Magnesium is an essential macro-mineral which is required for numerous functions in the body of all mammals including dairy and beef cattle. These functions include:

1. Co-factor for more than 300 enzyme systems involved in carbohydrate, protein and lipid metabolism in the body;
2. Nerve transmission and muscle contraction, and

The distribution of magnesium in the body of beef and dairy cattle include nearly 70 percent within the bone mineral, 29 percent within the cells of the body and 1 percent in blood and extracellular fluids (NRC, 2001).

Normal blood plasma magnesium concentrations range from 1.8 to 2.4 mg/dl, however when magnesium levels drop below 1.2 mg/dl, clinical symptoms of magnesium deficiency, or tetany, can occur (Kincaid, 2008; NRC, 2001). These symptoms can include excitability, twitching of muscles of the face and ears, uncoordinated walking gait, convulsion, paralysis, and death (Berger, 2003).

It should be noted that true dietary magnesium deficiency is rare. Low blood magnesium in cattle usually occurs in conjunction with diets that are low in concentrates and grains and high in lush spring pastures. The cause of the low blood magnesium usually has more to do with nutrient interactions in the rumen, that reduce magnesium availability and absorption, rather than low dietary levels of magnesium. This will be discussed in greater detail later.

Despite the large amounts of magnesium reserves within the bone tissue, maintenance of blood magnesium is nearly totally dependent on absorption of dietary magnesium. This is because the resorption of magnesium from bone mineral only occurs in response to a need for calcium to maintain blood calcium levels in fresh dairy cows around calving time. Magnesium absorption in young pre-ruminant calves occurs mainly in the intestine. However, after the development of a functioning rumen, the majority of magnesium absorption occurs at the rumen of cattle and sheep. In order for magnesium to be absorbed across the rumen wall into the bloodstream, dietary magnesium must be dissolved or solubilized in the rumen fluid. When rumen soluble magnesium concentrations are high, absorption can take place passively across the rumen wall. However, if rumen soluble magnesium levels are low, relative to blood magnesium concentrations, a sodium-linked active transport system in the rumen wall facilitates the absorption of magnesium into the bloodstream.

The bioavailability of magnesium from feeds including forages can be quite variable ranging from 11 to 40 percent, although the vast majority of feedstuffs have a bioavailability between 20 and 30 percent (Henry and Benz, 1995). Magnesium oxide, magnesium sulfate and magnesium chloride are the most common sources of supplemental magnesium. Bioavailability of magnesium oxide can vary from 28-50% depending on particle size (finer is more available), source (sea water source may be more available), and calcination temperature (1100 °C is more available than 800 °C) (NRC,2001;Henry and Benz,1995). A good quality magnesium oxide should be close to 50% bioavailability. The bioavailability of magnesium sulfate and chloride may be slightly higher than magnesium oxide at around 58% (NRC, 2001).

Even though magnesium sulfate and chloride have slightly higher availability, magnesium oxide is the most commonly used magnesium source in both beef and dairy rations. This is because magnesium sulfate and chloride are also sources of anionic salts that can acidify the blood pH in cattle. Feeding too high a level of these anionic salts in lactating cow diets can lower the dietary cation/anion difference (DCAD) or PCI balance below optimum levels. Conversely, magnesium sulfate and chloride can be used in the ration of dry and pre-fresh dairy cows as both a magnesium source and an anionic salt source to lower the DCAD or PCI balance to desired levels. Magnesium oxide can have a dual purpose in dairy and beef rations as both a magnesium source and a rumen alkalizing agent to help manage rumen pH when needed. Since magnesium oxide is an alkalizing agent, feeding an excessive amount of magnesium oxide to dry and pre-fresh dairy cows may have an alkalizing effect on blood pH and increase the risk to freshening issues including milk fevers. Therefore, feeding much more than .05 lbs./head/day of magnesium oxide to dry and pre-fresh dairy cows should be avoided if possible.

There are several nutrient related factors that can reduce magnesium bioavailability in cattle diets and increase...
the risk for grass or magnesium tetany symptoms. These factors include:

1. Feeding low levels of concentrates or grains along with high levels of lush spring pasture, that contain high concentrations of potassium, protein, and aluminum (from soil ingestion) and low levels of sodium, and

2. High dietary levels of unsaturated oils from lush pasture, vegetable oil and oilseed sources (such as distillers, roasted beans, etc.).

The high potassium from lush spring pastures can interfere with the absorption of magnesium by the sodium-linked active transport system in the rumen wall. Low dietary sodium may further reduce the sodium linked active transport of magnesium in conjunction with high potassium levels (Berger, 2003). This could be due to a sodium/potassium imbalance in the rumen. Therefore, it is recommended to add sodium in the form of salt or sodium bicarbonate to lessen the effects of high potassium levels on magnesium absorption (Berger, 2003).

In addition, feeding high protein pasture based rations along with no or minimal concentrates can result in a protein to energy imbalance in the rumen, which can result in elevated rumen ammonia-N and pH levels. When rumen pH exceeds 6.5 (normal pH ranges from 5.8-6.5), magnesium solubility and availability in the rumen fluid can decline, which further exacerbates reductions in magnesium absorption efficiency. High dietary aluminum intake from soil ingestion by cattle while grazing can also be a contributing factor to magnesium tetany risk as well. Absorbed aluminum may depress the parathyroid hormone secretion (PTH), which is important for cattle to maintain blood calcium and magnesium levels (NRC, 2001). Unsaturated oils from lush grass pastures can also form insoluble magnesium soaps that also reduces dietary magnesium solubility in the rumen, although this is not considered a major factor for reducing magnesium availability. To compensate for the reduced magnesium availability when cattle consume lush spring pasture, minerals can be formulated to contain higher levels of magnesium and sodium (mostly in the form of salt).

In addition, where possible, diluting lush pasture with other forages and grains and/or molasses can help improve energy to protein balance in the rumen, thereby reducing both rumen ammonia-N and pH. This can have a net affect of improving magnesium solubility/availability in the rumen.

Agri-King’s minimum nutrient requirement for magnesium includes:

1. 0.2% or greater dietary magnesium for beef cattle and dairy replacement heifers; and

2. 0.31% or greater dietary magnesium for dry, pre-fresh or lactating dairy cows. In situations where rations are high in potassium (>1.8%) and oil or fat (>4.0%) Agri-King’s beef and dairy ration program automatically increases magnesium levels to compensate for lower magnesium availability.

Magnesium toxicity is not likely since excess magnesium can be excreted readily in the urine (NRC, 2001). However, feeding diets that exceed 0.5 to 0.6 percent magnesium should be avoided. This is because high magnesium from supplemental magnesium sources (magnesium oxide and magnesium sulfate) can have a laxative effect on cattle, causing diarrhea. In addition, the alkalizing effect of excess magnesium oxide may also have an undesired effect on rumen pH, which could cause negative effects on rumin function.

In conclusion, magnesium is a vital macro-mineral that is required for numerous metabolic functions in beef and dairy cattle. Agri-King’s beef and dairy ration program is designed to optimally balance ration magnesium levels around your feedstuffs and forages and thereby optimize beef and dairy cattle performance. A K

References Used:

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