EVALUATION OF FEEDING PRACTICES AND CERTAIN MINERALS STATUS OF LACTATING BUFFALOES IN COASTAL ZONE OF WESTERN INDIA

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ABSTRACT

To evaluate the nutritional status of buffaloes (n=31), samples of feeds, fodder and blood serum were analyzed for proximate and certain mineral contents collected from the selected villages of coastal zone (Porbandar district) of western (Gujarat state) India. Average intakes of protein and metabolizable energy were 101 and 111% of requirement, respectively. Calcium (Ca) content ranged from 0.22 to 1.74% in roughages, as compared to 0.02 to 0.19% in concentrates. Average phosphorus (P) content in concentrates (0.42%) was almost three times higher than that of roughages (0.14%). Copper (Cu) level was recorded low in most of the feed resources.

Straws of jowar (*Sorghum bicolor*) (8.11 ppm), wheat (*Triticum aestivum*) (5.71 ppm) and bajra (*Pennisetum glaucum*) (9.82 ppm) were found low in zinc (Zn). Manganese (Mn) content in feeds and fodder ranged from 9.65 to 73.0 ppm. Average blood serum levels of Cu, Zn and Mn in buffaloes were 0.63, 0.79 and 0.05 ppm, respectively. As compared to critical level of Cu (0.65 ppm) and Zn (0.80 ppm) in blood serum, more than 60% of the animals screened showed low Cu and Zn status. Based on the calculated intakes of protein, energy, Ca, P, Cu, Zn and Mn from various feed resources, suggestions for correcting supply of protein and energy, and extent of supplementation required through area specific mineral mixture, for obviating deficiency in the ration of buffaloes were given to the farmers of Porbandar district.

Keywords: feedstuffs, nutritional status, buffalo, porbandar, India

INTRODUCTION

India possesses the world's largest livestock population having 57% of the world's buffalo (*Bubalus bubalis*) population. Currently, India is the largest milk producing country in the world and buffalo is the main milk producing animal, contributing more than 50% of the total milk production in India with an average lactation yield of ~1300 kg. This low yield is mainly due to feeding of poor quality feed resources, particularly crop residues and agro industrial by-products fed to animals in rural households. Moreover, buffalo milk has a much higher fat content at 6 to 7% in comparison to 3.1 to 4.5% in cow milk.

Accurate assessment of nutritional status of dairy buffaloes is invaluable in modern livestock production. For efficient production, reproduction and maintenance of normal health in dairy animals, it is essential to provide protein, energy and minerals according to their requirement. Limited information was available about the extent of

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nutrients availability from different feeds and fodder fed to lactating buffaloes in western zone of India. Therefore, present study was undertaken to evaluate the existing feeding practices to know the status of protein, energy and certain minerals in lactating buffaloes of Porbandar district of Gujarat state and to recommend necessary modifications.

MATERIALS AND METHODS

Sampling procedure

The survey was conducted in Porbandar and Ranavav tehsils of Porbandar district in Western India. Two villages were selected at random from each tehsil, for collection of samples of feeds, fodder and blood serum (Figure 1). In each village, about 15 dairy farmers were selected at random. The selected farmers were interviewed and the desired information was collected in the pro-forma developed for the purpose. While selecting farmers, due care was taken to ensure that selected farmers were evenly distributed in the village and truly represent animal management practices of the village. The recorded parameters from each farmer included number of livestock, land area, irrigated facilities, fodder and other crops being grown etc. In addition, information regarding the amount and types of feeds and fodder offered to their milch animals, rate of actual daily feed intake, milk yield and fat percent, physiological status of animal etc were collected with the fair degree of precision on a questionnaire, using standard sampling procedure.

Analytical methods

Composite samples of green and dry fodder, individual concentrate ingredients and homemade concentrate mixtures were collected from the surveyed area. Samples were dried in oven, ground (1 mm) and stored in airtight bags

Figure 1. Map of Porbandar district.

until analysis. The amount of dry matter (DM), crude protein (CP) and Metabolizable energy (ME) available to buffaloes were calculated from the records of intake of feeds and fodder, using digestibility coefficients/nutritive values given by ICAR (1998). Average body weight of buffaloes in the district was considered at 500 kg and requirements for protein (Kearl, 1982), energy (Mandal *et al*., 2003), calcium (Ca), phosphorus (P), copper (Cu), zinc (Zn) and manganese (Mn) (NRC, 2001) were worked out.

Feed and fodder samples were analyzed for proximate constituents (AOAC, 2007). For mineral analysis, samples were prepared and digested using 5 ml concentrated HNO_3 plus 1 ml concentrated HCl, by microwave digestion method and total volume of mineral extract was made to 25 ml with de-ionized water. Blood from jugular vein was collected from the individual buffalo and centrifuged at 2000 rpm for 10 minutes, to harvest the serum. Serum samples were preserved in deep freeze till further analysis. All the samples were analyzed for Ca, P, Cu, Zn and Mn, by Inductively Coupled Plasma-Optical Emission Spectrometer; Optima 3300 RL, Perkin Elmer, Waltham, MA, USA.

Statistical analysis

Data were statistically analyzed using SAS 9.3 software package (2012), SAS Institute, USA as per Snedecor and Cochran (1994). Overall differences between treatment means were considered significant when $P<0.05$. The data have been presented as mean±S.E.

RESULTS AND DISCUSSION

Current feeding practices

Survey revealed that most of the dairy animal owners/farmers reared their animals on grazing and supplementation of wheat straw (*Triticum aestivum*), maize straw (*Zea mays*), groundnut *gotars* (by-products of leguminous crops) or local grasses (a mixture of leguminous and non-leguminous species in varying proportions) collected from the wasteland, as the basal roughages. Tur gotar (by product of *Cajanus cajan*) was also fed, but availability was seasonal. Some of the farmers had employed the practice of feeding with cultivated fodder like lucerne (*Medicago sativa*) or *jowar* (*Sorghum bicolar*), *bajra* (*Pennisetum typhoides*) and maize (*Zea mays*). Green fodder availability was only for limited period due to water scarcity and frequent drought in the area. Those farmers, who did not have irrigation facilities, were feeding local green grasses and cotton balls with leaves available at the time of cotton crop harvesting. Whole carrot (*Daucus carota*) plants, as subsidiary green fodder was available for feeding to milch buffaloes.

The practice of feeding compounded cattle feed was rare in the area. Concentrates were mostly offered twice a day, at the time of milking. Interestingly, it was observed that none of the farmers supplemented the ration of animals with mineral mixture, except for therapeutic purpose or on recommendation of the veterinary practitioners. However, some of the farmers were supplementing common salt to their animals. These observations are consistence with the reports from Gujarat state (Garg *et al*., 2002; Chavda, 2003; Ghogale, 2003; Bhanderi, 2007). Some rich progressive farmers/ cattle owners were also feeding concentrates to pregnant (for steaming up) and growing animals. Crushed wheat (*Triticum aestivum*), bajra (*Pennisetum typhoides*), cottonseed cake (*Gossypium spp.*) and edible oil (approximately 100 g) were commonly used for steaming up.

Proximate composition

Chemical composition revealed that whole cottonseed and cottonseed cake were good source of protein and energy (Table 1). Amongst green fodders, lucerne (18.4%) had highest CP, followed by whole carrot plant (11.3%), bajra (10.1%) and jowar (8.6%). Straws were low in CP content, except *gotars* of groundnut and *tur*. Silica content was highest in jowar straw (5.8%), followed by maize straw (4.3%). Data are in agreement with the reports of Anonymous (2006) and Bhanderi (2007).

Nutritional status

Average DM intake (DMI) of buffaloes in the district was 15.1 kg/d. The DMI of buffaloes in different tehsils, as well as in different villages within tehsils did not differ significantly (Table 2). Lal *et al.* (1998) reported similar values of DMI (15.7 kg/d) by lactating buffaloes yielding 10 to 14 kg milk/d. Similarly, Singh *et al.* (2001) reported 15.3 kg DMI/d by Murrah buffaloes yielding 7 to 18 kg milk/d in their native breeding tract.

Average protein intake in villages of Porbandar and Ranavav tehsils was 0.88 and 0.90 kg/d, respectively, which did not differ significantly. However, the same differed ($P<0.05$) between villages within tehsils. Protein intake as percent of requirement in the district was 101. Lal *et al.* (1998) reported 1.28 kg protein intake as against requirement of 1.20 kg/d by lactating buffaloes yielding 10 to 14 kg milk/d. Lal *et al.* (1999) reported protein intake of 1.25 kg/d in Murrah buffaloes yielding 16 to 18 kg milk/d. Average protein intake in the district (0.89 kg/d) was lower as recorded by these workers.

The ME intake in Porbandar and Ranavav tehsils was 36.21 and 38.53 Mcal/d, respectively, which did not differ significantly. However, the same differed ($P<0.05$) between villages of Porbandar tehsil. Average energy intake as % of requirement in the district (111) was slightly higher than that of in Porbandar tehsil, whereas, lower than that of in Ranavav tehsil. Lal *et al.* (1998) reported 43.23 Mcal/d ME intake against the requirement of 46.44 Mcal/d by lactating buffaloes yielding 10 to 14 kg milk/day. The average ME intake (37.40 Mcal/d) by buffaloes in the district was in agreement with these authors. To fulfill the nutrient requirements of buffaloes in villages Rajpar and Vadwala, about 250 g protein meal may be included in the ration. The buffaloes in the district were fed adequately in terms of protein, whereas energy intake was slightly higher than the requirements.

Minerals profile of feeds and fodder

The average Ca content ranged from 0.22 to 1.74% in roughages as compared to 0.02 to 0.19% in concentrates (Table 3). Average P level in concentrates (0.42%) was almost three times higher than that of roughages (0.14%). Similar finding were also reported by Ramana *et al.* (2001), Udar *et al.* (2003) and Garg *et al.* (2008). About 100, 28.6 and 50.0% samples of concentrates, green fodder and dry fodder, respectively, were found to be below the critical level of Ca. All samples of green and dry fodders were also found to be deficient in P (Table 4).

Lucerne (26.7 ppm) and carrot leaves (24.2 ppm) were good source of Cu as compared to bajra, maize and jowar green. Tur gotar had highest Cu content (12.5 ppm) amongst the dry fodder, however, most of the concentrate feed ingredients were low in Cu. Zinc content was found to be very low in wheat straw (5.71 ppm). These values are in agreement with values reported by Yadav *et al.* (2002) and Mandal *et al.* (2004). Wheat bran (51.6 ppm) was a good source of Zn. Mn levels in the

Table 1. Chemical composition of feeds and fodder (% on DM basis; mean±S.E.).

Feedstuffs	CP	EE	CF	NFE	Ash	Silica
Grains/seeds						
Bajra (7)	10.3 ± 0.71	3.3 ± 0.25	1.5 ± 0.06	82.3 ± 0.45	1.5 ± 0.05	0.7 ± 0.04
Wheat (6)	8.9 ± 0.48	1.4 ± 0.02	1.4 ± 0.07	86.7 ± 0.51	1.5 ± 0.01	0.5 ± 0.04
Maize (6)	8.8 ± 0.40	2.8 ± 0.27	2.5 ± 1.13	83.9 ± 3.14	2.0 ± 0.74	0.5 ± 0.41
Whole cottonseed (10)	22.3 ± 0.21	18.2 ± 0.68	18.6 ± 0.74	37.1 ± 0.33	3.7 ± 0.17	0.6 ± 0.15
Brans and cakes						
Wheat bran (4)	16.3 ± 0.32	3.3 ± 0.06	5.0 ± 0.08	71.3 ± 0.25	4.1 ± 0.14	0.8 ± 0.04
Cotton seed cake (16)	27.0 ± 1.08	5.7 ± 0.53	21.2 ± 0.27	42.1 ± 0.21	4.0 ± 0.05	0.5 ± 0.06
Green fodder/grasses						
Jowar green (4)	8.6 ± 0.31	1.8 ± 0.05	23.4 ± 0.46	60.6 ± 0.28	5.5 ± 0.26	2.6 ± 0.32
Maize green (5)	6.5 ± 0.60	1.3 ± 0.03	27.5 ± 0.96	58.2 ± 0.36	6.5 ± 0.15	2.3 ± 0.77
Whole carrot plant (4)	11.3 ± 0.35	3.5 ± 0.18	12.3 ± 0.32	60.4 ± 0.27	12.5 ± 0.22	2.7 ± 0.05
Lucerne green (7)	18.4 ± 0.95	2.2 ± 0.05	28.1 ± 1.49	41.7 ± 3.74	9.6 ± 0.54	0.5 ± 0.07
Cotton ball with leaves (3)	5.5 ± 0.71	1.1 ± 0.06	26.0 ± 0.37	61.2 ± 0.40	6.3 ± 0.26	3.8 ± 0.20
Bajra green (4)	10.1 ± 0.84	2.5 ± 0.05	28.3 ± 0.70	45.8 ± 0.28	13.3 ± 0.36	1.4 ± 0.08
Local grass (3)	5.9 ± 0.80	3.1 ± 0.20	35.4 ± 3.45	40.1 ± 0.55	15.4 ± 2.84	6.8 ± 0.11
Dry fodder						
Groundnut *gotar* (7)	9.0 ± 0.80	1.4 ± 0.08	24.8 ± 1.24	56.2 ± 0.43	8.6 ± 0.38	3.2 ± 0.35
Jowar straw (8)	3.9 ± 0.28	1.2 ± 0.14	26.8 ± 0.36	60.9 ± 0.39	7.2 ± 0.57	5.8 ± 0.46
Tur gotar (3)	8.8 ± 0.22	3.0 ± 0.10	27.6 ± 0.28	51.5 ± 0.35	8.7 ± 0.36	0.2 ± 0.03
Maize straw (10)	4.9 ± 0.18	0.6 ± 0.04	31.6 ± 2.36	55.0 ± 0.46	7.9 ± 0.67	4.3 ± 0.36
Wheat straw (8)	3.2 ± 0.28	0.8 ± 0.06	39.4 ± 3.36	46.6 ± 0.44	9.9 ± 1.67	2.3 ± 0.26
Bajra straw (6)	3.1 ± 0.88	0.9 ± 0.14	26.6 ± 3.36	59.5 ± 0.31	9.9 ± 1.67	3.3 ± 0.30

Figures in the parentheses indicate number of samples analyzed.

Table 2. Nutritional status of lactating buffaloes in Porbandar district.

Particular	MY (kg/d)	DMI (kg/d)	Intake		Requirement		Intake as % of requirement	
			Protein (kg/d)	ME (Mcal/d)	Protein (lg/d)	ME (Mcal/d)	Protein	ME
Rajpar	9.7 ± 0.32	15.2 ± 0.84	0.85[a] ± 0.08	34.19[a] ± 0.46	0.87 ± 0.06	7.74 ± 0.64	97.7 ± 5.35	100[a] ± 6.23
Degam	9.4 ± 1.22	14.2 ± 0.66	0.91[b] ± 0.11	38.24[b] ± 0.75	0.90 ± 0.10	7.79 ± 0.82	100 ± 4.73	111[b] ± 3.24
Tehsil average	9.5 ± 0.71	14.7 ± 0.73	0.88 ± 0.10	36.21 ± 0.67	0.89 ± 0.07	7.77 ± 0.79	98.9 ± 4.38	106[a] ± 4.34
Vadwala	8.6 ± 1.65	14.6 ± 0.43	0.83[a] ± 0.12	38.95 ± 0.44	0.85 ± 0.12	7.63 ± 0.62	97.6[a] ± 2.45	116 ± 3.98
Bileshwar	9.6 ± 0.88	16.3 ± 0.49	0.96[b] ± 0.06	38.11 ± 0.75	0.87 ± 0.09	7.50 ± 0.45	110[b] ± 4.25	115 ± 4.34
Tehsil average	9.1 ± 0.94	15.5 ± 0.46	0.90 ± 0.07	38.53 ± 0.36	0.86 ± 0.12	7.57 ± 0.51	104 ± 3.50	116[b] ± 3.42
District average	9.3 ± 0.80	15.1 ± 0.61	0.89 ± 0.08	37.37 ± 0.42	0.87 ± 0.12	7.67 ± 0.64	101 ± 2.10	111 ± 3.95

[a,b] values differ significantly in a column ($P<0.05$)

Table 3. Minerals profile of feeds and fodder (DM basis; mean±S.E.).

Feedstuffs/ critical level	**Ca (%) < 0.30**	**P (%) < 0.25**	**Cu (ppm) < 8.0**	**Zn (ppm) < 30.0**	**Mn (ppm) < 40.0**
Grains/seeds					
Bajra (7)	0.04 ± 0.01	0.29 ± 0.01	5.58 ± 0.09	32.4 ± 0.47	13.2 ± 2.07
Wheat (6)	0.04 ± 0.00	0.29 ± 0.01	4.68 ± 0.18	23.0 ± 0.72	32.5 ± 1.08
Maize (6)	0.02 ± 0.00	0.21 ± 0.01	3.07 ± 0.20	17.6 ± 0.54	9.93 ± 0.32
Whole cottonseed (10)	0.15 ± 0.01	0.40 ± 0.01	7.77 ± 0.29	27.1 ± 0.49	9.65 ± 0.21
Brans and cakes					
Wheat bran (4)	0.11 ± 0.00	0.84 ± 0.01	12.7 ± 0.43	51.6 ± 1.44	48.9 ± 1.69
Cotton seed cake (16)	0.19 ± 0.02	0.48 ± 0.01	8.74 ± 0.43	31.6 ± 1.44	19.0 ± 1.69
Green fodder/grasses					
Jowar green (4)	0.41 ± 0.01	0.15 ± 0.01	8.60 ± 0.25	23.8 ± 0.18	50.9 ± 2.27
Maize green (5)	0.22 ± 0.01	0.12 ± 0.00	12.9 ± 0.24	26.5 ± 0.89	44.7 ± 1.96
Whole carrot plant (4)	1.03 ± 0.05	0.23 ± 0.02	24.2 ± 0.26	20.5 ± 0.57	40.8 ± 0.89
Lucerne green (7)	1.22 ± 0.06	0.22 ± 0.01	26.7 ± 0.61	23.2 ± 1.36	40.2 ± 2.21
Cotton ball with leaves (3)	0.36 ± 0.03	0.17 ± 0.01	8.41 ± 0.57	28.8 ± 0.40	30.7 ± 0.84
Bajra green (4)	0.26 ± 0.02	0.15 ± 0.01	14.3 ± 0.57	32.4 ± 0.40	30.2 ± 0.84
Local grass (3)	1.58 ± 0.11	0.13 ± 0.01	15.1 ± 0.54	24.4 ± 1.48	73.0 ± 2.10
Dry fodder					
Groundnut *gotar* (7)	1.74 ± 0.09	0.15 ± 0.02	9.82 ± 0.45	16.6 ± 1.27	54.1 ± 5.38
Jowar straw (8)	0.52 ± 0.05	0.11 ± 0.02	6.04 ± 0.25	8.11 ± 0.76	15.9 ± 0.65
Tur gotar (3)	1.07 ± 0.14	0.18 ± 0.03	12.5 ± 0.72	16.1 ± 1.44	23.0 ± 2.80
Maize straw (10)	0.28 ± 0.03	0.10 ± 0.02	5.64 ± 0.25	13.4 ± 0.16	24.3 ± 0.65
Wheat straw (8)	0.28 ± 0.04	0.08 ± 0.02	6.81 ± 0.85	5.71 ± 1.28	28.9 ± 7.65
Bajra straw (6)	0.24 ± 0.00	0.09 ± 0.01	6.34 ± 0.12	9.82 ± 0.08	34.3 ± 0.83

Table 4. Feedstuffs having below critical levels of minerals.

Feed stuff/ critical level	**Ca (< 0.30%)**	**P (< 0.25%)**	**Cu (< 8.0 ppm)**	**Zn (< 30.0 ppm)**	**Mn (< 40.0 ppm)**
Concentrate	All (100%)	Maize (16.7%)	All, except cottonseed cake, wheat bran (66.7%)	Wheat, maize, cottonseed (50%)	All, except wheat bran (83.3%)
Green fodder	Maize green, Bajra green (28.6%)	All (100%)	Jowar green, Maize green, Whole carrot plant (42.5%)	All, except bajra green (85.7%)	Cotton ball, bajra green (28.6%)
Dry fodder	Maize straw, Wheat straw, Bajra straw (50%)	All (100%)	All, except groundnut gotar and tur gotar (66.7%)	All (100%)	All, except groundnut gotar (83.3%)

Table 5. Minerals content in blood serum of buffaloes.

Particular	**Ca (mg/dl) < 8.0**	**P (mg/dl) < 4.50**	**Cu (ppm) < 0.65**	**Zn (ppm) < 0.80**	**Mn (ppm) < 0.02**
Buffaloes	8.75±0.23 (6.33-12.19)	5.31±0.23 (4.65-6.89)	0.63±0.8 (0.54-1.43)	0.79±0.03 (0.53-0.97)	0.05±0.00 (0.04-0.12)
% of buffaloes showing deficiency	47.0	56.0	57.6	66.7	0.0

Figure in the parenthesis indicate range.

district ranged from 15.9 to 73.0 ppm in roughages and from 9.65 to 49.0 ppm in concentrate feeds.

Mineral profiles of blood

The average blood serum Ca and P were 8.75 and 5.31 mg/dl, respectively (Table 5). Buffaloes screened in the district showed 47 and 56% lower serum Ca and P, respectively. These findings are similar to those of Ramana *et al.* (2001) and Mandal *et al.* (2004). Average serum Cu and Zn content were 0.63 and 0.79 ppm, respectively. As compared to critical level of Cu (0.65 ppm) and Zn (0.80 ppm) in blood serum (Cuesta *et al*., 1993) more than 50% of the buffaloes screened showed low Cu and Zn values. The Mn content of blood serum was within the normal range. The lower concentration of these minerals in feeds and fodder might have resulted in lower level in blood serum (Bhattacharya *et al*., 2004). However, blood serum mineral levels are not always true indicators of mineral deficiency as minerals may be mobilized from the target tissue, during low dietary intake and complex interrelationships (McDowell *et al*., 1993). Hence, regular supplementation of mineral mixture in the ration of buffaloes is necessary.

CONCLUSION

Study revealed that majority of lactating buffaloes in Porbandar district was deficient in essential minerals like Ca, P, Cu, Zn and Mn. It is necessary to supplement these deficient minerals, through supplementation of area specific mineral mixture along with protein meal in the ration of buffaloes. Deficient trace minerals may be supplemented in the form of chelates, for better minerals bio-availability.

ACKNOWLEDGEMENTS

The authors are grateful to the Department of Animal Nutrition, College of Veterinary Science and Animal Husbandry, Anand Agricultural University and the Management of National Dairy Development Board, for providing necessary facilities and financial support to carry out this research work.

REFERENCES

Anonymous, 2006. *Progress Report Presented in the Meeting of Research Sub-Committee on Animal Production*. Published by Animal Nutrition Research Department, Faculty of Veterinary Science and Animal Husbandry, Anand Agricultural University, Anand Campus, Anand, India.

AOAC. 2007. *Official Methods of Analysis*, 18th ed. Association of Official Analytical Chemists, Washington, D.C., USA.

Bhanderi, B.M. 2007. *Assessment of feeding practices and status of certain minerals in dairy animals of Jamnagar district of Gujarat state*. M.V.Sc. Thesis, Anand Agricultural University, Anand, Gujarat, India.

Bhattacharya, B.N., B.C. Sarmah, A. Baruah, K.K. Baruah, K.C., Goswami, R N and D.J. Kalita. 2004. Mineral profile of lactating cattle of two agro-climatic zones of Assam under field conditions. *Indian J. Anim. Sci*., **74**: 1206-1207.

Chavda, M.R. 2003. *Assessment of feeding practices and status of certain minerals in dairy animals of Patan district of north Gujarat*. M.V.Sc. Thesis, Gujarat

Agricultural University, Sardarkrushinagar, Gujarat, India.

Cuesta, P.A., L.R. McDowell, W.E. Kunkle, F. Bullock, A. Drew, N.S. Wilkinson and F.G. Martin. 1993. Seasonal variation of soil and forage mineral concentrations in North Florida. *Communication in Soil Science and Plant Analysis*, **24(3-4)**: 335-347.

Garg, M.R., B.M. Bhanderi and S.K. Gupta. 2008. Effect of supplementing certain chelated minerals and vitamins to overcome infertility in field animals. *Indian J. Dairy Sci*., **61**(1): 181-184.

Garg, M.R., B.M. Bhanderi and P.L. Sherasia. 2002. Trace minerals status of feeds and fodders in Junagadh district of Gujarat. *Indian J. Dairy Sci*., **55**: 154-158.

Ghogale, P.P. 2003. *Assessment of feeding practices and status of certain minerals in dairy animals of Sabarkantha district of North Gujarat*. M.V.Sc. Thesis, Gujarat Agricultural University, Sardarkrushinagar, Gujarat, India.

ICAR. 1998. *Nutrient Requirements of Livestock and Poultry*. Indian Council of Agricultural Research, New Delhi, India.

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

Lal, D., V.B. Dixit, U. Arora and T.R. Chauhan. 1999. Nutritional status of high yielding buffaloes – A case study. *Indian J. Anim. Prod. Manage*., **15**(1): 39-41.

Lal, D., V.B. Dixit, T.R. Chauhan and V.S. Solanki. 1998. A critical analysis of feeding system of lactating buffaloes in Hisar. *Indian J. Anim. Prod. Manage*., **14**(3): 164-166.

Mandal, A.B., S.S. Paul and N.N. Pathak. 2003. *Nutrient requirements and feeding of buffaloes and cattle*, 1st ed. International Book Distributing Co., Lucknow, U.P., India.

Mandal, A.B., P.S. Yadav and V. 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., J.H. Conrad and F.G. Hembry. 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).

NRC. 2001. *Nutrient Requirements of Dairy Cattle*, 6th ed. National Research Council, National Academy of Science, Washington, DC.

Ramana, J., C.S. Prasad, N.K.S. Gowda and K.S. Ramachandra. 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.

SAS. 2012. *Base SAS 9.3 Procedures Guide: Statistical Procedures,* 2nd ed. SAS Institute Inc. Cary, NC, USA.

Singh, J., K.K. Yadav and A.B. Mandal. 2001. Feeding plane of milch Murrah buffaloes in its native breeding tract. *Buffalo J.*, **17**(1): 1-12.

Snedecor, G.W. and W.G. Cochran. 1994. *Statistical Methods*, 6th ed. Oxford and IBH Publication Company, New Delhi, India.

Udar, S.A., S. Chopde and R.N. Dhore. 2003. Mineral profile of soil, feeds and fodder and buffaloes in Western Agro-climatic Zone of

Vidarbha. *Anim. Nutr. Feed Techn*., **3**: 165-172.

Yadav, P.S. A.B. Mandal and D.V. Dahiya. 2002. Feeding pattern and mineral status of buffaloes in Panipat district of Haryana state. *Anim. Nutr. Feed Techn*., **2**: 127-138.