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MACRO AND MICRO-MINERAL STATUS OF FEEDS AND FODDERS IN KOTA DISTRICT OF RAJASTHAN

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ABSTRACT

A survey was conducted in Kota district of Rajasthan, to record the prevalence of macro and micro-mineral deficiency in buffaloes, by collecting feed and fodder samples at random. The calcium content (0.27%) was low in concentrate ingredients, whereas, phosphorus content (0.45%) was higher. The average calcium content (0.39%) was higher in straws in comparison to phosphorus (0.11%). The magnesium content in feedstuffs was adequate, to meet the requirement of animals (0.20%). The survey area was rich in potassium content, whereas, sodium and sulphur content was consistently low in all feedstuffs and need to be supplemented in the total ration. The average copper content was low in straws (5.63 ppm) and moderate in green fodders (9.97 ppm), whereas, concentrate ingredients were better source of copper (13.80 ppm), except grains. Iron and manganese content was adequate in most feeds. Cobalt was inadequate, ranging from 0.0 to 0.85 ppm in different feed samples. Likewise, zinc showed a deficiency trend in all the feed ingredients. Molybdenum content in feeds was within the safe limit (< 0.40 ppm) and gave Cu:Mo ratio wider than 7.0. Selenium content in most feeds was adequate (> 0.30 ppm). From the present study, it can be concluded that looking into the macro and micro mineral content of various feeds and fodders in this region and the requirement of milch buffaloes yielding 7 kg milk per day, there is need to supplement calcium, phosphorus, sodium, sulphur, cobalt, copper and zinc through specific mineral salts, as they are deficient in the feeds and fodders offered to the animals.

Key words: Macro and micro-minerals, Survey/status, Feeds, Fodders, Buffaloes.

Mineral imbalances are of common occurrence in livestock through out the world affecting them in a number of ways (McDowell *et at.*, 1993). A number of researchers in the world have reported a high incidence of forage samples below critical levels for different mineral elements, especially copper, zinc, cobalt, sodium and phosphorus (Miles and McDowell, 1983; Underwood and Suttle, 1999). It is obligatory to assess feeds and fodders for minerals, which are dietary essentials, with the objective to recommend quantities needed extra in the ration. At the same time, it is advisable not to recommend excess, so as to avoid the problem of animal waste and toxicity (Garg *et al.*, 2003). The study was undertaken to assess the macro and micro-nutrient status in feeds and fodders and their requirement for buffaloes.

MATERIALS AND METHODS

The study was undertaken in Kota district of Rajasthan. Total area of Kota district is 5480 sq. km. distributed into 5 taluks, having 896 villages. The district is having annual rainfall of 250 mm, having latitude of 25° and longitude of 76°. Atmospheric temperature ranges from 4 to 46° C during different seasons. One village from each taluk of Kota district was selected for taking representative samples of feeds and fodders. From each village, 4-5 farmers were selected. The recorded parameters were number of livestock, land area, irrigated 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. Following collection, green samples were dried in oven at 80°C for 24 h and subsequently ground (1 mm). Ground samples of concentrate and fodder were stored in airtight bags until analysis. Samples were prepared and digested using 5 ml concentrated HNO_3 plus 1 ml concentrated HCl by microwave digestion method for preventing evaporation of volatile elements 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, S, Cu, Zn, Mn, Fe, Co, Mo and Se using Inductively Coupled Plasma-Optical Emission Spectroscopy (ICP-OES, Perkin Elmer, OPTIMA - 3300 RL). In case of Ca and Mg, the samples were diluted with 0.1 per cent lanthanum chloride before estimation, using ICP-OES to avoid interference of other minerals.

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 (Campbell *et al.*, 1999; NRC, 2001), so as to identify quantitative deficiency, sufficiency or even excess. In India, hardly any information on mineral requirements for milch buffaloes is available; hence, NRC (2001) was taken as a base for calculation of mineral requirements of buffaloes.

RESULTS AND DISCUSSION

Crop residues, predominantly wheat straw, were found to be the main source of roughages in the ration of animals in the surveyed area. The concentrate ingredients were usually the conventional type and home made. 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 maize but only limited quantity of green fodders were fed to productive animals.

The average calcium content (0.39%) in straws of wheat, sorghum and barley was adequate, but low in phosphorus (0.11%). Soybean *(Glycine max)* straw showed exceptionally higher level of calcium (1.64%). The concentrate ingredients such as crushed barley, cottonseed

Table 1 : Macro-mineral content in feeds and fodders collected from Kota district (DM basis)

Feed	Ca (%)	P (%)	Mg (%)	Na (%)	K (%)	S (%)	Ca:P
I. Grains							
Barley grain (8)	0.08	0.26	0.13	0.03	0.57	0.16	0.31
Wheat grain (3)	0.05	0.26	0.11	0.01	0.62	0.16	0.21
II. Oil meals							
Cottonseed cake (12)	0.22	0.60	0.39	0.02	1.23	0.27	0.36
Linseed cake (1)	2.94	0.79	0.39	0.15	1.14	1.25	3.72
III. Brans, churi and concentrate mixture							
Wheat bran (14)	0.14	0.79	0.37	0.02	1.07	0.20	0.17
Gram churi (7)	0.64	0.21	0.24	0.04	0.89	0.15	3.04
Guar churi (2)	0.50	0.26	0.28	0.03	1.04	0.24	1.92
Cattle feed (4) (Conc. mixture)	0.66	1.34	0.67	0.06	1.09	0.51	0.49
IV. Green fodders							
Lucerne green (2)	1.82	0.29	0.32	0.29	2.33	0.45	6.27
Maize green (1)	0.87	0.22	0.62	0.03	2.86	0.24	3.95
Methi green (3)	0.96	0.03	0.11	0.61	0.95	0.15	29.09
Sorghum green (4)	0.68	0.29	0.40	0.02	2.73	0.17	2.34
V. Dry fodders							
Local grasses (6)	0.47	0.04	0.25	0.02	0.82	0.16	11.19
Barley straw (1)	0.42	0.24	0.13	0.05	2.59	0.11	1.75
Sorghum straw (7)	0.39	0.06	0.26	0.01	1.13	0.07	5.90
Soybean straw (4)	1.64	0.10	0.53	0.04	1.10	0.18	16.40
Wheat straw (20)	0.37	0.03	0.12	0.06	1.41	0.12	10.57
Berseem hay (1)	1.58	0.08	0.23	0.88	1.51	0.14	19.50
VI. Husk and pods							
Coriander husk (1)	0.81	0.11	0.23	0.58	1.00	0.22	7.36
Gram pods (1)	0.82	0.02	0.47	0.02	1.25	0.08	28.27
Tuar pods (1)	1.54	0.10	0.47	0.02	1.07	0.11	15.40
Requirements	0.40	0.30	0.20	0.18	0.90	0.20	2:1

Figures in parentheses no. of samples analyzed.

cake and wheat bran, which were commonly fed to animal contained low calcium (0.27%) except linseed cake (Table 1), but high in phosphorus level (0.45%). The values were in agreement with the findings of Nasker *et al.* (2003). Berseem *(Trifolium alexandrium)*, lucerne and methi, being leguminous family contained higher amount calcium (Norton and Poppi, 1995). Local grasses, gram pods and tuar *(Cajanus indicus)* pods were poor source of P as compared to Ca. For efficient utilization of Ca and P, Ca:P ratio should be 2:1. However, most of the feeds and fodders showed variable Ca:P ratio (Table 1). Under such condition, calcium and phosphorus should be supplemented in the diet of animals to balance the Ca:P ratio for their proper utilization in the animal system (McDowell, 1992). The magnesium levels as estimated in the samples of crop residues were adequate (Table 1). Amongst the green fodders, maize *(Zea mays)* green (0.62%) had the highest Mg content, followed by sorghum green (0.40%) and methi green (0.11%), showing that considerable quantities of Mg were available from the livestock requirement point of view. Barley grain and wheat grain contained lower level of magnesium. Gram and guar *(Cyamopsis tetragonoioba)* churi contained moderate levels of Mg, while cottonseed *(Gossypium herbaceum)* cake, linseed cake and wheat bran were good sources of Mg. Compounded cattle feed contained 0.67 per cent magnesium, a level which is higher than required as a supplement, because of its sufficiency in feed ingredients. Magnesium is considered to be an important factor in the occurrence of grass tetany in animals (Garcia and Williams, 2000) and is necessary for all phosphate transfer reactions (NRC, 1980). Ruminants are generally at risk from hypomagnesaemia when the forage contains less than 0.20 per cent of Mg and high in K content.

Sodium content was unduly low in all the feeds and fodders, ranging from 0.019 to 0.29 per cent. Only berseem hay, coriander husk and methi *(Trigonella foenum)* green contained Na as high as 0.69 per cent. Higher K content of feedstuffs may be due to its selective uptake from the soil and was much higher than Na. Similar findings were also reported by Singh *et al.* (2002).

Sulphur content was low in most of the crop residues (0.12%), the reason being its transfer to seed proteins. The concentrate ingredients being fed to livestock in this area contained 0.19 per cent, except linseed *(Linum usitatissimum)* cake, which contained exceptionally high sulphur (1.25%). However, sorghum *(Sorghum vulgare)* green, maize green and methi green from various locations had variable S content (Table 1). The variation in S content of plants depends largely on the amount of S in plant proteins in the form of S-containing amino acids (McDowell, 1992).

The cobalt levels in this zone ranged from 0.26 ppm in straws, 0.17 ppm in green fodders and 0.20 ppm in cereals. Cottonseed cake and linseed cake revolved around 0.77 ppm Co (Table 2). Compounded cattle feed contained 1.85 ppm Co. Gram and guar churi contained 0.48 and 0.42 ppm cobalt, respectively.

Copper quantity was recorded consistently low in almost all the collected feed samples. Out of the green fodders, lucerne *(Medicago sativa)* green contained 13.20 ppm Cu, whereas in rest of the green fodders, it averaged around 8.89 ppm (Table 2). In grains, the levels again were very low. The values were in corroboration the findings of other workers (Ramana *et al.*, 2001). Cottonseed cake (13.60 ppm), linseed cake (25.40 ppm) and wheat bran (18.10 ppm) were better source of copper. Copper content below the critical of 8 ppm (Cuesta *et al.*, 1993) were found in most of the feedstuffs. Distribution of iron was found to exceed the requirement in all the feedstuffs, being fed to livestock (Table 2). Even straw samples were quite rich in Fe (565 ppm). Lucerne green, methi green, maize green and sorghum green showed an average of 419 ppm Fe. Grains had around 124 ppm Fe, while cottonseed cake, linseed cake and wheat *(Triticum aestivum)* bran was

Table 2 : Trace mineral content in feeds and fodders collected from Kota district (DM basis)

FEED	Co (ppm)	Cu (ppm)	Fe (ppm)	Mn (ppm)	Mo (ppm)	Se (ppm)	Zn (ppm)	Cu:Mo
I. Grains								
Barley grain (8)	0.31	12.08	159.66	28.20	0.05	0.17	29.00	219.60
Wheat grain (3)	0.10	4.87	88.50	21.56	0.00	0.25	8.34	—
II. Oil meals								
Cottonseed cake(12)	0.70	13.60	610.25	28.50	0.20	0.28	44.46	68.00
Linseed cake (1)	0.85	25.50	1820.0	87.60	1.24	0.65	71.00	20.56
III. Brans, churi and concentrate mixture								
Wheat bran (14)	0.38	18.10	611.75	117.57	0.42	0.40	75.10	43.09
Gram churi (7)	0.48	10.02	588.00	67.40	0.17	0.25	34.05	58.82
Guar churi (2)	0.42	12.40	372.00	60.40	0.91	0.19	40.15	13.62
Cattle feed (4) (Conc. mixture)	1.85	20.45	1031.7	145.50	0.84	0.18	79.20	24.34
IV. Green fodders								
Lucerne green (2)	0.22	13.20	541.50	49.65	0.88	0.51	26.70	15.00
Maize green (1)	0.10	11.50	422.0	92.30	0.00	0.32	30.40	—
Methi green (3)	0.21	3.98	329.66	23.86	0.00	0.50	11.85	—
Sorghum green (4)	0.17	11.20	384.75	57.72	0.28	0.26	36.17	40.0
V. Dry fodders								
Local grasses (6)	0.39	8.61	655.33	96.13	0.35	0.24	34.93	24.60
Barley straw (1)	0.12	4.58	352.00	42.00	0.00	0.18	23.40	—
Sorghum straw (7)	0.17	5.24	447.25	56.47	0.00	0.16	24.10	—
Soybean straw (4)	0.58	8.03	1098.5	84.57	0.57	0.47	24.55	14.00
Wheat straw (20)	0.14	4.69	363.20	58.30	0.23	0.17	9.69	20.40
Berseem hay (1)	0.35	8.89	783.00	35.60	1.01	0.46	39.90	8.80
VI. Husk and pods								
Coriander husk (1)	0.00	5.91	167.00	24.30	0.00	0.32	8.52	—
Gram pods (1)	0.52	5.11	430.00	44.00	0.73	0.67	11.30	7.00
Tuar pods (1)	0.84	11.90	900.00	143.00	0.36	0.46	23.00	33.05
Requirements	**0.50**	**10.0**	**50.0**	**40.0**	—	**0.30**	**80.0**	—

Figures in parentheses indicate no. of samples analyzed.

exceptionally rich, containing 1013 ppm iron. Thus, Fe seems to be quite rich in this district, as also reported from other parts of the country (Ramana *et al.*, 2001; Yadav *et al.*, 2002). High levels of Fe in all feed ingredients and forages could partly be attributable to soil and surface contamination (Gowda *et al.*, 2002). High levels of Fe in all feed ingredients and forages could partly be attributable to soil and surface contamination (Gowda *et al.*, 2002). The Fe concentration in the majority of feed ingredients was very high and could probably interfere with the copper absorption and metabolism (Youssef *et al.*, 1999).

Most of the straws offered to animal contained reasonable amount of Mn (60 ppm). However, Mn level was 49.65, 92.30, 23.86 and 57.72 ppm, in lucerne green, maize green, methi green and sorghum green, respectively (Table 2). Amongst the concentrate ingredients, wheat bran (117.5 ppm) had the highest Mn content, followed by linseed cake (87.60ppm), gram *(Cicer arietinum)* churi (67.40 ppm), guar churi (60.40 ppm) and cottonseed cake (28.56 ppm). The present values were in agreement with the findings of Yadav *et al.*, (2002). The molybdenum levels as estimated in the samples of crop residues were within the safe limit (Table 2). Amongst the dry fodders, berseem hay (1.01 ppm) had the highest Mo content, followed by soyabean straw (0.57 ppm), local grasses (0.35 ppm) and wheat straw (0.23 ppm). Lucerne green and sorghum green contained 0.88 and 0.28 ppm Mo, respectively. Gram churi had 0.17 ppm Mo, while guar churi contained high Mo (Table 2). Grains were low Mo content, whereas, cottonseed (0.20 ppm) and linseed cakes were high in Mo. The most of the feedstuffs contained Mo level within the safe limit and gave Cu:Mo ratio wider than 7.0. Miltimore and Mason (1971), stated that a Cu:Mo ratio below 2.0 would be expected to cause conditioned Cu deficiency in cattle. Mo levels of 5 to 6 ppm inhibit Cu storage and produce signs of molybdenosis (NRC, 1980). Even 2 ppm or less Mo can be toxic, if forage Cu is sufficiently low (Youssef *et al.*, 1999). The selenium content of the crop residues varied from 0.16 to 0.67 ppm (Table 2). However, Se level was recorded 0.51, 0.32, 0.50 and 0.26 ppm, in green lucerne, maize, methi and sorghum, respectively. Grains had around 0.20 ppm Se, whereas linseed cake (0.65 ppm) was an exception with high Se content (Table 2). Gram and guar churi contained 0.25 and 0.19 ppm Se, respectively.

Zinc is one element, which is found to be deficient in many geographical zones of India (Gowda *et al.*, 2002; Garg *et al.*, 2003). From this study (Table 2), it was apparent that most of the feed ingredients, particularly straws, were low in Zn content (21.0 ppm). The zinc content of the green fodders varied from 11.85 to 36.17 ppm (Table 2). Grains had around 18.5 ppm Zn, while wheat bran and linseed cake was an exception with higher Zn content (73.0 ppm). Zinc content was found below the critical level (30 ppm) in most of the feedstuffs and needed to be supplemented @ 80 ppm in the total ration (Arora, 1981) of animals, to overcome its deficiency.

A buffalo yielding 7 kg milk per day would need 50.55 g Ca, whereas, feeds and fodders available in the area when fed as per diet formulation given in Table 3, would provide only 39.55 g Ca, showing a deficiency of 11.09 g per day. Under such conditions, milk production is likely to be affected and freshly calved animal may suffer from milk fever (McDowell, 1992). The estimated

Table 3 : Availabilty and requirement of Ca, P, Mg, Na, K, S, Co, Cu, Fe, Mn and Zn for a milch buffalo (400kg) producing 7 kg milk (7% fat) per day

Attribute	Tentative daily DMI (kg)	Ca (g)	P (g)	Mg (g)	Na (g)	K (g)	S (g)	Co (mg)	Cu (mg)	Fe (mg)	Mn (mg)	Zn (mg)
Maintenance	12.0	18.0	13.0	—	—	—	—	—	—	—	—	—
Milk production	—	32.5	20.8	24.0	21.6	108.0	24.0	6.0	120.0	600	480.0	960.0
Feeds												
Wheat straw	4.0	14.8	1.4	4.8	2.4	56.4	4.8	0.5	18.7	1452	233.2	38.7
Sorghum Straw	2.0	7.8	1.3	5.2	0.3	22.6	1.4	0.3	10.4	894	112.9	48.2
Local grasses	1.5	7.0	0.6	3.7	0.3	12.3	2.4	0.5	12.9	982	144.2	52.4
Cottonseed cake	2.0	4.4	12.0	7.8	0.4	24.6	5.4	1.4	27.2	1220	57.0	88.9
Crushed barley	1.0	0.8	2.6	1.3	0.3	5.7	1.6	0.3	12.0	160	28.2	29.0
Wheat bran	1.0	1.4	7.9	3.7	2.3	10.7	2.0	0.3	18.1	611	117.5	75.1
Gram churi	0.5	3.2	1.0	1.2	0.2	4.4	0.7	0.2	5.0	294	33.70	20.0
Total availability	12.0	39.4	26.9	27.7	6.4	136.7	18.4	3.8	104.5	5616	726.7	352.4
Total requirement	12.0	50.5	33.8	24.0	21.6	108.0	24.0	6.0	120.0	600	480.0	960.0

value of phosphorus from feedstuffs was 26.90g against the requirement of 33.86 g per day for a milch buffalo yielding 7 kg milk, showing a deficiency of 6.96 g per day (Table 3). If cakes and brans are fed, the P requirement could be met.

The Mg requirement of a milch buffalo yielding 7 kg milk per day was 24.0 g (Table 3), whereas, feeds and fodders fed in that area provided 27.75 g of Mg per day. Potassium content in straws and stovers was higher than the concentrate feed ingredients and seemed to be another element like Mg, which did not require additional supplementation. Unlike K, the availability of Na from feed sources was only 6.49 g against the requirement of 21.60 g per day, showing a deficiency of 15.11 g per day, for milch buffalo yielding 7 kg milk per day (Table 3). The availability of S from feed sources was 18.43 g and the requirement was 24.0 g per day, showing a deficiency of 5.57 g per day.

A buffalo yielding 7 kg milk daily, would need 6.0 mg cobalt per day, as per the standard requirements, whereas, feeds and fodders available in the area when fed, provide 3.81 mg, showing a deficiency of cobalt (Table 3). Copper status from traditional feeds and fodders fed to a buffalo, yielding 7 kg milk per day, was 104.5 mg against the requirement of 120 mg per day (Table 3). In cases where there is high dietary Mo, Cu in chelated form would have an advantage over an inorganic form as it may escape the complexing that occurs in the digestive system between Cu, Mo and S (Nelson, 1988). Clinical and sub clinical syndromes are likely to occur in livestock due to its deficiency. Sub clinically, the problems of poor growth rate, coarse hair coat, anemia and infertility may be encountered in cows and buffaloes. Dietary adequate copper reduced the incidence of mammary gland infection (mastitis) and increased the killing ability of neutrophils (Harmon and Torre, 1994).

For a buffalo yielding 7 kg milk per day, the availability of Fe from feed resources was 5626.4 mg and the requirement was only 600mg per day (Table 3). Though iron content is very high in feedstuffs, its absorption is less than 20 per cent. Adequate Mn availability from feeds and fodder was also recorded in other parts of country (Garg *et al.*, 2000; Yadav *et al.*, 2002). The milch buffalo yielding 7 kg milk per day, required 480 mg Mn per day, whereas feed sources provided 726.7 mg (Table 3).

The minimum dietary Se requirements of all classes of ruminant livestock ranges from 0.10 to 0.30 ppm (NRC, 1980). Accepting the minimum requirements of 0.30 ppm Se, which is the level considered adequate for preventing deficiency in dairy cattle (NRC, 2001), most of the feeds and fodders studied would satisfy requirement of Se. Therefore, its supplementation in mineral mixture may not be necessary. A buffalo yielding 7 kg milk per day would need 960 mg Zn, whereas, feeds and fodders available in the area when fed as per diet formulation given in Table 3, would provide only 352 mg Zn, showing a deficiency of 607.55 mg per day. Mastitis, night blindness, parakeratosis and reproductive failure are the ailments, which may result from its deficiency (McDowell, 1992). The role of Cu and Zn in augmenting production and reproduction is well documented and are known to have a significant correlation with reproductive hormones (progesterone and estradiol), as they are specific activators of enzyme systems that assist in maintaining the activity of hypophyseal hormones in blood (McDowell, 1992). Probably that is the reason that majority of the animals in this area had reproductive problems like anestrus and repeat breeding.

It can be concluded that the requirement of milch buffaloes yielding 7 kg milk per day, there is need to supplement calcium, phosphorus, sodium, sulphur, cobalt, copper and zinc through specific mineral salts, as they are deficient in the feeds and fodders offered to the animals in this region.

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