Aiming for the Right Balance of Copper and Zinc
Carol Layton, B.Sc, M.Ed
Balanced Equine

A Balanced-Mineral Diet

The foundation of any diet should be highly fermentable fibre forage: pasture and/or hay. The ultimate goal in feeding should be to have a healthy horse able to perform at the best of their ability at their level of fitness and conditioning, with a well-supported and robust immune system. All horses, regardless of the level of work, or whether they are used for breeding, will benefit from an intake where no nutrient is deficient and the minerals are balanced.

The term “balanced minerals” is a confusing phrase, often used in commercial mineral mixes and other equine products; but for a horse’s diet to truly have the minerals balanced means that the whole intake must be taken into account, including forage. It is important not just to have sufficient levels of minerals in the diet to prevent a deficiency from being expressed, but also to have the amounts of each mineral at an optimal ratio to prevent one mineral outcompeting another. One example is the way in which the trace minerals copper and zinc interact; they are the two most common deficient minerals in a horse’s diet. [1]. Copper and zinc are required in very small amounts but that doesn’t take away their importance in the running of cellular processes in the body. Both copper and zinc are contained in more than 100 different enzymes in the body, many of which are involved in protein and carbohydrate metabolism. They are often discussed together as they are not only absorbed into the digestive system in a similar way, but also the symptoms of a copper and/or zinc deficiency can overlap.

Balance is important when it comes to mineral interactions. Too much zinc in comparison to copper has been documented to interfere with the absorption of copper and vice versa. In a study on growing foals, zinc intakes between 1,000 and 2,000 mg/kg without also increasing copper intake caused copper deficiency symptoms of joint swelling, lameness, joint effusions, and cartilage defects [2]. A low copper intake compared to high zinc has been implicated with Osteochondritis Dissecans (OCD) in growing horses, a type of Developmental Orthopaedic Disease (DOD) that includes symptoms like limb deformities and vertebral malformations [3] [4].

The National Resource Council’s (NRC) Nutrient Requirements of Horses (2007) recommends that zinc and copper be in a 4:1 ratio (4 parts zinc to 1 part copper) for the whole intake to ensure optimal absorption of both minerals [5]. Eleanor M. Kellon, VMD, and other nutritionists recommend that, ideally, the ratio of zinc to copper should be 3:1, or as close as possible to 3:1, to take into account the potential for other minerals to interfere with absorption, for example, with a high iron intake [6] [7] or sulfur in water or forage. Sulfur can create precipitates of sulfates and sulfides and thus prevent absorption. Moreover, if molybdenum is high then copper absorption is further compromised. [8] [9]

Some of the signs of copper and/or zinc deficiency due either to insufficient levels OR a secondary deficiency due to not being fed at an optimal ratio include:
- Faded coat color; bleached or reddish discoloration can be caused by a deficiency in copper or copper and zinc.
- Poor hoof quality.
- Predisposition to infections, including hoof issues such as thrush, seedy toe, and skin and allergy problems. Nutrients like copper and zinc are important for immune system functioning, as well, in particular copper- and zinc-containing enzymes. [10] [11] Excess iron plays a role with infections. [12]
- Muscle soreness and other immune system factors due to zinc’s role as an antioxidant. [13] [14]
- Poor fertility/infertility in stallions, especially zinc. [15] [16] [17]
- DOD in foals of deficient dams. [18] [19]
- OCD in foals with low copper levels. [20]
- Anaemia due to insufficient copper for the production of red blood cells as part of iron metabolism, not due to an iron dietary deficiency. [21] [22]
- Poor appetite due to a zinc deficiency. [23]
- Slow growth rate. [24]

Two of the more obvious signs are sun bleaching of coats and poor hoof quality.

**Coat Color**

A copper-dependent enzyme called tyrosinase [25] is responsible for the production of melanin, which are brownish black pigments synthesised from the amino acid tyrosine. Many coat colors have some level of brown and black pigmentation, including buckskin, chestnut, bay, and black. This occurs in plants and
animals including microbes and humans. The lack of tyrosinase activity is responsible for albinism and is related to grey hair in humans. Sufficient copper is needed to produce the pigment in buckskins and chestnuts and both copper and zinc are needed for darker coats.

The purpose of melanin is to act as a shield against chemical damage and light. The fading is caused by ultraviolet light oxidising melanin. If there are less than optimal levels of copper in the dietary intake, the hair will be more prone to bleaching but will look normal until enough pigment has been damaged to cause the color change. There is individual variation and some breeds can be more resilient to bleaching. For example, some Friesians can be jet black and still be copper and zinc deficient or imbalanced.

A newly grown summer or winter coat will appear darker but then lightens over time if the horse is copper deficient. If the horse is on a more than adequate nutrient- and mineral-balanced diet, there is no need for blankets or rugs to stop the coat from fading. Fading is often a direct indicator of mineral deficiency or imbalance.

Copper deficiency in other species influences coat quality and produces “rusting” of dark coats [26], which is especially noticeable in the manes of bay and black horses. This effect in horses has not been formally proven, but horses showing red tips on dark manes of dark coats respond well to zinc and copper supplementation when the whole dietary intake ratio is 3:1.

**Hoof Quality**

A range of nutrients is required for growing the best possible hoof, not just copper and zinc. Deficiencies in protein, including specific amino acids for keratin production, essential fatty acids (omega-3 and omega-6 in the correct ratios), selenium, vitamin E, and biotin will negatively impact hoof growth and quality. [27] [28] [29] [30] The following is a focus on copper and zinc.

Studies specifically looking at nutrition and hooves have shown that certain nutrients can affect rate of hoof growth, how hard and tough the hooves can be, how strong the cellular connections are in the wall, sole,
and frog, and the thickness of the wall. Any weaknesses in the horn can lead to microscopic openings for microbes to gain entry and potentially cause damage ranging from infections large cracks and chips. Poor hoof quality includes soft feet, cracks, shelly walls, and disconnected white lines, sole haemorrhages (bruised sole), abscesses, and lameness. [3]

Zinc is present in high concentrations in the hoof with one form being the zinc finger (ZnF) proteins, rich in the amino acid cysteine. As part of the zinc finger proteins, zinc is needed for cell multiplication and the assembly of keratin. Zinc proteins incorporated into keratin are also responsible for the helical structure that gives hooves their strength. It has been shown that horses with insufficient hoof horn strength had less zinc in the hoof horn and plasma than did horses with no hoof horn damage. [31]

The synthesis of the harder type of keratin is linked with copper as well as formation of connective tissue. In one study, a deficiency in both zinc and copper increased the incidence of seedy toe in performance horses. [31] In cattle, a copper deficiency is known to be a cause of poor hoof condition, greater incidence of foot rot, heel cracks, and sole abscesses. In sheep wool, a loss of kink and tensile strength is attributed to a copper deficiency. [32] A copper deficiency has also been linked to hoof abnormalities in the Alaskan Moose. [33]

Overall, there are many factors that influence the type of hoof a horse will have, including genetic traits, the type of environment the horse lives in, the amount of movement, the quality of hoof care — especially in the early years of a horse’s development and nutrition. No one factor on its own can produce the best possible hoof if one or more of the others are working against it. Nutrition alone can’t ensure it, nor can hoof care alone.

Feeding a more-than-adequate nutrient diet with balanced minerals is the key to providing an optimal diet for your horse. There are so many variables involved in the management of horses but your horse’s nutrition is one factor you can control.

References


Coenen, M, Spitzlei S, "The composition of equine hoof horn with regard to its quality (hardness) and nutrient supply of horses," in Proc Equine Nutr Physiol Symp. 15th, -, 1997, pp. 209-212.


