Animal Nutrition and Feed Technology (2003) 3 : 179-188

Short Communication

Macro-Mineral Status of Feeds and Fodders in Kutch District of Gujarat

M.R. Garg*, B.M. Bhanderi and P.L. Sherasia

Productivity Enhancement Group
Animal Nutrition and Feed Technology Laboratory
National Dairy Development Board
Anand-388 001, India

(Received June 27, 2002)

ABSTRACT

A study was undertaken to assess the macro-mineral status of feeds and fodders in Kutch district of Gujarat state, for formulation an appropriate mineral mixture for that area. The average calcium content in straws (0.45%) was higher, whereas concentrate ingredients were particularly low in calcium (0.10%). The phosphorus content of crop residues and green fodders was 0.14 and 0.29 per cent, respectively, which was higher in concentrate ingredients (0.52%). The magnesium levels in samples of feeds and fodders were adequate (average levels >0.40%). Sodium content was low in concentrate ingredients but high in green fodders. Due to high sodium content in water, it was not advisable to supplement sodium in diet. The area under survey seemed to be quite rich in potassium, because all samples were extra-ordinarily rich and were far exceeding the requirement level. Sulphur content was occasionally deficient in ration of milch animals; however, its supplementation was necessary due to high selenium content in feedstuffs. It was apparent that the levels of calcium, phosphorus and sulphur were inadequate to meet the requirement of animals; however, the levels of magnesium, sodium and potassium were sufficient in the surveyed area.

Key words: Calcium, Phosphorus, Magnesium, Sodium, Potassium, Sulphur, Feeds, Cows, Buffaloes.

*Reprint request: Dr. M.R. Garg, Tel: +91-2692-26265; Fax: +91-2692-60158;
E-mail: mrgarg@nddb.coop

INTRODUCTION

Mineral deficiency exists widely in livestock (McDowell *et al.*, 1983) and the severity of the deficiency depend upon the type of feed, physiological status of the animals and the agro-climatic condition of the region. However, toxicity of selenium, molybdenum and fluorine has also been observed due to their excess quantities in feedstuffs (Jackson, 1993; Randhawa, 1999; Tiffany *et al.*, 2000). For efficient production and maintenance of normal health in animals, it is necessary to provide essential nutrients in appropriate proportion (Garg *et al.*, 2000). Unlike protein and energy, micronutrients though required in small amounts, play an important role in the reproductive performance and health of animals. With the intensification of cultivation and changes in agricultural practices, the soil fertility is being affected, which in turn affects the uptake of minerals by the plants and animals. As indiscriminate supplementation of minerals through mineral mixture is neither economical nor practical, it will be useful to know the mineral status of feeds and fodders to ascertain the extent of deficiency / excess (Garg *et al.*, 2002). Therefore, the present study was undertaken to know the mineral status of Kutch district of Gujarat state, so as to suggest area specific mineral mixture for improving productive and reproductive performances of animals.

MATERIALS AND METHODS

One village from each taluka of Kutch district was selected for taking representative samples of feeds and fodders. Total area of Kutch district is 45,652 sq.km., distributed into 10 talukas, having 905 villages. The district is having annual rainfall of 250-500 mm, is located at 150 metres above mean sea level, having latitude of 23.5° and longitude of 69.5°. Atmospheric temperature ranges from 4 to 45°C during different seasons. Within the village help was sought from village milk producers and veterinary officer, for identification of 4 to 5 farmers, as there were no operational area of dairy cooperative societies. The recorded parameters were number of livestock, land area, irrigation facilities, fodder and other crops being grown etc. In identification of farmers, land location was considered essentially, one each from northern, eastern, western and southern directions, to cover soil types on each side of selected village. In addition to this, samples of water, which was offered to the animals, were also taken from different sources in that village. Following collection, green samples were dried in an oven at 80°C for 24 h and subsequently ground (1 mm). Ground samples of concentrate and fodder were stored in plastic bags until analysed. Samples were digested using 5 ml concentrated HNO_3 plus 1 ml concentrated HCl by microwave digestion method and total volume of mineral extract was made to 25 ml with deionized water. All the samples were analyzed for Ca, P, Mg, Na, K and S using Inductively Coupled Plasma - Optical Emission Spectrophotometer (Perkin Elmer, OPTIMA - 3300 RL).

Quantitative data on different feeds and fodders being fed to each of their milch animal was also recorded, to calculate intakes of certain mineral elements. Total intakes were compared against the requirements on dry matter basis (NRC, 2001), so as to identify quantitative deficiency, sufficiency or even excess. The word "critical" is used in this paper to note a concentration in feedstuffs below (or above with excess) what is considered the requirement for animal. This assumes the expected consumption as estimated by the NRC (2001). Total grams of minerals consumed per day determine the true adequacy of a mineral, not the forage concentration. Data were analyzed statistically as per Snedecor and Cochran (1967).

RESULTS AND DISCUSSION

Crop residues were found to be the main source of roughages in the ration of cows and buffaloes of the surveyed area. The concentrate ingredients were usually the conventional type and home grown. The practice of feeding compounded cattle feed and mineral supplements were rare in the area. Some farmers grew green fodders such as sorghum, lucerne and cowpea but only in limited areas due to water scarcity and as such limited quantity of green fodders were fed to productive animals. Sweet potato creepers were subsidiary green fodders fed to milch animals seasonally.

The mineral content of bore and river water is presented in Table 1. The calcium content in river water (1005 ppm) was high, as compared to bore well water (70 ppm). The calcium content was low (0.43%) in most of the non-leguminous than

Table 1. Mineral content of bore well and river water from Kutch district

Taluk	Village	Source	Ca	Mg	Na	K	S
			ppm				
Nakhatrana	Deshalpar	Bore well	98.20	51.30	394	12.0	71.20
Bhachau	Lakadia	Bore well	219	237	1190	7.15	77.10
Bhuj	Sukhapur	Bore well	29.20	23.40	95.80	4.48	20.90
Mandvi	Koday	Bore well	23.60	31.70	668	3.85	83.00
Mandvi	Koday	Bore well	84.30	84.80	609	7.58	153.00
Mundra	Jabalpur	Bore well	46.40	44.20	410	4.44	53.30
Mundra	Jabalpur	Bore well	37.10	40.50	368	4.92	53.80
Mundra	Jabalpur	Bore well	21.80	35.10	402	3.92	52.40
Nalia	Kosa	Khari river	1000	332	1210	83.90	576.00
Nalia	Kosa	Khari river	1020	337	4110	85.40	583.00
Nalia	Kosa	Khari river	995	332	1180	84.00	578.00

leguminous fodders (1.77%). However, groundnut straw was exceptionally high in calcium content (2.22%). The concentrate ingredients commonly fed to livestock contained 0.08 per cent calcium, with the exception of cottonseed cake and guar grain with higher (0.29%) concentrations (Table 3). The data further revealed that transfer of Ca from leaves and stems to seeds was quite disproportionate in non-leguminous crops. Surprisingly, sweet potato creepers being fed by some farmers were extra-ordinarily rich in calcium (1.80%) and this might be favourable to milk production, because of availability of carotene and other micronutrients. The calcium is required to the extent of 16.0 g and 18.0 g per day for maintenance and 3.21 g and 4.65 g per litre of milk yield for cow and buffalo, respectively. The calcium levels below the critical level of 0.30 per cent (Cuesta *et al.*, 1993) was found in grains of bajra, maize and wheat, cottonseed cake, bajra husk and wheat bran. On the other hand, adequate Ca levels were recorded when leguminous fodder was one of the components of the total ration for milch animals (Table 4). Those animals not given green fodder were mostly deficient in calcium.

The phosphorus content in bore well and river water was negligible. As expected, the values of P in crop residues (0.16%) were much less than Ca (Table 2). The ratio of Ca: P varied from 2.87:1 to 13:1 in straws of groundnut, wheat and sorghum. Mean value of P (0.28%) in lucerne green, cowpea green and sweet potato creepers were quite substantial but about 6 times less than Ca. Local grasses and sorghum green contained P to the extent that gave a Ca:P ratio of 1.80:1. Coconut cake, cottonseed cake and wheat bran provided phosphorus in substantial quantities (0.67%). Most of the grains studied, showed higher phosphorus (0.38%) than calcium levels (Table 3). Phosphorus is required to the extent of 11.0 g and 13.0 g per day for maintenance and 1.98 g and 2.88 g per litre of milk yield for cow and buffalo, respectively. Phosphorus content was found below the critical level (0.25 %) in bajra husk, groundnut straw, guar green, hybrid napier, local grasses, maize green, maize straw, *mung* pods, sorghum straw, sorghum green and wheat straw.

Average P deficiency in the ration of cows and buffaloes were recorded to the extent of 35 per cent in the surveyed area (Table 4). Furthermore, bioavailability of P from plant sources was low due to phytic acid-P (McDowell, 1992), leading to problems of infertility and haematuria in animals (Jagdeeshwaran and Jagdishkumar, 1998).

Magnesium content in bore well and river water was 68.5 ppm and 334 ppm, respectively (Table 1). The magnesium content as estimated in the samples of crop residues were adequate with groundnut straw having a very high concentration (0.98%). Magnesium and calcium contents in local grasses and sorghum green were similar (Table 2). Lucerne green, cowpea green and sweet potato creepers were

Table 2. Macro-mineral content (%) in dry and green fodders collected from Kutch district (DM basis)

Feeds	Ca	P	Mg	Na	K	S
[a]Critical level	< 0.30	< 0.25	< 0.20	< 0.06	< 0.80	...
Bajra green (2)	0.38±0.079	0.29±0.051	0.30±0.065	0.04±0.014	2.04±0.24	0.27±0.04
Bajra husk (2)	0.23±0.017	0.14±0.012	0.23±0.04	0.12±0.032	1.88±0.18	0.21±0.028
Bajra straw (3)	0.31±0.069	0.24±0.026	0.43±0.093	0.25±0.091	3.07±0.83	0.32±0.089
Cowpea green (4)	1.87±0.32	0.25±0.04	0.52±0.09	0.30±0.091	1.94±0.22	0.42±0.12
Groundnut straw (15)	2.22±0.093	0.17±0.008	0.97±0.044	0.21±0.036	1.12±0.073	0.29±0.015
Guar green (3)	1.89±0.061	0.24±0.006	0.72±0.028	0.14±0.046	2.57±0.34	0.40±0.057
Hybrid napier (2)	0.36±0.02	± 0.12±0.015	0.23±0.024	0.047±0.008	2.16±0.12	0.15±0.004
Local grasses (35)	0.66±0.053	0.19±0.021	0.44±0.10	0.52±0.075	1.73±0.29	0.44±0.042
Lucerne green (11)	1.68±0.074	0.31±0.022	0.44±0.031	0.83±0.11	1.81±0.17	0.42±0.035
Maize green (3)	0.36±0.025	0.23±0.01	0.36±0.013	0.13±0.004	1.43±0.053	0.10±0.007
Maize straw (5)	0.46±0.065	0.26±0.019	0.41±0.06	0.32±0.081	2.12±0.2	0.14±0.014
Mung pods (5)	1.13±0.074	0.11±0.019	0.55±0.041	0.05±0.010	1.78±0.13	0.084±0.014
Moth green (2)	2.10±0.016	0.13±0.014	0.52±0.057	0.033±0.007	2.38±0.11	0.095±0.017
Sorghum green (17)	0.36±0.024	0.23±0.022	0.35±0.018	0.061±0.010	1.30±0.11	0.13±0.007
Sorghum straw (6)	0.40±0.023	0.14±0.016	0.29±0.02	0.26±0.17	1.71±0.26	0.15±0.015
Sweet potato creepers (3)	1.80±0.16	0.28±0.05	0.72±0.076	0.17±0.076	2.09±0.72	0.34±0.053
Wheat straw (4)	0.47±0.08	0.10±0.031	0.30±0.026	0.52±0.072	1.79±0.18	0.31±0.11

Figures in parentheses indicate number of samples analysed.

[a]Critical level: concentrations below which are low or considered deficient, based on requirements for cattle (NRC, 2001).

good source of magnesium (0.56%). Grains contained lower levels of Mg (0.17%). Wheat bran, coconut cake and cottonseed cake samples contained moderate levels of magnesium (Table 3). Magnesium is needed to the extent of 0.20 percent for cow and buffalo. The Mg content in most of feedstuffs was found above the critical levels (0.20%) except for grains. It was apparent from the feeding systems in the villages that the requirement of Mg was being met even without feeding compounded cattle feed or green fodder, as reported earlier in Mehsana district (Garg *et al.*, 1999a).

The sodium content was low in crop residues (0.12%) except for wheat straw (Table 2). Amongst the green fodders, lucerne green had the highest Na content (0.83%), followed by local grasses (0.52%), cow pea green (0.30%), sweet potato creepers (0.17%) and sorghum green (0.06%). Concentrate ingredients including grains were poor source of sodium (0.033%). However, as water contained high levels of sodium (Table 1), its supplementation in diets was not advisable. Most of the feeds and fodder contained Na above the critical levels (0.06%) except for grains, cottonseed cake, bajra green, hybrid napier, wheat bran and *moth* green (Table 2 and 3).

The potassium content was very low in water (Table 1). The potassium levels in all the feedstuffs ranged from 0.35 to 3.07 per cent on dry matter basis. Green fodders were higher in potassium than dry fodders (Table 2). Grains contained 0.62 per cent K, whereas wheat bran, coconut cake and cottonseed cake exhibited still higher potassium levels (1.25%). Sodium is required to the extent of 0.18 per cent, whereas, potassium is needed to the extent of 0.90 per cent for animals. Potassium was abundant mineral in most of the feedstuffs, as reported for feeds and fodder of Mehsana and Junagadh districts (Garg *et al.*, 1999b; 2002), and hence do not require supplementation in the diet of animals (Table 4). The potassium content in samples of feed and fodder were above the critical levels (0.80 %) except for grains of bajra, barley and maize (Table 3).

Sulphur content was low (0.23%) in dry fodders than green fodders (0.36%). The concentrate ingredients being fed to livestock in this region had 0.24 per cent sulphur (Table 3). Sulphur is required to the extent of 0.20 per cent in the ration of animals. Most of the feed ingredients were adequate in sulphur content; however, its supplementation is necessary in view of high level of selenium in the feeds and fodder of that region and bioavailability of sulphur from feedstuffs were low (McDowell, 1992).

Mineral status of feeds and fodders depends upon the interaction of a number of factors, such as soil type, soil pH, plant species, stage of growth and harvesting, crop yield, intensity of agricultural systems, climate and fertilizer rate (Anon, 1992; McDowell *et al.*, 1993). Plants take up small fraction of mineral elements out of

Table 3. Macro-mineral content (%) in concentrate feeds collected from Kutch district (DM basis)

Feeds	Ca	P	Mg	Na	K	S
[a]Critical level	< 0.30	< 0.25	< 0.20	< 0.06	< 0.80	...
Bajra grain (1)	0.044	0.34	0.15	0.03	0.41	0.16
Barley grain (2)	0.074±0.013	0.36±0.005	0.16±0.003	0.056±0.011	0.52±0.024	0.17±0.005
Coconut cake (3)	0.087±0.010	0.60±0.008	0.31±0.053	0.067±0.010	1.81±0.026	0.43±0.021
Cottonseed cake (14)	0.23±0.009	0.54±0.028	0.36±0.021	0.055±0.027	0.97±0.045	0.26±0.023
Guar grain (4)	0.35±0.024	0.49±0.051	0.27±0.026	0.022±0.0027	1.14±0.061	0.28±0.037
Maize grain (3)	0.013±0.001	0.35±0.0067	0.12±0.0068	0.024±0.014	0.35±0.013	0.14±0.00
Wheat bran (17)	0.15±0.015	0.86±0.039	0.37±0.013	0.035±0.0026	0.98±0.031	0.24±0.057
Wheat grain (3)	0.053±0.009	0.34±0.045	0.15±0.01	0.02±0.003	0.72±0.30	0.16±0.027

Figures in parentheses indicate number of samples analysed.

[a]Critical level: concentrations below which are low or considered deficient, based on requirements for cattle (NRC, 2001).

Table 4. Prevalence of deficiency (%) of various macro-minerals[1] in the ration of cows and buffaloes

Village	Species	Milk yield (kg/d)	Elements			
			Calcium	Phosphorus	Sodium	Sulphur
Koday	Cow	14.0	25.40	40.35	8.10	adequate
	Buffalo	6.5	18.10	32.44	2.47	adequate
Jabalpur	Cow	6.0	24.40	41.70	2.88	2.16
	Buffalo	6.0	25.10	45.40	3.76	3.15
Nanavaladiya	Buffalo	3.5	adequate	18.75	adequate	adequate
Sukhapur	Cow	6.8	10.10	25.40	3.46	3.46
	Buffalo	8.0	25.10	30.81	4.80	4.65
Deshalpar	Cow	8.0	19.75	20.40	adequate	adequate
	Buffalo	8.0	30.40	35.60	adequate	adequate
Khirai	Buffalo	5.5	15.01	41.40	2.30	adequate
Lakadia	Buffalo	5.0	18.35	32.45	adequate	adequate
Adipur	Cow	14.0	35.18	42.14	8.10	7.14
	Buffalo	12.0	32.20	32.92	10.80	5.76
Kosa	Cow	6.5	18.80	35.70	adequate	adequate
Dayapur	Cow	7.0	22.10	36.78	adequate	3.10
	Buffalo	5.0	18.21	31.46	adequate	adequate

[1]Mg and K were adequate.

the total soil mineral content and the later depends upon their availability in solution form. Therefore, mineral deficiencies in concentrates and herbages are associated with soil characteristics. Leaching of soil in tropical regions with considerable rainfall and high temperature makes plant deficient in mineral content. Leguminous fodder is rich in a number of minerals having greater uptake capacity from the soil. Straws and stovers show decline in the number of minerals, because of maturity and possible transfer to seeds. Variations in mineral content within the district were noticed from crop to crop in different villages, might be due to variations in crop yields and stage of harvesting.

It is apparent that milch cows and buffaloes in various taluks of Kutch district are able to meet their macro-mineral requirements except for Ca, P and occasionally S, when fed a ration with green fodders. Other minerals such as magnesium, potassium and sodium were adequate in the ration of milch animals.

REFERENCES

Anonymous. 1992. Centre for Tropical Veterinary Medicine (CTVM), Edinburgh University. Report on the mineral status of animals in some tropical countries and their relationship to drainage geochemical maps of minerals in those countries. *British Geological Survey Technical Report* WC/92/60.

Cuesta, P.A., McDowell, L.R., Kunkle, W.E. Bullock, F., Drew, A., Wilkinson, N.S. and Martin, F.G. 1993. Seasonal variation of soil and forage mineral concentrations in North Florida. *Communication in Soil Science and Plant Analysis*, 24: 335-347.

Hinders, R. 1999. Research needed to determine correct trace mineral levels. *Feedstuffs*, 71: 10.

Garg, M.R., Bhanderi, B.M., Sherasia, P.L. and Singh, D.K.1999a. Mapping of certain minerals in feeds and fodders in the Mehsana district of Gujarat State. *Indian Journal of Dairy Science*, 52: 69-77.

Garg, M.R., Bhanderi, B.M., Sherasia, P.L., Singh, D.K. and Arora, S.P. 1999b. Sodium and potassium status of different feeds and fodders of Mehsana district of Gujarat. *Indian Journal of Animal Sciences*, 69: 862-863.

Garg, M.R., Arora, S.P., Bhanderi, B.M., Sherasia, P.L. and Singh, D.K. 2000. Mineral status of feeds and fodders in Kaira district of Gujarat. *Indian Journal of Dairy Science*, 53: 291-297.

Garg, M.R., Bhanderi, B.M. and Sherasia, P.L. 2002. Mineral contents of feeds and fodders in Junagadh district of Gujarat. *Indian Journal of Animal Nutrition*, 19: 57-62.

Jackson, M.J. 1993. *Zinc Deficiency and Human Health. Environmental Geochemistry and Health in Developing Countries*. The Geological Society, Burlington House, Piccadilly, London, W1V OJU.

Jagadeeshwaran, A. and Jagadishkumar, B. 1998. Influence of single administration of phosphorus salts on serum and urinary inorganic phosphorus levels in dairy heifers. *Indian Veterinary Journal*, 75: 912-914.

McDowell, L.R. 1992. *Minerals in Animal and Human Nutrition*. Academic Press, San Diego, CA, pp. 49-51.

McDowell, L.R., Conrad, J.H., Ellis, G.L. and Loosli, J.K. 1983. *Minerals for Grazing Ruminants in Tropical Regions*. Bulletin: Department of Animal Science, University of Florida, Gainesville, Florida, p. 89.

McDowell, L.R., Conrad, J.H. and Glen Hembry, F. 1993. *Minerals for Grazing Ruminants in Tropical Regions*. Animal Science Department, Centre for Tropical Agriculture, University of Florida. The U.S.Agency for International Development and Caribbean Basin Advisory Group (CBAG).

N.R.C. 2001. *Nutrient Requirements of Dairy Cattle*, 7th revised ed. National Academy of Sciences, Washington, DC.

Randhawa, C.S. Randhawa, S.S. and Sood, N.K. 2002. Effect of molybdenum induced copper deficiency on peripheral blood cells and bone marrow in buffalo calves. Asian-Australasian *Journal of Animal Sciences*, 15: 509-515.

Snedecor, G.W. and Cochran, W.G. 1967. *Statistical Methods*. 6th ed. Oxford and IBH Publishing Co., New Delhi, India.

Tiffany, M.E., McDowell, L.R., O'Connor, G.A., Martin, F.G., Wilkinson, N.S., Cardoso, E.C., Percival, S.S. and Rabiansky, P.A. 2000. Effects of pasture applied biosolids on performance and mineral status of grazing beef heifers. *Journal of Animal Science*, 78: 1331.