Research Article

Assessment of Dietary Macro and Micro-Minerals Status of Milch Buffaloes in Sub-Mountain Zone of Punjab

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A study was carried out to assess dietary macro and micro-mineral status of milch buffaloes in sub-mountain zone of Punjab. Feed and fodder samples were collected at random from various locations following standard sampling procedure. The average calcium (Ca) content in straws was low (0.23%). Green fodders such as berseem (1.78%), chikori (1.67%), oat (0.56%) and rye grass (0.61%) were found to be rich source of Ca. Concentrate ingredients were particularly low (0.12%) in Ca. The phosphorus (P) content in crop residues and green fodders was 0.09 and 0.30%, respectively, which was low but higher (0.57%) in concentrate ingredients. The magnesium content in green and dry fodders was 0.19 and 0.31%, respectively. The sodium content was low in concentrate ingredients (0.038%) and dry fodder (0.07%) but very high in green fodder (0.74%). The dry and green roughages were found to be rich in potassium content (2.27%) than concentrate ingredients (0.81%). The sulphur content was adequate in green fodder (0.26%), whereas, crop residues (0.10%) and concentrate ingredients (0.12%) were deficient in sulphur; hence, its supplementation was necessary in the ration of milch animals. The cobalt was deficient in the diet of animals to the extent of 56%, however, iron (> 161 ppm) and manganese (> 61 ppm) in most of the feed ingredients were adequate with traditional feeding system. The average copper content was low in straws (3.34 ppm) and moderate in green fodders (12.18 ppm). Concentrate ingredients were again low in copper (7.94 ppm). Molybdenum content in feeds was within the safe limit and gave Cu : Mo ratio wider than 3 except berseem green. Selenium content in most of the feeds and fodder samples was found to be excess (0.85 ppm) and its supplementation in the diet was not advocated. Zinc was deficient in most of the feedstuffs (average level<41 ppm) and need to be supplemented for proper productive and reproductive functions. From the present study, it was apparent that the levels of certain minerals such as calcium, phosphorus, magnesium, sulphur, zinc, copper and cobalt were inadequate, as per the prevailing feeding practices and requirement of a buffalo yielding 10 kg milk (6% fat) per day. However, the levels of some other mineral elements such as sodium, potassium, iron, manganese and selenium were found to be adequate in the sub-mountain zone of Punjab.

Keywords: Calcium, Phosphorus, Copper, Selenium, Molybdenum, Buffalo, Punjab

INTRODUCTION

The significance of minerals in regulating growth, production and reproduction is well documented (McDowell, 1992; Underwood and Suttle, 1999). Optimum productive and reproductive efficiency of animals could be exploited only when the animals receive a balanced ration along with mineral supplementation (Garg, 2006). Most of the farmers in Punjab do not supplement the ration with mineral mixture (Singh et al. 2005). Therefore, the animals are solely dependent on feeds and fodders to meet their mineral requirements. However, feeds alone can not meet the entire requirement, as they are deficient in a number of macro and micro-minerals (McDowell and Arthington, 2005; Garg *et al.* 2005). There is paucity of information regarding the mineral status of animals reared under field conditions in different agro-climatic zones including in Punjab and mineral deficiency or excess is an area specific problem and influenced to a great extent by mineral content and its bioavailability from feeds and fodders fed to animals. Therefore, present study was carried out to ascertain the mineral status of animals in sub-mountain zone of Punjab.

MATERIALS AND METHODS

Sampling Procedure

One centrally located village from each taluka of Ropar and Gurdaspur districts from sub-

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mountain zone was selected at random for taking representative samples of feed and fodder. The zone is having annual rainfall of 775 mm and atmospheric temperature ranges from 4° to 45°C during different seasons. Within the village, help was sought from the village milk producers and District Cooperative Milk Producers' Unions, for identification of 4 to 5 farmers. 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 to be essential, one each from northern, eastern, western and southern directions, to cover soil types on each side of the selected village.

Further, information regarding the amount and types of feeds and fodders being offered to the animals, actual rate of daily feed intake and milk yield of individual animals was collected from individual farmer, using standard sampling procedure. Total intake was compared against the requirement 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 buffalo is available, so the standards of Kearl (1982) and NRC (2001) were taken as base for calculation of mineral requirements of buffaloes.

Sample Preparation and Analytical Methods

Composite samples of green fodder, dry fodder, individual concentrate ingredients and the compound cattle feed (concentrate mixture) were collected from all over the surveyed area. Green fodder 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 analyzed. 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 extracts was made to 25 ml with deionized water. All the samples were analyzed for calcium (Ca), phosphorus (P), magnesium (Mg), sodium (Na), potassium (K), sulphur (S), copper (Cu), zinc (Zn), manganese (Mn), iron (Fe), cobalt (Co), molybdenum (Mo) and selenium (Se) using Inductively Coupled Plasma-Optical Emission Spectroscopy (Perkin-Elmer, OPTIMA – 3300 RL). The data were analyzed statistically as per Snedecor and Cochran (1967).

RESULTS AND DISCUSSION

Feeding and Management

The survey work revealed that most of the farmers fed their animals on straws of wheat and maize in Ropar district and wheat and rice in Gurdaspur district. Amongst the green fodders, berseem (Trifolium alexandrium) and oat (Avena sativa) were fed in most of the villages in Ropar and Gurdaspur districts, under sub-mountain zone. In addition, chikori (Cichorium intybus) green, rye grass, hybrid napier, mustard green and sugarcane tops were also fed by some of the farmers. Concentrate ingredient in the form of crushed maize, wheat, barley, whole cottonseed or cottonseed cake and rice polish were fed to animals in Ropár district whereas, wheat bran and cottonseed cake were fed in Gurdaspur district. Those farmers who did not use multiple units concentrate ingredients, fed compound cattle feed available from cattle feed plants, Khanna in Ropar district and Ghania-Ke-Banger in Gurdaspur district depending upon the level of milk production. It was noticed that the farmers practise feeding their animals with 'sanni', a mixture of chaffed green and dry fodder along with concentrate feed ingredients. Interestingly, it was observed that some of the farmers supplemented the ration of animals with commercial mineral supplements.

Macro and Micro Minerals Profile of Feeds and Fodders

The profile of Ca, P, Mg, Na, K, S, Co, Cu, Fe, Mn, Mo, Se and Zn in the feeds and fodder is presented in Tables 1 and 2. The average Ca content in straws of wheat, maize and rice was low (0.23%). Berseem being leguminous family contained higher Ca, to the extent of 1.78% (Table 1). Green chikori (1.67%) being a non-legume was also a good source of Ca. Other fodders such as hybrid napier (0.43%), oat green (0.56% and rye grass (0.61%) were moderate sources of Ca. Phosphorus (P) was low in crop residues (0.09%) and green fodder (0.30%) but higher in concentrate feed ingredients (0.57%). Compound cattle feed contained around 1.0% each of Ca and P. For efficient utilization of Ca and P, Ca : P ratio should be 2 : 1 (McDowell et al. 1993). However, most of feeds and fodders showed variable Ca : P ratio which may disturb

Table 1: Macro-Mineral Content in Feeds and Fodders in Ropar District (DM basis)

Feed	Ca (%)	P (%)	Mg (%)	Na (%)	K (%)	S (%)
Critical level[a]	<0.30	<0.25	<0.20	<0.06	<0.80	<0.20
I. Dry and green roughages						
Maize straw (6)	0.33 ±0.041	0.14 ± 0.048	0.30 ± 0.041	0.025 ± 0.005	0.75 ± 0.20	0.06 ± 0.008
Rice straw (8)	0.17 ± 0.03	0.076 ± 0.013	0.18 ± 0.026	0.098 ± 0.043	0.96 ± 0.19	0.12 ± 0.024
Wheat straw (24)	0.20 ± 0.019	0.054 ± 0.003	0.11 ± 0.006	0.094 ± 0.012	1.05 ± 0.10	0.13 ± 0.008
Berseem green (21)	1.78 ± 0.082	0.46 ± 0.03	0.33 ± 0.014	1.83 ± 0.17	2.43 ± 0.18	0.21 ± 0.01
Chikori green (2)	1.67 ± 0.18	0.54 ± 0.003	0.36 ± 0.031	1.00 ± 0.045	3.89 ± 0.67	0.29 ± 0.007
Hybrid napier (2)	0.43 ± 0.10	0.27 ± 0.04	0.35 ± 0.06	0.12 ± 0.016	2.49 ± 0.27	0.11 ± 0.07
Mustard green (4)	1.35 ± 0.17	0.37 ± 0.08	0.43 ± 0.077	0.91 ± 0.10	2.85 ± 0.63	0.42 ± 0.054
Oat green (18)	0.56 ± 0.093	0.37 ± 0.029	0.21 ± 0.011	0.72 ± 0.086	3.43 ± 0.26	0.22 ± 0.015
Rye grass (3)	0.61 ± 0.17	0.36 ± 0.08	0.35 ± 0.076	0.54 ± 0.11	3.74 ± 0.46	0.33 ± 0.058
Sugarcane tops (2)	0.49 ± 0.13	0.14 ± 0.035	0.14 ± 0.035	0.078 ± 0.008	1.09 ± 0.49	0.25 ± 0.10
II. Concentrate feed ingredients						
Barley grain (1)	0.30	0.29	0.14	0.03	0.44	0.15
Cottonseeds (4)	0.19 ± 0.011	0.70 ± 0.043	0.40 ± 0.021	0.05 ± 0.01	1.30 ± 0.05	0.11 ± 0.014
Cottonseed cake (6)	0.19 ± 0.023	0.53 ± 0.04	0.34 ± 0.022	0.053 ± 0.01	1.18 ± 0.10	0.10 ± 0.012
Maize grain (5)	0.044 ± 0.013	0.33 ± 0.03	0.12 ± 0.011	0.021 ± 0.004	0.41 ± 0.042	0.11 ± 0.008
Rice polish (1)	0.13	1.23	0.57	0.043	1.09	0.15
Wheat grain (1)	0.06	0.36	0.14	0.03	0.47	0.10
Wheat bran (10)	0.12 ± 0.01	0.92 ± 0.10	0.58 ± 0.02	0.08 ± 0.001	0.78 ± 0.10	0.11 ± 0.002
Compound feed (21)	1.08 ± 0.07	1.26 ± 0.11	0.62 ± 0.051	0.64 ± 0.09	1.44 ± 0.11	0.15 ± 0.017

Figures in parentheses indicate no. of samples analyzed.
[a]Critical level = concentrations below which are low or considered deficient (McDowell et al. 1993), based on requirements for cattle (NRC, 2001).

the metabolism of these minerals when adequate vitamin D_3 is not available in the ration.

The Mg content in straws of rice and wheat was inadequate (Table 1). However, maize straw was adequate in Mg (0.30%). Amongst the green fodders, mustard green (0.43%) had the highest Mg content followed by chikori green (0.36%), rye grass (0.35%), hybrid napier (0.35%), berseem green (0.33%) and oat green (0.21%), showing that considerable quantities of Mg were available from the livestock requirement point of view. Sugarcane tops (0.14%) were poor in Mg content. Grains of barley, maize and wheat were found to contain low levels of Mg (0.14%). Whole cottonseed (Gossypium herbaceum) and cottonseed cake were good sources of Mg (Table 1). Rice polish (0.57%) and wheat bran (0.58%) were rich in Mg content. Compound cattle feed contained 0.62% Mg, a level that is higher than required as a supplement, because of its sufficiency in feed ingredients. Recommended concentrations for dietary Mg are within the

Table 2: Trace Mineral Content in Feeds and Fodders in Ropar District (DM basis)

Feed	Co (ppm)	Cu (ppm)	Fe (ppm)	Mn (ppm)	Mo (ppm)	Se (ppm)	Zn (ppm)	Cu : Mo
Critical level*	<0.10	<8.0	<50.0	<40.0	>6.0	<0.20	<30.0	...
I. Dry and green roughages								
Maize straw (6)	0.27 ± 0.093	3.88 ± 0.52	488.85 ± 72.51	52.02 ± 12.35	0.40 ± 0.12	0.34 ± 0.097	19.75 ± 2.46	9.70
Rice straw (8)	0.32 ± 0.09	2.89 ± 0.44	670.52 ± 188.8	171.34 ± 62.74	0.34 ± 0.15	1.69 ± 0.27	33.78 ± 1.33	8.50
Wheat straw (24)	0.22 ± 0.034	3.26 ± 0.50	459.67 ± 48.90	20.29 ± 1.99	0.55 ± 0.05	0.47 ± 0.099	10.53 ± 1.10	5.92
Berseem green (21)	0.49 ± 0.049	15.70 ± 1.00	671.0 ± 84.30	64.94 ± 5.84	8.76 ± 0.35	2.74 ± 0.40	48.90 ± 2.72	1.79
Chikori green (2)	1.79 ± 0.30	13.82 ± 1.71	2091.0 ± 31.72	132.75 ± 15.02	2.54 ± 1.52	0.58 ± 0.007	46.03 ± 3.76	5.44
Hybrid napier (2)	0.50 ± 0.01	15.55 ± 4.94	659.30 ± 127.0	88.86 ± 29.03	1.06 ± 0.35	1.72 ± 0.18	40.31 ± 3.47	14.66
Mustard green (4)	0.31 ± 0.083	10.51 ± 2.38	555.72 ± 185.6	67.92 ± 13.97	1.31 ± 0.73	2.28 ± 0.14	67.18 ± 20.2	8.02
Oat green (18)	0.19 ± 0.028	9.16 ± 0.76	346.70 ± 23.58	56.32 ± 3.58	0.83 ± 0.22	0.62 ± 0.17	34.18 ± 2.86	11.03
Rye grass (3)	1.07 ± 0.62	16.06 ± 3.56	711.43 ± 204.3	79.29 ± 7.19	2.88 ± 0.72	1.23 ± 0.40	57.33 ± 12.1	5.57
Sugarcane tops (2)	0.17 ± 0.06	4.50 ± 1.86	505.5 ± 42.5	47.90 ± 27.90	1.49 ± 0.60	0.47 ± 0.32	18.70 ± 4.10	3.65
II. Concentrate feed ingredients								
Barley grain (1)	0.16	6.93	161.90	29.55	0.74	0.11	65.02	9.36
Cottonseeds (4)	1.20 ± 0.23	7.15 ± 0.83	265.40 ± 42.89	19.78 ± 1.50	1.24 ± 0.26	0.33 ± 0.17	40.00 ± 2.60	5.76
Cottonseed cake (6)	0.81 ± 0.33	8.85 ± 0.75	392.50 ± 114.7	23.29 ± 3.75	0.42 ± 0.14	0.28 ± 0.076	40.75 ± 3.02	21.07
Maize grain (5)	0.18 ± 0.048	4.97 ± 0.75	324.6 ± 102.8	15.25 ± 2.84	0.57 ± 0.16	0.18 ± 0.048	33.08 ± 2.53	8.71
Rice polish (1)	0.37	12.59	1350	77.90	1.03	0.55	77.78	12.22
Wheat grain (1)	0.36	7.20	267.0	37.40	0.97	0.10	30.49	7.42
Wheat bran (10)	0.14 ± 0.01	10.36 ± 1.10	418.5 ± 16.18	86.35 ± 4.12	0.95 ± 0.10	0.21 ± 0.02	65.06 ± 3.93	10.90
Compound feed (21)	0.55 ± 0.051	12.00 ± 1.09	675.04 ± 75.83	80.49 ± 5.55	0.84 ± 0.09	0.47 ± 0.098	62.19 ± 6.27	14.28

Figures in parentheses indicate no. of samples analyzed.
*Critical level = concentrations below which are low or considered deficient or excessive in the case of Mo (McDowell et al. 1993), based on requirements for cattle (NRC, 2001).

range of 0.2-0.4% of total DMI (Underwood and Suttle, 1999; Goff, 2000). Mg 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 forages contain less than 0.20% of Mg and are high in K content (Garg *et al.* 2003).

The Na content was unduly low in dry fodder, ranged from 0.025 to 0.098%. Amongst the green fodders, green berseem (1.83%) had the highest Na content followed by chikori green (1.0%), mustard green (0.91%), oat green (0.72%) and rye grass (0.54%), showing that considerable quantities of Na were available from the green fodders from the requirement point of view. Sugarcane tops contained low Na (0.078%) and concentrate feed ingredients were also low (0.038%) in Na. However, compound cattle feed had an appropriate quantity of sodium to the extent of 0.64% because of added NaCl (Table 1). Higher potassium (K) content of feedstuffs may be due to its selective uptake from the

Table 3: Ca, P, Mg, Na, K and S requirement for a milch buffalo (450kg) producing 10 kg milk (6% fat) per day

Attribute	Tentative daily DMI (kg)	Ca (g)	P (g)	Mg (g)	Na (g)	K (g)	S (g)
Maintenance	14.00	18.00	13.00	—	—	—	—
Milk production	—	46.50	29.80	28.00	25.20	126.0	28.00
Daily requirement	14.00	64.50	42.80	28.00	25.20	126.0	28.00
Feedstuffs							
Wheat straw	4.00	4.80	1.28	2.52	2.24	25.20	4.00
Maize straw	2.00	4.00	1.68	3.60	0.30	9.00	2.20
Oat green	2.50	8.25	5.75	3.25	10.75	51.50	5.50
Berseem green	2.50	26.75	6.75	4.75	27.25	36.50	6.25
Cottonseed cake	1.00	1.20	3.20	2.10	0.32	7.00	1.60
Cattle feed	2.00	13.00	15.00	7.40	7.60	17.20	4.20
Daily availability	14.00	58.00	33.66	23.62	48.46	146.4	23.75

Table 4: Availability and requirement of Co, Cu, Fe, Mn, Zn and Se for a milch buffalo (450 kg) producing 10 kg milk (6% fat) per day

Attribute	Tentative daily	Daily mineral intake (mg)					
	DMI (kg)	Co	Cu	Fe	Mn	Zn	Se
Daily requirement	14.00	7.00	140.00	700	560.0	1120.0	4.20
Feedstuffs							
Wheat straw	4.00	0.56	7.80	1100	84.0	25.28	1.12
Maize straw	2.00	0.32	4.66	586	104.0	23.70	0.40
Oat green	2.50	0.27	13.75	520	82.5	51.27	0.92
Berseem green	2.50	0.73	23.50	1005	160.0	72.50	4.10
Cottonseed cake	1.00	0.48	5.31	235	56.0	24.45	0.16
Cattle feed	2.00	0.66	14.40	810	96.0	74.00	0.56
Daily availability	14.00	3.02	69.42	4256	582.5	271.20	7.26

soil and due to application of K based fertilizers to the soil. Similar findings were also reported by Singh et al. (2002). K content in dry and green fodders were higher (2.27%) than the concentrate feed ingredients (0.81%) and seemed to be another element like Na, which need not to be supplemented in the ration.

The S content was low in most of the crop residues (0.10%), the reason being its transfer to seed proteins. The concentrate ingredients fed to livestock in this area had also low (0.12%) S, however, green fodders had around 0.26% S (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 Co level in this zone ranged from 0.22 to 0.32 ppm in straws, 0.17 to 1.79 ppm in green fodders and 0.16 to 1.20 ppm in concentrate ingredients (Table 2). Compound cattle feed contained 0.55 ppm Co. The Co was deficient in the diet of animals to the extent of 56%, therefore, its supplementation was considered essential.

Cu level was recorded consistently low in almost all the collected feedstuffs. Straws of maize, rice and wheat contained very low level of copper (3.34 ppm). Amongst the green fodders, rye grass (16.06 ppm) had the highest Cu content followed by berseem (15.70 ppm), hybrid napier (15.55 ppm), chikori green (13.82 ppm), mustard green (10.51 ppm), oat green (9.16 ppm) and sugarcane tops (4.50 ppm). Whole cottonseed (7.15 ppm) and cottonseed cake (8.85 ppm) were low in Cu, however, rice polish (12.59 ppm) and wheat bran (10.36 ppm) were moderate source of Cu. In grains, the level was again very low (Table 2). Kumar et al. (2004) reported low Cu in feedstuffs available in sub-mountain zone of Punjab. Since Cu content was below the critical level of 8 ppm (Cuesta et al. 1993) in most of the feeds and fodders (Table 2), its supplementation in the ration of animals was considered necessary.

Distribution of Fe was found to be unique in the sense that it exceeded the requirement in all the feedstuffs, fed to livestock (Table 2). High levels of Fe in feeds and fodders were reported (Ramana et al. 2001; Udar et al. 2003; Mandal et al. 2004; Garg et al. 2005) in different agro-climatic zones of India. Even straws were quite rich in Fe (>450 ppm). Amongst the green fodders, chikori green (2091 ppm) had the highest Fe content followed by rye grass (711 ppm), berseem green (671 ppm), hybrid napier (659 ppm), mustard green (555 ppm), sugarcane tops (505 ppm) and oat green (346 ppm). Grains of barley, maize and wheat contained around 250 ppm Fe while rice polish (1350 ppm) was rich in Fe. Whole cottonseeds and cottonseed cake contained 265 and 392 ppm Fe, respectively. The Fe concentration in majority of feed ingredients was very high and could probably interfere with the copper absorption (Bremmer et al. 1987; Youssef et al. 1999), which needs to be investigated. In view of very high levels of Fe in all the feeds and fodders, its supplementation was not considered necessary.

Straws of maize and wheat contained 36 ppm Mn. However, rice straw (171 ppm) was quite rich in Mn. The average Mn content was comparatively higher in green fodders (76 ppm). Amongst the concentrate ingredients, rice polish (77.90 ppm) had the highest Mn content, followed by wheat bran (86.35 ppm), wheat grain (37.40 ppm), barley grain (29.55 ppm), cottonseed cake (23.29 ppm), cottonseeds (19.78 ppm) and maize grain (15.25 ppm). Compound cattle feed contained about 80 ppm Mn (Table 2). Similar to Fe, Mn supplementation was also not considered necessary, as overall ration of animals was adequate.

The Mo level in the samples of crop residues was within the safe limit (Table 2). Mo content in straws ranged from 0.34 to 0.55 ppm. Amongst the green fodders, berseem green (8.76 ppm) had the highest Mo content followed by rye grass (2.88 ppm), chikori green (2.54 ppm), sugarcane tops (1.49 ppm), mustard green (1.31 ppm), hybrid napier (1.06 ppm) and oat green (0.83 ppm). Cottonseeds and rice polish contained 1.24 and 1.03 ppm Mo, respectively. Most of the feedstuffs contained Mo level within the safe limit and gave Cu : Mo ratio wider than 3.0. However, berseem green was high in Mo content and gave Cu : Mo ratio below 2.0. Kumar et al. (2004) reported high Mo level in green fodders in Punjab. Suttle (1991) 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). In case of ruminants, Mo reacts with sulphur in the rumen and forms mono-, di-, tri- and tetra-thiomolybdates (Suttle, 1991). Thiomolybdates can cause Cu deficiency by reacting with dietary copper in the digestive tract and making it unavailable for absorption and utilization (Nelson, 1988).

None of the fodders offered was deficient in Se rather the levels were on the higher side (Table 2). Se content of the crop residues varied from 0.34 to 1.69 ppm. Amongst the green fodders, berseem green (2.74 ppm) had the highest Se content, followed by mustard green (2.28 ppm), hybrid napier (1.72 ppm), rye grass (1.23 ppm), oat green (0.62 ppm) and chikori green (0.58 ppm). Grains had 0.13 ppm Se. Whole cottonseed and cottonseed cake contained 0.33 and 0.28 ppm Se, respectively. Selenium acts as an antioxidant and is essential constituent of glutathione peroxidase which destroys peroxides before they can attack cellular lipid membranes. The minimum dietary Se requirement 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 would satisfy requirement of Se. Therefore, its supplementation in the ration is not advocated.

Zn deficiency in feeds and fodders of many agro-climatic zones of the country has been reported (Ramana et al. 2001; Garg et al. 2002; Udar et al. 2003). In sub-mountain zone of Punjab, Zn was found to be deficient in straws of maize, rice and wheat. The zinc content of the green fodders varied from 18 to 57 ppm (Table 2). Grains contained 42.83 ppm Zn, while rice polish was an exception with higher Zn content (77.78 ppm). Wheat bran contained 65 ppm Zn. Whole cottonseed and cottonseed cake contained 40 ppm Zn. Zinc content was found below the critical level (30 ppm) in most of the crop residues and need to be supplemented to reach a level of 80 ppm in the total ration (Arora, 1981) of animals to overcome its deficiency.

Requirement and Availability of Macro and Micro-Minerals for Milch Buffaloes

Daily intake and requirement of different minerals by a milch buffalo (450 kg body weight) yielding 10 kg milk (6% fat) in villages of Ropar and Gurdaspur districts are presented in Tables 3 and 4. Since mineral mixture supplementation was not being practised by the farmers, intake of minerals through feeds and fodders was taken as the index of total dietary supply and compared with the recommended requirement to know the dietary mineral status.

A buffalo yielding 10 kg milk per day would need 64.50 g Ca, whereas, feeds and fodders available in the area when fed as per diet formulation given in Table 3, would provide 58.0 g Ca, showing adequacy. Calcium was found to be deficient in the ration of animals, when green berseem was not available. Under such conditions, milk production is likely to be affected and freshly calved animals may suffer from milk fever (McDowell et al. 1993). The estimated value of P from feedstuffs was 33.66 g against the requirement of 42.80 g per day for a milch buffalo yielding 10 kg milk, showing a deficiency of 9.14 g per day (Table 3). Singh et al. (2005) found deficiency of P in dairy animals and suggested mineral supplementation in different agro-climatic zones of Punjab. Furthermore, bioavailabilty of P from plant sources has been reported to be low due to phytic acid-P (McDowell, 1992), leading to problems of pica, infertility and haemoglobinuria in animals (Garg et al. 2005).

The Mg requirement of a milch buffalo yielding 10 kg milk per day was 28.0 g (Table 3), whereas, feeds and fodders fed in that area provided 23.62 g of Mg per day, showing marginal deficiency. The availability of Na and K from feed sources was adequate for a buffalo yielding 10 kg per day (Table 3). However, Na was found to be deficient in the diet of animals, when green oat and berseem fodder were not available. The availability of S from feed sources was 23.75 g and the requirement was 28.0 g per day, showing a deficiency of 4.25 g per day, for milch buffalo yielding 10 kg milk per day. Hence, sulphur supplementation was necessary in the ration of animals (McDowell, 1992, Garg et al. 2003).

Similarly, the buffalo yielding 10 kg milk day, would need 7.0 mg cobalt per day, as per the standard requirements, whereas, feeds and fodders available in the area when fed, provide only 3.02 mg Co, showing a deficiency of cobalt (Table 4). Copper status from traditional feeds and fodders fed to a buffalo, with this level of milk production, was 69.42 mg against the requirement of 140 mg per day (Table 4). Randhawa and Randhawa (2002) also reported Cu deficiency in dairy animals in Punjab. Availability of Fe from feed resources was 4256 mg and the requirement was only 700 mg per day (Table 4). Adequate Mn availability from feeds and fodder was recorded in other parts of country (Garg et al., 2000; Yadav et al. 2002). The milch buffalo yielding 10 kg milk per day, require 560 mg Mn per day, whereas, feed sources provided 582.5 mg (Table 4), showing adequacy of Mn.

For the milch buffalo with 10 kg milk per day, requirement difference for Zn was to the extent of 848.8 mg per day, with the traditional feeding system (Table 4). Mastitis, night blindness, parakeratosis and reproductive failure are the ailments, which may result from its deficiency (McDowell, 1992; Singh and Pachauri, 2001). The role of Cu and Zn in augmenting production and reproduction is well documented (Garg et al. 2008) 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; Prasad and Gowda, 2005). Probably that is the reason that many animals in this zone had reproductive problems like anestrous and repeat breeding. Excess Se availability from feeds and fodder was recorded in other parts of country (Garg et al., 2005). The milch buffalo yielding 10 kg milk per day, require 4.20 mg Se per day, whereas, feed sources provided 7.26 mg (Table 4), showing adequacy of Se.

CONCLUSION

It is apparent from the present study that the milch buffaloes in various talukas of Ropar and Gurdaspur districts under sub-mountain zone were deficient in calcium, phosphorus, magnesium, sulphur, cobalt, copper and zinc with the available feed resources in that zone. Therefore, it is necessary to supplement these minerals in the ration by formulating area specific mineral mixture, having highly bioavailable mineral salts. However, the levels of some other mineral elements such as sodium, potassium, iron, manganese, selenium and molybdenum were found to be adequate or even in excess in the diet of animals and may not be supplemented in the ration.

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REFERENCES

Arora, S. P. 1981. Zinc and Vitamin A Relationship in Metabolism. In Gawthorne, J. M. *et al.* (ed.). TEMA4 (pp.572). Perth, Australia: Springer-Verlag, Berlin, New York.

Bremmer, I.; Humphries, W. B.; Phillippo, M.; Walker, M. J. and Morrice, P. C. 1987. Iron Induced Copper Deficiency in Calves. Dose Response Relationships and Interactions with Molybdenum and Sulphur. *Anim. Prod.* **45**:403-414.

Campbell, M. H.; Miller, J. K. and Schrick, F. N. 1999. Effect of Additional Cobalt, Copper, Manganese and Zinc on Reproduction and Milk Yield of Lactating Dairy Cows Receiving Bovine Somatotropin. *J. Dairy Sci.* **82**:1019.

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. Commun. *Soil Sci. Plant Anal.* **24**:335-347.

Garcia-Gomez, F. and Williams, P. A. 2000. Magnesium Metabolism in Ruminant Animals and Its Relationship to Other Inorganic Elements. *Asian-Austral. J. Anim. Sci.* **13**:158-170.

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 J. Dairy Sci.* **53**:291-297.

Garg, M. R.; Bhanderi, B. M. and Sherasia, P. L. 2002. Trace Minerals Status of Feeds and Fodders in Junagadh District of Gujarat. *Indian J. Dairy Sci.* **55**: 154-158.

Garg, M. R.; Bhanderi, B. M. and Sherasia, P. L. 2003. Macro-Mineral Status of Feeds and Fodders in Kutch District of Gujarat. *Anim. Nutr. Feed Tech.* **3**:179-188.

Garg, M. R.; Bhanderi, B. M. and Sherasia, P. L. 2005. Assessment of Adequacy of Macro and Micro-Mineral Content of Feedstuffs for Dairy Animals in Semi-Arid Zone of Rajasthan. *Anim. Nutr. Feed Tech.* **5**:9-20.

Garg, M. R. 2006. Nutritional Approaches Relevant to Dairy Animals in India. *Indian Dairyman*, **58**:37-43.

Garg, M. R.; Bhanderi, B. M. and Gupta, S. K. 2008. Effect of Supplementing Certain Chelated Minerals and Vitamins to Overcome Infertility in Field Animals. *Indian J. Dairy Sci.* **61**:181-184.

Goff, J. P. 2000. Patho-Physiology of Calcium and Phosphorus Disorders. Vet. Clin. North America: *Food Anim. Prac.* **16**:319-337.

Kearl, L. C. 1982. Nutrient Requirements of Ruminants in Developing Countries. International Feedstuffs Institute, Utah State University, UMC 46, Logan, Utah 84322 USA.

Kumar, A.; Rajiv Singh and Randhawa, S. S. 2004. Trace Element Status of Buffaloes from Sub-Mountainous Region of Punjab. *Indian J. Vet. Med.* **24**(1):23-27.

Mandal, A. B.; Yadav, P. S. and Vanita Kapoor. 2004. Mineral Status of Buffaloes Under Farm Feeding Condition of Faridabad District of Haryana State. *Indian J. Anim. Nutr.* **21**:104-110.

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

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).

McDowell, L. R. and Arthington, J. D. 2005. Minerals for Grazing Ruminants in Tropical Regions. Animal Science Department, Centre for Tropical Agriculture, University of Florida. 4th Ed. pp. 33-34.

Nelson, J. 1988. Review of Trace Mineral Chelates and Complexes Available to the Feed Industry. Western Nutrition Conference, Winnipeg, Manitoba, September, p.1.

N.R.C. 1980. National Research Council, Mineral Tolerances of Domestic Animals, National Academy of Sciences, Washington, D.C.

N.R.C. 2001. Nutrient Requirements of Dairy Cattle, 7th Revised edn. National Academy of Sciences, Washington, D.C.

Prasad, C. S. and Gowda, N. K. S. 2005. Importance of Trace Minerals and Relevance of Their Supplementation in Tropical Animal Feeding System: A Review. *Indian J. Anim. Sci.* **75**(1):92-100.

Ramana, J.; Prasad, C. S.; Gowda, N. K. S. and Ramachandra, K. S. 2001. Levels of Micro-Nutrients in Soil, Feed, Fodder and Animals of North East Transition and Dry Zones of Karnataka. *Indian J. Anim. Nutr.* **18**:235-242.

Randhawa, C. S. and Randhawa, S. S. 2002. Copper Status of Crossbred Cows of the Organized and Rural Dairy Herds in Central Punjab. *Indian J. Anim. Sci.* **72**:1087-1091.

Singh, S. V. and Pachauri, S. P. 2001. Zinc, Immunity and Mastitis, *Pashudhan* **16**:1.

Singh, K. K.; Nag, S. K.; Pailan, G. H., Kundu, S. S.; Garg, M. R. and Bhanderi, B. M. 2002. Sodium and

Potassium Contents of Some Common Forages. *Indian J. Anim. Nutr.* **19** : 378-380.

Singh, R.; Randhawa, S. S. and Kumar, A. 2005. Macro-Mineral Status of Crossbred Cattle of Shivalik Hills in Relation to Soil and Fodder. *Indian J. Anim. Sci.* **75**:1179-1182.

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

Suttle, N. F. 1991. The Interactions Between Copper, Molybdenum and Sulphur in Ruminant Nutrition. *Annual Rev. Nutr.* **11**:121-140.

Udar, S. A.; Chopde, S. and Dhore, R. N. 2003. Mineral Profile of Soil, Feeds and Fodder and Buffaloes in Western Agro-Climatic Zone of Vidarbha. *Anim. Nutr. Feed Tech.* **3**:165-172.

Underwood, E. J. and Suttle, N. F. 1999. The Mineral Nutrition of Livestock. 3rd ed. CAB International Publishing Co.

Yadav, P. S.; Mandal, A. B. and Dahiya, D. V. 2002. Feeding Pattern and Mineral Status of Buffaloes in Panipat District of Haryana State. *Anim. Nutr. Feed Tech.* **2**:127-138.

Youssef, F. G.; McDowell, L. R. and Brathwaite, R. A. I. 1999. The Status of Certain Trace Minerals and Sulphur of Some Tropical Grasses in Trinidad. *Tropical Agri.* **76**:57-62.