Hyperkalemic Periodic Paralysis (HYPP) is a genetic disease in horses related to a specific Quarter Horse stallion. The disease is the result of a defective sodium ion channel in the muscle cell membrane. Diets high in potassium should be avoided in HYPP horses, and a potassium level of less than 1 percent is suggested.

Magnesium.

Magnesium makes-up about 0.05 percent of a horse's body weight with 60 percent associated with the skeleton. Magnesium is also an activator of many enzymes.

Foals fed a ration low in magnesium exhibited nervousness, muscle tremors and ataxia followed by collapse, hyperpnea, sweating, convulsive paddling and some deaths. Low magnesium intake results in mineralization of the aorta.

Horses deficient in magnesium tend to be more excitable, spook easily and may fatigue from performance. Deficiencies or excesses have not been reported in horses fed adequate natural feeds.

Common horse feeds contain from 0.1 to 0.3 percent magnesium. Alfalfa hay containing 0.5 percent magnesium has been fed without problems. The magnesium need is about 0.1 percent. Where horses are grazed with cattle and high magnesium blocks are used, horses might over consume magnesium, resulting in diarrhea.

Sulfur

Sulfur makes up about 0.15 percent of the body weight. Most horse owners probably relate sulfur to sulfur-containing amino acids, such as cystine, methionine and cysteine. Other sulfur containing substances are the B-vitamins biotin and thiamin, heparin, insulin and chondritic sulfate. Sulfur content is high in hooves and hair. Protein keratin found in the hoof is about 4 percent sulfur.

Adequate, high-quality dietary protein provides about 0.15 percent organic sulfur, which appears adequate to meet the horse's need. Most feeds seem to have adequate organic sulfur.

No sulfur deficiencies have been described in the horse nor has a maximum level been estimated. There is no known requirement for sulfur.

Accidental feeding of excessive amounts of sulfur resulted in horses becoming lethargic with colic. A yellow, frothy nostril discharge, jaundiced mucous membranes and labored breathing were observed in these horses. Two of twelve horses had convulsions and died.

Dietary Cation-Anion Difference (DCAD).

DCAD is the balance of positively and negatively charged fixed (nonmetabolizable) ions in the diet. The

strong inorganic cations are sodium and potassium and the strong inorganic anions are chloride and sulfur. These ions are involved in the osmotic pressure in body fluids as well as the maintenance of the acid-base status (balance) of the horse. This term is being used more in regard to horse mineral nutrition.

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