Journal of Animal Research: v.5 n.2, p. 341-346. June 2015

DOI Number: 10.5958/2277-940X.2015.00059.5

Minerals Profile of Soil, Feed, Fodder and Serum of Dairy Cattle in North Eastern Ghat (NEG) of Odisha

M.K.Panda[1*], N.Panda[1], R.K.Swain[1], P.C.Behera[2], S.P.Sahoo[3], S.C.Jena[4] and A.R.Sahu[4]

[1]Department of Animal Nutrition, Orissa University of Agriculture and Technology, Bhubaneswar, Odisha, INDIA
[2]Department of Veterinary Biochemistry, Orissa University of Agriculture and Technology, Bhubaneswar, Odisha, INDIA
[3]Division of Livestock Production Management, Indian Veterinary Research Institute, Izatnagar, Bareilly, Uttar Pradesh, INDIA
[4]Division of Veterinary Biotechnology, Indian Veterinary Research Institute, Izatnagar, Bareilly, Uttar Pradesh, INDIA

**Corresponding author: MK Panda; Email: drmkpanda9@gmail.com*

Received: 26 November, 2014 **Accepted:** 21 May, 2015

ABSTRACT

A survey based study was planned in North Eastern Ghat (NEG) of Odisha to analyse the mineral profile of soil, feed, fodder and serum of dairy cattle. This agro-climatic zone comprises of four districts namely Kandhamal, Ganjam, Raygada and Gajapati. Amongst those two districts viz Ganjam and Gajapati are taken for the study considering the density of dairy cattle population. In the similar manner two Blocks from Ganjam District namely Khallikote, Kukudakhandi and two blocks from Gajapati District namely Mohana, R.Udayagiri was considered for our experimental area with two villages from each of the block. Macro and micro minerals like Calcium (Ca), Phosphorus (P), Zinc (Zn), Copper (Cu), Manganese (Mn) and Iron (Fe) were estimated for soil, feed, fodder and serum. Soil Ca was estimated by rapid titration method and available soil phosphorus was determined by colorimetric analysis. The soil micro minerals like Cu, Fe, Zn and Mn were analyzed as per the method of Lindsay and Lindsay (1978). Dry ash and Wet ash method were used for analysis of macro and micro minerals respectively for feed and fodder. The concentration of Ca and P in serum was estimated by using the kit method. The serum micro minerals like Cu, Fe, Zn and Mn were estimated by Atomic Absorption Spectrophotometer method. The findings depicted that cattle of this region are severely deficient in Ca, Zn, and Cu and marginally deficient in P and Mn with higher value of Fe content than the respective critical levels. Considering the importance of productivity and reproductive performance of dairy animal an area specific mineral mixture must be prepared and fed to the animals to meet the deficiencies of these minerals.

Keywords: Macro and Micro mineral, Odisha, Serum, Feed and fodder, Soil

The livestock of Odisha are mostly dependent on forages of different types with a wide variation in mineral content according to soil and season. Minerals play an integral role for the growth, production and reproduction of both plants and animals. Being structural components and a constituent of body fluids and tissues, minerals act as electrolytes and catalysts in enzyme and hormone system (Sharma *et al.*, 2007). They constitute about 3 per cent of body weight of animals (Reddy, 2001). Either of their deficiency, imbalance, and toxicity severely inhibits both production and reproduction in living being (Kumar *et al.* 2011). Large numbers of livestock in many parts of the world consumes mineral deficient diets and suffers from nutritional disorders. To alleviate this mineral deficiencies, recommendation of a mineral mixture of fixed composition for dairy animals of the wide and diversified agro-geological conditions, across the country is quite questionable. In Odisha, the use of mineral mixture is out of bound for most of the livestock owners. Besides the economic constraints, there exists a lack of awareness regarding the positive impact of mineral supplementation in terms of enhance productivity. In such a situation, a blanket recommendation to use one or two percent mineral mixture in the diet of dairy animals seems highly irrelevant. Odisha being a large state with diverse climatic conditions, soil type, rain fall etc. is divided into ten agro-

climatic zones and requires a zone-wise assessment of mineral profile of available feed and fodder. . Hence the present study was planned to assess the mineral status of the soil, feed and fodders along with the mineral status of the animals present in the NEG region of Odisha.

MATERIALS AND METHODS

The survey was carried out in the NEG region of Odisha (between 29°-29°4' N latitude and 82°15' E longitude). This agro-climatic zone comprises of four districts namely Kandhamal, Ganjam, Raygada and Gajapati. Amongst those two districts viz Ganjam and Gajapati are taken for the study considering the density of dairy cattle population. In the similar manner two Blocks from Ganjam District namely Khallikote, Kukudakhandi and two blocks from Gajapati District namely Mohana, R.Udayagiri was considered for our experimental area with two villages from each of the block. The average rainfall is about 1597 mm with mean maximum and minimum temperature variation of 37 °C and 10.4 °C. The important soil groups of NEG are lateritic, brown forest, red, red and yellow soil which is sandy loam in texture, moderate to highly acidic in reaction and medium in fertility which favours rice as the principal crop with other important crops like maize, green gram, groundnut, sesame, mustard, sugarcane, cotton and spices like turmeric, chilly, ginger, onion and vegetables. The feeding practices were all predominantly based on dry fodder, the most popular being paddy straw. Concentrate feeds were only fed to milking animals and to working animals during work season. The most popular feed ingredients are rice bran, wheat bran and chuni balanced concentrate feeds, maize, oil cakes etc.

Collection of soil sample

The 16 representative soil samples from eight different villages were taken from two districts of NEG region of Odisha. The top soil was scrapped to remove surface litter. Then uniformly thick (2.5 cm) slice of soil sample was taken from the surface of the plough depth (15 cm) by digging 'V' shaped hole from number of spots using pickaxe and khurpi (Trowell). About 250 grams of soil sample were collected and stored in plastic packets for further analysis.

Collection of feed and fodder samples

Representative samples of paddy straw and grazing green grass, agricultural by products, feed ingredients and compounded feed were collected from the grazing land of the village and from the farmers. About 250 grams of samples of these collected and all the samples were first air dried in shade and thereafter, in hot air oven at 80° C for 24 hours, then ground to 1 mm particle size and stored in acid washed glass container for further analysis of major and trace elements. The details of the forages/feedstuffs collected are given in Table 1.

Table 1. Forages and feedstuffs collected from the surveyed areas

Sl. No.	Feed and Fodders	Specific name of the samples
	A. Green roughages	
1.	Local mixed grass	Cynodon dactylon and Mixed grass
	B. Dry roughages	
	Dry roughages	
1.	Cereal straws	Paddy straw
2.	Legume straws	Black gram straw,
	C. Concentrates	
	Concentrates	
1.	Cereal grain and by-products	Rice bran, wheat bran,
2.	Pulse chuni and husk	Pulse chuni
3.	Oil cakes ..	Ground nut oil cake
4.	Commercial concentrate mixture	Compounded feed

Collection of blood samples

Blood samples were collected from 20 healthy animals from each village for serum mineral estimation.

Parameters studied

Macro and micro minerals like Ca, P (i), Zn, Cu, Mn and Fe were estimated for soil, serum and feed and fodder. Soil Ca was estimated by rapid titration method described by Piper (1966) and available soil phosphorus was determined calorimetrically (Olsen *et al.,* 1954). The micro minerals like Zn, Cu, Mn and Fe were analyzed as per the method of Lindsay and Lindsay (1978). The serum micro minerals like Cu, Fe, Zn and Mn were estimated by Atomic Absorption Spectrophotometer (AAS) method as described by Piper (1966). Dry ash and Wet ash method were used for analysis of macro and micro minerals respectively for feed and fodder (AOAC, 2007).The concentration of Ca and P(i) in serum was estimated by using the kit method i.e. NICE Chemicals Pvt. Ltd and LABKIT, CHEMELEX, S.A respectively.

Statistical analysis

The statistical analysis of the data was done according to Snedecor and Cochran (1994). The data were analyzed for analysis of variance (ANOVA) and DMR test (Duncan, 1955) was used to test the difference in treatment means.

RESULTS AND DISCUSSION

Mineral profile of soil

The mineral status of the soil in the surveyed zones is presented in Table 2. The Ca content of the soil in the surveyed zone was 0.12% which is much below the critical level (0.80%). Sharma *et al. (*2003), Ghanwat *et al.* (2004) and Kawitkar (2004) reported that the level of Ca of the soils of different locations of India were much above the critical level. Except Fe all the macro and micro minerals of the soil was much below the critical level. The phosphorus status of the soil of NEG is below the critical level. This can be attributed to the low pH of the soil in NEG region and the ionic acidity of the soil induces the formation of complex with Fe and the availability of inorganic phosphorus is reduced. The average Zn, Cu and Mn content of the soil was higher than the critical level as suggested by Ali *et al.* (1992) and Sahu *et al.* (1992). Higher Fe status of this region showed that the soil is very rich in Fe. This is because most of the Fe and Mn mines are located in Odisha. Baruah *et al.* (2000) reported soil Fe content 24.26 ppm in Mandira, Assam. Ramana *et al.* (2001) reported soil Fe content 69.4 to 72.5 ppm of in North East Zone of Karnataka and Das *et al.* (2003) reported 107 ppm in West Bengal.

Mineral contents of feed and fodders

The mineral content of feed and fodders are presented in Table 3. The Ca content of the black gram straw is higher than the paddy straw. This can be attributed to high uptake of Ca from the soil by the legumes than the cereals. This observation corroborates with the findings of Ramana *et al.* (2001), who reported 2% to 2.60% of Ca in black gram and green gram fodders. Mishra *et al.*(2006) also reported higher Ca content in legume straw than the critical level in the Dhenkanal district of Odisha. Rice bran, wheat bran, ground nut oil cake (GNOC) and compounded feed contain higher level of Phosphorus than that of critical level. Garg *et al.* (2004) reported similar range of phosphorus in rice bran and wheat bran as observed in the present study. However lower phosphorus level was observed by Kawitkar (2004) who reported 0.98% of phosphorus in wheat bran. The Mn content of the maize, paddy straw

Table 2. Mineral status of the soil in NEG of Odisha

	Ganjam			Gajapati			North	Critical
Minerals	Khallikote	Kukudakhandi	Average	Mohana	R.Udayagiri	Average	Eastern Ghat	Value
Ca (%)	0.12±0.01	0.14±0.01	0.13±0.01	0.11±0.01	0.13±0.01	0.12±0.01	0.12±0.01	0.80
P (%)	5.28±0.09	4.75±0.08	5.01±0.08	6.46±0.12	5.39±0.09	5.93±0.10	5.47±0.09	6.79
Zn (ppm)	1.18±0.03	1.34±0.05	1.26±0.04	0.97±0.02	1.23±0.03	1.10±0.02	1.18±0.03	0.60
Cu (ppm)	1.86±0.04	2.23±0.07	2.04±0.06	2.42±0.07	3.22±0.08	2.82±0.07	2.43±0.07	0.30
Mn(ppm)	34.56±1.06	26.25±1.01	30.40±1.04	36.84±1.37	24.32±0.98	30.58±1.05	30.49±1.05	5.00
Fe (ppm)	36.42±1.36	39.26±1.43	37.84±1.37	65.23±2.68	58.46±2.31	61.85±2.37	49.85±2.10	2.50

Table 3. Mineral status of the feed and fodders of NEG of Odisha

Feed and Fodders	Minerals					
	Ca (%)	P (%)	Mn (ppm)	Cu (ppm)	Zn (ppm)	Fe (ppm)
Paddy Straw	0.27 ±0.01	0.11 ±0.42	24.50 ±0.24	8.16 ±1.02	25.80 ±0.25	128.24 ±1.52
Rice bran	0.29 ±0.24	0.68 ±0.45	40.90 ±1.24	24.23 ±0.12	42.77 ±0.05	179.06 ±1.24
Maize	0.30 ±0.08	0.50 ±0.02	19.16 ±0.23	7.29 ±1.25	34.55 ± 0.64	138.48 ±2.31
	0.45 ±0.05	0.19 ±0.04	40.32 ±0.25	41.36 ±0.56	29.31 ± 0.08	224.16 ±1.02
Mixed grass	0.61 ±0.21	0.13 ±0.03	30.67 ±0.27	26.04 ± 0.45	27.94 ± 0.24	213.72 ±1.25
Compound feed	0.95 ±0.01	0.45 ±0.56	55.58 ±0.85	20.10 ±0.86	32.42 ±0.56	213.76 ±1.05
GNOC	0.53 ±0.21	0.82 ±0.25	49.24 ±0.05	34.73 ±0.12	49.47 ± 0.25	221.84 ±1.63
Wheat bran	0.54 ±0.21	0.71 ±0.32	46.40 ±0.21	5.10 ±0 .12	47.38 ±0.65	149.98 ±1.25
Black gram straw	0.35 ±0.21	0.11 ±0.45	22.38 ±0.25	31.56 ±0.59	39.28 ±0.62	135.97 ±1.69
Critical Level[1]	0.30	0.25	40.00	8.00	30.00	50.00

[1]McDowell *et al.* (1993) based on requirements for cattle (NRC, 2001).

and rice bran are below the critical level and other feed ingredients have higher level of Mn than compounded feed. The variation of Mn concentration in some roughage might be due to effect of climate, stages of maturity and forage management. The observed values were in agreement with Kawitkar (2004). The lower Cu values were found in paddy straw, maize and wheat bran in the zone and higher values were observed in dub grass, mixed grass, rice bran and compounded feeds. Garg *et al.* (2004) reported lower Cu content (5.4 ppm) in the straw. Higher Zn concentration was seen in GNOC and varied from 47.78 ppm to 49.47 ppm and the lowest value was seen in paddy straw which ranged from 25.80 ppm to 33.38 ppm. It is generally observed that plant protein concentrate are variably high in Zn content than cereal grains. Deficient Zn content in dry fodders was reported by Sharma and Joshi (2004).The Fe content of all the feed and fodders are much above the critical levels which is due to higher Fe content of the soil and higher up take of Fe from the soil as well. Gowda *et al.* (2001) reported 592 ppm of Fe in paddy straw and Yadav *et al.* (2002) reported 530 ppm Fe in wheat straw.

Table 4. Serum mineral concentration of the animals in NEG of Odisha

Minerals	Ganjam	Gajapati	Noth-Eastern Ghat	Critical level[1]
Ca (mg/dl)	7.22 ±0.33	6.16 ±0.52	6.69 ±0.49	8.00
P (mg/dl)	4.25 ±0.20	4.44 ±0.21	4.35 ±0.22	4.50
Mg (mg/dl)	0.89 ±0.04	0.82 ±0.04	0.86 ±0.04	1.20
Zn (ppm)	0.35 ±0.15	0.37 ±0.03	0.36 ±0.03	0.60
Cu (ppm)	0.41 ±0.03	0.34 ±0.02	0.38 ±0.02	0.65
Mn (ppm)	0.29 ±0.02	0.33 ±0.04	0.31 0.03	0.20
Fe (ppm)	1.17 ±0.13	1.49 ±0.42	1.33 ±0.36	1.00

[1]McDowell (1993).

Serum macro mineral status

The serum P(i) levels of the cattle of NEG were 4.35 mg/dl which were above the critical level. But the percentage of animals below critical level is 54.3%. It shows that more than 50% of the animals are showing deficiency of phosphorus. Higher Fe concentration in the soil, feed and fodders causes precipitation of P(i) making it unavailable to plants, subsequently to animals. One of the reasons of phosphorus deficiency is that the basal feed available for animal was mainly Paddy straw which was found severely deficient in phosphorus. Kawitkar (2004) reported significantly lower phosphorus level in summer than autumn and winter season. The variations found between the animals maintained by different categories of farms did not show statistical significance. The average Mg concentration of both the district of NEG was 0.89 mg/dl and 0.82 mg/dl with an average of 0.86 mg/dl. The Mg level in the serum of the zone is slightly below the critical

level. Magnesium is one of the important macro minerals which is necessary for many enzyme systems and plays an important role in carbohydrate metabolism and necessary for proper function of nervous system. Gowda *et al.* (2001) found that the serum Mg level of cattle and buffaloes ranged from 2.0 to 3.70 mg/dl, which is much above the critical level in coastal zone of Karnataka. In the present study there is a great variation in Mg level which ranges from 0.48 to 3.12mg/dl in different animals. This might be due to the animals which have access to green fodders might have better Mg status than the animals reared in dry fodders.

Serum micro minerals status

Micro minerals are an integral part of nutrient management system as they are essential for growth, reproduction and immunity. Similar to present study, Ramana *et al*. (2000) had reported up to 50% and Mishra *et al.* (2006) up to 46% of cattle showed the serum Zn below critical level. Kawitkar (2004) also reported lower serum Zn value in lactating animals than pregnant animals and heifers. Zn as co-factors of more than 100 enzymes in the body is one of the most important trace elements required for reproduction and immunity. Therefore, most of the cattle in the zone surveyed have more reproductive problems like anoestrus, repeat breeding and wide post partum interval, which can be alleviated through suitable feeding of trace minerals like Zn and Cu. The serum Cu concentration of NEG was 0.38 ppm. The animals of NEG showed drastically lower Cu concentration than the critical value. More than 40% of animals here were deficient in Cu concentration. Although the Cu content of soil, feed and fodders of this zone is marginally higher than the critical level, the deficiencies of Cu is observed in the serum of cows. This might be due to poor bioavailability of Cu resulted from the increased lignifications of the fodders in tropical countries (McDowell, 1993). The variation in the serum Cu level of the animals in this region might be attributed to the variation in the soil type, plant composition and the difference in feeding pattern. In addition the grazing animals might be receiving substantial amount of Fe by soil ingestion which could negatively affect the absorption of Cu and other elements. Gowda *et al.* (2001), Yadav (2002) and Singh *et al.* (2004) reported deficiency of serum cu concentration in most of animals in different parts of India. Serum Fe concentration in most of the animals in surveyed zone were above critical level even without any mineral supplementation. This might be due to abundance of Fe in feed and fodder grown of naturally Fe rich soil. It was in agreement with the earlier findings of many workers like Dutta *et al.* (2000), Das *et al.* (2002), Mandal *et al. (*2003) and Sukla *et al.* (2010). The temperature was the primary factors effecting Fe availability and uptake by the plants which contribute the higher serum Fe content of the dairy animals.

CONCLUSION

Cattle of these zones are severely deficient in Ca, Zn, and Cu and marginally deficient in P and Mn. Mineral mixture may be prepared and fed to the animals for better productivity and reproductive performance to meet the deficiencies of these minerals. Further research should be continued after feeding the suitable mineral mixture to the cattle with optimal feeding of protein and energy to ameliorate their deficiencies to validate the findings of this study.

ACKNOWLEDGMENTS

The authors are gratified to the Orissa University of Agriculture and Technology, Bhubaneswar, Orissa for providing a valuable platform to carry out this research programme.

REFERENCES

Ali, M.H., Ghosh, K.K., Mohana, D.P. and Goswami, C. 1992. Distribution of available micronutrients and their association with some soil characteristics in soil of Orissa. Proceedings of the workshop on micronutrients held at Bhubaneswar, Orissa. **22:** 93-102.

AOAC, 2007. Official Methods of Analysis of the Association of Official Analytical Chemists International, 18th ed. Gaithersburg, MD, USA.

Baruah, K.K., Newar, S., Baruah, A. and Bhuyan, D. 2000. Status of macro and micro mineral levels in postpartum anoestrus swamp buffaloes in relation to soil and plants. *Ind. J. Dairy Sci*., **53(6):** 424-427.

Das, A., Haldar, S., Biswas, P. and Ghosh, T.K. 2003. Distribution of some major and trace elements in soil, feed, fodder and livestock in red laterite zone of West Bengal. *Ind. J. Anim. Nutr*., **20(2):** 136-142.

Das, P., Biswas, S., Ghosh, T.K. and Haldar, S. 2002. Micronutrient status of dairy cattle maintained by farmers

in the new alluvial zone of West Bengal. *Anim. Nutri. Feed Technol*., **2:** 19-26.

Duncan, D.B. 1955. Multiple range and multiple "F" tests. *Biometrics*., **11:** 1-42.

Dutta, A., Baruah, B., Sarmah, B.C., Baruah, K.K., Sarmah, D.N. and Dutta, J.C. 2000. Micro mineral profiles during cyclic, post partum anoestrus and repeat breeding cows in lower Brahmaputra valley of Assam. *Ind. J. Anim. Sci*., **70(7):** 712-713.

Garg, M.R., Bhanderi, B.M. and Sherasia, P.L. 2004. The status of certain trace minerals in feed and fodders in Kutch district of Gujarat. *Ind. J. Anim. Nutr.*, **21 (1):** 8-12.

Gowda, N.K.S., Prasad, C.S., Ramana, J.V. and Shivaramaiah, M.T. 2001. Mineral status of soil, feeds, fodders and animals in coastal agri-eco zone of Karnataka. *Anim. Nutr. Feed Tech*., **1:** 97-104.

Ghanwat, D.V. 2004. Studies on mineral profile in certain parts of Vidarbha. MV.Sc. Thesis submitted to Maharashtra Animal and Fishery Sciences University, Nagpur.

Kawitkar, S.B. 2004. Mineral status of Deoni animals in relation to soil feed and fodders in Udgir Taluka of Maharashtra State. Ph.D thesis submitted to MAFSU, Nagpur.

Kumar, S., Pandey, A.K., AbdulRazzaque, W.A. and Dwivedi, D.K. 2011. Importance of micro minerals in reproductive performance of livestock. *Vet. World*., **4(5):** 230-233.

Lindsay, W.L. and Norvell, W.A. 1978. Development of DTPA soil test for Zn, Fe, Mn and Cu. *Soil Sci. Soc. Am. J*., **42:** 421-428.

Mandal, M., Payne, S.K. and Samanta, G. 2003. Mineral status of feeds, fodders and its influence on buffaloes and its products in red laterite zone of West Bengal. In: Proceedings of 4th Asian Buffalo Congress. New Delhi, India. pp. 161-162.

McDowell, L.R., Conrad, J.H. and Glen Hembry, F. 1993. Minerals for grazing ruminants in tropical regions. 2nd Ed. Animal Science Department. Center for Tropical Agriculture, University of Florida. pp. 77-80.

Mishra, S.K. 2006. Effect of supplementation of minerals on the reproductive performance of cows in Dhenkanal district of Orissa. Ph.D. thesis submitted to Orissa University of Agriculture and Technology, Bhubaneswar, Orissa.

Olsen, S.R., Cole, C.V., Watnabe, F.S. and Dean, L.A. 1954. Estimation of available phosphorus by extraction with sodium bicarbonate. U.S. Department of Agriculture, CIRC. pp. 939-945.

Piper, C.S. 1966. Soil plant analysis. Hans Publication. Bombay. pp. 135-136.

Ramana, J.V., Krishna, N. and Raghavarao, E. 2001. Levels of micronutrients in soil, feed, fodder and animals of northeast transition and dry zones of Karnataka. *Ind. J. Anim. Nutr.,* **18(3):** 235-242.

Ramana, J.V., Prasad, C.S. and Gowda, S.K. 2000. Mineral profile of soil, feeds, fodders and blood plasma in southern transition zone of Karnataka. *Ind. J. Anim. Nutr*., **17:** 179-183.

Reddy, D.V. 2001. Principles of animal nutrition and feed technology. 1st Ed., Oxford and IBH Publishing Co., New Delhi, pp. 95-96

Sahu, S.K. and Mitra, G.N. 1992. Micronutrient status of soil of Orissa and their management. In: Proceedings of the workshop on micronutrients. Bhubaneswar, Orissa. pp. 84-92.

Sharma, M.C. and Joshi, C. 2004. Soil, fodder and serum micro mineral status and haematobiochemical profile in cattle of Garhwal region of Uttaranchal state. *Ind. J. Anim. Sci*., **74 (7):** 775-779.

Sharma, M.C., Joshi, C. and Sarkar, T.K. 2003. Status of macro minerals in soil, fodder and serum of animals in Kumoun Hill. *Ind. J. Anim. Sci*., **73 (3):** 308-311.

Sharma, M.C., Joshi, C., Das, G. and Hussain, K. 2007. Mineral nutrition and reproductive performance of the dairy animals: A review. *Ind. J. Anim. Sci*., **77 (7):** 599-608.

Singh, B., Rawal, C.V.S. and Singh, J.P. 2004. Studies on certain serum constituents in anoestrus and repeat breeder buffaloes. *Ind. Vet. Med. Jour.*, **28:** 261-263.

Snedecor, C.W. and Cochran, W.G. 1994. Statistical methods, 6th Ed., Iowa State University Press. Anes, USA.

Sukla, S., Tiwari, D.P., Mondal, B.C. and Kumar, A. 2010. Mineral inter-relationship among soil, plantand animals in Pithoragarh district of Uttarakhand. *Anim. Nutr. Feed Tech*., **10:** 127-132.

Yadav, P.S., Mandai, 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.