Biological Times

Volume No. 2 | Issue No. 9 | Pages 31-32

Magnesium and calcium deficiencies in calves and their management

Muhammad Bilal Arshad[1], Abdul Hannan Haider[2], Saif Ullah[1], Arslan Muhammad Ali Khan[3] and Saad Irfan[4]

1. Faculty of Veterinary Science, University of Agriculture Faisalabad, Pakistan.
2. The Islamia University of Bahawalpur, Pakistan.
3. Department of Parasitology, Faculty of Veterinary Science, University of Agriculture Faisalabad, Pakistan.
4. Animal Science Department, Faculty of Animal and Agriculture Sciences, Universitas Diponegoro, Semarang, Indonesia.

*Corresponding Author: arslanrajpootkhan374@gmail.com

ABSTRACT

Magnesium and calcium are necessary cations that function as a cofactor for adenosine triphosphatases in numerous enzymatic processes. These components are involved in the protein synthesis mechanism and anaerobic phosphorylation. The two important vital organs, i.e., the kidney and small intestine work together to keep the concentration of magnesium and calcium in the blood within a specific range because they both absorb more nutrients even when there is a deficiency of nutrients. If there is a deficiency of magnesium and calcium in extracellular fluid, some of their quantity is exchanged with the bones. In the context of intracellular Mg depletion, the serum Mg can be normal, and the occurrence of a low level typically denotes severe Mg insufficiency. Calves frequently experience hypomagnesemia and hypocalcemia. Hypomagnesemia and hypocalcemia can result from several gastrointestinal (GIT) causes, protein-deficient diet, total nutrition, intravenous (IV) administration of Mg and Ca-free fluids, chronic watery diarrhea, and steatorrhea, and in rare cases, primary familial Mg and Ca malabsorption. The clinical presentation, the severity of the magnesium deficit, and renal function all play a role in determining the dosage and method of magnesium delivery for treating hypomagnesemia.

Introduction:

A diet with poor nutrition leads to the collapsing of immunity which causes the mortality of calves. As a result, food supplementation has become a popular alternative for satisfying animal nutritional demands, particularly those related to mineral requirements [1]. These metallic (magnesium, calcium, selenium, manganese, potassium, copper, and phosphorus) nutrients act as cofactors, increasing the efficiency of cell metabolism and leading to improvements in immunity [2]. As a result, animals are more resistant to infectious diseases and perform better. These nutrients, being a cofactor act as act as potent antioxidants for various enzymes that are responsible for the reduction of hydrogen peroxide and are also involved in the conversion of various hormones from the inactive form to the active form [3]. For example, Cu plays an important role in enhancing immune functions, and blood circulation, and provides protection against oxidative stress and pathogenic attack. Similarly, Magnesium acts as a cofactor which increases the ATP production during oxidative phosphorylation and Krebs cycle, while phosphorus is essential in bone growth and development [4]. The importance of dietary supplements in boosting immunity and calf health is underscored by the fact that mineral elements are crucial to calf health. This study aimed to determine whether intramuscular mineral supplementation had any positive effects on dairy calf health and, as a result, avoided diarrhea. If there is a deficiency of nutrients, it will lead to severe cases of poor animal health and calf mortality. Magnesium is a mineral that is necessary for several energy-producing processes as well as the transmission of nerve impulses in animals. Magnesium must be consumed continuously by livestock to maintain proper blood levels, yet it is poorly absorbed by the rumen [5]. Magnesium and calcium are very important minerals and if both nutrients are deficient in diet it will lead to grass tetany or Hypomagnesaemia and hypocalcemia globally. The 'slow' calvers and lambers are already causing birthing issues. When the grass starts to grow even more as the weather warms, unexpected mortality, and grass staggers are likely to be observed in grazing animals. Experimental studies have shown that lush green grass, rich in potassium and protein will lead to the decreased absorption of magnesium from the rumen, which results in poor feed intake [6]. The likelihood of lower feed intake is further increased by the stress of cold weather or worse, by the frequent shifts between cold, wet, warm, and chilly days, with a significant percentage of the magnesium being absorbed into fat tissue.

How we recognize Hypomagnesemia and Hypocalcemia

Animals that are 4-6 years old are typically at the largest risk for severe magnesium and calcium insufficiency, and abrupt death is the most typical symptom of a problem. The acute form of tetanism most frequently manifests in sheep between 4 and 6 weeks after lambing, with severe instances collapsing and exhibiting recurrent tetanic spasms with all four limbs rigidly extended; some sheep are immobile, some move stiffly, while others are sensitive to touch and have trembling facial muscles [7]. Like this, calf muscles twitch, irritate, and become aggressive. Less serious symptoms are frequently linked to milk fever and calving issues brought on by weak uterine muscles.

Causes of Magnesium deficiency

Nutritional Causes:

1) starvation 2) metabolic acidosis 3) Diabetic ketoacidosis 4) Protein calorie malnutrition

Intestinal Causes

1) Chronic diarrhea leads to chronic ulcerative colitis and increased use of laxatives 2. Intestinal malabsorption. Short bowel syndrome, Pancreatic insufficiency with steatorrhea

Renal Causes:

1) Renal tubular acidosis 2) Acute tubular necrosis 3) Chronic glomerulonephritis which leads to renal magnesium loss 4) Diuretics-furosemide and ethacrynic acid 5) Antibiotic-induced tubular dysfunction-gentamicin, ticarcillin, carbenicillin

Hormonal causes: 1) primary and secondary aldosteronism 2) Hyperthyroidism 3) increased lactation 4) hypercalcemia in serum 5) Primary hyperparathyroidism [8]

Clinical Manifestations

1) Hyperactivity of synapse neuromuscular junction
2) Tremor of tongue
3) Myoclonic jerks
4) Convulsions
5) Ataxia
6) Dysphagia and gut hypomotility
7) Ventricular arrhythmias
8) Ventricular fibrillation
9) Sudden death [9]

Treatment

The most frequent cause of death in grazing livestock is hypomagnesemia, which is virtually entirely avoidable with sufficient preparation. Prior to the spring grass flush and other high-risk times, stock should receive supplemental magnesium. It is advised to all farmers to provide common salt (NaCl) to grazing livestock on a year-round, ad-lib basis. Magnesium oxides, such as causmag, and lime, calcium carbonate, can be mixed with this salt in equal parts (1:1:1) using multiple containers in each paddock prior to spring, calving, or lambing [10].

Management and prevention

Knowing the causes of calf losses should help us create a management strategy to address the issues that have a negative impact on reproductive effectiveness. This activity is not extremely challenging, in general. Each farmer must carefully assess which issues are characteristic of the herd, create a management plan to address these issues, and determine the financial impact of these management adjustments. If the plan is to be successful, it must be tailored to the farmers' specific needs. In order to achieve this, it is

To cite this article: Arshad MB, AH Haider, S Ullah, AMA Khan & S Irfan, 2023. Magnesium and calcium deficiencies in calves and their management. Biological Times, 2(9): 31-32.

crucial to have thoroughly established performance records, as well as precise animal identification and performance tracking.

Despite the fact that it has long been known that nutrition can have a significant impact on calf survival [11]. According to the study, a calf's performance drops by a certain proportion when it lacks certain minerals, such as P, Mg, Co, Cu, I, Mn, Se, and Zn [12]. While 5% of the operations reported magnesium shortage, the remaining minerals were found to be inadequate in 0.5 to 3.9% of the herds. Overall, we discovered that mineral supplementation was advantageous to dairy calves' health due to their significant antioxidant and immunological capabilities [13]. Important minerals including Se, Mg, Zn, and Cu have a crucial function in erythropoiesis, enhance the antioxidant system, prevent diarrhea, and lower bacterial counts in dairy cows, according to studies. The erythrocyte and hemoglobin counts were greater in the mineral-rich diet group compared to the control group. Since copper is involved in red cell manufacturing and is a necessary component of adult red cells, its vital involvement in erythropoiesis can be used to explain this [14]. However, it is unclear how copper affects erythropoiesis. In one of the research trial, it was explained that one control group developed pneumonia, which are indicated by higher WBC, lymphocyte, and eosinophil counts and increased inflammatory processes. Mineral supplementation can therefore be thought of as a method of preventing anemia or viral disorders in the early stages of life in dairy cows because it promotes erythropoiesis and strengthens the immune system [15].

Total protein and globulin levels are also positively impacted by mineral supplementation; in dairy calves, the minerals stopped these factors from dropping. Since the reduction in total protein levels is linked to the reduction in globulin levels, an essential protein for the establishment of an efficient immune response, the drop in serum protein levels is related to low immunity. Because Se, a vital mineral with anti-inflammatory properties, is present, the usage of mineral supplements can help avoid immune system deterioration [16].

On the other hand, we found higher levels of albumin and serum glucose in the calves that had received supplements, which may indicate physiological stress and possibly hepatic changes brought on by too much of one or more minerals. Barton and Iwama contend that a rise in blood glucose happens in reaction to a stressor to meet the majority of the body's energy needs under stressful situations [17]. Another study showed that high levels of Cu and Mg might cause stress, which is manifested as an increase in glucose levels [18]. Additionally, as the liver is where albumin is entirely synthesized, a reduction in serum levels of albumin may be a sign of hepatic change.

In this regard, data has shown that high amounts of Cu, zinc, and Mg cause liver damage, supporting our findings. As a result, adding minerals to dairy calves' diets can boost their immune systems, but too much of a certain substance can cause hepatic changes. In contrast to the control group, the enzymatic activities were higher in the mineral-supplemented dairy calves, proving that mineral supplementation was effective in boosting the antioxidant defense system in dairy cows throughout the transitional phase. Because Cu, Zn, Mg, and Se are cofactors of these antioxidant enzymes, the rise in their activity can be explained. Consequently, the antioxidant defense system in dairy calves is improved by the administration of mineral supplements.

Other managemental factors

Environmental factors can have a big impact on calf calves' survival. Negative weather can be extremely difficult for newborn calves, and an increase in population could make it simpler for infectious diseases to spread. As a result, the place and time of calving are very important management factors. During severe weather, calves might require more protection, yet the additional protection or close confinement could hasten the spread of disease [19]. This decision alone will determine what kinds of shelter needs an operation has, how frequently it will utilise its shelter, and, eventually, how crowded the operation will probably get during the important neonatal stage of a calf's life.

References:

[1] Roohani N, Hurrell R, Kelishadi R, Schulin R. Zinc and its importance for human health: An integrative review. Journal of research in medical sciences: the official journal of Isfahan University of Medical Sciences. 2013 Feb;18(2):144.

[2] Libera K, Konieczny K, Witkowska K, Żurek K, Szumacher-Strabel M, Cieslak A, Smulski S. The association between selected dietary minerals and mastitis in dairy cows—A review. Animals. 2021 Aug 7;11(8):2330.

[3] Kurutas EB. The importance of antioxidants which play the role in cellular response against oxidative/nitrosative stress: current state. Nutrition journal. 2015 Dec;15(1):1-22.

[4] Killilea DW, Killilea AN. Mineral requirements for mitochondrial function: A connection to redox balance and cellular differentiation. Free Radical Biology and Medicine. 2022 Mar 1;182:182-91.

[5] Lall SP, Dumas A. Nutritional requirements of cultured fish: Formulating nutritionally adequate feeds. InFeed and feeding practices in aquaculture 2022 Jan 1 (pp. 65-132). Woodhead publishing.

[6] Goff JP. Calcium and magnesium disorders. Veterinary Clinics: Food Animal Practice. 2014 Jul 1;30(2):359-81.

[7] Van Eetvelt A. Pitfalls during lambing in modern sheep (Doctoral dissertation, Ghent University).

[8] Huang CL, Kuo E. Mechanism of hypokalemia in magnesium deficiency. Journal of the American Society of Nephrology. 2007 Oct 1;18(10):2649-52.

[9] Pham PC, Pham PA, Pham SV, Pham PT, Pham PM, Pham PT. Hypomagnesemia: a clinical perspective. International journal of nephrology and renovascular disease. 2014 Jun 9:219-30.

[10] Ledgard SF, Welten B, Betteridge K. Salt as a mitigation option for decreasing nitrogen leaching losses from grazed pastures. Journal of the Science of Food and Agriculture. 2015 Dec;95(15):3033-40.

[11] Goff JP. Major advances in our understanding of nutritional influences on bovine health. Journal of dairy science. 2006 Apr 1;89(4):1292-301.

[12] Hilal EY, Elkhairey MA, Osman AO. The role of zinc, manganse and copper in rumen metabolism and immune function: a review article. Open Journal of Animal Sciences. 2016;6(04):304.

[13] McDowell LR, Wilkinson N, Madison R, Felix T. Vitamins and minerals functioning as antioxidants with supplementation considerations. InFlorida Ruminant Nutrition Symposium; Best Western Gateway Grand: Gainesville, FL, USA 2007 Jan 30 (Vol. 3, pp. 30-31).

[14] Anderson HL, Brodsky IE, Mangalmurti NS. The evolving erythrocyte: red blood cells as modulators of innate immunity. The Journal of Immunology. 2018 Sep 1;201(5):1343-51.

[15] Niers L, Stasse-Wolthuis M, Rombouts FM, Rijkers GT. Nutritional support for the infant's immune system. Nutrition reviews. 2007 Aug 1;65(8):347-60.

[16] Uwitonze AM, Rahman S, Ojeh N, Grant WB, Kaur H, Haq A, Razzaque MS. Oral manifestations of magnesium and vitamin D inadequacy. The Journal of steroid biochemistry and molecular biology. 2020 Jun 1;200:105636.

[17] Barton BA. Stress in fishes: a diversity of responses with particular reference to changes in circulating corticosteroids. Integrative and comparative biology. 2002 Jul 1;42(3):517-25.

[18] Aliko V, Qirjo M, Sula E, Morina V, Faggio C. Antioxidant defense system, immune response and erythron profile modulation in gold fish, Carassius auratus, after acute manganese treatment. Fish & shellfish immunology. 2018 May 1;76:101-9.

[19] Muktar Y, Mamo G, Tesfaye B, Belina D. A review on major bacterial causes of calf diarrhea and its diagnostic method. Journal of Veterinary Medicine and Animal Health. 2015 May 31;7(5):173-85.