MAPPING OF CERTAIN MINERALS IN FEEDS AND FODDERS IN THE MEHSANA DISTRICT OF GUJARAT STATE

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A study was conducted to assess the mineral status of feeds and fodders in Mehsana district of Gujarat state, for formulating an appropriate mineral mixture for that area. Calcium was usually low in straws, stovers and the concentrate ingredients. Lucerne green and carrot tops had high levels of Ca. Phosphorus contents were low in crop residues and moderate in lucerne green, carrot tops and chikodi, giving variable Ca:P ratios. Magnesium in feeds was adequate, whereas, iron and cobalt levels in most feeds exceeded animal's requirements. Copper deficiency seemed to be a problem and needed supplementation through mineral mixture. Zinc was acutely deficient in the region and needed to be supplemented at a level of 80 ppm in the total ration for optimum metabolic functions. Green fodders provided adequate quantities of manganese but straws were deficient.

INTRODUCTION

In most of the developing countries, mineral deficiencies are frequently encountered in livestock rations. However, toxicity of F, Se and Mo have also been observed due to their excess quantities (Thornton, 1983; Appleton and Greally, 1992; Dissanayake and Chandrajith, 1993; Jackson, 1993). Goitre is encountered in livestock and humans due to iodine deficiency in a number of countries, including India (Arora, 1986). Zinc deficiency in India is rampant both in soils and plants, affecting crop yields (Kanwar and Randhawa, 1967; Nayyar *et al.* 1990; Dangarwala, 1994). Skeletal deformities associated with excess of fluorine and necrotic skin lesions as a result of selenium toxicity are frequently encountered in Indian livestock (Arora *et al.* 1975; Prasad and Arora, 1991). Other reported mineral problems are those of Fe, Mn, Cu and Mo in different regions (Thornton *et al.* 1972; Underwood, 1981; Zu, 1981; Mills, 1987; Dangarwala, 1994).

It is likely that deficiency of certain minerals may not affect crop yields but their availability from such forages may be inadequate for requirements of livestock. It is, therefore, necessary to generate information on mineral status, zone wise, so as to identify deficiencies or toxicities. Regional mapping of elements in feeds and fodders is relatively a rapid reliable and cost effective method of providing base line data on the levels of macro and micro-elements (Aggett *et al.* 1988).

At the first instance, Mehsana district of Gujarat (India) was selected because of having good dairy breeds of buffaloes.

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An attempt has been made to assess the mineral status of feeds and fodders for mapping deficiencies, if any, from requirement point of view, so as to formulate suitable mineral mixture for that region.

MATERIALS AND METHODS

One randomly selected village in each taluka of Mehsana district was included in the survey. For collecting samples of feeds and fodders from within the village, four or five farmers were identified with the help of village dairy co-operative society and Mehsana district dairy co-operative union. Details regarding total number of livestock, irrigated or non-irrigated and holdings, fodder or other crops grown were recorded. Selection of farmers was based on the location of their agricultural land, so as to cover the soil types in northern, eastern, western and southern sides of the village.

Fodder and feed samples fed to the animals were collected and analysed for Ca, Mg, Cu, Zn, Mn, Fe and Co contents, using Atomic Absorption Spectrophotometer (Varian, Model). P contents were analysed colorimetrically (AOAC, 1980). Fodders were mostly straws and stovers harvested at maturity for removal of grains. Concentrates were mostly conventional and wholesome available in that region. Green fodders were grown by some farmers such as lucerne but only in limited areas and limited quantity was fed usually to milch animals. Other green fodders grown by farmers were green sorghum and green oat. Carrot tops was a green subsidiary fodder fed to milch stock.

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, 1989), so as to identify quantitative deficiency, sufficiency or even excess. Data were analysed statistically as per Snedecor and Cochran (1967).

RESULTS AND DISCUSSION

Calcium (Ca)

The calcium content was low in most of the crop residues particularly in straws and stovers (0.28%). As usual, lucerne green being leguminous was able to pick up Ca from the soil selectively and had around 1.74 percent Ca (Table 1). Chikodi also exhibited some what similar picture with 1.60% Ca. Most of the concentrate ingredients being fed to livestock in this region have less than 0.1 per cent Ca, indicating that its supplementation was necessary to make up the requirement. Cotton seed cake contained 0.30 per cent Ca, matching with some other non-leguminous fodder crops. The data further revealed that transfer of Ca from leaves and stems to seeds was quite disproportionate in non-leguminous crops. Surprisingly, carrot tops being fed by some farmers, were extra ordinarily rich in Ca (1.24%) and this might be favourable to milk production, because of availability of carotene and other micro nutrients. It was further evident that Ca per cent varied significantly

Table 1
Variations in mineral contents of some feed ingredients on DM basis (Mehsana district)

1	2	3	4	1	2	3	4
Feed	Variable	Mean ± SD	F.value	Feed	Variable	Mean ± SD	F.value
Bajra grain (10)	Ca	0.03±0.01	5.13*	Hybrid napier	Ca	0.64±0.08	0.03
"	P	0.30±0.06	1.12	(6)	P	0.29±0.11	16.35**
"	Mg	0.15±0.06	10.47**	"	Mg	0.35±0.25	66.57**
"	Cu	8.11±3.70	35.77**	"	Cu	16.23±6.47	29.41**
"	Zn	37.14±5.42	1.02	"	Zn	21.81±7.78	11.24*
"	Mn	20.40±9.62	2.39	"	Mn	111.20±24.90	45.34*
"	Co	1.64±0.66	1.79	"	Co	1.54±0.24	0.22
"	Fe	46.15±5.37	0.28	"	Fe	359.68±91.12	0.45
Bajra husk (7)	Ca	0.14±0.06	21.21**	Local grass (16)	Ca	0.44±0.18	2.17
"	P	0.14±0.04	12.43**	"	P	0.19±0.10	0.71
"	Mg	0.18±0.04	1.84	"	Mg	0.26±0.21	10.63**
"	Cu	7.08±4.47	1.61	"	Cu	7.78±3.99	0.52
"	Zn	13.25±4.14	1.46	"	Zn	16.79±8.21	1.99
"	Mn	32.37±8.79	19.09**	"	Mn	58.10±18.44	1.09
"	Co	0.69±0.24	0.19	"	Co	1.09±0.23	2.08
"	Fe	306.68±60.31	4.08	"	Fe	436.51±225.44	0.81
Bajra straw (31)	Ca	0.41±0.10	3.29**	Lucerne green	Ca	1.74±0.23	2.21
"	P	0.14±0.05	2.08*	(30)	P	0.33±0.10	3.26**
"	Mg	0.30±0.11	5.13**	"	Mg	0.41±0.11	2.73*
"	Cu	10.96±5.25	6.71**	"	Cu	28.57±7.82	9.18**
"	Zn	16.92±7.31	5.21**	"	Zn	35.55±5.06	0.49
"	Mn	51.03±17.48	0.90	"	Mn	84.09±19.96	4.53**
"	Co	0.60±0.01	2.39**	"	Co	1.68±0.37	1.08
"	Fe	287.43±90.68	1.68	"	Fe	450.57±192.48	0.58
C.S.Cake (25)	Ca	0.30±0.06	10.76**	Oat green (3)	Ca	0.60±0.03	0.01
"	P	0.58±0.03	1.22	"	P	0.44±0.09	1.56
"	Mg	0.35±0.05	9.28**	"	Mg	0.21±0.11	0.59
"	Cu	23.00±6.33	4.80**	"	Cu	26.00±4.06	0.48
"	Zn	49.44±6.49	9.79**	"	Zn	21.33±2.65	4.34
"	Mn	46.66±8.84	3.36**	"	Mn	170.90±1.11	0.75
"	Co	1.06±0.26	4.54**	"	Co	1.43±0.09	2.25
"	Fe	438.25±110.09	1.77	"	Fe	492.96±138.64	16.55
Chikodi (4)	Ca	1.60±0.47	1.44	Isabgol husk (4)	Ca	0.24±0.07	148.50**
"	P	0.44±0.09	4.85	"	P	0.33±0.01	0.19
"	Mg	0.34±0.11	0.99	"	Mg	0.17±0.07	173.50**
"	Cu	34.78±6.37	0.65	"	Cu	8.40±0.61	0.44
"	Zn	43.52±22.59	-	"	Zn	26.72±7.37	13.63**
"	Mn	143.55±31.87	0.39	"	Mn	13.77±2.34	19.88*
"	Co	1.09±0.33	1.78	"	Co	0.66±0.17	10.58*
"	Fe	456.00±118.49	748.36**	"	Fe	74.72±5.91	61.61**

contd..

Feed	Variable	Mean ± SD	F.value	Feed	Variable	Mean ± SD	F.value
Sorghum green	Ca	0.20±0.17	2.82*	Wheat grain (7)	Ca	0.05±0.01	7.21*
(24)	P	0.23±0.09	0.78	"	P	0.30±0.04	12.13**
"	Mg	0.17±0.89	4.74**	"	Mg	0.15±0.01	6.36*
"	Cu	9.39±5.33	2.81*	"	Cu	8.73±1.72	5.48*
"	Zn	25.91±7.43	1.57	"	Zn	32.13±6.88	7.10*
"	Mn	37.19±19.53	2.86*	"	Mn	40.85±9.67	21.68**
"	Co	1.05±0.34	1.51	"	Co	0.87±0.15	5.33*
"	Fe	272.35±76.28	3.15**	"	Fe	67.34±11.13	1.77
Sorghum straw	Ca	0.38±0.10	3.49**	Wheat straw (19)	Ca	0.19±0.08	0.62
(35)	P	0.14±0.06	1.09	"	P	0.07±0.03	2.41
"	Mg	0.30±0.11	2.56*	"	Mg	0.13±0.06	6.48**
"	Cu	7.53±3.60	3.92**	"	Cu	3.48±1.78	6.14**
"	Zn	14.69±7.93	1.10	"	Zn	5.99±2.62	0.78
"	Mn	64.82±22.05	2.81**	"	Mn	42.48±7.54	2.17
"	Co	0.84±0.30	1.63	"	Co	0.66±0.23	0.61
"	Fe	222.39±84.17	4.07**	"	Fe	185.84±41.18	0.37
Sagardan (28)	Ca	1.08±0.17	0.58				
"	P	0.93±0.07	0.84				
"	Mg	0.53±0.08	2.68*				
"	Cu	36.46±5.89	4.37**				
"	Zn	58.27±10.06	4.66**				
"	Mn	97.71±17.46	1.25				
"	Co	6.17±1.44	0.79				
"	Fe	806.72±210.22	6.42**				

Note : *P<0.05 ** P<0.01
Values of Ca, P, Mg are in percentage, while Cu, Zn, Mn, Co and Fe are in ppm.

($p<0.05$; $p<0.01$) between similar samples of certain feeds from different villages, which might be the effect of soil type, geochemically (Table 1). Such a trend was noticed in bajra grain, bajra straw, bajra husk, cotton seed cake, isabgol husk, sorghum straw and wheat grain. Certain other feeds such as chikodi, hybrid napier, local grass, lucerne green, oat green and wheat straw did not show significant variations in Ca levels between samples from different villages. If farmers were feeding their own feed mixtures without use of sagardan, Ca levels were adequate because lucerne green, carrot tops or chikodi was one of the ingredients rich in Ca. On the other hand, adequate Ca levels were recorded when sagardan was one of the components of the total ration for milch animals (Table 2). Those animals not given sagardan or green fodder were mostly deficient in calcium.

Phosphorus (P)

As expected, the values of P in crop residues (0.12%) were much less than Ca. The ratio of Ca:P varied from 2:1 to 5:1 in straws of wheat, bajra, sorghum and rice. Mean values of P (0.38%)

in lucerne green and chikodi were quite substantial but about 4 times less than Ca. Hybrid napier contained P to the extent that it gave a Ca:P ratio of 2:1. In bajra and isabgol husks, P values were 0.23% and were equal to Ca content. Local grass, which was infact an admixture of a number of plant species, had P about one-half to one-third of Ca content. Carrot tops showed Ca:P ratio of 5:1. Oat green and sorghum green from various locations had variable P content. Most of the grains studied in this investigation, showed a very different trend of P levels (0.28%), which was more than the Ca levels (Table 1). Cotton seed cake contained a level of 0.58 per cent P which was about double the quantity present in grains. Sagardan had about equal quantities of P and Ca (Table 1).

Variations in P content in samples from different villages did not differ in bajra grain, cottonseed cake, chikodi, isabgol husk, sorghum straw, local grasses, lucerne green and wheat straw. However, significant differences were noticed only in bajra husk, bajra straw, hybrid napier and wheat grain (Table 1). On the whole, feed ingredients did not provide enough P for meeting the requirements of livestock in all the villages. With sagardan, when it was one main feed, P adequacy was observed in the whole tract, especially when green fodder was fed alongwith. In village Vav, Bortwada and Gujarwada some farmers were not feeding sagardan which led to overall low P content in the total feed as against the requirement. As observed in case of Ca, P deficiency was also recorded in the ration of animals without supplementation of green fodders, which contained approx. 0.3 per cent P.

Magnesium (Mg)

Magnesium levels in wheat straw, bajra straw, sorghum straw, bajra husk, rice straw and isabgol husk were similar (0.20%) to P (Table 1). However, Mg level (0.30%) was better in lucerne green, hybrid napier, local grass, chikodi, carrot tops, oat green and sorghum green. Bajra, wheat and maize grains were found to be poor sources of Mg (0.13%). Cotton seed cake showed a substantial level of Mg (0.60%), about 1.5 times more than the P. Sagardan contained a level of 0.53 per cent Mg (Table 1). Village to village variation in Mg content was observed in some of the ingredients, whereas, it was not so in bajra husk, cotton seed cake, chikodi, hybrid napier and oat green. It was apparent from the feeding systems in the villages, that the requirement of Mg was being met even without incorporation of sagardan or with or without green fodder (Table 2).

Iron (Fe)

Distribution of this element was found to be unique in the sense that it exceeded the requirement in all the feed ingredients, being fed to livestock (Table 1). Even the straw samples were quite rich in Fe (216.4 ppm). Lucerne green, hybrid napier, local grass, sorghum green, carrot tops, chikodi and oat green showed an average of 446 ppm Fe (Table 1). Grains had around 57.7 ppm, while cotton seed cake was exceptionally rich,

Table 2
Per cent deficiency of various mineral elements in animals with sagardan feeding as compound feed

Village	Animal type	Daily milk yield (kg)	Calcium	Phosphorus	Copper	Zinc	Manganese
Kherva	Buffalo	14.66	adequate	20.91	adequate	59.30	7.58
	Cow	25.00	adequate	adequate	adequate	43.53	adequate
Boratwada	Buffalo	8.50	23.34	25.70	adequate	76.03	adequate
Gujarwada	Buffalo	5.50	29.32	22.11	18.83	76.32	12.80
Madhupura	Buffalo	13.33	31.71	15.62	adequate	69.96	3.50
	Cow	16.00	19.75	14.16	adequate	70.15	adequate
Hansapur	Buffalo	17.17	17.17	3.34	21.05	75.41	adequate
	Cow	10.00	adequate	adequate	adequate	73.87	adequate
Dhinoj	Buffalo	10.25	3.63	17.90	adequate	57.13	adequate
Hathipura	Buffalo	7.00	7.28	10.58	adequate	68.67	adequate
	Cow	8.66	adequate	11.88	adequate	73.90	adequate
Denap	Buffalo	8.75	18.40	6.47	adequate	62.11	adequate
Vav	Buffalo	6.75	26.06	27.27	adequate	53.88	adequate
Medaadaraj	Buffalo	11.40	34.25	16.32	adequate	76.99	adequate
	Cow	19.00	21.81	13.33	adequate	61.02	adequate
Balva	Buffalo	7.00	6.70	13.05	adequate	61.95	adequate
	Cow	12.00	adequate	adequate	adequate	67.99	adequate
Charada	Buffalo	8.00	adequate	adequate	adequate	57.46	adequate
	Cow	26.00	6.11	adequate	adequate	51.46	adequate

	Cow	Buffalo
Av.body weight (kg)	400	450
Av.milk fat%	4.0	7.0

	Calcium (g) Cow	Calcium (g) Buffalo	Phosphorus (g) Cow	Phosphorus (g) Buffalo			
Maintenance	16.0	18.0	11.0	13.0	Mg : 2.0 g/kg DMI	Zn : 80 ppm*	Co : 0.5 ppm
Milk production (per ltr.)	3.21	4.65	1.98	2.88	Cu : 10 ppm	Mn : 40 ppm	Fe : 50 ppm

(NRC, 1989) * Arora (1981)

containing 438.2 ppm Fe. Fe incorporation into sagardan was not a requirement, instead it contained 806.7 ppm of Fe (Table 1).

Areawise, Fe content did not vary much between the samples from different villages. Such a trend has been reported even earlier in Vadodara district (Desai *et al.* 1984).

Copper (Cu)

Copper, unlike Fe, seemed to be low in some of the collected samples. In feeds like wheat straw, sorghum straw, bajra husk, local grasses, sorghum green and rice straw, the quantities were under 6.63 ppm. On the other hand, lucerne green, bajra straw, hybrid napier, carrot tops, chikodi and oat green recorded levels more than 21.25 ppm (Table 1). In grains, Cu levels were marginal (8.9 ppm), whereas, cotton seed cake contained 23 ppm Cu and sagardan 36.4 ppm. Cu levels varied considerably from village to village, ingredient wise. However, exceptions were noticed with bajra husk, chikodi, isabgol husk, local grasses and oat green, where variations were non-significant. In some of the villages, the ingredients being fed were not adequate in Cu (Table 2) without sagardan.

Zinc (Zn)

Zinc is one element which is reported to be most deficient in many geographical zones. As a result, plants do not contain this element in sufficient quantity so as to meet the requirements of livestock. From this surveillance (Table 1), it was apparent that most of feed ingredients, particularly straws and husks, were unusually low in Zn content (11.5 ppm). Hybrid napier, local grasses, sorghum green, carrot tops, oat green, and chikodi were showing somewhat better levels (24.87 ppm). Lucerne green was still better in its levels (35 ppm). It seemed that Zn transfer from plant segment to seeds was quite substantial i.e. about four times as apparent from the figures in bajra grain, wheat grain and maize grain.

Zn content in samples collected from different villages did not show any difference statistically. Only a few ingredients such as bajra straw, bajra grain and cottonseed cake showed significant variations from village to village.

Evidently, it is clear that Zn is deficient in fodders as well as concentrates. Even with sagardan feeding (58.27 ppm Zn), its quantity remained deficient. To overcome Zn deficiency, its content should be 80 ppm in the total ration (Arora, 1981) so as to avoid subclinical and clinical problems.

Manganese (Mn)

Most of green fodders offered to livestock contained reasonable amount of Mn (106.4 ppm) whereas, straws and stovers (47.3 ppm) were poor source (Table 1). Carrot tops and chikodi were unusually rich and had 145.1 ppm of Mn. It seemed that transfer of Mn from plant segments to seeds is quite low, as grains showed a level of 30.6 ppm only, though cotton seed cake had somewhat higher level (46.6 ppm).

Village to village variations of Mn content in feed samples did not reveal any significant difference in bajra grain, bajra straw, chikodi, local grass, oat green and wheat straw. Differences were, however, observed between samples from different villages in bajra husk, cotton seed cake, hybrid napier, isabgol husk, sorghum green, sorghum straw, lucerne green and wheat grain (Table 1).

Adequacy of Mn was recorded in few villages without sagardan but in majority of villages, its quantity being offered was inadequate as reported earlier in Vadodara district (Desai *et al.* 1984). With sagardan feeding, sufficient quantity of Mn (97.7 ppm) was available.

Cobalt (Co)

The situation with Co in feed ingredients was found to be very similar to Fe. Most of the feeds contained sufficient levels of Co, irrespective of source. Straws and stovers showed a level of 0.78 ppm, whereas, lucerne green had a level of 1.68 ppm. Hybrid napier, local grasses and sorghum green showed a similar trend 1.39 ppm (Table 1). Grain samples exhibited levels higher than 1 ppm. Sagardan provided 6.17 ppm Co level.

Co variations in samples from different villages were non-significant in most of the feeds, except bajra straw, cottonseed cake, isabgol husk and wheat grain. Adequate Co levels were recorded in all the villages, irrespective of any feeding system as observed in case of Fe recorded in this study.

Overall, it is apparent that milch cows and buffaloes in various talukas of Mehsana district are able to meet their mineral requirements, except Zn and occasionally Cu and Mn, when fed a ration with sagardan and green fodder. However, animals without green fodder are likely to be deficient in Ca, P, Zn and Mn. Quantity of sagardan per day has an important bearing on the quantity of minerals being received by the animals. Mineral status of feeds and fodders depends upon the interaction of a number of factors, such as soil type, plant species, stage of growth, yield, climate and fertilization scale (Annon 1992; McDowell *et al.* 1993). Plants take up small fraction of mineral elements out of the total soil content and the latter 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 mineral contents deficient. Lucerne, being leguminous, is rich in a number of minerals having capacity for greater uptake. Straws and stovers show decline in the levels of a number of minerals, because of maturity and possible transfer to seeds. Ca was the only element which was not affected by the stage of plant growth. Differences noticed from crop to crop in different villages, might be due to variations in crop yields as a result of irrigation facility and over dosing of N and K fertilizers.

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