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Sodium for the Prevention of Grass Tetany and Fetal Losses Associated with Nitrate Toxicosis in Herbivores

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Opinion

Frosts and freezes to pasture forages in the late Spring provided hints as to the cause of the grass tetany syndrome as well as other syndromes associated with an increase in nitrate and reduced sodium in pasture forages [1-3]. Climatic changes involving frosts and freezes commonly damage pastures in mid-western and eastern USA states, especially when they occur in late Spring. Herbivores grazing affected pastures often experience different syndromes, including fetal losses in cows and mares, related to increased levels of potassium and nitrate, and a deficiency in sodium.

In late Spring of 2001, several frosts and freezes occurred that affected pasture forages. During this time several cattle succumbed from the grass tetany syndrome and acute bloat consistent with rumen tympany. In addition, several cows were affected with rectal and vaginal prolapses. The pathogenesis of rumen tympany appears similar to the grass tetany syndrome because magnesium and calcium are depleted in the blood which disturbs muscular tissues of the gastrointestinal tract. Magnesium and calcium are critical for muscular tissues, and when a deficiency exists, atony of the gi-tract occurs, causing the gi-tract to become more prone to torsions due to atony and gas formation [3]. We found that cattle did not succumb to acute bloating when adequate loose salt was made available. A similar finding was observed in sheep in New Zealand [4]. Regarding fetal losses, in addition to cows, it was found that mares not exposed to high nitrate pasture forages and fed adequate salt, were less likely to abort from the Mare Reproductive Loss Syndrome (MRLS).

A comprehensive review of the literature on grass tetany substantiates our findings that sodium is indeed an important factor in the pathogenesis of grass tetany. Our findings suggest that high levels of potassium and nitrogen in pastures and feedstuffs are likely inducing a sodium deficiency along with a mineral and electrolyte imbalance.

Workers in Holland first noted that intensive managed pastures suppressed sodium in pasture forages that were high in potassium and nitrogen. Cows grazing these pastures showed signs of sodium deficiency [5]. Also, Smith and Aines demonstrated that cattle with severe sodium deficiency exhibited clinical signs consistent with grass tetany [6]. Workers in New Zealand noted that increased potassium in herbage decreased the uptake of sodium in pasture grasses and legumes [4]. After frosts and freezes, potassium increases in pasture forages. In damaged pastures by frosts and freezes the uptake of sodium is decreased and magnesium is not affected [7].

In the 1950s, researchers in Europe reported that when pasture forages were fertilized with high potassium and nitrogen, there was a dramatic incidence of grass tetany [8]. During the same time period, there was great interest in intensive grazing of grass. Consequently, farmers in Europe heavily fertilized the pastures with potassium and nitrogen. In the Spring, these workers observed a remarkable increase of grass tetany [8]. It appeared that when only magnesium was increased in the diet, cattle with grass tetany did not respond. Interestingly, these workers also considered that cattle might be experiencing a sodium deficiency after pastures were fertilized with potassium and nitrogen.

The British workers decided to treat affected cattle herds with adequate salt, and not with mineral mixes, nor any additional magnesium. The results were immediate and outstanding because the cases of grass tetany, for the most part, disappeared. Not surprisingly, the same results observed by the British workers were consistent with our findings in affected cattle herds grazing grass pastures with abundant legumes, or pastures recently fertilized with nitrogen [1-3]. British workers later confirmed that pasture forages fertilized with high potassium and nitrogen did indeed suppress the uptake of sodium [9,10]. They also observed an immediate increase in milk production in cattle that were not fed additional magnesium but given adequate sodium. After recording these results, they recommended to dairymen, whose cattle were affected with grass tetany, to first change their fertilizer program before providing additional magnesium to

pastures and to the diet. Dairymen were also instructed to feed an adequate amount of salt.

Interestingly, British workers did not see an increase in magnesium in the blood of affected animals that were given adequate salt. A plausible explanation for this is that the high potassium in the diet may have suppressed the absorption of magnesium. This is a logical hypothesis that has been proposed by Martens & Schweigel [11].

However, an additional factor may be involved. High nitrate in the diet eliminates excessive magnesium and calcium through the urine and feces and consequently, lowers the magnesium and calcium, which becomes unavailable and cannot be absorbed from the gastrointestinal tract. Excessive nitrate anions in the diet may induce a deficiency of magnesium, calcium and sodium. Sufficient cations are needed in the diet to counterbalance the excess nitrate anions. When adequate sodium is in the diet, the excessive nitrate is eliminated through the urine and feces as sodium nitrate. However, when sodium is deficient, the bi-valent cations are utilized to eliminate the excess nitrate. Because magnesium is more active it is eliminated first followed by calcium. When there is an adequate amount of sodium in the diet the excess nitrate is eliminated as sodium nitrate. As a result, the magnesium and calcium are preserved and available to be absorbed in the blood [3].

European researchers, in previous reports, advocated that additional magnesium might not be necessary in forages and the diet. These researchers suggested that prolonged feeding of high magnesium seemingly reduced milk production. Our observations in the 1990's suggested that feeding high levels of magnesium over an extended amount of time and reducing the salt in beef cattle might cause a wasting syndrome as well as a decrease in milk production [3]. Researchers in California reported similar findings of decreased milk production in dairy cattle fed excessive amounts of magnesium [12].

When beef cattle are fed mineral mixes, it is difficult to be assured that all cattle are receiving sufficient salt. In some cases, especially related to excessive potassium and nitrate, it may be necessary to force feed salt. Most dairy cattle are fed minerals and salt in complete feed rations. It is important that salt, preferably in the loose form, be made available at all times free choice for animals that may desire additional salt [13,14].

Clearly, when cattle display signs of nitrate toxicosis from pastures or feedstuffs that are excessive in nitrogen, additional nitrogenous compounds should not be added to mineral mixes that are low in salt, because the low salt entices cattle to eat more nitrogenous compounds. This would be counterproductive. On the other hand, if diets are low in protein or other nitrogenous compounds, less magnesium, calcium and sodium are necessary in the rations. However, if the protein or the nitrogenous compounds are high, then higher concentrations of calcium, magnesium, sodium and other cations are essential to counteract the excessive anions, primarily nitrate, and other anions, like sulfate, in the diet.

To assure that grass tetany does not occur it may be necessary to reduce the dietary potassium and nitrogenous feeds and provide adequate salt to the ration. These findings suggest that when cattle show signs of grass tetany, milk fever or the downer cow syndrome, they should be treated with magnesium and calcium solutions, and be given sodium in the form of sodium bicarbonate and/or sodium chloride. Our work has demonstrated that animals with magnesium and calcium deficiency recover more often when adequate salt is available, and they actually consume it.

It is difficult to determine the significance of different levels of nitrate in the blood. When cations are low in the blood, less nitrate may induce toxicosis. Conversely, if cations are high, the same level of nitrate may not induce toxicosis. Because nitrate will be affected by the level of cations in the blood, perhaps, when magnesium and sodium are below normal, nitrate toxicosis should be considered as the cause.

Regarding nitrate toxicosis and a sodium deficiency, seemingly there is an association with the grass tetany syndrome in herbivores, primarily cattle. It was also found that there is an association with nitrate toxicosis and a sodium deficiency and fetal losses in cows and mares and other herbivores.

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