

Vitamin B: It's importance in Energy Metabolism



What is Vitamin B?

This group of vitamins is diverse containing a wide range of substances that serve as catalysts in the metabolism of protein, fat and carbohydrate and in the formation of tissues from nutrients. Because of their wide-ranging roles within the horse's body these vitamins are necessary for reproduction, growth, physical performance, maintenance of health and food utilisation - without them, the body ceases to function!

Requirements

The requirements for the B complex vitamins are affected by many factors such as;

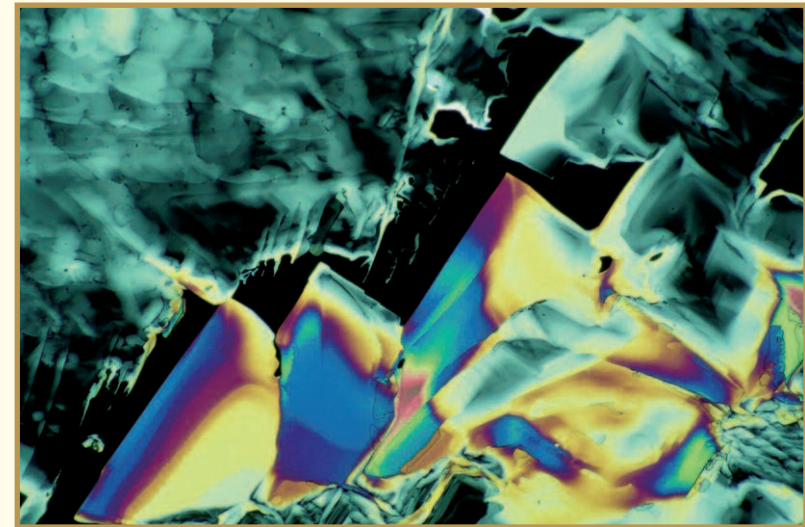
- type and quality of diet;
- presence of dietary contaminants such as mycotoxins;
- quantity of microbial synthesis in the gut;
- extent of absorption in different segments of the gut (bioavailability);
- age;
- genotype;
- extent of feed processing;
- exercise;
- intestinal infection/malfunction;
- parasitism;
- reproductive status.

It should be clear that it is difficult to precisely define requirements since there are so many confounding factors that can have an impact on them. Furthermore, there are different levels of requirement. For example, the minimum requirement is that daily quantity of a vitamin that will prevent deficiency symptoms occurring. It is noteworthy that the B complex vitamins are water-soluble and are not stored for any length of time within the animal's body hence necessitating a regular, daily supply. In contrast to the minimum requirement the animal has an optimum requirement that requires a quantity of vitamin that will maximise the functionality of the body whether it is for say, exercise or lactation.

Suboptimal performance is often the result of the undersupply of vitamins and should not be confused with a clinical deficiency. Good feeding practice for horses demands that the supply of B complex vitamins be optimised so that these animals can realise their genetic potential. A more recent development has been the realisation that the provision of extra vitamins can contribute to the long term well being of both animals and people. This is in situations where the vitamins are having an activity beyond their normal physiological function such as in terms of reducing health risks. A case in point would be Biotin where although sufficient may be fed to support normal body function in the horse, the provision of large amounts (>20mg/day), well beyond “normal” requirements, have resulted in significant improvements in hoof horn quality.

Sources of B complex vitamins

There are two sources of B vitamins to the horse, from the diet and from microbial synthesis within the gut; the latter is confined to the caecum and colon. Production of B vitamins within the large intestine is dependent on the type of diet fed thus, less will be formed when a high cereal diet is fed because small intestinal digestion will be maximised whilst large intestinal fermentation will be minimised. In contrast, a very active fermentation will occur when an all-forage diet is fed and as a result, more B vitamins will be produced. Unfortunately, fermentation occurs after the major site of absorption which is in the small intestine so it is questionable as to what proportion of the B vitamins produced in the large intestine will be subsequently absorbed. Dietary B vitamins are well absorbed from the small intestine (Vitamin B12 is exceptional in that it requires a carrier, known as intrinsic factor, to assist its absorption through the intestinal wall) as they are water soluble so, provided there is a good supply in the diet, the animal will be well provided for. In this context, a dietary supply of these vitamins is the only reliable means of ensuring an optimal supply to the horse.



Vitamin B12 under a high power microscope.

Vitamins of the B complex

Cyanocobalamin (B12)

This is probably the best known member of the complex because of its established importance in human diets. It was originally known as the animal protein factor and is one of the most important missing ingredients in vegan diets, although it can now be extracted from fermentation products. It is the only vitamin to incorporate a mineral element, Cobalt, and it is interesting to note that horses, grazing pastures upon which ruminants die from Cobalt deficiency, remain healthy. Production of B12 in the large intestine of the horse has been proven and there is evidence of some absorption at that site, however this has not been quantified. It is involved with one carbon metabolism in conjunction with another member of the complex, Folic Acid (folacin). It is primarily involved in protein metabolism but also plays a part in fat and carbohydrate metabolism, and importantly, is involved with the interconversion of propionic acid, one of the volatile fatty acids produced

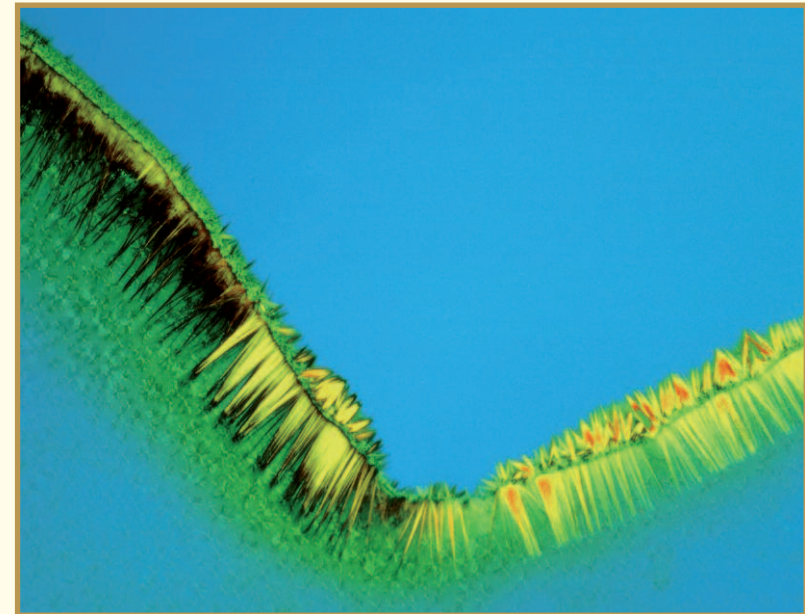
during the fermentation of starch. Its interaction with Folic Acid has already been mentioned but in addition, it interacts with other members of the B complex (B6, Biotin, Pantothenic Acid, B1, Choline). Animal protein is no longer included in horse diets so B12 supplementation is essential to meet requirements and it is possible to feed quantities beyond that necessary for normal body function to try to quieten hyperactive and performance horses. Critically for performance horses it is involved in the production of blood cells, and signs of deficiency include anaemia with enlarged red blood cells.

Biotin

Optimum hoof quality depends on a galaxy of nutrients including Sulphur, Copper, Zinc, Selenium, Calcium, Phosphorus, Amino Acids and Biotin. The latter is available and in plentiful supply in good grass/legume mixtures but is otherwise poorly available from other food sources. Intestinal synthesis of Biotin is inadequate for active horses and its production is severely compromised by reductions in caecal pH. Dietary supplementation with Biotin is essential to maintain hoof strength and integrity. It has been shown that hoof problems may be resolved by using very high levels of Biotin (>20mg/day) over an extended period of time (9-12months) and then following this by feeding lower maintenance levels.

Thiamine (B1)

Only about 25% of the free Thiamine produced in the caecum is absorbed into the blood, and it is used by the horse for carbohydrate metabolism, and the formation of Adenosine Triphosphate (ATP). Microbial synthesis within the gut is considered not enough to prevent deficiency symptoms (eg., loss of appetite, ataxia, weight loss) appearing so a dietary supply is essential. Exercising horses may well benefit from further supplementation beyond the recommended level of 5mg Thiamine/kg dry food intake.



Vitamin B2 under a high power microscope.

Riboflavin (B2)

Apart from fresh legumes, dietary sources are relatively poor. Since it is a key co-enzyme involved in energy release (oxidation/reduction reactions for producing and breaking down Fatty Acids and Amino Acids) dietary supplementation is advisable, since the contribution from microbial synthesis is small.

Folic Acid

Fresh green food contains a lot of Folic Acid but unfortunately many horses and ponies do not have access to grass all the time and during the winter intakes are minimal. For example, it has been reported by several researchers that serum folate concentrations in horses on pasture were much higher (about three to four times) than that of stabled horses fed conserved forage. Typically alfalfa will supply 2.5-4mg/kg DM. of Folate, Timothy hay around 2.3mg, and cereal grains just 0.3-0.6mg. In view of the fact that B12 and Folic Acid are essential for red blood cell production in the bone marrow, dietary supplementation is obligatory, particularly for horses in work.



Production of Vitamin B at TRM's collaborative raw material synthesiser.

Niacin (nicotinic acid/nicotinamide)

It is involved in similar biochemical pathways as Riboflavin within the horse's body. It is a constituent of both NAD (Nicotinamide Adenine Dinucleotide) and NADP (Nicotinamide Adenine Dinucleotide Phosphate) – these act as hydrogen-transferring co-enzymes in metabolic reactions relating to carbohydrates, fats and amino acids. In cereals up to 90% may be bound and thus unavailable to the horse, whilst in oilseeds such as soya, only 40% may be unavailable. Apart from food sources, Niacin can be produced by microbial synthesis and derived from the amino acid Tryptophan in the liver, however, low forage diets will limit large intestinal production of Niacin.

Pyridoxine (B6)

Pyridoxine is a component of a co-enzyme which plays a central part in various reaction processes during the metabolism of amino acids. It is one of the haemopoietic vitamins involved in the maintenance of healthy red blood cells.

Pantothenic Acid

Pantothenic Acid is a component of co-enzyme A, which is vital for the synthesis and degradation processes in the metabolism of proteins, carbohydrates and fats.

Choline

Unlike other members of the B complex, Choline is not a metabolic catalyst, but forms an essential structural component of tissues. For example, it is a component of Lecithin and Acetylcholine. It is synthesised from the amino acid Methionine in the horse's liver, so that the extent of supplementation will depend on the dietary Methionine content. Compared to other B vitamins its requirement as a vitamin is unusually large. It is important in terms of preventing fat accumulation in the liver.

Conclusion

The B complex vitamins are critically important to the well being of the horse. They can be produced to some extent within the animal's body, but their production depends on there being a satisfactory fermentation within the large intestine. Performance horses fed limited amounts of forage should be supplemented.