



Calcium and Phosphorus

Always remember that in nature nothing acts in isolation – just as it is with minerals and vitamins and their interactions. This is particularly the case in calcium and phosphorus metabolism in the horse's body where there are many complex interactions with other minerals and compounds. To reduce a nutritional problem to a simplistic lack of one mineral and supplementing with just that is a flawed approach to nutrition.

Why are calcium and phosphorus needed in the diet?

Together they are both essential for sound and normal bone development – bone structure is 35% calcium and 17% phosphorus. In addition calcium is essential for normal muscle contraction where it is needed to activate potassium ion channels. It is a cell membrane transmitter and regulates enzymes and their actions. Nearly all the body's calcium is in the bones (99%) and the remaining 1% circulates in the blood stream. Phosphorus is essential for energy production in cells and is part of cell membranes in the form of phospholipids. Approximately 80% of phosphorus is in the bones.

What are the dietary sources of calcium and phosphorus?

Most grassy hays contain low to moderate levels of these minerals whilst cereal grains are low in calcium and high in phosphorus. Bran is also a rich source of phosphorus but very low in calcium. Lucerne has a high level of calcium and very low phosphorus. If Lucerne is more than 50% of the ration there will be excessive calcium and protein in the diet. Lucerne contains more than 1% calcium on a dry matter basis whilst grassy hay is approximately 0.6% on a dry matter basis.

It is generally assumed that approximately 50% of dietary calcium is absorbed. With regards to phosphorus, the phytate phosphorus found in grain is not as effectively

utilised as inorganic sources of phosphorus. Phytate phosphorus is hard to digest and because of this it is estimated to be 35% is absorbed.

How much calcium and phosphorus does my horse require?

The amount of calcium and phosphorus required by horses depends upon their age, stage of growth, pregnancy and lactation status in a mare, and how much work the horse is doing. It is generally accepted that a 500kg horse requires approximately 20 grams calcium and 14 grams phosphorus per day for maintenance needs. This equates to calcium being 0.21% and phosphorus being 0.15% of the daily diet. For a four month old foal this requirement rises to 0.62% for calcium in the diet and 0.34% for phosphorus; for a two year old horse the calcium requirement is 0.28% and the phosphorus required is 0.15% of the daily diet. A pregnant mare in the last 90 days of gestation requires a diet with 0.4% calcium and 0.3% phosphorus. A lactating mare with a foal up to three months of age requires 0.47% calcium and 0.30% phosphorus in the diet. A horse in very hard work requires 0.31% calcium and 0.23% phosphorus in the diet which equals a 48% increase in calcium needs and 53% increase in phosphorus needs over maintenance levels. Any increase in calcium and phosphorus needed by working horses appears to be met by increasing the ration amount to meet energy needs.

Aged horses over 20 years may require more phosphorus than adult maintenance. Excess calcium intake i.e. more than 1% of the ration should be avoided in older horses.

It is a fascinating story of the calcium:phosphorus ratio and the dance they do with other minerals and other compounds.

The calcium phosphorus ratio is critically important for your horse's nutritional wellbeing as well as the absolute

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amount of each mineral fed. All diets should have more calcium than phosphorus – most requirements yield ratios of 1.2:1 to 1.4:1.

Diets with less calcium than phosphorus (< 1:1) adversely affect calcium absorption. For every gram of phosphorus eaten by the horse it must be matched by calcium before the phosphorus can be absorbed across the intestinal wall. Diets high in grain and bran invert the ratio from the ideal. Excess lucerne in the diet also affects the ratio.

The calcium phosphorus ratio, the form of calcium, the level of calcium intake and the presence of phytates and oxalates all influence the absorption of calcium. Oxalate levels of 1% in the diet will decrease calcium absorption by 60%. Oxalates are chemical compounds found in grasses such as Kikuyu, Buffel, Pangola, Green Panic and Setaria. The oxalates bind the dietary calcium in the gut and prevent its absorption across the gut wall. Phytates are found in grains and effectively bind the calcium as well.

If the dietary level of calcium is low the efficiency of absorption increases. If there is excess calcium in the diet less will be absorbed by the gut and more is excreted in the urine.

If this isn't confusing enough then consider the role other minerals play – high magnesium levels in the diet will increase calcium absorption but excess phosphorus will decrease calcium absorption. High zinc levels will decrease calcium and copper absorption while high calcium levels will interfere with copper, manganese, zinc and iron absorption. High calcium levels limit phosphorus absorption and high sodium and chloride levels increase phosphorus absorption by 30-60%.

Regulation of calcium levels in the blood and bone.

Given this complex interaction of minerals and the often ad hoc supplementation of minerals by horse owners, the horse's body on the whole seems to regulate mineral levels fairly well providing the diet supplies adequate amounts. Calcium levels in the body are regulated by Vitamin D and by the hormones calcitonin and parathyroid hormone. Blood levels of calcium are maintained in a very narrow range to ensure normal neuromuscular activity. Daily requirements of calcium are ideally supplied by the diet. If they are not then parathyroid hormone is released to take

calcium from the bones to circulate in the bloodstream. The body will sacrifice optimal bone strength to maintain normal blood calcium levels. If the blood calcium levels get too high calcitonin and parathyroid hormone act to decrease gut absorption and increase urinary excretion. Vitamin D is needed to help with absorption of calcium and to a lesser extent phosphorus from the gut.

What are the signs of calcium deficiency and excess?

These can range from clinical to subclinical in presentation. Signs include shifting lamenesses, weak bones, osteopenia (crooked bones and enlarged joints), spontaneous fractures of bones, tying up, and poor performance. These are non specific signs that can mimic other conditions so a thorough veterinary check is essential. A horse with calcium depletion can take up to twelve months to correct the problem. A spelling horse can have increased needs for minerals as it tries to make up for depletions from poor diets. Low blood calcium levels present as stress tetany, thumps and exhausted horse syndrome – these are all medical emergencies and require prompt and thorough veterinary workups. Stress tetany occurs in horses with marginal blood calcium levels that are subjected to stress with travel and start twitching, spasming and have rigid, stiff legs. Thumps are a synchronous diaphragmatic flutter where there is very low blood calcium, potassium and chloride from excessive sweating. The phrenic nerve becomes hyperactive and irritable and the diaphragm thumps in synchrony with the heartbeat. Exhausted horse syndrome occurs when a horse has been pushed with work way beyond its ability to cope metabolically and is in multi mineral depletion.

Calcium excess particularly through the addition of excess lucerne (alfalfa) in the diet can lead to enteroliths (intestinal stones).

What are the consequences of phosphate deficiency and excess?

High phosphorus levels will lead to chronic calcium deficiency which leads to nutritional hyperparathyroidism (big head). Deficiency of phosphorus will lead to soft bones.

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