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Mineral status of fodders offered to dairy animals in Mansa and Fazilka districts of Punjab

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Abstract
A study was conducted to assess mineral contents of fodder crops offered to dairy animals in the semi-arid South-West region of Punjab in India. A random survey was conducted in Mansa and Fazilka districts of the region and green and dry fodders offered to the dairy animals were collected and analyzed for various essential minerals. Considering the dietary requirements for dairy animals, low levels of Ca, P, Cu, Zn, Co and excess of Mo was observed in 16.2, 18.2, 54.7, 21.7, 17.4 and 35.9% green fodder samples. The Mg, Na, K and Mn contents of green fodders were adequate for animal needs. Dry fodders were found to be very poor source of Ca, P, Mg, Na, K, Cu, Zn and Mn and had excess of Mo. Season of the year had significant ($P<0.05$) influence on Ca, Mo and Mn concentrations of the green fodder. The Ca levels were higher in winter, and the Mo and Mn levels were higher in the summer season. The widespread deficiency of minerals in the fodders along with abnormal ratio of some of the essential minerals may result in occurrence of minerals deficiency diseases in dairy animals of this region.

Keywords: Cattle, Fodder, Minerals, Season, Semi-arid region

Introduction

Minerals play important role as structural and functional components of body organs, metalloenzymes, metalloproteins and hormones and are involved in wide range of metabolic processes in the animal body. The farm animals derive their mineral requirements primarily from the fodders as the practice of mineral supplementation to them is almost non-existent in field conditions in India. Recently, analysis of soil and fodder crops in Haryana, Himachal Pradesh, Uttar Pradesh and Rajasthan revealed deficiency of macro and micro minerals (Pathak *et al.*, 2006).The mineral composition of fodder varies according to climate, mineral composition of soils, plant age, fertilizer practice, species and variety (Kaplan, 2013). Therefore, it is essential to generate information on mineral status of feed and fodders from a particular region to develop mineral supplementation strategy for the livestock of that region. The South-West region of Punjab differs considerably from other regions of Punjab with respect to its soils, climate, groundwater quality and agronomic practices. The soils of the area are predominantly calcareous aridisols, developed under hot and arid to semi-arid climatic conditions. The groundwater of this sub-region is highly saline, alkaline and having fluoride in excess. Hence the present study was undertaken to assess mineral status of fodders from this region and information may be used to develop mineral supplementation strategy for the livestock of this region.

Materials and Methods

Study area and climate

A random survey was conducted in Mansa and Fazilka districts of the South-West Punjab. All the blocks of the Mansa (Bhikhi, Mansa, Budlada, Jhunir and Sardulgarh) and Fazilka district (Abohar, Fazilka, Khuian, Sarwar and Jalalabad) were included in the survey. The agro climatic conditions of the sub region are characterized by hot and dry summers and cold winters. The mean annual temperature ranges between 24°C and 27°C rising to the maximum of more than 44°C in summer months of May and June and minimum (1.5°C) in the month of January. The mean annual rainfall ranges between 300 and 450 mm with wide fluctuations. The quality of irrigation water is generally not good due to high salinity and alkalinity. The soils in this area are subjected to frequent drought having very low plant available water capacity and are mainly classified as ustic torripsamments, ustic haplocambids and ustic haplocalcids.

Sampling and analysis

The period of survey was November-February (winter season) and May-July (summer season).Dairy units in the region were visited and the samples of chaffed green fodder and dry fodder were collected in paper bags.

Collected samples were washed with distilled water, dried in hot air oven at 65°C for 72 hours, grounded and stored in air tight polythene packets. The wet samples were digested by the method of Trolson (1969). For digestion, 1 g sample was mixed with 5ml concentrated nitric acid and 1ml concentrated sulfuric acid in the digestion flask, kept overnight at room temperature followed by digestion on low heat (70-80°C) using digestion bench until the volume was reduced to 1 ml. To this, 3 ml double acid mixture of concentrated nitric acid and per-chloric acid in 3:1 ratio was added and low heat digestion continued until white fumes erupted. Digested mixture was diluted with 2 ml double distilled deionized water and filtered through Whatman filter paper No. 1. Repeated washings of digestion flask and filter paper were given to make final volume of the filtrate up to 50 ml. Simultaneous digestion of reagent blank was undertaken. Digested samples were analysed for various minerals by using atomic absorption spectrophotometer (AAS, PerkinElmer A Analyst 700, USA).The Na, K, Cu, Mo, Zn, Fe, Mn and Co concentrations were measured directly from the filtrates, whereas, for Ca and Mg estimation, filtrates were further diluted with lanthanum chloride (0.1% w/v). Phosphorus contents of fodder samples were estimated by Vanado molybdate phosphoric yellow colour method in nitric acid system (Jackson, 1967).The data was analysed by using SPSS (Statistical Package for Social Sciences) for Window version 11.0.1© SPSS Inc. USA computer software program.

Results and Discussion

The green fodders offered to dairy animals includes berseem (*Trifolium alexandrinum*) and oat (*Avena sativa*) during the winter season and sorghum (*Sorghum bicolor*), pearl millet (*Pennisetum glaucum*) and maize (*Zea mays*) during the summer season. Wheat straw was used as the dry fodder.

Green fodder: Considering the dietary requirements of various macro and trace minerals (McDowell, 2003) for dairy cattle, it was found that considerable numbers of green fodder (Table 1) in the South-West Punjab were low in Ca (16.2%) and P (18.2%) (Fig. 1). The observed P deficiency in green fodder was probably due to widespread deficiency of P in soils of South West region of Punjab (Brar, 1979). Similarly, Mircha (2009) had also reported low levels of Ca and P in green fodders from the Central alluvial plains of Punjab. It suggested that unless some other sources of Ca and P are provided, dairy cattle in this region might suffer from primary Ca and P deficiency. The Mg and Na contents of green fodder were adequate and only a few samples were low in Mg (3.3%) and Na (1.8%). Deficiency of Mg in cattle is more likely when the animals ingest green fodder with Mg concentrations below 0.07% (Guimarães *et al*., 1992) and therefore, if fed in sufficient quantities, the occurrence of primary deficiency of Mg in dairy cattle is unlikely in this area. The K levels in green fodder were considerably higher than the dietary requirement of 0.90%. High K levels could affect metabolism of Mg and Ca by reducing their absorption from gut of the ruminants (Dua and Care, 1995).

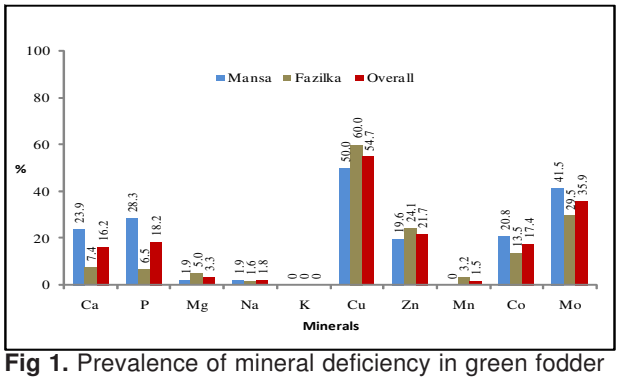

Fig 1. Prevalence of mineral deficiency in green fodder

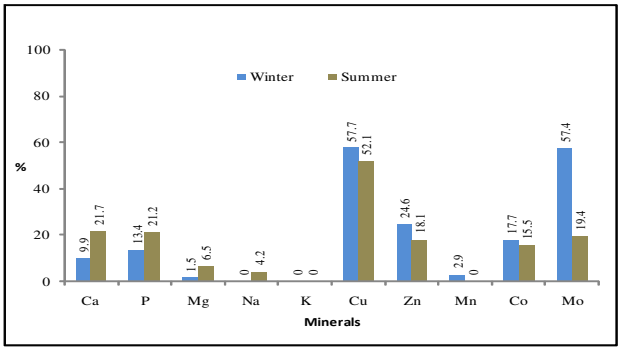

Fig 2. Seasonal variations in prevalence of mineral deficiency in green fodder

The mean concentration of Cu in green fodder was close to the minimum dietary requirements of 10 ppm and a high proportion of samples (54.7%) were low in Cu. Moreover, the Mo concentrations in the green fodder were higher than the permissible limit of 3 ppm and 35.9% samples were having higher Mo contents.The Mo contents of plants vary widely depending upon availability of Mo in soils. Leguminous fodder like berseem accumulates high concentrations of Mo (Singh, 2002). In ruminants, the deficiency of Cu can occur as a primary deficiency when Cu intake is inadequate, or as a secondary deficiency resulting from reduction in Cu absorption and/or increase in its excretion by the antagonistic effects of Mo, S and other elements (Radostits *et al.,* 2007).

Table 1. Mineral contents of green and dry fodders (on dry mater basis) in South-West Punjab {Mean±SE (range)}

Mineral	Dietary requirement	Mansa		Fazilka	
		Green(n=93)	Dry(n=64)	Green(n=81)	Dry(n=59)
Ca (%)	0.30	0.71±0.06 (0.13-1.92)	0.14±0.01 (0.02-0.40)	0.91±0.06 (0.22-2.15)	0.14±0.01 (0.01-0.35)
P (%)	0.25	0.30±0.01 (0.16-0.62)	0.03±0.008 (0.01-0.06)	0.35±0.01 (0.16-0.63)	0.02±0.009 (0.01-0.04)
Mg (%)	0.20	0.43±0.02 (0.12-0.96)	0.13±0.008 (0.02-0.31)	0.43±0.02 (0.10-0.96)	0.11±0.008 (0.01-0.28)
Na (%)	0.18	0.36±0.01 (0.11-0.48)	0.07±0.002 (0.01-0.10)	0.35±0.01 (0.13-0.58)	0.07±0.002 (0.01-0.09)
K (%)	0.90	1.80±0.01 (1.50-1.96)	0.38±0.002 (0.37-0.39)	1.86±0.01 (1.67-2.12)	0.38±0.001 (0.33-0.40)
Cu (ppm)	10	10.50±0.66 (3.60-20.31)	4.14±0.19 (0.92-8.87)	10.23±0.55 (3.24-30.11)	5.82±0.32 (1.59-16.17)
Mo (ppm)	3	3.64±0.38 (0.49-12.69)	5.08±0.12 (1.06-5.94)	3.25±0.34 (0.53-12.69)	4.81±0.10 (1.07-7.58)
Zn (ppm)	30	44.05±3.49 (14.31-143.90)	6.02±0.36 (2.29-17.10)	38.46±2.46 (15.42-132.30)	9.76±1.17 (0.73-31.60)
Fe (ppm)	50	687.10±57.66 (59.71-1816.03)	196.75±11.09 (67.45-457.70)	639.54±47.79 (65.15-1892.01)	246.59±14.66 (70.14-659.00)
Mn (ppm)	30	50.09±2.30 (30.11-88.68)	15.62±0.75 (3.09-37.47)	62.66±3.85 (23.94-160.60)	18.41±1.21 (2.45-45.13)
Co (ppm)	0.1	0.92±0.13 (ND-3.87)	–	1.30±0.15 (ND-4.39)	–
Ca: P	–	2.20±0.17 (0.73-5.49)	4.65±0.34 (0.78-10.96)	2.59±0.18 (0.80-7.52)	4.69±0.34 (0.76-10.34)
Cu: Mo	–	4.10±0.42 (0.68-12.77)	0.86±0.07 (0.24-2.36)	4.65±0.33 (0.98-12.93)	1.26±0.14 (0.39-4.40)

Mineral	Dietary requirement	Overall		Mineral	Dietary requirement	Overall	
		Green(n=174)	Dry(n=123)			Green(n=174)	Dry(n=123)
Ca (%)	0.30	0.80±0.06 (0.13-2.15)	0.14±0.01 (0.01-0.40)	Zn (ppm)	30	41.45±3.01 (14.31-143.90)	7.81±0.75 (0.73-31.60)
P (%)	0.25	0.32±0.01 (0.16-0.63)	0.03±0.01 (0.01-0.06)	Fe (ppm)	50	664.96±53.07 (59.71-1892.01)	220.66±12.80 (67.45-659.00)
Mg (%)	0.20	0.43±0.02 (0.10-0.96)	0.12±0.01 (0.01-0.31)	Mn(ppm)	30	55.94±3.02 (23.94-160.60)	16.96±0.97 (2.45-45.13)
Na (%)	0.18	0.36±0.01 (0.11-0.58)	0.07±0.002 (0.01-0.10)	Co (ppm)	0.1	1.10±0.14 (ND-4.39)	-
K (%)	0.90	1.83±0.01 (1.50-2.12)	0.38±0.002 (0.33-0.40)	Ca: P	–	2.38±0.17 (0.73-7.52)	4.67±0.34 (0.76-10.96)
Cu (ppm)	10	10.37±0.61 (3.24-30.11)	4.95±0.25 (0.92-16.17)	Cu: Mo	–	4.36±0.38 (0.68-12.93)	1.05±0.10 (0.24-4.40)
Mo (ppm)	3	3.46±0.36 (0.49-12.69)	4.95±0.11 (1.06-7.58)				

ND: non-detectable

Although, the mean concentrations of Zn in green fodders were higher than the dietary requirements of 30 ppm, but the levels varied widely from 2.29 to 143.9 ppm, and 21.7% samples were low in Zn. Due to low levels of Zn in soils and forages, widespread deficiency of this element had been reported in ruminants from more than 25 tropical countries including India (McDowell, 2003). Sharma and Joshi (2004) had observed low blood Zn levels in animals grazing on pasture having low Zn levels between 20 to 30 ppm. The Fe content in green fodder was considerably higher than the dietary requirement of 50 ppm. Fe concentration required for normal plant growth ranges from 100 to 200 ppm (Jones *et al.*,1991), but higher Fe levels from 250 to 500 ppm in the green forages may be toxic and could produce Cu depletion in ruminants. Moreover, high dietary Fe affects utilization of other minerals like P, Zn and Mn (Underwood and Suttle, 1999). The Mn concentrations in green fodder were adequate and only few samples (1.5%) were low in Mn. Conversely, Mircha (2009) had reported higher deficiency of Mn in green fodder (34.6%) from the Central alluvial plains of Punjab, due to low Mn content of soils. Considerable number of green fodders samples (17.4%) were found to be low in Co concentration. Deficiency of Co in dairy animals can be predicted if forages consistently contained cobalt less than 0.08 ppm (McDowell, 2003).

Dry fodder: Wheat straw was an important dietary component of dairy animals due to low availability of green fodder in this region. Mineral analysis of wheat straw revealed that the concentrations of Ca, P, Mg, Na, K, Cu, Zn and Mn were less than the dietary requirements of dairy cattle. Moreover, the Mo and Fe concentrations were higher than the permissible limits.

Seasonal variations

The season of the year had significant (P<0.05) influence on Ca, Mo and Mn concentrations of green fodder (Table 2). The Ca concentration was higher in the winter, whereas the Mo and Mn concentrations were higher in the summer season (Fig. 2). The Mg, Na, K, Cu, Zn, Fe and Co contents of green fodder were unaffected by the change of the season. Higher Ca levels in winter season might be due to higher Ca contents of winter fodder (berseem) as compared to that of summer fodders *viz.*, maize, sorghum, pearl millet (Gupta and Ahuja, 1998).

Table 2. Seasonal variations {Mean±SE (range)} in mineral contents of green fodder (on dry matter basis).

Mineral	Winter (n=97)	Summer (n=77)
Ca (%)	0.91±0.06[a]	0.71±0.06[b]
	(0.13-2.15)	(0.15-1.92)
P (%)	0.34±0.01[a]	0.31±0.01[a]
	(0.16-0.62)	(0.18-0.61)
Mg (%)	0.43±0.02[a]	0.44±0.02[a]
	(0.18-0.93)	(0.10-0.96)
Na (%)	0.36±0.01[a]	0.35±0.01[a]
	(0.18-0.48)	(0.11-0.49)
K (%)	1.84±0.01[a]	1.82±0.01[a]
	(1.50-2.12)	(1.66- 2.11)
Cu (ppm)	10.24±0.50[a]	10.52±0.74[a]
	(4.17-20.31)	(3.24-30.11)
Mo (ppm)	2.58±0.27[a]	4.65±0.43[b]
	(0.49-10.11)	(0.53-12.69)
Zn (ppm)	39.38±2.67[a]	43.45±3.37[a]
	(14.38-143.90)	(15.42-130.70)
Fe (ppm)	625.78±50.06[a]	712.78±53.97[a]
	(59.71-1816.01)	(65.16-1892.0)
Mn(ppm)	50.74±1.88[a]	65.49±4.90[b]
	(23.94-87.73)	(32.11-160.60)
Co (ppm)	1.06±0.12[a]	1.22±0.18[a]
	(ND-3.87)	(ND-4.39)
Ca:P	2.58±0.17[a]	2.22±0.18[a]
	(0.73-7.52)	(0.74-6.38)
Cu:Mo	5.32±0.35[a]	3.10±0.31[a]
	(0.98-12.93)	(0.68-9.94)

Figures bearing different superscript in a row differ significantly (p<0.05). ND: non-detectable

Conclusion

The forages grown the semi-arid environment of South-West Punjab were deficient in essential minerals like Ca, P, Cu, Zn and Co and also had excess of Mo and Fe which may result in occurrence of minerals deficiency diseases in dairy animals of this region. Health and milk production status of animals in semi arid region can be improved with balanced mineral supplementation or with the bio-fortification of fodder crops with essential macro and micro minerals.

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