Building a Healthy Hoof

Meri Stratton Phelps, DVM, MPVM, DACVIM (LAIM), DACVN

A healthy hoof is the foundation of soundness in the horse, and diet plays a prominent role in maintaining hoof integrity. Key nutrients for hoof health include amino acids, fatty acids, macro minerals, trace minerals and vitamins. A hay or pasture-based diet provides many of these essential nutrients but may not provide the horse with high enough nutrient levels to optimize the strength and integrity of the hoof.

The Starting Point

Horses depend on a balanced ration to keep their hooves strong and healthy. Because the hoof wall is in a continuous state of growth, dietary changes will affect the integrity of the hoof. Rations should provide enough energy to promote growth of the hoof wall and maintenance of an ideal body condition score between a 4 to 6 out of 9. Excessive weight gain should be avoided to help prevent complications from obesity and insulin resistance which can be associated with laminitis. Equine rations that provide a high concentration of non-structural carbohydrates from sugar, starch, or fructans should be avoided because these dietary carbohydrates can also lead to complications from laminitis.

Macro-Nutrients

Protein is a core building block of a solid hoof. The hoof wall is over 90% protein on a dry weight basis.[1] Providing horses with a ration that includes highly digestible protein helps to ensure adequate protein is available to promote normal growth of the hoof wall. Methionine, an amino acid that contains sulfur, stimulates strong, healthy hoof growth[2] and is essential to prevent brittle, cracked hooves.[3] Sulfur-containing amino acids play a key role in the development of the "cellular envelope," also known as the marginal band,[4] which protects horn cells against protein-degrading enzymes.[5] Fatty acids are also important nutrients for healthy hooves because they help in connecting hoof horn cells and sustain a permeability barrier.[4] Linoleic acid, an essential omega-6 fatty acid, and arachidonic acid are important components of the intercellular cementing substance of the hoof horn that acts in a similar fashion to the mortar of a brick wall by connecting horn cells. The cementing substance helps control hydration levels in the hoof, affects the mechanical property of the hoof wall, and directly influences the fracture toughness of the hoof horn material.[4]

Minerals

Macro minerals including calcium and phosphorus maintain health of the bone and soft tissue structures in the foot. In addition, the calcium-required activation of the enzyme epidermal transglutaminase directly influences formation of the cellular envelope,[6] which protects horn cells from degradative enzymes. Sulfur is a critical component of the primary structural protein, keratin, and is found most abundantly in the hoof and hair.[3] Sulfur content in the hoof wall has been positively associated with the ability of the hoof to withstand tearing forces.[7] Trace minerals like copper, zinc and manganese provide strength to hoof wall and foot structures and also support important cellular antioxidant activity.[8] Copper-dependent enzymes maintain connective tissue,[9] making copper critical for normal bone and cartilage development.[3] Zinc supports epidermal and dermal cells and blood vessels[10] that are critical for healthy hoof growth. In regard to hoof growth, organic trace minerals may be more bioavailable compared to inorganic mineral sources. Yearling horses that consumed organic trace minerals had an

increased rate of hoof growth compared to yearlings that only consumed inorganic minerals.[11]

Biotin

Biotin is an important vitamin that supports the growth of healthy hooves,[12] in part due to its role as a cofactor for several major enzymes.[4,13] Horses that do not consume enough biotin in their diet may suffer from cracked hoofs and tender feet.[14] Supplementation of the ration with biotin leads to improved hoof wall strength and an increase in the rate of hoof growth.[15-17]

Summary

Healthy horses with normal hoof wall conformation and strong hooves should be adequately supplemented with a comprehensive blend of amino acids, fatty acids, vitamins and minerals. Horses with hoof problems, like dry cracked hooves or other hoof wall abnormalities, may benefit from dietary supplementation to provide additional amino acids, zinc, copper, manganese, and biotin.

Literature Cited

1. Butler KJ, Hintz H. Effect of level of feed intake and gelatin supplementation on growth and quality of hoofs of ponies. *J Anim Sci* 1977;44:257-261.
2. Ekfalck A, Appelgren L, Funkquist B, et al. Distribution of labelled cysteine and methionine in the matrix of the stratum medium of the wall and in the laminar layer of the equine hoof. *Zentralbl Veterinarmed A* 1990;37:481-491.
3. Lewis L. Chapter 2. Minerals for Horses. Equine Clinical Nutrition: Feeding and Care. *Media: Williams & Wilkins,* 1995;25-60.
4. Mulling K, Bragulla H, Reese S, et al. How structures in bovine hoof epidermis are influenced by nutritional factors. *Anat Histol Embryol* 1999;28:103-108.
5. Elias P. Lipids and the epidermal permeability barrier. *Arch Dermatol Res* 1981;270:95-117.
6. Rice R, Green H. Relation of protein synthesis and transglutaminase activity to formation of the cross-linked envelope during terminal differentiation of the cultured human epidermal keratinocyte. *J Cell Biol* 1978;76:705-711.
7. Ley W, Scott Pleasant R, Dunnington E. Effects of season and diet on tensile strength and mineral content of the equine hoof wall. *Equine Vet J* 1998:46-50.
8. Abreu I, Cabelli D. Superoxide dismutases-a review of the metal-associated mechanistic variations. *Bochim Biophys Acta* 2010;1804:263-274.
9. Rucker R, Kosonen T, Clegg M, et al. Copper, lysyl oxidase, and extracellular matrix protein cross-linking. *Am J Clin Nutr* 1998;67:996S-1002S.
10. Rink L, Gabriel P. Extracellular and immunological actions of zinc. *Biometals* 2001;14:367-383.
11. Ott E, Johnson E. Effect of trace mineral proteinates on growth and skeletal and hoof development in yearling horses. *J Eq Vet Sci* 2001;21:287-292.
12. Reilly J, Cottrell D, Martin R, et al. Effect of supplementary dietary biotin on hoof growth and hoof growth rate in ponies: a controlled trial. *Equine Vet J Suppl* 1998:51-57.
13. Biotin. *Altern Med Rev* 2007;12:73-78.
14. Lewis L. Chapter 3. Vitamins for Horses. Equine Clinical Nutrition: Feeding and Care. *Media: Williams & Wilkins,* 1995;61-89.
15. Geyer H, Schulze J. The long-term influence of biotin supplementation on hoof horn quality in horses. *Schweiz Arch Tierheilkd* 1994;136:137-149.
16. Buffa E, Van Den Berg S, Verstraete F, et al. Effect of dietary biotin supplementation on equine hoof horn growth rate and hardness. *Equine Vet J* 1992;24:472-474.
17. Comben N, Clark R, Sutherland D. Clinical observations on the response of equine hoof defects to dietary supplementation with biotin. *Vet Rec* 1984;115:642-645.

6 51403 64132 3