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MINERAL STATUS OF FEEDS AND FODDERS IN KAIRA DISTRICT OF GUJARAT

A two dimensional survey was conducted to map the distribution of certain elements in Kaira district, by collecting feed and fodder samples at random, taking conceptual village as a unit. The average calcium content (0.23%) in straws and stovers was lower, whereas in green leguminous fodders (1.45%), it was higher. The concentrate ingredients were particularly low in calcium (0.07%), whereas the phosphorus contents of crop residues and leguminous fodders were 0.14 and 0.38 percent, respectively. Rice polish showed exceptionally higher level of phosphorus (1.50%). The magnesium levels in collected samples of feeds and fodders were adequate, (Average levels > 0.23%). The area under survey seems to be quite rich in iron content, because all samples were extraordinarily rich, and were far exceeding the requirement levels. On the deficiency side, copper content was consistently low in straws, (5.52 ppm), green fodders (4.63 ppm) and the concentrate ingredients (9.55 ppm). Likewise, zinc showed a deficiency trends in all the feed ingredients. Manganese content was low in grains (22.5 ppm) but adequate in straw samples (53.91 ppm). Cobalt was adequate, ranging from 0.37 to 0.54 ppm in different feed samples. Village to village variation was noticed for almost all the mineral elements. From the present survey, it was apparent that the availability of certain mineral elements such as calcium, phosphorus, copper and zinc were inadequate, as per the estimates for the requirement of buffalo yielding 10 kg milk per day. However, the availability of some other mineral elements such as magnesium, iron, manganese and cobalt were found to be sufficient in the survey area.

INTRODUCTION

Geochemical surveys are rather essential to determine the occurrence of elements in feed and to draw inferences for practical applications in feeding systems in health and disease. At the same time, it is advisable not to recommend excess, so as to avoid the problem of animal waste. Recommending supplemental elements without considering the base levels in feedstuffs may not be a satisfactory system (Hinders, 1999). Such a survey in relation to animal health may be classified as having one, two or three dimensions (Tourtelot, 1980). In this study, two dimensional survey was adopted to map a number of elements by collecting feed samples in a particular district, according to random sampling design based on conceptual landscape units.

MATERIALS AND METHODS

Two dimensional survey technique was adopted taking village as a unit for collection of feed samples in different areas (talukas) of Kaira district, to identify the elemental deficiency or excess, to judge the magnitude of the problem and to indicate its origin, which happens to be feed in this case study. Total area of Kaira district is 7194 sq km, distributed

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into 10 zones, from where one village was selected at random in each of the 10 talukas, showing natural sampling areas of conceptual units. The district is having annual rain fall of 80 cm., its location is 50 metres above sea level, having a latitude of 23.5°C and longitude of 73°. Atmospheric temperature ranges from 12-45°C during different seasons. Samples of feeds and fodders from within the identified village were collected from four or five farmers, selected with the help of village dairy cooperative society and Kaira district Cooperative Milk Producers' Union. Details regarding the number of livestock, irrigated land or otherwise and the crops grown were recorded. Farmer selection was based on land location in northern, eastern, western and southern sides of villages. All the collected samples of feeds and fodders were analysed for Ca, Mg, Cu, Zn, Mn, Fe and Co using Atomic Absorption Spectrophotometer (Varian-20 plus Model). The phosphorus was estimated colorimetrically according to AOAC (1980).

Assessment of quantitative intake of total feed in milch animals was made to calculate the dry matter (DM) intake. On the basis of which mineral status was composed against the standard requirements (NRC, 1989; Campbell *et al.* 1999) to identify quantitative deficiency, sufficiency or even excess. The data were analyzed statistically as per Snedecor and Cochran (1967) by analysis of variance.

RESULTS AND DISCUSSION

Crop residues were found to be the main source of roughage in the ration of animals of the survey area. The concentrate ingredients used were usually of the conventional type. The practice of growing green fodders is rare in the area. Lucerne was recorded to be grown in six villages, depending upon the irrigation facility available.

The calcium content in straws and stovers was low (Table 1). Calcium availability from rice straw is expected to be still poor, because of higher oxlate content, which binds dietary calcium. Both Lucerne and chikodi, being from leguminuous family contained higher calcium amounts and provided sufficient calcium (Norton and Poppi, 1995). The concentrate ingredients commonly fed to livestock contained 0.07 percent calcium, whereas cotton seed cake with higher Ca content was an exception. As expected, there were significant quantitative differences in elements among feed samples from different villages. Bajra straw, deoiled maize cake, maize grain and wheat grain did not show much variability. Further, it was evident that unless Amuldan or leguminous fodders formed the part of total ration for milch cows or buffaloes, the calcium intake was usually low (Table 2). In such situations, high yielders are likely to suffer from milk fever and young ones may suffer from calcium tetany (Maynard *et al.* 1979; Gant *et al.* 1998). As an example, a buffalo yielding 10 kg milk per day would need 64.50 g calcium per day as per the standard requirements, whereas feeds and fodders available in the area when fed, provide only 44.45 g per day, showing a deficiency of 20.05 g per day (Table 2).

Crop residues were again poor source

of phosphorus (0.14%). Lucerne green and chikodi provided phosphorus in substantial quantities. Local grass which was a mixture of a number of species, was also a good source of both calcium and phosphorus. Green maize, cotton seed cake and maize grain were medium in phosphorus quantity. Rice polish was exceptionally high in phosphorus content (1.50%). Some of the ingredients collected from different locations showed differences, whereas the others did not exhibit any trend (Table 1).

The estimated value of phosphorus from feeds and fodders was 48.50 g against the requirement of 41.80g for a milch buffalo yielding 10 kg milk, but there might be a limitation with vegetable sources of phosphorus because of its partial bioavailability, being in phytic acid form. The problem of Phosphorus deficiency, of late, has been recorded in milch cows, buffaloes and broilers in the form of haematuria and chondrodystrophy respectively, with a considerable high incidence (McDowell, 1992; Haque and Verma, 1992; Mohamed and Vale, 1994, Jagadeeswaran and Jagdishkumar 1998).

The magnesium levels as estimated in the samples of crop residues were sufficient. Amongst the green fodders, maize green (0.44%) had the highest mg content, followed by lucerne (0.33%) and local grass (0.28%), showing that considerable quantities of magnesium were available from the livestock requirement point of view. Deoiled maize cake, maize grain and wheat grain contained lower levels of magnesium. Rice polish was exceptionally high in magnesium (0.79%) from the study area. Cotton seed cake and chikodi samples contained moderate levels of magnesium.. Amuldan, a compound feed contained 0.48 percent magnesium, a level which is higher than required as a supplement, because of its sufficiency in feed ingredients (Table 1). Village to village variation in the quantity of magnesium was significantly different, but not in all cases. Quoting an example of a 10 kg milch buffalo (Table 2), Mg requirement is 24.0 g per day, whereas feeds and fodders from that area when fed in required quantities shall provide 35.25 g per day.

Iron seems to be quite rich in this district, as also reported from Mehsana district (Desai *et al.* 1984; Garg *et al.* 1999a). Its quantity in normally fed ingredients (Table 1) was far above the nutritional requirements (NRC, 1989). The iron content of straw samples was less than its content in green fodders. Wheat and maize grains were relatively low in iron content. Village to village difference in iron content amongst the samples was not much (Table 1). For a buffalo yielding 10 kg milk per day, the availability of iron from feeds is 3309.8 mg and the requirement is only 600 mg per day (Table 3).

Copper quantity was recorded consistently low in almost all the collected feed samples. Out of the green fodders, lucerne contained 15.21 ppm copper, whereas in rest of the green fodders, it averaged around 4.63 ppm (Table 1). In grains, the levels again were very low. Village to village differences in copper level for a particular feed were significant except

Table 1
Variation in mineral contents of some feed ingredients on DM basis (Kaira district)

1 Feed	2 Ca(%)	3 P(%)	4 Mg(%)	5 Cu(ppm)	6 Zn(ppm)	7 Mn(ppm)	8 Co(ppm)	9 Fe(ppm)
Amuldan (35)	1.28*	0.96	0.48**	26.54	53.69*	77.14	3.55	863.31*
(Compound feed)	±0.05	±0.01	±0.01	±0.56	±1.11	±1.99	±0.12	±22.83
Bajra Straw (15)	0.42	0.17**	0.40*	6.40	16.71	49.34	0.53	372.20
(Pennisetum typhoides)	±0.02	±0.01	±0.05	±0.69	±1.30	±3.20	±0.05	±44.87
Chikodi (4)	1.17	0.40	0.32	9.26	41.17	83.55	0.55	686.10
(Euphorbia prostrata)	±0.05	±0.02	±0.01	±1.58	±0.68	±12.53	±0.04	±76.85
Cotton seed cake (11)	0.27**	0.53**	0.34	14.51**	51.49	25.80**	0.89**	408.44**
(Gossypium spp)	±0.01	±0.02	±0.03	±2.44	±1.41	±5.02	±0.04	±37.54
Deoiled maize cake (8)	0.09	0.39	0.10	9.84**	58.03	16.79**	0.88**	413.81
(Zea mays)	±0.01	±0.02	±0.01	±0.94	±3.06	±2.46	±0.09	±59.11
Groundnut straw (4)	0.39**	0.20	0.14	12.20**	32.89*	40.21**	0.42**	558.47
(Arachis hypogaea)	±0.03	±0.05	±0.02	±1.73	±4.08	±4.03	±0.12	±40.41
Local Grass (7)	0.41*	0.43**	0.28	3.92	31.55	63.84	0.22	358.90
	±0.05	±0.12	±0.05	±0.33	±5.59	±8.86	±0.11	±57.42
Sorghum straw (5)	0.27*	0.11	0.29	5.32	32.82**	43.57**	0.47	277.96
(Sorghum bicolar)	±0.06	±0.01	±0.05	±1.43	±6.13	±3.07	±0.09	±30.19
Lucerne (16)	1.73	0.36*	0.33*	15.21	36.01**	61.23	0.49	571.20**
(Medicago sativa)	±0.04	±0.02	±0.02	±1.27	±1.83	±3.59	±0.07	±53.62
Maize grain (7)	0.05	0.34	0.12	2.81	33.32	11.61	0.44	53.56
(Zea mays)	±0.01	±0.01	±0.01	±0.78	1.12	±2.98	±0.03	±2.20
Maize green (4)	0.41	0.22	0.44	4.24	31.58	38.00	0.44	265.23
(Zea mays)	±0.07	±0.04	±0.03	±0.84	±1.58	±1.48	±0.16	±30.47
Rice Polish (10)	0.09**	1.50**	0.79	12.80**	70.74**	121.04	0.50	192.94
(Oryza sativa)	±0.01	±0.10	±0.06	±1.29	±1.67	±4.90	±0.06	±11.21
Rice straw (34)	0.20*	0.09**	0.18*	2.40	13.24**	105.18*	0.52**	230.30*
(Oryza sativa)	±0.01	±0.00	±0.01	±0.29	±0.52	±3.28	±0.04	±13.44
Wheat grain (7)	0.06	0.33	0.14	5.75**	35.27	35.89*	0.58	69.59
(Triticum aestivum)	±0.01	±0.02	±0.01	±1.07	±2.77	±3.86	±0.11	±0.19
Wheat straw (2)	0.20	0.10	0.15	1.29	8.95	31.25	0.13	204.65
(Triticum aestivum)	±0.01	±0.00	±0.05	±0.82	±1.85	±0.15	±0.02	±3.05

Note : * P<0.05 ** P<0.01

for some feeds from specific places. Clinical or subclinical syndromes are likely to occur in livestock due to its deficiency. Swayback or anaemia are the deficient diseases observed in sheep, goat and other livestock in all the age groups (Prasad *et al.* 1982). Subclinically, the problems of poor growth rate, coarse wool and infertility may be encountered in certain species due to decrease in activity of superoxide dismutase enzyme. Heart abnormalities such as cardiac hypertrophy and aortic aneurysms are the other ailments which can occur as a result of its deficiency effect on lysyl oxydase (McDowell, 1992). In adult cattle, falling

Table 2
Ca, P and Mg requirements for a milch buffalo (450 kg) yielding 10 kg milk (7% fat) per day

Attribute	DM (kg)		Ca (g)		P (g)		Mg (g)
Maintenance	12.0		18.0		13.0		-
Milk production	-		46.5		28.8		24.0
Total	12.0		64.5		41.8		24.0
		Calcium		Phosphorus*		Magnesium	
Feeds	DM (kg)	(%)	(g)	(%)	(g)	(%)	(g)
Maize grain	1.5	0.05	0.75	0.34	5.10	0.12	1.80
Cotton seed cake	2.0	0.27	5.40	0.53	10.60	0.34	6.80
Rice polish	1.5	0.09	1.35	1.50	22.50	0.79	11.85
Lucerne	1.5	1.73	25.95	0.36	5.40	0.33	4.90
Rice straw	5.5	0.20	11.00	0.09	4.90	0.18	9.90
Total	12.0		44.45		48.50*		35.25
Extra from mineral mixture			20.05		27.25		-
Total			64.50		41.80		

*70 percent phytic acid-P partly available in ruminants

disease has been recorded in Australia due to its deficiency. Copper status from traditional feeds and fodders fed to a buffalo, yielding 10 kg milk per day, is 88.44 mg per day against the requirement of 120 mg (Table 3).

Zinc was deficient in most of the feed and fodder samples, a picture very similar to Mehsana district (Garg *et al.* 1999a). Straw samples showed exceptionally low levels (20.92 ppm). Green fodders in general showed Zn values around 35.08 ppm, which of course, were higher than the straw samples. Rice polish was rich but other feed sources were poor in Zn content. Village to village variation was significantly different ($P<0.05$) for some ingredients, whereas it was not so for some others (Table 1). Amuldan, a compound feed, predominantly being fed by farmers in the study area was also not adequate (53.69 ppm) to meet its standard requirements of 80 ppm (Arora, 1981). For a milch buffalo yielding 10 kg milk per day, the requirement difference was to the extent of 574.12 mg per day with a feeding system without Amuldan. Night blindness, hyperkeratosis and reproductive failure are the ailments which may result from its deficiency (Saraswat and Arora, 1972; Chhabra and Arora, 1985).

The picture of manganese seemed to be quite different from plant distribution

Table 3
Fe, Cu, Zn, Mn and Co requirements of buffalo (450 kg) producing 10 kg milk/day (7% fat)

Attribute	DM (kg)	Fe		Cu		Zn		Mn		Co	
	(ppm)	Rate (mg)	Qty. (ppm)	Rate (mg)	Qty. (ppm)	Rate (mg)	Qty. (ppm)	Rate (mg)	Qty. (ppm)	Rate (mg)	Qty.
Requirement	12.0	50	600	10	120	80	960	40	480	0.5	6.0
SOURCES											
Concentrate											
Maize grain	1.5	53.56	80.34	2.81	4.21	33.32	49.98	11.61	17.41	0.44	0.66
Cotton seed cake	2.0	408.40	816.80	14.51	29.02	51.49	102.98	25.80	51.60	0.89	1.78
Rice Polish	1.5	192.90	289.35	12.80	19.20	70.74	106.10	121.00	181.50	0.50	0.75
Fodder											
Lucerne	1.5	571.20	856.80	15.21	22.81	36.01	54.00	61.20	91.80	0.49	0.74
Rice straw	5.5	230.30	1266.60	2.40	13.20	13.24	72.82	105.10	578.00	0.52	2.86
Total	12.0		3309.89		88.44		385.88		920.31		6.79

point of view. Grains generally contained low levels (22.52 ppm), except rice polish. The levels in straws were better and rice straw was exceptionally rich (105.18 ppm). The green fodders were also superior to contain 61.65 ppm. Village to village variation of this element was sometimes very wide and sometimes very narrow, a trend found with all other elements.

Contrary to the levels recorded in Mehsana district (Garg *et al.* 1999a; 1999b), manganese availability was recorded adequate from most of the feeds and fodders (Table 1). The milch buffalo yielding 10 kg milk per day required 480 mg manganese per day whereas feeds and fodders provided 920.31 mg per day (Table 3).

The cobalt levels in this zone ranged from 0.37 ppm in straws to 0.42 ppm in green fodders and 0.54 ppm in cereals. Cotton seed cake and deoiled maize cake revolved around 0.88 ppm cobalt (Table 1). Amuldan contained 3.55 ppm cobalt. Village to village variation of cobalt for the same feed did not show a significant difference. The standard requirement was 6.0 mg per day and the computed diet provided 6.79 mg.

Overall, it is to emphasize that dietary ingredients need to be explored for all the required minerals quantitatively. On the other hand, it is important to investigate whether those minerals are bioavailable for the animal to prevent environmental pollution (Um *et al.* 1999; Mahan and Kim, 1999). Unless deficient elements are adequately supplemented through the diets, not only are the animals likely to exhibit subclinical or clinical signs of mineral deficiencies (Serra *et al.* 1997), but also production levels may be low for milk, meat and eggs (Patel *et al.* 1997).

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