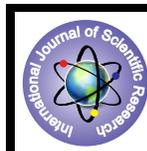


Nutritional Biochemistry of Healthy Hoof



Veterinary Science

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ABSTRACT

Healthy hooves are very important for the well-being of the animal. Many factors are responsible for the condition of hoof, including environment, hoof diseases and proper nutrition. Nutritious feed containing optimum amount of proteins, energy, vitamins, minerals and fats are essential for hoof health. Amino acids like cystine and methionine are very important in the metabolism of hoof. Energy deficient feed may lead to secondary protein deficiency. Calcium, phosphorus, iodine, copper, zinc, manganese and selenium are the minerals that have an important role in hoof metabolism. Absence of vitamins A, D, E and all B-complex vitamins especially biotin adversely affect hoof integrity. Fat also acts as a seal to prevent entry of excess moisture into hoof. Perfusion of blood vessels that supply hoof producing tissue, farriery techniques adopted, health care measures and genetic selection methods implemented in the farm can also affect hoof health.

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Lameness in hooved animals is caused, to a larger extent, by infectious and non-infectious hoof diseases. Evulsion of hoof, bush foot etc cause severe economic loss to the farmer either due to culling of the animal at an early age or due to veterinary intervention for prolonged periods.

Though nutrition is not the only factor affecting hoof health, a balanced diet with sufficient amount of proteins, energy, minerals, vitamins and fats are necessary for proper maintenance of hoof. Other factors like wetness, slippery floor, lack of exercise, poor farriery, metabolic disturbances, mycotoxins, poor management after parturition, old age also adversely contribute to the general condition of the hoof. Deficiency of sulphur containing amino acids like cysteine, fatty acids like linoleic and arachidonic acid, minerals especially calcium, trace elements like zinc and vitamins especially biotin can aggravate hoof damage.

Hoof is nearly 100% protein, predominantly keratin. Keratin is an insoluble protein. Keratin provides mechanical and chemical stability to the hoof since the keratins are cross-linked to form stable protein complex. Intercellular cementing substance produced by keratinising epidermal cells establishes a stable connection between cells. The detrimental effect of wetness of the floor is prevented to a large extent by cementing substance which also prevents excessive drying up of hoof tissue due to water loss.

Hoof contains high levels of cysteine, arginine, leucine, lysine, proline, serine, glycine and valine and lower levels of methionine,

phenylalanine and histidine (Samata and Matsuda, 1988). Sulphur present in cysteine and methionine from strong cross links between collagen fibres during hoof formation and also increase bonds between laminae of hoof wall (Ekfalck et al., 1990).

To ensure functional integrity of hoof, energy requirements during lactation and growing periods should be met sufficiently. A negative energy balance will lead to utilization of proteins in the feed which may lead to secondary protein deficiency and consequent hoof damage.

Being major minerals, calcium and phosphorus play an important role in normal hoof development. Cell to cell attachment in the hoof is maintained by calcium levels. It is also important in the metabolism of intercellular lipids. Calcium and phosphorus levels together with their ratio to each other are significant since excess phosphorus can block the absorption of calcium from small intestine.

Hoof being metabolically very active tissue, free radicals that can cause cell damage are constantly produced. Manganese is important in protection of hoof due to its anti-oxidant activity by which it removes super oxide radicals.

Iodine is the component of thyroxine which regulates overall metabolic rate of the body. Growth rate and production, in general, are affected by thyroxine levels. Sub-clinical iodine deficiency can lead to increased incidence of foot rot in hooved animals.

Micro-minerals like copper, zinc and selenium are essential for the integrity of the hoof. Enzymes like glutathione peroxidase, superoxide dismutase, lysyl oxidase and thiol oxidase contain copper. Copper, in association with vitamin E, has an important role in eliminating free radicals. Copper increases structural strength and elasticity of connective tissues and blood vessels. It activates the formation of chemical bonds between keratin filaments. (O'Dell, 1990). Deficiency may lead to foot rot, sole abscesses or cracked heels and increased susceptibility to parasitism of hoof.

Zinc is also important in the keratinisation of hoof. Being a component of over 200 enzymes, of which many are involved with hoof production, zinc can improve the integrity of hoof. Depletion of zinc stores may occur during early lactation or post-partum period. This may lead to production of hoof of poor quality.

Another micro-mineral that reduces hoof damage is selenium. Selenium along with vitamin E acts as an immune stimulant. Selenium supplementation can boost immune system and prevent bacterial infections of hoof. Enzyme Glutathione peroxidase, which has selenium as its component is involved with the metabolism of arachidonic acid to prostaglandins. Selenium protects and maintains intercellular cementing substance due to its anti-oxidant activity. However, excessive supplementation of selenium may have a detrimental effect since this may reduce the number of chemical bonds between keratin proteins (Combs, 2000).

Studies conducted by Buffa et al. (1992) proved that most important vitamin involved in hoof production is Vitamin H or biotin. Enzymes involved in various important metabolic pathways have biotin as the co-factor. Keratinisation of epidermal cells and composition of intercellular cementing substance are affected by deficiency of biotin since biotin is essential for keratin protein synthesis and formation of intercellular cementing substance. High grain rations in stall fed animals may reduce ruminal synthesis of biotin. Biotin supplementation may be needed to reduce the incidence of

conditions like digital dermatitis, heel erosion, sole ulcers etc.

Fat soluble vitamin, vitamin A, is needed for healthy growth of hoof. The quality of hoof tissue is affected by vitamin A since it is essential for maintenance of highly active hoof producing epidermal cells. Vitamin D and all B-complex vitamins are important in hoof nutrition. Vitamin E also exerts its anti-oxidant action by maintaining cellular integrity of hoof tissue. It acts as a free radical scavenger and reduces cellular damage due to free radicals.

3-6% fat is also present in hoof tissue. Fat binds cells together and also aids in repulsion of water. Fat also helps in maintaining positive energy balance. Grass is a rich source of the essential fatty acids like linolenic and linoleic acid .

Other than nutritional and environmental factors, a determining factor of hoof health is the perfusion of blood vessels that supply nutrients to the hoof producing tissue. Compression of tissue, presence of toxic bio-active molecules, formed as a result of metabolic activity, mechanical overload or systemic diseases can reduce the blood flow to hoof producing tissue. This condition can also impair hoof production or lead to production of hoof of inferior quality leading to hoof damage.

Hoof reflects the overall nutritional status of the animal. It is also a sensitive indicator of farriery techniques, health care measures and genetic selection methods practiced in the farm since hoof quality is even influenced by genetics.

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