

Hypomagnesemia in a Herd Fed on High Protein Diet

Sushma Chhabra¹ and
Sunil Dutt Bhardwaj²

Abstract

In a herd of 23 high yielding cross bred cows, 4 cows showed classical symptoms of hypomagnesemia. All the animals were being fed with high protein diet whereby they were provided with *ad lib* leguminous green fodder particularly berseem (*Trifolium alexandrinum*) that was fertilized with urea. Even the concentrate being fed @10 kg/animal/day, was having >40% protein source in form of mustard cake and soybean. Blood samples from all the cows of the herd were collected for plasma minerals (Ca, Mg, K, Na, Cu, Fe and Zn) estimation. Lower concentration of magnesium and sodium were recorded whereas marginal levels of calcium were observed in the affected animals. With oral supplementation of magnesium oxide and diet change there was no relapse of the condition.

Keywords: Cows; Hypomagnesemia; Protein

- 1 Department of Veterinary Medicine, College of Veterinary Science, GADVASU, Ludhiana, Punjab, India
- 2 Veterinary Office, Department of Animal Husbandry, Punjab, India

Corresponding author: Sushma Chhabra

✉ chhabrasushma@rediffmail.com

Senior Scientist, Department of Veterinary Medicine, College of Veterinary Science, GADVASU, Ludhiana-141 004, Punjab, India.

Tel: +911612414008

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Introduction

Due to aberrations in the supply of minerals required for maintaining optimal performance, high yielding animals are always at a risk of mineral imbalances. Nowadays, feeding regimens are often the cause of problems related to mineral imbalances in dairy animals. Deficiencies of various minerals, inadequate intakes, energy-protein imbalances and excessive protein intakes are the likely contributors to mineral imbalances among dairy animals. The present study involved a dairy unit where the animals were kept on a high protein diet and developed hypomagnesemia.

Materials and Methods

In a stall fed herd of 23 high yielding cross bred cows, 4 cows with classical symptoms of hypomagnesemia (keeping their heads and ears in an erect position, stiffening of and convulsions), were treated with parenteral administration of calcium and magnesium (10% MgSO₄, IV@ 300-500 ml) along with magnesium sulphate enema that led to the clinical improvement. However, due to the relapse of the clinical signs after one week, further investigations were carried out on all the animals whereby blood samples from all the cows of the herd were collected for plasma minerals (Ca, Mg, K, Na, Cu, Fe and Zn) estimation.

For plasma mineral estimation, blood samples from all the animals of the herd were collected in mineral free (heparinised) glass vials. The samples were centrifuged at 3000 rpm for 30 minutes at room temperature to separate plasma. The plasma

was stored in small aliquots in mineral free glass vials at -10°C until analysis. Concentrations of various plasma minerals viz. Ca, Mg, K, Na, Cu, Fe and Zn were measured using Atomic Absorption Spectrophotometer (Spectra AA 20 plus, Varian, Melbourne, Australia). Fodder samples were washed with water and then dried in hot air oven (Overnight at 65°C). Dried and ground fodder samples (500 mg) were digested on hot plate and their mineral contents (Ca, Mg and K) were estimated similarly as described for plasma using Atomic Absorption Spectrophotometer.

Results and Discussion

Hypomagnesemic tetany usually affects cattle that are high producing and being fed a ration excessive in protein. All the animals included in the present study were stall fed with high protein diet that included *ad lib* leguminous green fodder (*Trifolium alexandrinum*) fertilized with urea and concentrate @10 kg/animal/day, that was having >40% crude protein source in form of mustard cake and soybean. Plasma mineral estimation revealed that all the animals of the affected herd were having low plasma Ca (78.73 ± 9.23 ppm) and Mg (16.40 ± 2.47 ppm) as compared to those given by Puls [1] (**Table 1**). Hypomagnesemia and hypocalcemia are more likely to occur in high producing animals that are fed diets high or excessive in protein, and non-

Table 1 Estimated mean and standard deviations of various plasma minerals in cows (n=23) and estimated value of fodder minerals being fed to the animals on ratio excessive in protein.

Mineral	Normal range values (ppm)*	Mean \pm SD (ppm) values in affected cows	Critical forage mineral levels (ppm) required by ruminants**	Mineral levels (ppm) of forage being fed to the animals
Ca	80-110	78.73 \pm 9.23	3000	3833
Mg	18-30	16.40 \pm 2.47	2000	1808
K	160-220	210.3 \pm 43.7	6000	13087
Na	3090-3450	3030.3 \pm 54.23	600	878.5
Fe	4-6 (high)	4.75 \pm 3.23	30	869.8
Cu	0.6-1.5	0.79 \pm 0.19	10	6.55
Zn	0.8-1.4	0.99 \pm 0.35	30	20.63

protein nitrogenous compounds, including nitrates. When these components are high in diet, anionic imbalance occurs due to excessive nitrates and these excessive anionic ions need to be neutralized by cations. Magnesium, calcium and sodium are the most soluble cations having highest affinity for nitrate [2]. This leads to washing out of cations in the urine, faeces and milk in the animals fed on high protein diet thus resulting in hypocalcemia, hyponatremia and hypomagnesemia.

The clinical signs of hypomagnesemia are unlikely to occur unless there is accompanying hypocalcemia as was the situation in the present study (**Table 1**). The clinical signs are usually seen in animals at peak lactation and in high producing cows. The increase in feed and forage intake, even with adequate magnesium and calcium, cannot completely compensate for the loss of magnesium and calcium in the milk. Cows in the present study were high yielders and being fed high protein diet which resulted in clinical signs of hypomagnesemia. Rapidly degradable protein has a negative effect on magnesium absorption, as does a high rumen pH [3]. Similarly, Burns and Allcroft [4] reported that clinical signs of hypomagnesemia rarely occur unless affected animals are high producing and being fed a ration high,

or excessive in protein which includes non-protein nitrogenous compounds. Martens and Schweigel [5] worked on excessive nitrogen and suggested that excessive NH_4^+ may interfere with the absorption of magnesium from the gut. Similarly, Urdaz et al. [6] reported the importance of appropriate amounts of magnesium in rations for dairy cows, especially in rations high in protein.

Low levels of sodium recorded in the present study (**Table 1**) could also be associated with tetany which was in accordance with observations of Kumar et al. [7], Sood et al. [8] and Das and Debbarma [9] who reported hyponatremia as a frequent finding in neonatal seizures. K/(Ca+Mg) ratio of the fodder was also higher (2.32) than the critical value of 2.2 which may be another contributing factor to the symptoms of hypomagnesemia in the cows. For the control and treatment, the affected animals were administered parenteral calcium and magnesium [10]. The diet regimen of the herd was altered whereby measured amount of green fodder (30-35 kg/animal) mixed with wheat straw and change of concentrate with <25% crude protein source. Subsequent oral supplementation of magnesium oxide @60 g/day for 2 weeks and diet change prevented the relapse of the condition.

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