MAGNESIUM

The Mineral Superhero

with Dr Jennifer Stewart

Jenquine
BRINGING SCIENCE TO YOUR FEED BIN

On the topic of intake, magnesium (Mg) is 'hot' in humans & animals. In human medicine, Mg has been found to protect against inflammation, psychiatric disorders (anxiety, agitation & panic attacks), muscle problems, insulin-resistance & diabetes, heart failure & stroke. In equine medicine, intravenous Mg is both an anaesthetic & a rescue therapeutic for bronchoconstriction in pasture asthma, & oral Mg supplementation is heavily promoted as a calmative.

EQUINE VETERINARIANS AUSTRALIA

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Hot behaviour & anxiety are common in horses & the possibility that natural oral supplements might be useful, is very attractive. So let's have a look at the recent research. Certainly, anecdotal reports on the benefits of oral Mg are numerous — with many owners & vets describing reduced skin sensitivity, 'hot' behaviour, tying-up, irritability, muscular cramping, weakness, insulin-resistance, cresty necks & stiffness — when horses receive a Mg supplement. Most of these reports have not been scientifically validated, but recently some great research has confirmed the anecdotes & observations.

Conducted in Australia, a recently-published study compared the effect of Mg to acetylpromazine (ACE) in horses undertaking a reaction speed test. This test measures the time taken for a horse to cover 2 m in a custom-built chute after being startled. Before the test, the horses travelled at 5.3m/sec, after receiving ACE they reduced their speed to 3.5m/sec. When they received 10g of Mg per day for 7 days, their speed reduced even more, to 3.1m/sec – ie they were less reactive than the ACE-sedated horses! This is the first time an objective measurement of behavioural change due to oral Mg supplementation has been reported in the horse. But, as scientists we like to see consistency & repeatability – which another new study has provided.
This study, published in 2017 looked at the amount of stress horses experienced (in terms of heart rates & cortisol levels) performing a set task when they received either ACE or a Mg supplement, compared to when they were unsupplemented. The horses were loaded onto a weighbridge for 3 seconds. Heart rate was significantly lower when the horses received ACE or Mg, compared to when they were unsupplemented. The veterinarians from the University of Guelph who undertook the studies weren't surprised to see the Mg have a similar effect to ACE.

The link between low Mg & anxiety has been well-established & supplementing Mg reduces stress in several species, including humans & rodents.

The primary active in the study was Mg, with supporting bioactivity from thiamine. Mg required for conversion of thiamine into its active form asnd a Mg deficiency could potentially induce a secondary thiamine deficiency. A tranquilising effect & slowing of heart rate was described in racehorses over 50 years ago. In 1961, researchers noted that: '…on three occasions after thiamine had been administered the horses were less excitable while walking to the racecourse. This was observed also by the jockey & the trainer, neither of whom knew the identity of the injections being administered …'.

Studies in rats also demonstrate a thiamine-induced reduction in biomarkers of anxiety, & that a combination of Mg & thiamine reduces post-natal depression in mice! In the Canadian equine study, when given 30 minutes before the onset of a stress, Mg-thiamine is as effective as ACE in blunting stress-induced increases in heart rate.

Mg is also thought to help soothe nervous horses by working in concert with calcium on muscle contractions. Calcium stimulates contraction, Mg relaxation. If Mg levels are low, muscles can spasm due to an inability to achieve full relaxation of the fibres. Although the presence of low Mg in the muscle tissue may stem from a genetic disorder rather than dietary intake, many horses have responded to Mg supplementation for treatment of chronic tying-up.

International Olympic veterinarians found Mg reduced muscle tiredness & increased work tolerance in show jumping, 3-day event, dressage & four-in-hand horses.

They also reported a decrease in skin sensitivity, 'hot' attitudes, unexplained hindleg lameness (muscular in origin), tying-up, irritability & muscular cramping, weakness & stiffness, particularly of the hindlimbs. Providing supplemental Mg alleviated signs & symptoms of deficiency – improving behaviour & performance.

More recent studies examined the effect of daily Mg on muscle function in horses – specifically tying up (PSSM, exertional rhabdomyolysis). Enzymes released during exercise indicate the amount of muscle damage. These are measured by your veterinarian when they test for AST, LDH, CK & ALP. A daily Mg supplement had an effect on muscle function, with lower enzyme levels after exercise, & also lower heart rates. In addition to allowing the proper relaxation of muscle fibres, Mg is a catalyst for generating energy (ATP – the basic currency of energy), & it facilitates oxygen delivery & uptake in working muscles. To sustain the high oxygen consumption required for optimum muscle function & performance requires correct levels of Mg.

Other veterinary conditions in which Mg is involved in the cause, management, treatment & prevention, include insulin resistance (IR) & Equine Metabolic Syndrome (EMS), synchronous diaphragmatic flutter (SDF) in endurance, event & racehorses, developmental bone & growth disorders in young horses, & tetany (grass & transit). There is no evidence that Mg has a role in nutritional secondary hyperparathyroidism – in fact numerous studies have confirmed that oxalates have no effect on magnesium status in horses.* Species is important here — while Mg deficiency has been implicated in oxalate toxicoses in ruminants, the opposite is true for horses.**

Insulin modulates the movement of Mg in & out of the cells in the body. Blood levels of Mg increase & cell levels decrease after sugar or starch-rich meals & this is thought to impair the cells ability to take up sugar from the blood (ie insulin-resistance). The link between Mg deficiency within the cells & diabetes has been made in man, but has yet to be confirmed in the horse. There are anecdotal reports of Mg supplementation improving insulin resistance, reducing & softening crest neck fat & lowering EMS & laminitis risk in horses. Ponies with EMS often have high blood pressure (hypertension) & some veterinarians recommend 10g of Mg per day to help control blood pressure. More studies are needed to determine whether adding Mg to a diet that already meets minimum requirements is useful in the management of IR. However it is recommended that we ensure diets for IR horses at least meet minimum requirements.

Synchronous diaphragmatic flutter (SDF) is common in electrolyte-depleted & exhausted horses. SDF involves spasmodic contractions of the diaphragm (often occurring at the same fast rate as the heart beat). Other clinical findings in horses with SDF include dehydration, reduced blood volume, gut stasis (reduced gut sounds & gut motility) & metabolic alkalosis. It is also known as 'thumps'. All affected horses have low blood electrolyte & Mg concentrations. The role of Mg in nerve excitability has been established as a problem in SDF & treatment with calcium & Mg speeds recovery.

The dominant response in all animals to inadequate Mg intake is poor performance - including growth, increased disease risk due to immune-incompetence & muscle weakness. Young horses, especially those growing rapidly, are at risk of developmental bone disorders. Known as DOD, this syndrome mostly occurs with fast, rapid growth. It includes osteochondritis dissecans (OC), subchondral cystic lesions, angular limb deformities, physitis, flexural deformities (these may have no defined cause, or may be secondary to OC or physitis), cubodial bone abnormalities in the knee & hock, & juvenile osteoarthritis. Recent research in Europe looked at the influence of Mg supplementation on the incidence of OC.

FORMS OF MAGNESIUM

Magnesium is available in different forms:

Magnesium Sulfate, commonly called Epsom salts. A side effect of regular use is diarrhoea & its use is not recommended.

Magnesium Oxide, a fine white powder. This is the usual form found in horse feeds as the horse's body will not absorb it if it is not needed, so difficult to overdose. It also contains the highest amount of Mg (see table).

Magnesium chloride, is a very good source of magnesium as it is easily absorbed by the body.

Magnesium Chloride flakes, all forms of this are bitter tasting and unpalatable to horses, although it has a high bioavailability rate. The taste can be masked by dissolving the flakes in water.

Magnesium hydroxide, must be broken down in the horse's stomach by hydrochloric acid to form magnesium chloride.

Magnesium Oil, this is liquid magnesium chloride which provides a speedy delivery to the body.

Sources of magnesium	% Mg	Amount to feed to provide 10g Mg per day
Dolomite	8-11%	90 - 125g
Magnesite (magnesium carbonate)	12-31%	35 - 80g
Magnesium chloride	10-14%	75 - 90g
Magnesium oxide	56-60%	17-19g
Magnesium citrate*	10-12%	85 - 100g
*Studies in humans show better absorption, not demonstrated in horses		

They concluded supplements containing Mg reduced OC incidence & that Mg plus correct exercise lowered the prevalence of OC, especially in the knee.

Severe Mg deficiencies, such as seen in grass tetany in cows, are rare in horses but have been documented since 1935. Observations of the condition include: '…Pronounced hypomagnesæmia, as well as hypocalcæmia, is shown to be a characteristic feature of "transit tetany" occurring in pasture-reared horses, generally suckling mares, during or after the disturbance of a long railway journey…" Other veterinary textbooks describe '…Out breaks of grass tetany…in humid, grassland areas of Australia. The addition of magnesium oxide to the diet was protective. Low magnesium has also been described in foals grazing spring pasture in the Hunter Valley. If a pasture is Mg deficient (spring pasture & winter pastures with little herbage that have been fertilized with potash & /or nitrogen), supplementary Mg is indicated.

The link between potassium, calcium & Mg has been studies in horses. An intake of 34g/kg of potassium did not decrease calcium or Mg retention. Although Mg can increase the absorption of calcium, the effect is only seen when Mg is provided at a rate of 0.86% of the diet – ie for a 400kg horse eating 10kg of feed per, the feed would need to contain 86 grams of Mg –

this is equivalent to approximately 150g of magnesium oxide per day.

Although a high intake of calcium decreases Mg absorption in humans on low-fibre diets, this does not occur in the horse where fibre intake is a normal part of the diet. High intakes of dietary phosphorus reduces both Mg solubility in the ileum & Mg absorption. And combined high intakes of calcium & phosphorus together can lead to formation of an insoluble calcium magnesium phosphate complex, lowering Mg solubility in the intestine & causing decreased Mg absorption.

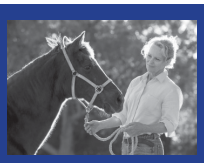
There important differences in absorption between species & the form of Mg. In cows, Mg is absorbed in the small & large intestine & in the rumen. Horses have extensive fermentation of fibre in the large intestine & absorb a great deal of Mg from the hindgut. Chelated forms of Mg are absorbed only in the small intestine. If you supplement with only chelates, you will lose large bowel absorption & the amount of Mg available from chelates can actually be less than from an inorganic form, like magnesium oxide.

Magnesium helps protect against inflammation & free-radical damage. What shows promise in the field of veterinary medicine is the link to the protective role of magnesium against damage from endotoxins. Horses with colic that results in endotoxin release or laminitis are known to often have low blood magnesium levels, & there is hope that treatment with magnesium during these critical times may decrease the amount of damage that occurs.

Mg is an essential cofactor for more than 300 enzymatic reactions involving ATP — such as translation of genetic information & cellular energy production. It is necessary for membrane stabilization, nerve conduction, ion transportation, regulation of Ca channel activity, & normal functioning of the sodium-potassium pump which regulates cellular potassium levels. Consequently, Mg plays an important role in excitable tissues. Defective function of cellular trace mineral channels interferes with ATP pumps & ion channels & disturbs cell membrane function resulting in neuromuscular abnormalities. The body attempts to maintain the balance of Mg inside & outside cells & there is very little Mg outside the cells – which is why testing blood for Mg deficiency is meaningless.

Dietary Mg deficiency in horses is very rare, unless extreme conditions combine to lead to reduced Mg intake & increased demand, such as in long-distance travel in lactating mares, or 'hard' water in areas with a limestone base. Extreme Mg deficiency is life-threatening but rarely seen in horses – unless they are critically ill. Adding supplementary Mg to the daily diet is intended to address subclinical deficiencies, diagnosis of which is difficult — but the clinical signs are recognizable.

* https://www.cambridge.org/core/journals/journal-of-agricultural-science/article/the-effect-of-dietary-oxalate-on-calcium-phosphorus-and-magnesium-balances-in-horses/C6F6A0E53F60B0D52BD618CB695F2D0B



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Dr Jen Stewart has been an equine veterinarian for more than 40 years & an equine nutritionist for more than 10 years. Jen has been developing premium formulas for studs, trainers & feed companies in Australia & around the world & regularly consults to leading international studs & trainers in various countries. Jen has spent a fair bit of time researching & being involved in nutritional management of developmental orthopedic diseases, colic, tying-up, laminitis, performance problems, post-surgery & other conditions. And is currently the only practicing equine veterinarian & clinical nutritionist in Australia. ***Jen's promise is to continue to BRING SCIENCE TO YOUR FEED BIN***

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