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STATUS OF TWO MACRO ELEMENTS CALCIUM AND MAGNESIUM, OF PASTURE AND CATTLE GRAZING IN A SEMIARID REGION OF CENTRAL PUNJAB, PAKISTAN

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Abstract

In the present investigation, concentrations of two macro elements Ca and Mg in forages and plasma of lactating cows in a pastureland located in Sargodha district, central Punjab, Pakistan were assessed during the winter season of the year 2009. At this animal ranch the lactating cows were not being supplemented with minerals. Blood samples of these cows were sampled at one month interval and a total of 50 forage and blood samples of each month were obtained and analyzed by wet digestion. Macro mineral levels in forage samples during different sampling periods ranged from 0.15 to 0.25 % for Ca, 0.321 to 0.344 % for Mg, whereas macro mineral levels in plasma at different sampling intervals were 75 to 90 mg/L Ca and 11.81 to 16.84 mg/L Mg, respectively. The findings of this study indicate that forage Ca was moderately and Ca and Mg in blood plasma were marginally deficient indicating the warranted requirement of supplementation to enhance the plasma Ca and Mg levels and to prevent any growth and metabolic disorders in animals at this ranch.

Introduction

Of different macro minerals, calcium and magnesium play a vital role in a variety of metabolic processes in both plants and animals (Underwood, 1977). All mineral nutrients including these two can have hazardous effects on ruminants if included in the dietary sources at very high levels. Theoretically, there is a series of required levels and also of tolerance levels of each element which will vary from animal-to-animal and from day-to-day in the same animal (Khan *et al.,* 2009; 2010). However, due to the range of the optimal response zone, it is necessary to determine so precisely requirements and tolerances by each type of animal. The soil is the foundation of all life forms which contains nutrients, minerals, and even animal life, and is comprised of substances that enable plant life to flourish (McDowell & Arthington, 2005).

Imbalances in mineral profiles in soil and forages in semi-arid and arid regions of Pakistan and other countries with similar climatic conditions, is the main constraint in achieving the maximum production and reproduction potential in livestock (Khan *et al.,* 2008, 2009; McDowell & Arthington, 2005). The existing information on the mineral status of soil, forage and animals points out the need for mineral supplementation regimes to improve the reproduction potential in ruminants under grazing conditions in these arid and semi-arid animal pasturelands. During the harsh and dry season, important components of forages such as protein, energy, and fibre are often not available to the grazing livestock which in turn reduce the intake of different minerals in the animals in these pastureland conditions (McDowell *et al.,* 1983; McDowell, 2003).

Table 1. Mean Ca and Mg concentrations (%dry basis) of forages during different sampling periods at the livestock farm

Sampling Duration	Ca	Mg
1	0.25	0.344
2	0.22	0.336
3	0.18	0.331
4	0.15	0.321
Overall mean[a]	0.20	0.33
S E[b]	0.02	0.03
MER[c]	0.30	0.18
% below MER[d]	0.30	0.0

[a] least square means, [b] standard error, [c] mineral element requirement(MER), [d] percentage of samples below the (MER)

Keeping in view, the importance of macro minerals such as Ca and Mg and their deficiencies in forages and animals, the objective of the present investigation was to assess the status of these two elements in forages and blood plasma of cows to gain insight into mineral profile for the formulation of mineral supplements for grazing animals.

Materials and Methods

Study area: The study was conducted at Khizer Abad Livestock Experimental Station during 2008-2009. This farm is located in central Punjab, district Sargodha, Pakistan. This rural farm is situated 22 km away from Bhalwal and 37 km from Sargodha. It receives average annual precipitation of 180–200 mm. The soils of the station are loamy to clayey in nature with pH ranging from 7.8 to 8.4. A total of about 5000 animals are being reared at the ranch of which 1208 are of Sahiwal breed cattle. This ranch is situated in a low drying semi-arid region of central Punjab (located between 32º08'00"N and 73º7′00″ E). Average temperature during the experimental year was 29 ± 2 ºC during summer and 14 ± 3º C during winter. Average relative humidity during the experimental period remained 48.5 %.

Forage and blood plasma samples were collected four times with one month interval during the winter season to assess the variation in the mineral concentrations during transfer of the nutrients from soil to forage and forage to animal during the study period.

Sample collection

Forage: The livestock farm comprised different improved pastures as feeding sites. These pastures were managed with fertilized soils irrigated with canal and tube well water and with grazing fields with sown forage and grasses. During winter, the main forage species available to ruminants were *Medicago sativa* and *Trifolium alexandrinum* as the major forages, and *Cichorium intybus*, *Brassica campestris*, and *Avena sativa* were the minor forages. These forage pastures were the main source of diet for dairy cattle throughout the research period. Forage samples were collected from the same sites from where soil sampling was done. Each sample consisted of five sub-samples per feeding site.

Clipping of the forage samples was done at a height of 3-6 cm to simulate the grazing behaviour of the ruminants and placed in cloth bags for preservation. All forage samples were air-dried, packed in labelled brown papers and dried at 60° C in an incubator for 48 h. After drying, the forage samples were ground well and passed through 1 mm screen mesh.

Animals: Twenty each of clinically healthy lactating cows of Sahiwal breed in their second lactation, with average body weight of 315 kg were investigated for the study purpose. The experimental animals were allowed to graze in the pasture whole day daily. The forage and blood samples of lactating cattle were collected concurrently from this ranch with one month interval.

About 10 mL blood plasma was collected carefully by puncturing the Jugular vein in heparinzed evacuated tubes of each animal during the research period. Blood plasma was harvested by centrifugation at 3000 rpm for 15-30 min and separated with the help of a micropipette. Plasma samples were put into clean labelled polypropylene vessels and frozen at -20° C.

Sample preparation

Forage: One g dried and crushed plant material was subjected to wet-digestion with H_2SO_4 and H_2O_2 in 1:2 ratios on a hot plate at 250º C for 3-4 h until complete digestion. The digested samples filtered through Whatman filter paper # 42 and made the desired volume with double distilled water.

Table 2. Blood plasma Ca and Mg (mg/L) of cows during different sampling periods at the livestock farm.

Element	Sampling period			
	I	II	III	IV
Ca	90.0	85.0	80.0	75.0
Mg	11.81	11.86	13.84	16.84

Blood plasma: A sample of 1 ml of blood plasma was taken in a conical flask and dried slowly on a hot plate separately at 150º C for 30 min. After drying, all samples were digested with H_2SO_4 and H_2O_2 in 1:2 ratio. After completing digestion the clear solution was filtered and the volume was made up to 50 ml by adding distilled water.

Sample analysis: All digested samples of forage and blood plasma were subjected to atomic absorption spectrophotometer for the determination of Ca and Mg (Perkin-Elmer, Co., 18820).

Statistical analysis: Data for Ca and Mg in forage and plasma were subjected to statistical analysis using the SPSS software and one-way analysis of variance (ANOVA). Statistical significance was tested at 0.05 level of probability following Steel & Torrie (1980).

Results and Discussion

Mean concentrations of Ca and Mg of forages as affected by the sampling frequency are presented in Table I and of blood plasma in Table 2. A significant variation ($P < 0.001$) for the two macro mineral levels was found with respect to growth intervals. Earlier some researchers have reported that levels of most macro elements decrease with increase in maturity of forages (McDowell, 1992; Morillo *et al.,* 1997; Khan *et al.,* 2008, 2009). Mean Ca forage levels were inadequate for livestock as earlier recorded in different studies (Anonymous, 1989; McDowell, 1997).

The mean Mg concentration exceeded the values that required for ruminants during this investigation. Similar low levels of Mg have already been reported by Little, (1989)

in Indonesian forages, Morillo *et al.,* (1997) in Venezuela, and Khan *et al.,* (2008, 2009) in Pakistan in various types of forages for ruminants. Ca levels in forage were found to be deficient in the studied ranch of animals and it necessitates the supplementation of this element to the livestock being reared there. Forage Mg levels were sufficiently higher than the required amounts for ruminants and there is no need of supplementation of this element to the animals.

Mean plasma Ca and Mg were affected significantly ($p<0.01$) by sampling intervals with a consistent decrease with the time of samplings. This decrease in plasma Ca and Mg levels was parallel to the decrease in the levels of these elements in forages. This indicates a relationship between Ca and Mg of forages and those of plasma. The plasma Ca was at marginal deficient level based on critical level of 80 mg/L for ruminants as suggested by Herd, (1994) and McDowell *et al.,* (1984). It has been suggested that Ca level in blood plasma is mostly influenced by severely deficient level of Ca in the diet and mainly regulated by hormonal control in the body of the organisms. Thus, Ca in forages and dietary factors for ruminants would be an important criterion to evaluate plasma Ca status of ruminants (Velasquez-Pereira *et al.,* 1997; McDowell & Arthington, 2005). The Mg levels in plasma were at severe deficient limits according to critical level of 20 mg/L for livestock as suggested by Herd, (1994). These results disagree with the findings of Velasquez-Pereira *et al*., (1997) where higher Ca and Mg levels in plasma were found compared to those found in the present study.

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